Performance Evaluation of Mobility Speed over MANET Routing Protocols

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Abstract

Ad-hoc networking is a concept in computer communications. Each node participating in the network acts both as host and a router and must therefore is willing to forward packets for other nodes. Research in this area is mostly simulation based; Random waypoint is the commonly used mobility model in these simulations. Random waypoint is a simple model that may be applicable to some scenarios. In the performance evaluation of a protocol for MANETs, the protocol should be tested under realistic conditions including. In recent years, a variety of routing protocols targeted specifically at this environment have been developed and some performance simulations are made on numbers of routing protocols likes DSDV, DSR and AODV, Research efforts haven't focused much in evaluating their performance when applied to variable number of nodes and constant pause times, We perform extensive simulations using NS-2 simulator, which carried out based on the Rice Monarch Project.

Keywords: Ad-hoc networks, AODV, DSDV, DSR, MANET

1 Introduction

An ad-hoc network has a certain characteristics, which imposes new demands on the routing protocol. The most important characteristics are the dynamic topology, which is a consequence of node mobility. Nodes can change position quite frequently, which means that we need a routing protocol that quickly adapts to topology changes. The node in an ad-hoc network can consist of laptops and personal digital assistants and are often very limited in resources such as CPU capacity, storage capacity, battery power and bandwidth, so the routing protocol should try to minimize control traffic, such as periodic update messages. Instead the routing protocol should be reactive, thus only calculate routes upon receiving a specific request. To be effective, the routing protocols have to

1) Keep the routing table up-to-date and reasonably small,

2) Choose the best route for given destination (e.g., in terms of number of hops, reliability, throughput and cost) and

3) Converge within an exchange of a small amount of messages [8].

Mobility pattern, in many previous studies was assumed to be random waypoint. In the current network simulator (NS-2) distribution, the implementation of this mobility model is as follows: at every instant, a node randomly chooses a destination and moves towards it with a velocity chosen uniformly randomly from $[0, V_{max}]$, where V_{max} is the maximum allowable velocity for every mobile node [2]. Most of the simulations using the random waypoint model are based on this standard implementation. A mobile ad-hoc network [8] is an autonomous system of mobile hosts connected with each other using multi-hop wireless links. There is no static infrastructure such as base stations, each node in the network acts as a router, forwarding data packets for other nodes, which in such a network move arbitrarily thus network topology changes frequently and unpredictably. Nodes are free to move, independent of each other, topology of such networks keep on changing dynamically which makes routing much difficult, therefore routing is one of the most concerns areas in these networks. Normal routing protocol which works well in fixed networks does not show same performance in Mobile Ad-hoc Networks. In these networks routing protocols should be more dynamic so that they quickly respond to topological changes [23]. If two hosts are not within radio range, all message communication between them must pass through one or more intermediate hosts that double as routers. The hosts are free to move around randomly, thus changing the network topology dynamically. Thus routing protocols must be adaptive and able to maintain routes in spite of the changing network connectivity. Such networks are very useful in military and other tactical applications such as emergency rescue or exploration missions, where cellular infrastructure is unavailable or unreliable. Commercial applications are also likely where there is a need for ubiquitous communication services without the presence or use of a fixed infrastructure; Examples include on-the-fly conferencing applications, networking intelligent devices or sensors etc...

The remainder of the paper is organized as follows. Section 2 gives a brief description of the related work. Section 3 discusses some limitations of the random waypoint model. Section 4 Overview on Ad-hoc routing protocols, Section 5 we provide the simulation model with mobility of our system and describe the effect of some metrics, Section 5 presents the evaluation performance metrics, Section 6, gives simulation results and performance comparison of the typical routing protocols and Finally, we conclude the paper in Section 7.

2 Related Work

Extensive research has been done in modeling mobility for MANETs. In this section, we mainly focus on experimental research in this area. This research can be broadly classified as follows based on the methodology used.

2.1 Random Waypoint Based Performance Comparisons

Much of the initial research was based on using random waypoint as the underlying mobility model and Constant Bit Rate (CBR) traffic consisting of randomly chosen source-destination pairs as the traffic pattern. Routing protocols like DSR [12], DSDV [17], AODV [18] and TORA [16] were mainly evaluated based on the following metrics: packet delivery ratio (ratio of the number of packets received to the number of packets sent) and routing overhead (number of routing control packets sent). And found that on-demand protocols such as DSR and AODV performed better than table driven ones such as DSDV at high mobility rates, while DSDV performed quite well at low mobility rates [4]. And some performed a comparison study of the two on-demand routing protocols: DSR and AODV, using the performance metrics of packet delivery ratio and end to end delay [19]. It observed that DSR outperforms AODV in less demanding situations, while AODV outperforms DSR at heavy traffic load and high mobility. However, the routing overhead of DSR was found to be lesser than that of AODV. In the above studies, focus was given on performance evaluation, while parameters investigated in the mobility model were change of maximum velocity and pause time. In our work, however, we design our test suites very carefully to pick scenarios that span a much larger set of mobility characteristics.

2.2 Scenario based Performance Comparisons

Random waypoint is a simple model that is easy to analyze and implement. This has probably been the main reason for the wide spread use of this model for simulations. Realizing that random waypoint is too general a model, recent research has started focusing on alternative mobility models and protocol independent metrics to characterize them. Some conducted a scenario based performance analysis of the MANET protocols [11]. It proposed models for a few "realistic" scenarios such as a conference, event coverage and disaster relief. To differentiate between scenarios used, the study introduced the relative motion of the mobile nodes as mobility metric. But some used a mobility model in which each node computes its next position based on a probability distribution [9]. This model does not allow significant changes in direction between successive instants. It concluded that proactive protocols perform better than reactive ones in terms of packet delivery ratio and end-to-end delay. However, reactive protocols were seen to incur a lower routing overhead [10]. Mobility framework that consisted of a mobility vector model can be used to generate "realistic" movement patterns used in several varied applications. It proposed the Displacement Measure that is a normalization of the actual distance travelled by the geographic displacement as a metric to evaluate the different movement patterns including those generated by random waypoint, random Walk, RPGM and Mobility Vector models. By experiments, it observed that random waypoint and random Walk produced higher Displacement Measure as compared to the Mobility Vector model. It studied the effect of transmission range on throughput across different mobility models and concluded that as the transmission range is increased, the rate of link changes decreased and the throughput for all protocols increased. However, the link change rate does not seem to vary greatly across the different mobility models. As far as routing overhead was concerned, Mobility Vector was seen to produce a worse overhead than random waypoint.

However, in this paper we focus on the impact of mobility models on the performance of MANET routing protocols, so our two observations regarding to discuss the effect of movement mobility speed of the nodes to evaluate the performance of the traditional proactive routing protocol *DSDV* from traditional proactive family comparing with the two prominent On-demand reactive routing protocols *AODV* and *DSR* from the reactive family for mobile ad-hoc networks, using NS-2 simulator considering the problem from a different perspective, using the simulation model with a dynamic network size with varying number of movement speed at an invariable pause time which should be zero under weakest case because a longer pause time of the node may be insignificant for mobile Ad-hoc network with frequently and fastly moving nodes, based on the routing load and the connectivity of three typical routing protocols of ad-hoc networks with the different simulation model and metrics like (varying network load, mobility speed, simulation times, connectivity sources).

3 Limitations of Random Waypoint

Random waypoint model [4] is among the most commonly used mobility models in the MANET research community. In this model, at every instant, each mobile node chooses a random destination and moves towards it with a speed uniformly distributed in $[0, V_{max}$, where Vmax is the maximum allowable speed for a node. After reaching the destination, the node stops for a duration defined by the "pause time" parameter. After this duration, it again chooses a random destination and repeats the whole process again until the simulation ends. The random waypoint model is widely accepted mainly due to its simplicity of implementation and analysis. However, it observes that [1] the basic random waypoint model as used in most of the simulations is insufficient to capture the following mobility characteristics:

1) *Temporal dependency:*
   Due to physical constraints of the mobile entity itself, the velocity of mobile node will change continuously and gently instead of abruptly, i.e. the current velocity is dependent on the previous velocity. However, intuitively, the velocities at two different time slots are independent in the random waypoint model.

2) *Spatial dependency:*
   The movement pattern of a mobile node may be influenced by and correlated with nodes in its neighborhood. In random waypoint, each mobile node moves independently of others.

3) *Geographic restrictions:*
   In many cases, the movement of a mobile node may be restricted along the street or a freeway. A geographic map may define these boundaries.

4 Routing Protocols for Ad-hoc Networks

To compare and analyze mobile ad-hoc network routing protocols, appropriate classification methods are important. Classification methods as Figure 1 help researchers and workers on mobile wireless ad-hoc protocols and designers to understand distinct characteristics of a routing protocol and find its relationship with others. Therefore, we present protocol characteristics and classifications which are used to group and compare different approaches in. These characteristics mainly are related to the information which is exploited for routing, when this information is acquired, and the roles which nodes may take in the routing process. We will ask some question about routing like route discovery: How do we get from source to destination? Route update: How do we find out if a route has changed? Stored route state: What route bookkeeping is involved? Route decision/metric: How do we choose which path to follow?

Mobile Ad-Hoc Networks MANETs:
In order to facilitate communication within the network, a routing protocol is used to discover routes between nodes. The primary goal of such an ad-hoc network routing protocol is correct and efficient route establishment between a pair of nodes so that messages may be delivered in a timely manner. Route construction should be done with a minimum of overhead and bandwidth consumption. An Ad-hoc routing protocol is a convention or standard that controls how nodes come to agree which way to route packets between computing devices in a MANET. In adhoc networks, nodes do not have a priori knowledge of topology of network around them, they have to discover it. The basic idea is that a new node announces its presence and listens to broadcast announcements from its neighbors. The node learns about new near nodes and ways to reach them, and announces that it can also reach those nodes. As time goes on, each node knows about all other nodes and one or more ways how to reach them.

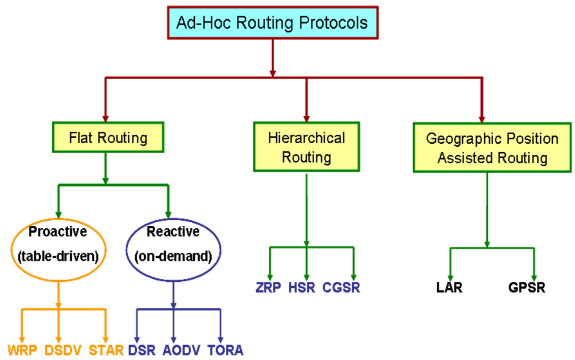

Figure 1: Classification of routing protocols

4.1 DSDV (Destination Sequenced Distance Vector)

The Destination Sequence Distance Vector is the best-known protocol for a proactive routing scheme. The DSDV described is a table-driven proactive protocol, based on the classical Bellman-Ford routing mechanism (DBF) [7]. The basic improvements made include freedom from loops in routing tables, more dynamic and less convergence time. Every node in the MANET maintains a routing table which contains list of all known destination nodes within the network along with number of hops required to reach to particular node. Each entry is marked with a sequence number assigned by the destination node. The sequence numbers are used to identify stale routes thus avoiding formation of loops. In DSDV

[13] each node have a routing table, here each table must contain the destination node address, the minimum number of hops to that destination and the next hop in the direction of that destination. The tables in DSDV also have an entry for sequence numbers for every destination. These sequence numbers form an important part of DSDV as they guarantee that the nodes can distinguish between stale and new routes. Here each node is associated with a sequence number and the value of the sequence number is incremented only by the node the sequence number is associated with. Thus, these increasing sequence numbers here emulate a logical clock. Suppose a node receives two updates from the same source, then the receiving node here makes a decision as to which update to incorporate in its routing table based on the sequence number. A higher sequence number denotes a more recent update sent out by the source node. Therefore it can update its routing table with more actual information and hence avoid route loops or false routes.

Having seen the table entries in DSDV, let us see how DSDV works. DSDV determines the topology information and the route information by exchanging these routing tables, which each node maintains. The nodes here exchange routing updates whenever a node detects a change in topology. When a node receives an update packet, it checks the sequence number in the packet. If the information in the packet is older than the receiving node has in its routing tables, then the packet is discarded. Otherwise, information is updated appropriately in the receiving node's routing table. The update packet is then forwarded to all other neighboring nodes (except the one from which the packet came). In addition, the node also sends any new information that resulted from the merging of the information provided by the update packet. The updates sent out in this case, by nodes resulting from a change, can be of two types that is either a full update or a partial update. In case of full updates, the complete routing table is sent out and in case of a partial updates only the changes since last full update are sent out.

4.2 AODV (Ad-hoc On-Demand Distance Vector Routing)

The Ad-hoc On-Demand Distance Vector (AODV) routing protocol builds on the DSDV algorithm, it is an on demand routing algorithm, but in contrast to DSR it is a not source based routing scheme rather every hop of a route maintains the next hop information by its own [20]. Operation of the protocol here is also divided in two functions, route discovery and route maintenance. At first all the nodes send Hello message on its interface and receive Hello messages from its neighbors. This process repeats periodically to determine neighbor connectivity. When a route is needed to some destination, the protocol starts route discovery. The source sends Route Request Message to its neighbors. If a neighbor has no information on the destination, it will send message to all of its neighbors and so on. Once request reaches a node that has information about the destination (either the destination itself or some node that has a valid route to the destination), that node sends Route Reply Message to the Route Request Message initiator. In the intermediate nodes (the nodes that forward Route Request Message), information about source and destination from Route Request Message is saved. Address of the neighbor that the Route Request Message came from is also saved. In this way, by the time Route Request Message reaches a node that has information to answer Route Request Message; a path has been recorded in the intermediate nodes. This path identifies the route that Route Request Message took and is called reverse path. Since each node forwards Route Request Message to all of its neighbors, more than one copy of the original Route Request Message can arrive at a node. When a Route Request Message is created at the initiator, it is assigned a unique id. When a node receives Route Request Message, it will check this id and the address of the initiator and discard the message if it had already processed that request.

A node that has information about route to the destination sends Route Reply Message to the neighbor from which it received Route Request Message. This neighbor then does the same. This is possible because of the reverse path created by the Route Request Message. While the Route Reply Message travels back using reverse path, that path is being transformed into forward path, by recording the node that Route Reply Message came from (i.e. same procedure as mentioned above just in opposite direction). When Route Reply Message reaches the initiator, the route is ready, and the initiator can start sending data packets. If one of the links on the forward path breaks, the intermediate node just above the link that failed sends new Route Reply Message to all the sources that are using the forward path to inform them of the link failure. It does this by sending the message to all neighbors using the forward path. In turn, they will send to their neighbors until all upstream nodes that use forward path are informed. The source nodes can then initiate new route request procedures if they still need to route packets to the destination.

4.3 DSR (Dynamic Source Routing)

The Dynamic Source Routing (DSR) [20] protocol is an on-demand routing protocol that is based on the concept of source routing. Operation of DSR can be divided in two functions, route discovery and route maintenance. Route discovery operation is used when routes to unknown hosts are required. Route maintenance operation is used to monitor correctness of established routes and to initiate route discovery if a route fails. In DSR, when a node needs to send a packet to a destination it does not know about, the source node will initiate route discovery. The node sends route discovery request to its neighbors. The neighbors can either send a reply to the initiator or forward the route request message to their neighbors after having added their address to the request message (i.e.

source routing). Every node that receives the route request message does the following:

- If the node has already seen this request, then the request is discarded.
- If the node has not seen it, but the route request message already has address of this host, then also it is discarded.
- Otherwise, if this host is the target of the route discovery message, then it appends the address of this host and returns it to the initiator of the route request message. The route request packet contains the route from the initiator to this host, which is the destination.
- If this host is not the destination, then just append the host's address in the packet and forward it to all of hosts' neighbors.

The route reply message can be returned to the initiator in two ways. If the host that sends reply already has the route to the initiator, it can use that route to send the reply. If not, it can use the route in the route request message to send the reply. Route maintenance is performed when there is an error with an active route. When a node that is part of some route detects that it cannot send packets to next hop, it will create a Route Error message and send it to the initiator of data packets. The Route Error message contains the addresses of the node that sent the packet and of the next hop that is unreachable. When the Route Error message reaches the initiator, the initiator removes all routes from its route cache that have address of the node in error. It then initiates route discovery for a new route if needed.

5 Simulation Model and Evaluation Metrics

5.1 The Mobility Model

A mobility model [6] should attempt to mimic the movements of real Mobile Networks. Changes in speed and direction must occur and they must occur in reasonable time slots. For example, we would not want Mobile Networks to travel in straight lines at constant speeds throughout the course of the entire simulation because real Mobile Networks would not travel in such a restricted manner. There is several mobility models supported,

The mobility model uses the random waypoint model in a rectangular field. The field configurations used is: 1000 m x 1000 m area size field with different number of nodes 10, 20, 40, 50 and 100. we run the implementation of this paper (random trip models) [3] in NS-2 of the model random waypoint can be obtained freely from [15] to generate the Scenario mobility files for the simulation time as Table 1 with a velocity uniformly chosen 2 m/s, 20 m/s and 40 m/s, Here, each packet starts its journey from a random location to a random destination with a randomly chosen speed from (uniformly distributed between 0-2 m/s, 0-20 m/s and 0-40 m/s) called a node starts at a random position, and then chooses a new random location and moves there with a velocity uniformly chosen between 0 and vmax which will change. When it arrives, it repeats the process. Like much previous work in evaluating ad-hoc network routing protocols e.g., once the destination is reached, another random destination is targeted. Simulations are run for 100 simulated seconds. Identical mobility and traffic scenarios are used across protocols to gather fair results.

A traffic generator named Cbrgen [21] was developed to simulate constant bit rate sources in NS-2, act as the important parameter of our simulation to compare the performance of each routing protocol, we chose our traffic sources to be constant bit rate (CBR) sources. When defining the parameters of the communication model. The number of source-destination pairs and the packet sending rate in each pair is varied to change the offered load in the network. We can use shell command. Cbrgen to generate 5 pair of, 10 pair of, 20 pair of, 25 pair of and 50 pair of UDP stream stochastically, thus, the network connectivity is 0.5. Each CBR package size is 512 bytes and one second transmits one package which used varying the number of CBR source was approximately equivalent to varying the sending rate. We have chosen this value because smaller payload sizes penalize protocols that append source routes to each data packet.

5.2 Simulation Model & Evaluation Metrics

The simulator for evaluating our routing protocols is implemented with the network simulation version 2 (NS-2) [22], which consists of a set of wireless and mobile networking extensions that have created Broch 1998, which include the classical four routing protocols of MANET and works well in Linux OS.

Effect of Unvarying Pause Time: Pause time can be defined as time for which nodes waits on a destination before moving to other destination. We used a constant pause time as a parameter as it is measure of mobility of nodes. Low pause time means node will wait for less time thus giving rise to high mobility scenario.

Effect of Varying Number of Nodes: Number of nodes may be another varying parameter as it plays important role in performance. Our simulations show various performance parameters versus no. of nodes, we tested the different routing protocols by varying the number of nodes to account for system scalability.

Our simulation models the network with variable (different) size 10, 20, 40, 50, and 100 mobile hosts placed randomly within a 1000 m 1000 m area. Radio propagation range for each node is 250 m and channel capacity

Table 1: Scenario for NS-2 topology

Parameter	Value
Number of simulated Nodes	10-20-40-50-100
Area size of topography x(m)	1000 m
Area size of topography y(m)	1000 m
Wireless range	150 m
Packet size	512 byte
Send rate of traffic	1 packets / s
Traffic type	Cbr
Number of traffic sources	5-10-20-25-50
Speed	2-20-40 m/s
Pause Time (s) at simulation	0 s
Simulation Time	100 s
Simulated Routing Protocols	DSDV-AODV-DSR

is 2 M bit/s. The node mobility speed is varied from 2, 20 and 40 m/s generated by uniform distribution and the pause time is 0 s which means the node is always moving in the entire simulation period. Each simulation executes for 100s, the simulation altogether will produces 25 kinds of stochastic topologies, each group of nodes corresponding 5 kinds and the collected data is the averaged over those 5 runs. Here, we average 5 trials for each group of nodes, because of only one scenery not guaranteed the initial position of every node is distributed among the simulation areas uniformly [14]. We think 5 trials are an appropriate value and more are not necessary for the similarity among them. We will using a simulator like NS-2, it is an open source discrete event simulator used by the research community for research in networking. The NS-2 simulation software was developed at the University of California at Berkeley and the Virtual Inter Network Test bed (VINT) Project Fall 1997.

5.3 Metrics for Performance Evaluation

In this section, we present performance metrics that have been proposed for (or used in) the performance evaluation of an ad-hoc network protocol. The following metrics are applied to comparing the protocol performance. Some of these metrics are suggested by the MANET working group for routing protocol evaluation [14].

- *End-to-end data throughput:* The sum of the data packets generated by every source, counted by k bit/s.
- *Average end to end data delay:* This includes all possible delays caused by buffering during routing discovery latency, queuing at the interface queue, and retransmission delays at the MAC, propagation and transfer times.
- *Packet delivery fraction ratio:* The ratio between the number of data packets originated by the "application layer" CBR sources and the number of data packets received by the CBR sink at the final destination [19, 24].
- *Routing packet overhead:* Routing Packet overhead RPO is the total number of transmissions routing packets transmitted during the simulation. For packets sent over multiple hops, each transmission of the packet (each hop) counts as one transmission [5].
- *Normalized routing load:* The sum of the routing control messages such as RREQ, RREP, RRER, HELLO etc, counted by k bit/s.
- *Packet loss ratio:* The ratio of the data packets originated by the sources failure to deliver to the destination.

There are other "context" factors such as the following: Network size, Link capacity, Nodes mobility, Fraction of the unidirectional links, the topology rate of change, Fraction and frequency of sleeping nodes and so on. The first five metrics are the important statistical measures of data routing performance.

These are the measures of a routing policy's effectiveness how well it does its job as measured from the "external" perspective of other policies that make use of routing.

6 Simulation Results and Performance

This section presents a comparative analysis of the performance metrics generated from all simulations, evincing general and relevant aspects of the evaluated routing protocols in the diversity of network sizes and mobility levels that can occur over DSDV, AODV and DSR routing protocols. Considering the diversity of routing protocols, network sizes, number of nodes and user mobility levels (2, 20 and 40 m/s).

6.1 Comparison between DSDV, AODV and DSR

Performance comparison of the protocols, an attempt was to compare all of the three protocols under the same simulation environment, we conducted simulations using three different node movement speeds, while generate a fixed number of traffic sources depend on constant bit rate for packets, and will try to discuss the behavior of our routing simulation protocols depend on a constant pausing time and variable network size with changing in range of movement node speeds where we choose 2, 20 and 40 m/s speed for the movement nodes, we found it relevant to use another terminology for the mobility of the nodes, which basically shows how fast the nodes are moving. We will consider a wide range of speeds for our mobile nodes from 2 m/s that correspond to walking at a slow pace, to 40 m/s, the speed of a very fast car. The figures from (2 to 13) explain and highlight the relative performance of the three routing protocols DSDV, AODV and DSR depend on some metrics to our simulations.

6.1.1 Packet Routing Overhead

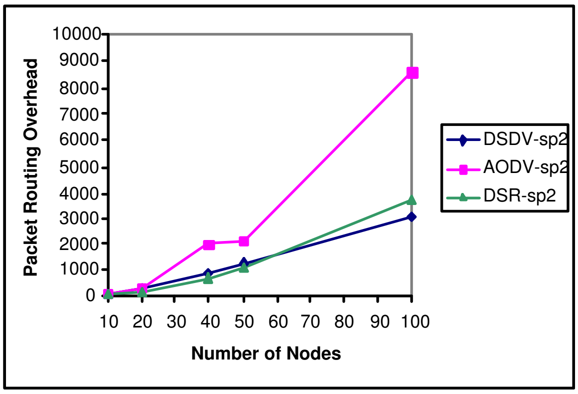

Figure 2: Routing overhead for speed 2

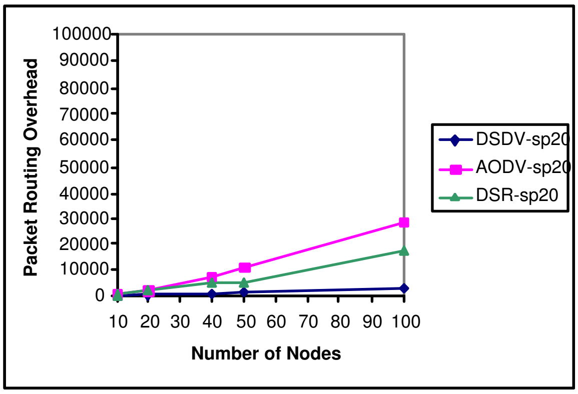

Figure 3: Routing overhead for speed 20

The routing overhead of the transmitted packet from sender to destination as shown in Figures 2, 3, 4, which generated by the routing protocols to achieve this level of data packet delivery, expect to increase because there are more destinations to which the network must maintain working routes. When number of nodes increases the routing packet overhead for the three protocols, in both low and high speed for movement nodes seems to be increased, at speed 10 m/s and 20 m/s the overhead packet be highest overhead for AODV, but when the movement nodes increased to 40 m/s DSR overhead will increased over both AODV and DSDV, although DSDV overhead be minimum in all cases from the two protocols.

But we notice that the routing overhead tends to saturate where the node speed increase. The three routing protocols impose vastly different amounts of overhead, as shown in Figures 2, 3, 4, where the routing protocols, and their overhead drops as the mobility speed rate drops.

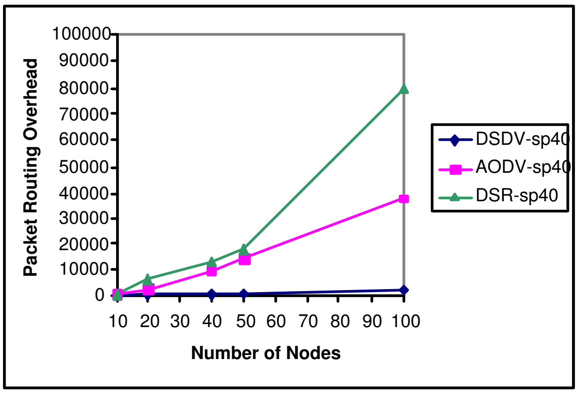

Figure 4: Routing overhead for speed 40

The results of the simulation show that AODV and DSR impose a huge routing overhead compared with DSDV, as shown in Figures 2, 3, 4. This is not surprising due to the extensive and regular updates of the routing tables at the nodes. Note that within the same node group, the percent quickly saturates to a certain limit. Moreover, as the number of nodes increases, the routing overhead clearly increases since more table updates are being sent.

6.1.2 Packet Delivery Ratio

This metric which we call the ratio of delivered packets is an important as it describes the loss rate that will be seen by the transport protocols, which in turn affects the maximum throughput that the network can support. Figures 5, 6, 7 shows the fraction of the originated application data packets each protocol was able to deliver, as a function of node mobility rate (pause time which be constant) and network load (number of sources). For AODV, DSR and DSDV packet delivery ratio is independent of offered traffic load.

At lower speed 10 of node movement, the routing protocols AODV and DSR performed particularly well, they delivering the large amount of data packets regardless of mobility rate from DSDV, which delivered half ratio of the original data packets as figure 4 shows. But in all cases of nodes speed, all protocols AODV, DSR and DSDV always perform better at low speed of nodes; we well see that AODV and DSR delivered 100% of the originated packet although DSDV delivered from 50% to 70% of the originated packets as Figure 5.

When movement speed of nodes greater than 2 m/s the routing protocols AODV and DSR can delivered data packet between 80% to 90% and 20% to 30% for DSDV routing protocol, unlike when the speed greater than 20 m/s the ratio of delivered packet will go to decreasing in all routing protocols. Finally, all of the three protocols deliver a greater percentage of the originated data packets when there is change in node mobility and networks size, converging to 100% delivery when there is no node motion. Perform particularly well, delivering over 95% of

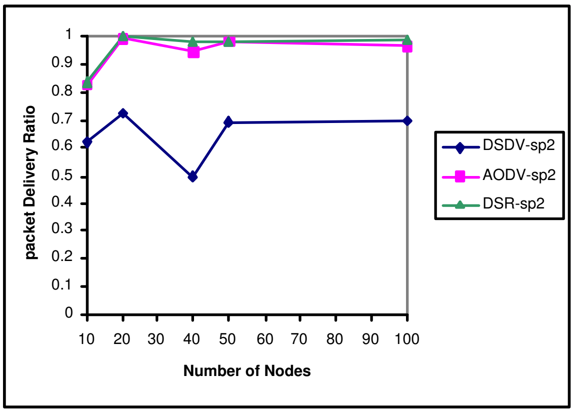

Figure 5: Packet delivery ratio for speed 2

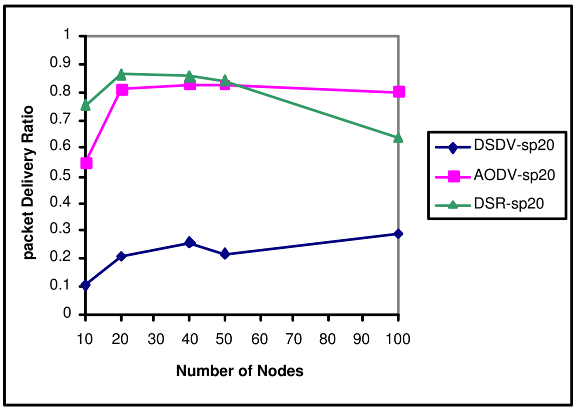

Figure 6: Packet delivery ratio for speed 20

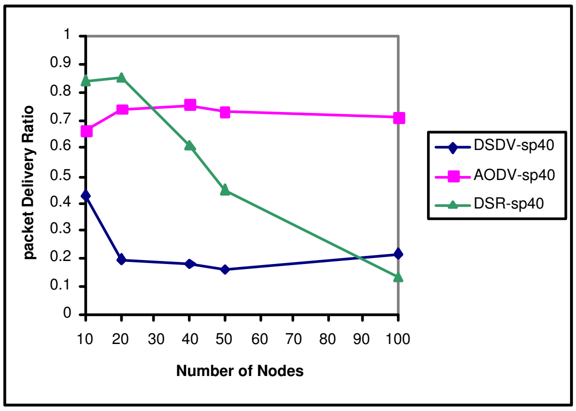

Figure 7: Packet delivery ratio for speed 40

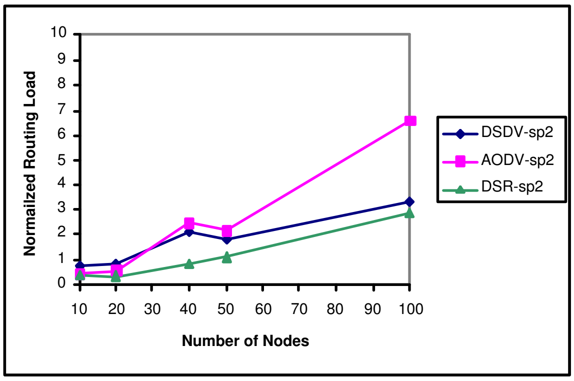

Figure 8: Normalized routing load for speed 2

the data packets regardless of mobility rate.

6.1.3 Normalized Routing Load

Normalized Routing Load defined as the sum of the routing control messages such as RREQ, RREP, RRER, HELLO etc, counted by k bit/s. When run our simulation due to simulated time 100 s, we find that this metric exchange in the same way when speed of the movement nodes increase as Figures 8, 9, 10 show that.

When number of nodes increases all of the protocols AODV, DSR and DSDV the normalized routing load increase, but when the speed of node movement increase, the normalized routing load for DSR begin with low load and it will reach to highest load when the speed increase as Figure 10, protocol shows the best routing load unlike AODV and DSDV which don't effect with network size and be saturated in all cases of node low movements.

6.1.4 Average End-End Delay

In Figures 11, 12, 13, it can be seen that increasing in node speeds results in significant change in the average end-to-end packet delivery delay of DSR protocol. This is because when a node receives a route request for which it has the answer in its routing table, it immediately replies with the route rather than forwarding it to the destination. The source can now start to communicate with the destination.

At low movement speed all of the three protocols begin with low delay and then increased the high delay value as Figure 11, when the movement speed of nodes increased the average delay for DSR will have a longest delay than both DSDV which have a longest delay of AODV routing protocols.

6.2 Performance Summery

Our goal was to compare the three routing protocols to each other, not to find the optimal performance possible in our scenarios, we observe that the mobility pattern does influence the performance of MANET routing protocols.

This conclusion is consistent with the observation of previous studies. But unlike previous studies that compared different ad hoc routing protocols, there is no clear winner among the protocols in our case, since different mobility patterns seem to give different performance rankings of the protocols. In the absence of congestion or other

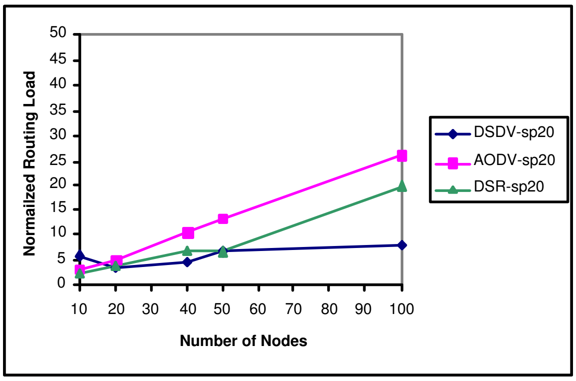

Figure 9: Normalized routing load for speed 20

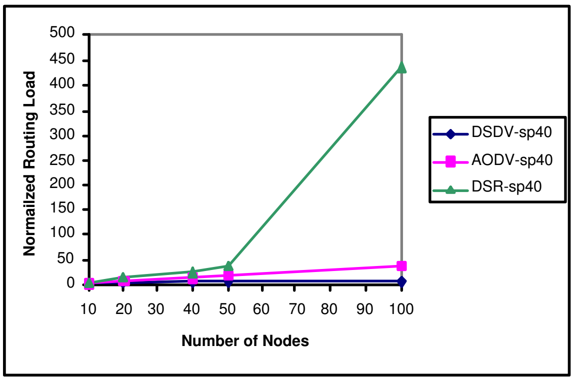

Figure 10: Normalized routing load for speed 40

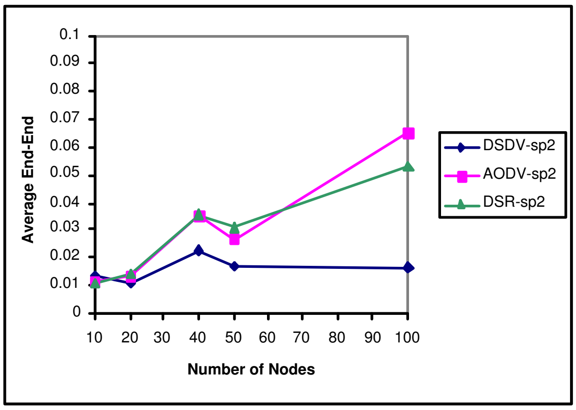

Figure 11: Average end-end for speed 2

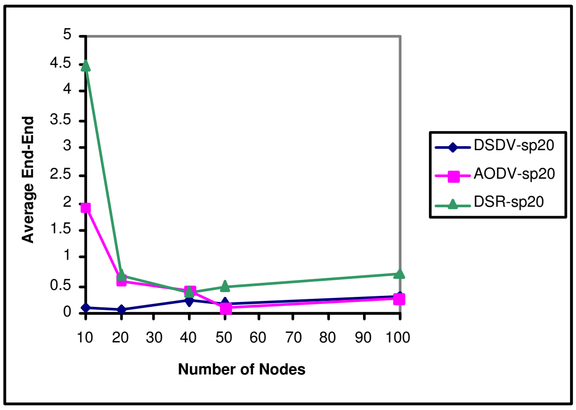

Figure 12: Average end-end for speed 20

"noise", movement speed optimality measures the ability of the routing protocol to efficiently use network resources by selecting the speed from a source to a destination which depend on our experiment to some metrics that can measure the performance for any routing protocols for mobile Ad-hoc networks like the following, *Packet delivery ratio* is important as it describes the loss rate that will be seen by the transport protocols, which in turn effects the maximum throughput that the network can support. This metric characterizes both the completeness and correctness of the routing protocol, *Routing overhead* is an important metric for comparing these protocols, as it measures the scalability of a protocol, the degree to which it will function in congested or low-bandwidth environments, and its efficiency in terms of consuming node battery power. Protocols that send large numbers of routing packets can also increase the probability of packet collisions and may delay data packets in network interface transmission queues, *Normalized Routing Load* which calculated by as sum of the routing control messages such as RREQ, RREP, RRER, HELLO etc, counted by k bit/s, *Average end to end data delay* a metric which includes all possible delays caused by buffering during routing discovery latency, queuing at the interface queue, and retransmission delays at the MAC, propagation and transfer times.

After our simulation which depend on scenario files using NS-2 simulator we bring out some important characteristic differences between the routing protocols, the presence of different mobility speed and variable network size react on network behavior depend on our routing protocols.

7 Conclusion

The area of ad-hoc networking has been receiving increasing attention among researchers in recent years, as the available wireless networking and mobile computing hardware bases are now capable of supporting the promise of this technology. Over the past few years, a variety of new routing protocols targeted specifically at the ad-hoc networking environment have been proposed, but little performance information on each protocol and node tailed performance comparison between the protocols has previously been available.

This paper has presented a comparing performance of protocols for routing packets between wireless mobile

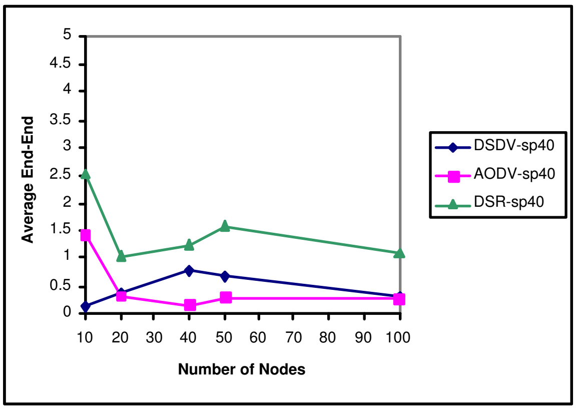

Figure 13: Average end-end for speed 40

hosts in an ad-hoc network AODV, DSR and DSDV using a network simulator like NS-2 with scenario consist of dynamic network size and different number of movement speed at invariable pause time which used an AODV and DSR from On-Demand protocols compared with DSDV from proactive table-driven routing protocols.

The general observation from our simulation:

- AODV Based on standard Distance Vector Algorithm, so that nodes maintain route cache and uses destination sequence number for each route entry, Route Discovery Mechanism is initiated when a route to new destination is needed by broadcasting a Route Request Packet (RREQ). And Route Error Packets (RERR) are used to erase broken links.

- DSR has two main mechanisms: Route Discovery is similar to the one in AODV but with source routing instead and Route Maintenance is accomplished through route caches each entries in route caches are updated as nodes learn new routes, multiple routes can be stored.

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