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Routing Performance Analysis of Infrastructure-less Wireless Networks with Intermediate Bottleneck Nodes

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Abstract: Mobile random The evolution of network technology is working toward the goal of ubiquitous, anytime, everywhere internet connectivity. Since there is no underlying network infrastructure, nodes are free to move about and set up shop in any way they see fit. The nodes in a network are independent units that operate together and exchange information.An efficient dynamic routing protocol is essential for MANET's communication efficiency. In this post, we looked into the effectiveness of numerous reactive routing methods for MANETs.The purpose is to lay the groundwork for future study of MANETs by learning as much as possible about reactive routing protocols made specifically for them. Several performance metrics are used in the article's assessment of performance and their results are analyzed. Our research presents a comprehensive evaluation of reactive routing algorithms across many data rates, hop counts, and topologies, both dynamic and static.

Keywords: *include MANETs, routing, simulation, and performance*.

1. Introduction

Information technology and networked devices have become an indispensable element of our daily lives. Previously, wired networks were used to communicate between computer equipment. Wireless networks are also meant to offer communication. The present generation, on the other hand, emphasizes interaction with self-reliant, free-moving computing devices. Mobile ad hoc networks (MANETs) may be able to fill the void [1,7].

The primary motivation for the growth of MANETs is the provision of constant, location-independent internet connectivity. In this network, nodes are untethered and can go anywhere they like. assemble themselves arbitrarily. MANETs are self-configuring, self-maintained networks that communicate with one another. MANETs technology embeds network intelligence inside each node, putting it in charge of its own networking setup and letting it make its own choices. MANET is used in places with a lack of readily available infrastructure because of its advantageous characteristics [6].

It is common practice to prioritize MANET security and QoS and which delay-sensitive data delivery, scalability, and resource management during the development and design phases. However, MANET applications are the backbone on which the difficulty of developing routing protocols rests. However, with MANET a routing protocol is not intended to find the optimal path between communication nodes. should additionally incorporate QoS, resource management, and security.

The paper offers a thorough performance assessment of protocols for reactive routing created for MANETs in terms of network performance indicators like packet delivery and delay characteristics. Reactive routing techniques discover routes on demand, with the primary goal of minimizing routing overhead. Simulation knowledge ('SK') is used in the routing analysis that is performed with the help of a network simulator (NS2) [4, 5].

Despite the fact that there have been numerous reviews on In addition to the standard metrics [3, 4] used to assess the efficacy of MANETs' reactive routing protocols, Across a wide range of hop counts, we present a unique performance metric: the varying radio communication area of nodes., taking mobility into account, as an example—that provides an accurate estimate of these protocols' effectiveness in a multi-hop setting.

2. Adaptive Routing Methods In Mobile Ad Hoc Networks

Finding a productive interaction channel in MANETs is a current research subject. Various routing protocols have been created in the literature to offer efficient communication services such as low overhead, prolonged packet delivery, and low platinocyanate applications need dependable connectivity. Reliability is essential, especially in military applications. Different routing techniques have been developed to solve the issue of reliable communication in MANETs [5].

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Because of their features, MANETs provide issues in routing, QoS, and dependability as in contrast to traditional infrastructure-based networks (both wired and wireless). As a result, Even now, a routing protocol is essential. to address the MANET problems. Routing protocols developed should provide QoS and security, in addition to being fully adaptable and scalable to the unpredictable behavior of MANETs. The paper examines the popular reactive routing protocol when it comes to creating and keeping a route, sending and receiving packets, and delay. Specifically, it examines Reactive Energy Aware routing selection based on the Knapsack algorithm [1]. RER-SK was developed to improve upon the AODV routing protocol.

RER-SK is a MANET-specific reactive distance vector routing protocol. The Reactive Energy Routing in Sensor Networks (RER-SK) protocol was designed for use in MANETs. The protocol creates the route "on demand" and stores it in memory until it is required during the current conversation. Sending a route request message, RREQ, with fields for (When a source has data and wishes to send it to a destination, the source initiates the route establishment process by sending the necessary information (e.g., source and destination addresses, broadcast ID, source and destination sequence numbers, and routing metric). RREQ messages can only be identified as such thanks to their specific mix of source address and broadcast id. Source will increase the broadcast id by one with each incoming RREQ message. The Sequence number of an RREQ message indicates its one-of-a-kind nature.

The packet processing capacity of a node in terms of energy and traffic is used as a RER-SK routing protocol's route-finding metric. After receiving an RREQ, a relay node will add one to the hop count field before sending the message on. Even if intermediate nodes pick up on routing path information Specifically, the RER-SK RREQ message is used to figure out how to get from one communication entity to another. In response to receiving an RREQ message, the destination will send an RREP message in a unicast fashion to the sender. Fields in an RREP message include (to and from locations, timing, distance, and number of relays).

In order to detect connection failure due to mobility, the RER-SK routing protocol allows for periodic broadcasts of the HELLO message. of intermediary nodes and the identification of the destination node through the RERR message.

3. Simulation Setup

The RER-SK performance is examined using the Network Simulator (NS2). Initially, simulation study determines the protocol's capacity to adapt to different traffic scenarios such as topology variation and modifications in relation to IEEE 802.11 specifications. Several performance measures, including node variation, stop time, and traffic, will be compared later in the simulation research. When a source node generates a packet, the RER-SK routing protocol determines whether or not it can reach its intended mobile destination.

In order to evaluate and compare RER-SK performance across different hop counts, stop times, node speeds, and radio coverage areas, a trace file is accepted in every simulation run. Information about packets and nodes, as they occurred throughout the experiment, is detailed below. Using a simulated network of 1,500 square meters, we put the RER-SK protocol through its paces. The idea of random waypoints allows nodes to freely roam a network. Table 1 details the default simulation parameters utilized in the simulation trials. Once the RER-SK protocol has been implemented in NS2, its performance must be assessed. So, several different multihop route tests were executed. We developed two simulation environments to analyze packet delivery, delay, and overhead while using the RER-SK protocol in a network.

1. Varying radio communication area
2. Varying hop count

Table -1: Simulation parameters

Parameters	Value
Channel type	CHANNEL/WIRELESS CHANNEL
Simulator	NS-2(VERSION 2.3.4)
Simulation area	1000M*1000M
Mac protocol	802.11
No of nodes	VARIES

Max packet in ifq	60
Radio propagation model	TWO RAY ROUND WAVE
Simulation time	5.83 MIN
Rating protocols	DSDV, AODV
Source type	UDP, TCP
Queen type	DROP TAIL
Antenna	LL

4. Performance Results

The performance findings are detailed in detail below.

4.1Time for Route Discovery

Several scenarios were run to determine how long it took for RER-SK to find its course. In each case, the ping utility selects a path with a hop count between one and ten. The time it takes for a source to send an RREQ and get a reply from the destination in the form of an RREP is called the "route discovery time." To rephrase, how long does the origin have to hold out before transferring the data.The experiment findings show that as the hop count grows, so does the route discovery time. Tables 2, 3, and 4 demonstrate this.

Hop count Vs Route Discovery time

Tables 2, 3, and 4 show route finding times increase along with the nodes' communication radio areas. Time to find a new route: 3.14 seconds for 100m and 4.696 seconds for 200m. Tables 2, 3, and 4 illustrate the results of three separate radio area simulations for varying hop counts. As the radio area of nodes rises, so does the route finding time.

Different Traffic Conditions Vs Route discovery time

MANETs operate as peer-to-peer networks. It implies that each A network node can perform the functions of both a host and a router. Knowing the effects on the intermediate node when it acts as a router for more than two sources is therefore crucial. at the same time. We started with one intermediate node that was involved in another transmission. We estimated the influence on route discovery time at the time. Table 3 displays these findings. According to the SK table, the effect of intermediate When it comes to node communication, route discovery time is crucial. And it's becoming much taller as the hop count increases. As the radio communication region of nodes expands, the route-finding time increases somewhat. Table 3 demonstrates this.

We also estimated the impact of two intermediate nodes acting in another conversation as intermediaries or as participants, same time. Table 3 shows the findings of calculating the influence on route discovery time. It is clear from the SK table that intermediary node communication has an effect on the path. finding time is significant. And it is becoming higher as the hop count increases. However, there is a little variation when the radio communication region of nodes expands.

Table -2: Time required for a typical route to be discovered, based on hop count and coverage region.

Hop count	**Average route discovery time (ms) radio area of 200m**	**Average route discovery time (ms) radio area of 100m**	**Average route discovery time (ms) radio area of 250m**
1	4.696	3.148	4.686
2	8.566	5.502	7.724
3	21.489	8.059	20.626
4	29.420	20.685	28.519
5	40.767	22.762	40.174
6	52.1	27.182	50.700
7	60.944	32.355	60.322
8	74.037	35.551	71.946

Table -3: Involving two intermediate nodes in another connection, we calculated the average time required for route finding over a range of hop counts and radio coverage areas.

Hop count.2	Average route discovery time (ms) radio area of 200m	Average route discovery time (ms) radio area of 100m	Average route discovery time (ms) radio area of 250m
2	25.372	16.037	25.075
3	91.411	27.504	90.282
4	132.03	42.082	157.451
5	1925.474	102.681	1925.256
6	1904.832	68.378	1904.574
7	1937.721	1861.401	1935.721
8	1935.655	1900.171	1931.829
9	1920.705	170.806	1920.233

Table -4 The typical time it takes to find a path between two points, given a certain hop count and radio coverage region, when a single intermediary node is involved in both communications.

Hop count.1	Average route discovery time (ms) radio area of 200m	Average route discovery time (ms) radio area of 100m	Average route discovery time (ms) radio area of 250m
2	25.372	16.037	25.075
3	41.785	29.338	41.307
4	54.366	37.411	54.684
5	65.315	1828.166	65.206
6	87.138	180.098	86.952
7	97.765	1841.162	87.34
8	1895.3	1856.153	1894.76
9	1905.615	189.806	1905.913

4.2. Throughput

The projected throughput is then tested fifty times using statistical computing. We determined throughput for various combinations of hop count, radio distance, and traffic conditions, ranging from 1 to 10. To determine throughput, we divide the amount of bytes received at the destination by the sum of the times from the beginning of the transmission to its end.

Comparison of Hop Count across Various Radio Zones and Throughput

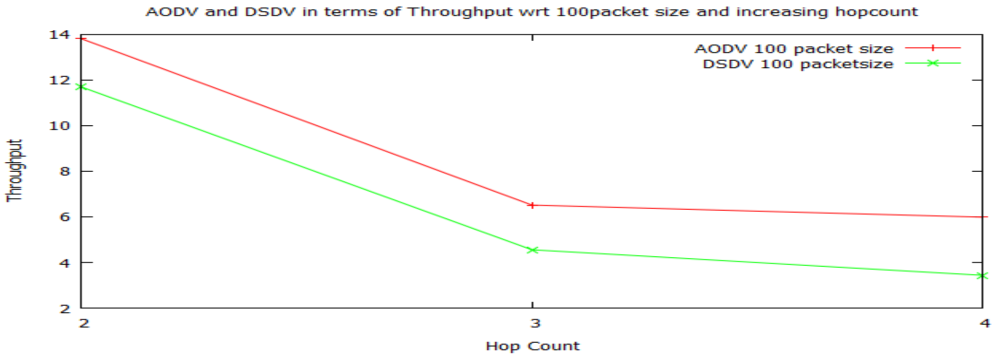
The simulation setting was built such that there may be anything from one to 10 hops from the beginning point to the final destination. As seen in Figures 1, 2, and 3, throughput drops as the number of hops in a network grows. Route discovery was longer and throughput was marginally lower when we simulated the RER-SK protocol by increasing the number of hops while holding the radio area of each node constant. Figure 1 demonstrates that, within a radio range of 100 meters between each node, the RER-SK protocol performs admirably for up to five hop counts before beginning to degrade. This is because the bandwidth delay product grows proportionally with the number of hops. Figure 2 demonstrates that the RER-SK protocol demonstrated respectable performance up to three hop counts, and thereafter gradually degraded. Figure 3 demonstrates that RER-SK performs admirably for the first two hop counts, degrades marginally for each additional hop count, and notably worsens by the ninth hop count. It is evident from SK that the hop count and the node radio communication area have a significant impact on RER-SK performance.

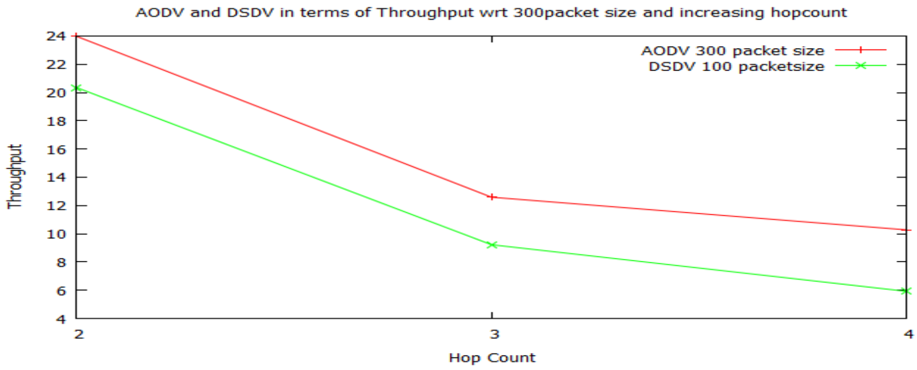
Throughput vs traffic density in various radio zones

The simulation setup allows for a range of hop counts, from one to ten, between the origin and the final destination. We also made the assumption that a single intermediate node is busy with several communication. Data from simulations shows that throughput rapidly decreases with increasing hop count in this kind of traffic situation.The RER-SK protocol performs admirably up to three hop counts, degrades slightly between five and ten hop counts, and drastically declines when the hop count is increased above ten within 100 meters of the node's radio communication range, as shown in Figure 4. Figure 5 shows that the RER-SK protocol's performance is acceptable only up to a count of one hop, then drops somewhat at two hops, then drops dramatically after that. Figure 6 demonstrates a little decrease in performance when compared to Figure 8. Results from computer simulations show that RER-SK's effectiveness is sensitive to the volume of traffic at intermediate nodes.

The simulation setup includes a hop count that may range from one to ten, with two intermediate nodes carrying out a variety of communications. The simulation findings show that the throughput drastically drops when the number of hops increases. As can be seen in Figures 7, 8, and 9, the RER-SK protocol operates admirably up to two hop counts but quickly deteriorate as more hops are added. From SK, we may deduce that the traffic conditions at intermediate nodes have a significant impact on RER-SK's performance.

Throughput Vs Hopcount with different packet size





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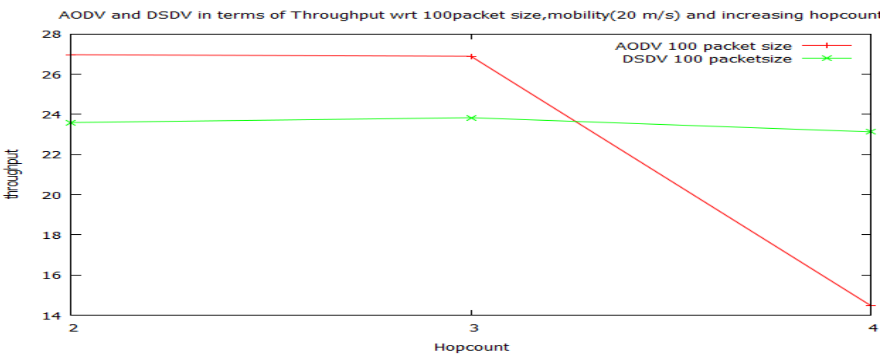
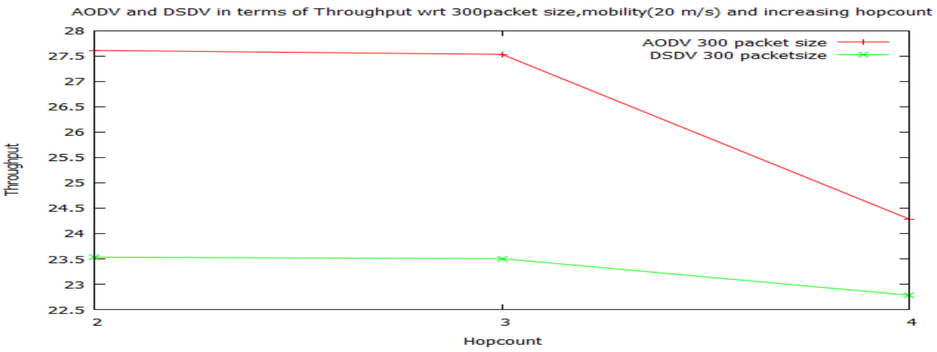
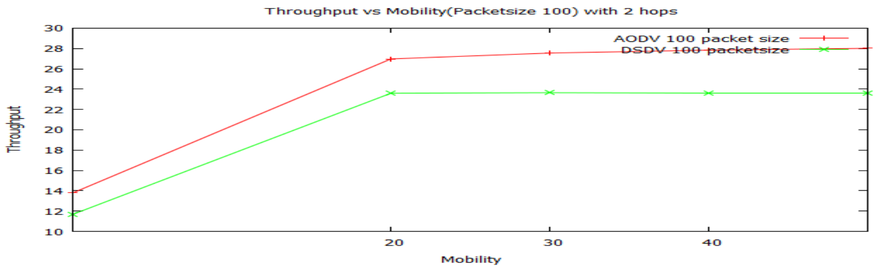
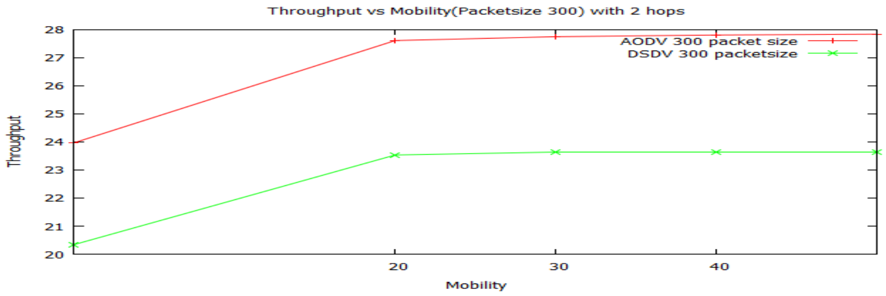
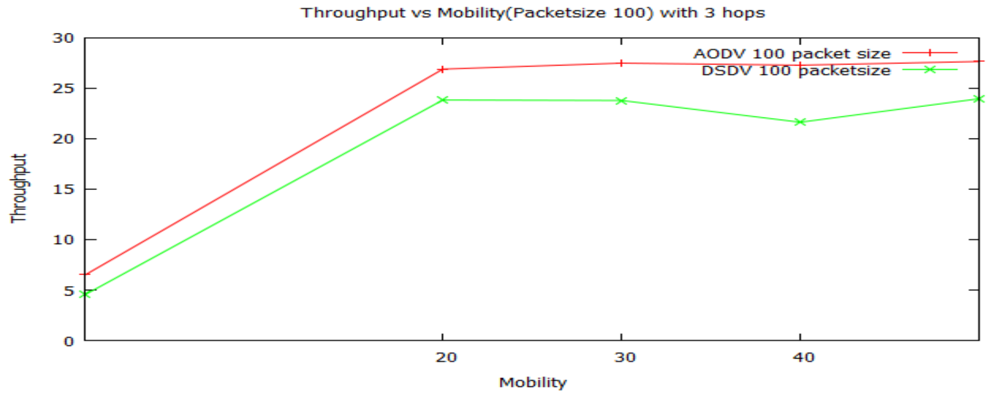


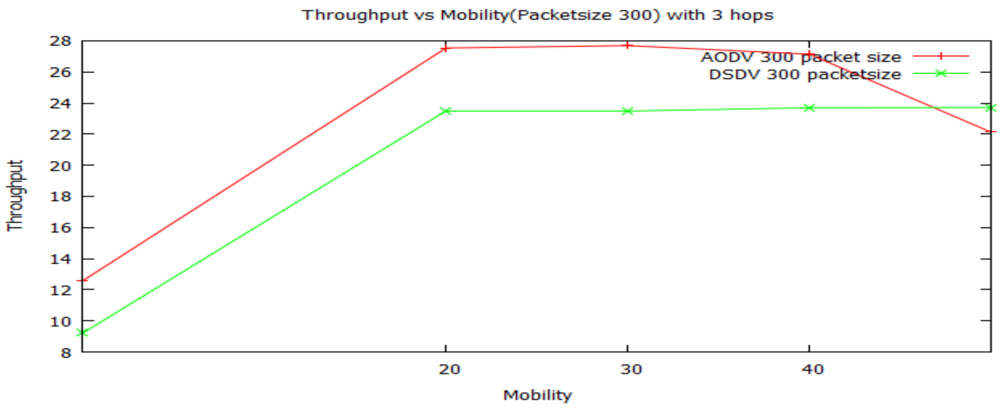


Throughput Vs Mobility

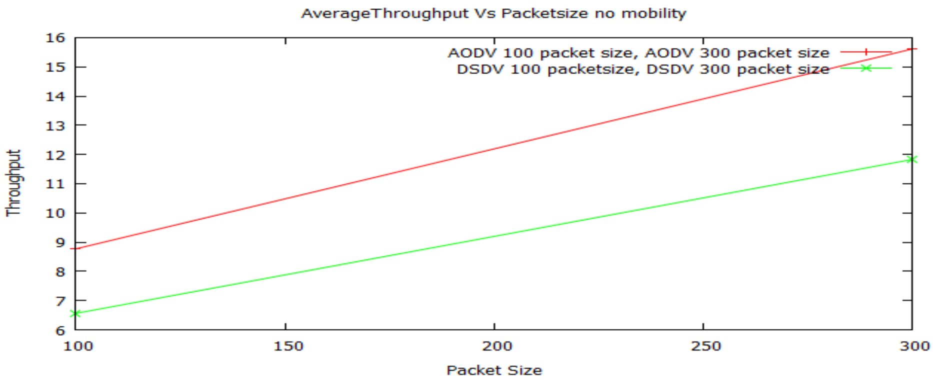


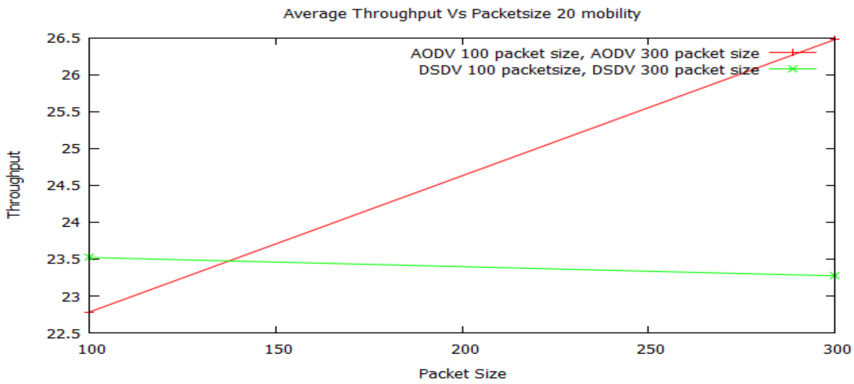




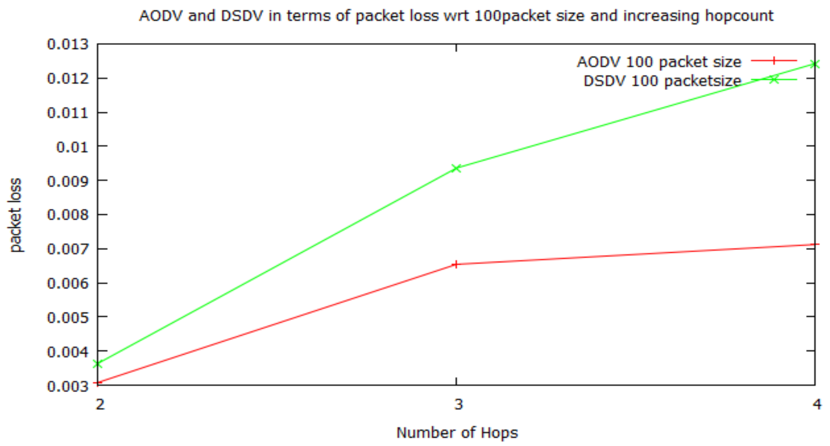


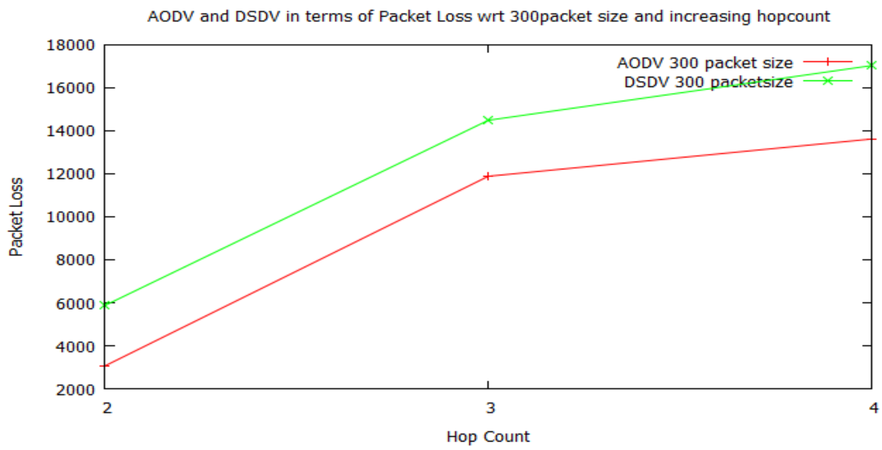
Average Throughput Vs Packetsize



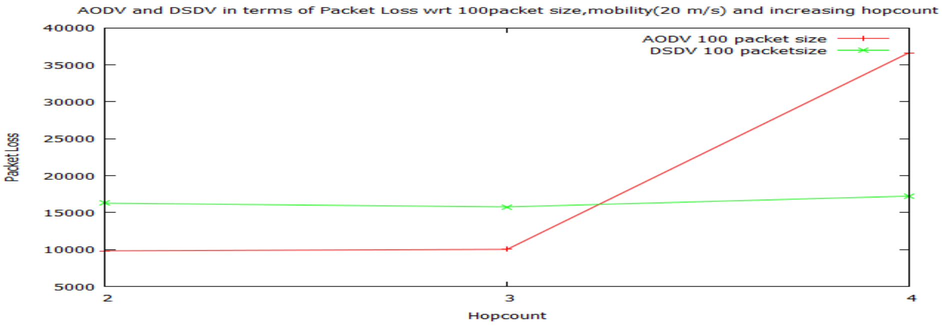


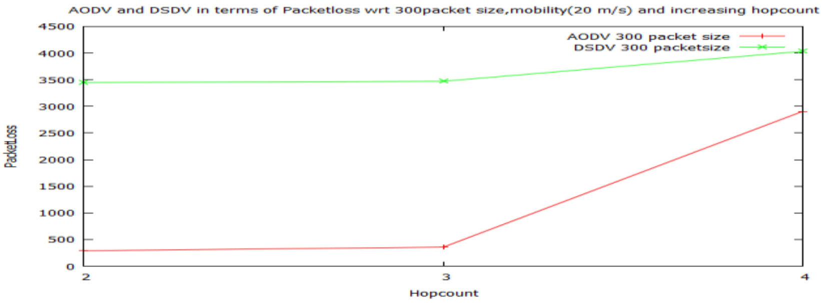
Packet Loss Vs Hopcount



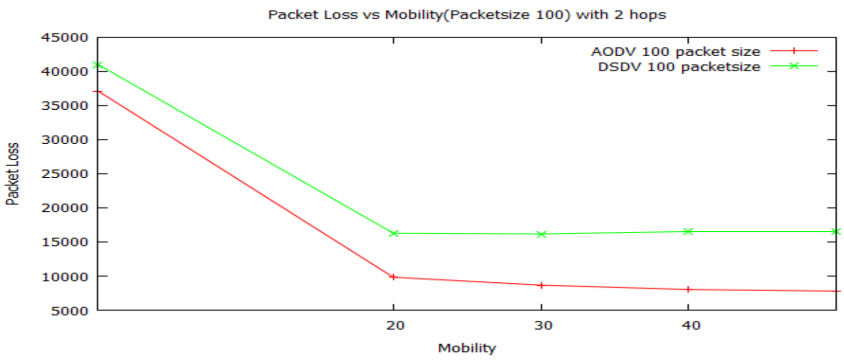


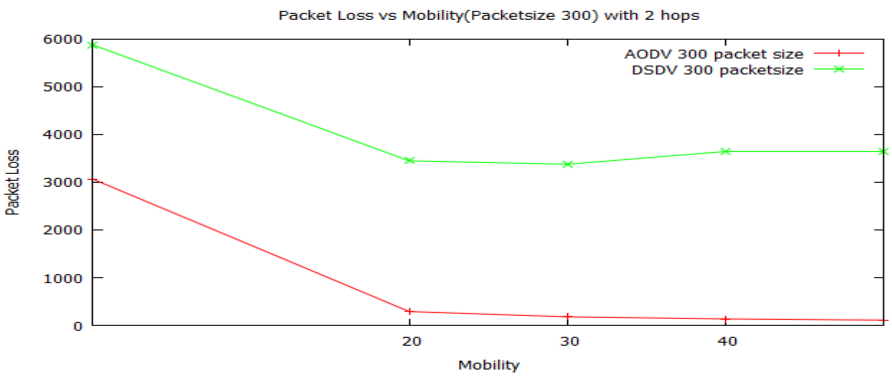
Packet Loss Vs Hop count with 20 Mobility

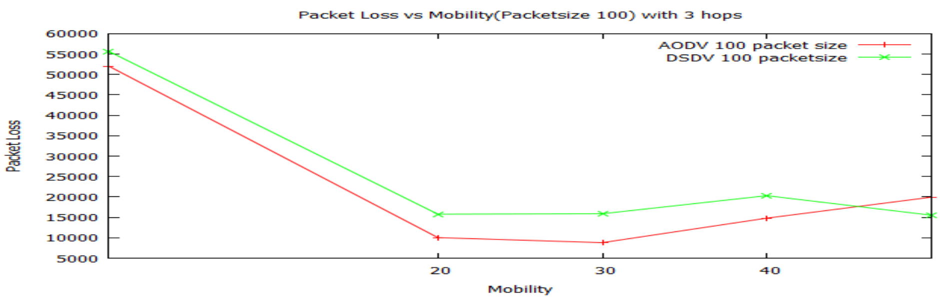


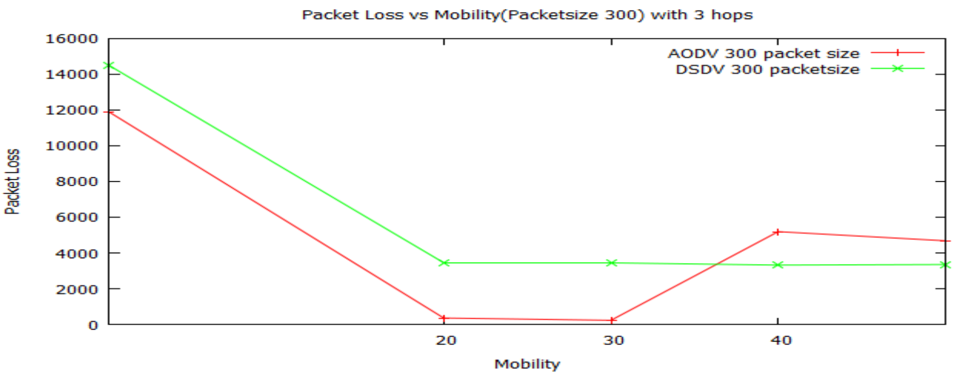


Packet Loss Vs Mobility

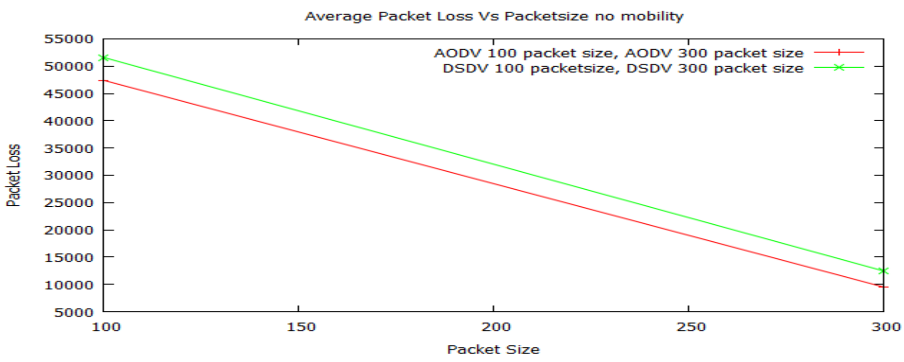


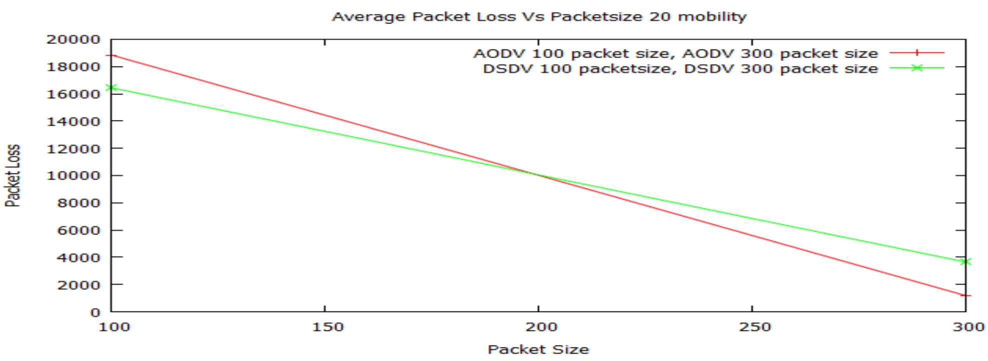




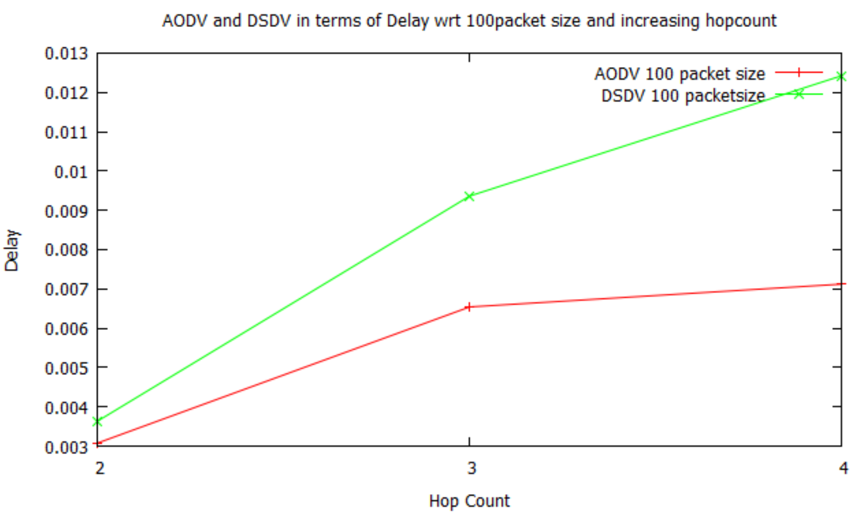


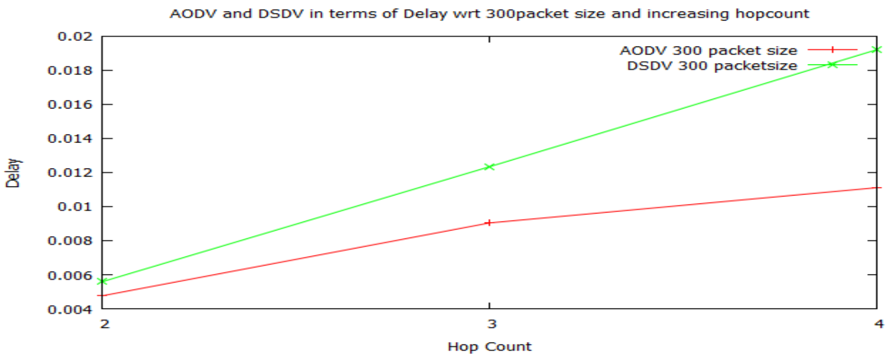
Average Packet Loss Vs Packet size



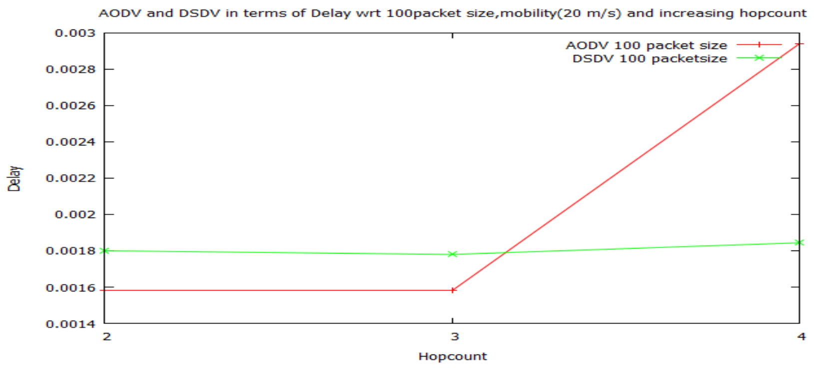


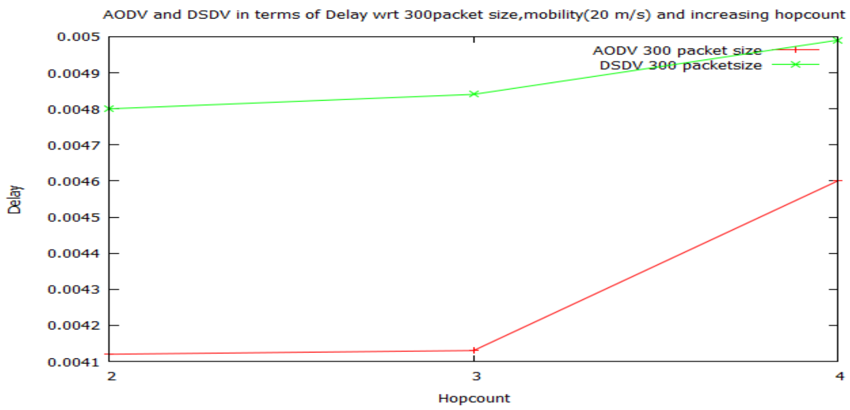
Delay Vs Hop Count



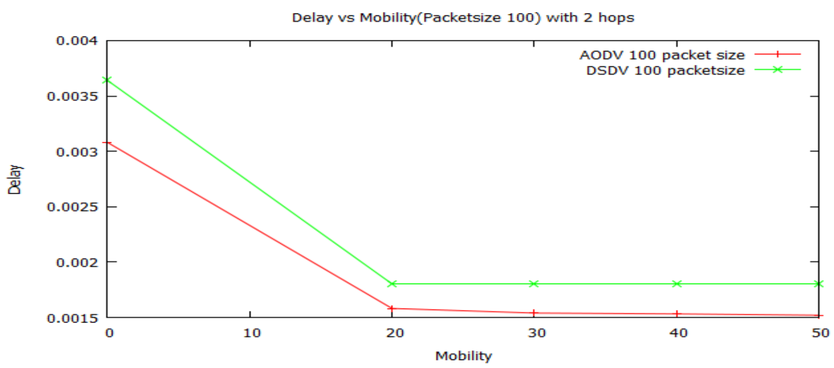


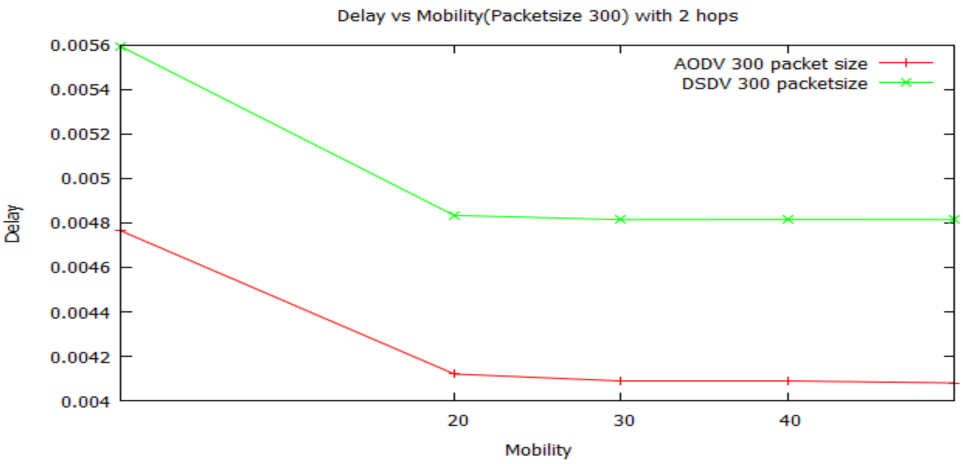
Delay Vs Hopcount with 20 Mobility





Delay Vs Mobility




Delay vs Mobility(Packetsize 300) with 2 hops
AODV 300 packet size
DSDV 300 packetsize
Delay
Mobility
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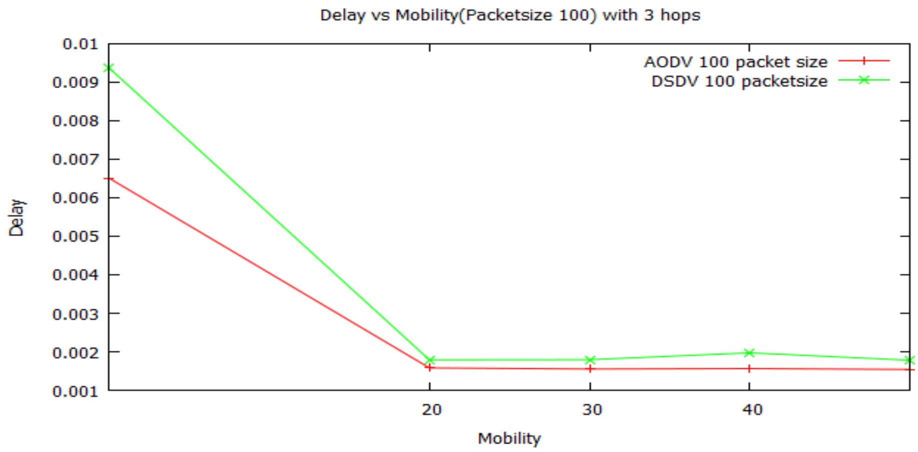
0.0052
0.005
0.0048
0.0046
0.0044
0.0042
0.004
20
30
40


Delay vs Mobility(Packetsize 100) with 3 hops
AODV 100 packet size
DSDV 100 packetsize
Delay
Mobility
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0.008
0.007
0.006
0.005
0.004
0.003
0.002
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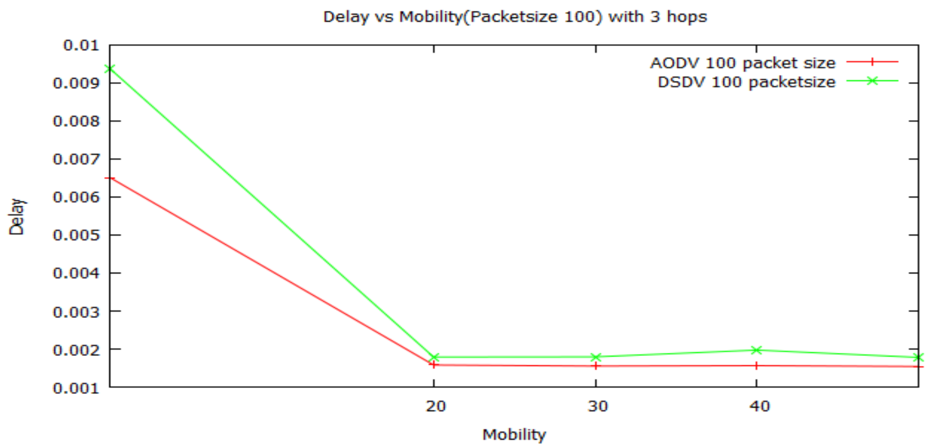
Delay vs Mobility(Packetsize 100) with 3 hops
AODV 100 packet size
DSDV 100 packetsize
Delay
Mobility
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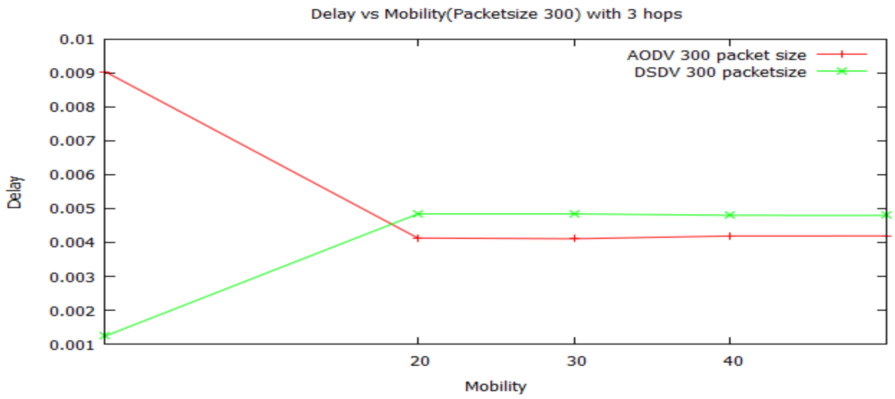
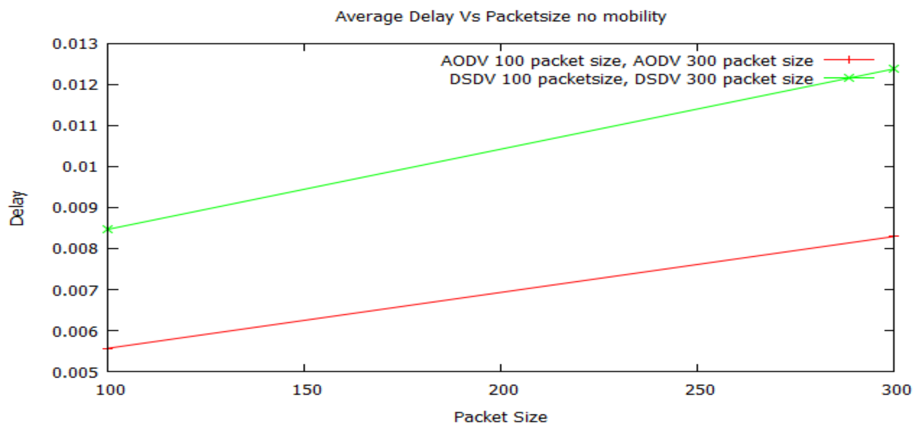
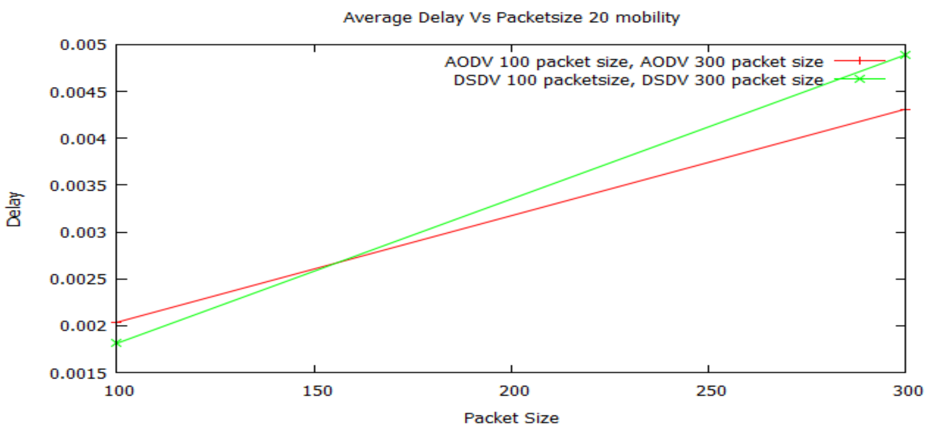

Delay vs Mobility(Packetsize 300) with 3 hops
AODV 300 packet size
DSDV 300 packetsize
Delay
Mobility
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
20
30
40

Average Delay Vs Packet size





4.3 End to End Delay

The time it takes for a packet to travel from its origination point to its final destination is used to calculate the end-to-end latency. We determined round-trip times for scenarios with variable radio ranges, traffic loads, and hop counts, from 1 to 10.

Hop Count on different radio areas Vs End to End Delay

We began our end-to-end latency computation by simulating various numbers numbering anything from one to ten hops (between origin and destination). As can be seen in Figures 10, 11, and 12, the latency increases with the number of hops. Each additional hop in the AODV protocol simulation results in a little increase in latency and additional processing time at each node, provided that the radio area of each node remains unchanged. End-to-end latency performance of AODV is heavily reliant on hop count and node radio area, as reported by Simulation Knowledge.

Different traffic conditions with different radio areas Vs END to End Delay

We then created a simulation with a variety of hop counts from 1 to 10, with a single intermediate node exchanging a number of different types of messages.

Our final test included constructing a network with two talking nodes in the middle. According to Simulation Knowledge, the latency in such a traffic scenario exponentially increases as the hop count rises. There is a little increase through seven hops, but the delay increases considerably with eight, nine, and ten hops. Exhibits 13–18 show this to be true..

4.4 Packet Loss

The percentage of packets lost during transmission from source to destination due to packet loss is measured using the Mean Number of Absorbed Ethernet Packets (MNAET) algorithm.

Comparison of Hop Count vs. Packet Loss across Various Radio Zones

End-to-end packet loss was determined by simulating a network with hop counts varying from one to ten.. Figure 19 illustrates that the packet loss is minimal up to 9 hop counts, but increases dramatically after the 10th hop. And the packet losing level is reduced for the subsequent hops. The packet dropping level aggressively rises with the node's radio communication depth increases, as illustrated in figures 20 and 21.

Packet loss versus radio frequency coverage and traffic circumstances

We simulated packet loss in a network with hop counts ranging from one to ten to see how it would affect the results., each with one intermediate node engaged in a separate connection. In the third experiment, we built a network Featuring two nodes in the middle that were already in the middle of another conversation. Data from simulations shows that packet loss rapidly rises with increasing hop count in such a high-traffic environment. Figures 22 and 23 show that, up to 5 hop counts, there is almost no packet loss. However, the resulting packet loss is significant. It depends significantly on the nodes' ability to communicate through radio waves.. The packet loss grows dramatically in figures 22, 23, and 24. Figures 25, 26, and 27 show that packet loss is significantly larger when two intermediate nodes are engaged in another conversation.

5. Discussion

We conducted extensive simulations of the RER-SK MANET routing protocol. It included several forms of information on Efficiency of the RER-SK. We found that the amount of time needed to choose a route significantly increases as the hop count increases. Furthermore, there is no linear relationship between increasing the hop count and increasing the route-finding duration. The RER-SK protocol performs adequately up to a particular initial hop count but drastically degrades when the hop count is raised. (Figure 4 indicates that the RER-SK protocol performs well up to 5 hops and somewhat worsens as the hop count increases in the 100m radio range). As the radio communication region of each node expands, throughput performance declines marginally. As distance covered by a radio signal and number of hops rise, so does the end-to-end latency. Losses are low up to a hop count of 9, but as seen in fig. e1, they increase considerably after that.It was demonstrated that expanding the range of a radio transmission causes an increase in packet loss.

Our efficiency metrics, the four parameters are customizable.

Count of hops: The hop count ranges from one to 10.

Node movement is determined through the mobility of points at random configurable stop time.

Node Radio Spectrum: 100 kHz, 250 kHz, and 1 GHz, and 300 meters.

Routes with 512 kilobyte packets indicate heavy traffic. are constructed, and intermediary nodes serve as routers as well as hosts for other communications.

The following performance measures are taken into account: packet loss, end-to-end latency, throughput, and the time it takes to choose a route. In the next section, we will examine the effects of hop count, mobility, radio area, and traffic load on the efficiency of the RER-SK routing protocol in the setting of MANETs.

Impact of Hop count

Both route time and delay are affected by the number of hops. creation and maintenance likelihood. We alter the hop count from one to 10 to see how it affects the outcome. According to 'SK,' the length of time it takes to find a route grows with the number of hops included in the search. marginally, and a higher hop count may increase end-to-end latency since it raises broadcast cost. The longer it takes to reach the target, the more hops there are. Throughput is also influenced by increasing the hop count, since increasing the hop count increases the time it takes to reach the destination, but regrettably the planned route may have broken owing to MANET features such as mobility and heterogeneity.

Impact of Mobility

The efficiency of a network might be negatively affected by mobile users. The dynamics of the network might therefore shift in ways that are not immediately apparent. The effects on routing delays and probabilities are also considered.As a result of node mobility, retransmission overhead may increase and control packets may be lost, both of which degrade network throughput.

Impact of Traffic

In terms of route creation and maintenance volume of travel detrimental influence the efficiency of networks. Because MANETs are peer-to-peer networks, an intermediary node engaged in the context of some other form of communication (as a source, a router, etc.) would generate traffic collisions and congestion. As the cost of broadcasting from each node increases, rises, the amount of network management messages increases dramatically.

6. Conclusion & Future Work

Researchers are working on mobile ad hoc network technologies to make global, always-on internet access a reality. There is no physical support for this network. that allows nodes to roam freely and arrange themselves arbitrarily. A network's nodes are autonomous, self-organize, and communicate with one another. To ensure efficient communication, MANET requires an effective dynamic routing protocol. Several reactive routing protocols were suggested for MANETs, and their performance was analyzed in this study. The purpose is to lay the groundwork for future study of MANETs by learning as much as possible about reactive routing protocols made specifically for them. The performance was evaluated in respect to multiple scenarios, and the study examined the results using several different performance metrics. Analysis of the data shows a thorough evaluation of reactive routing protocols across several dimensions, including dynamic and static topology, multi-hop communication, and variable data rates. In light of our description in this article, further research into the RER-SKresults is warranted for a complete grasp of the RER-SK routing protocol. This is done to improve RER-SK and attain the Quality of Service (QoS) and security standards necessary to support multimedia applications over MANETs. Our simulated results may also be compared to those obtained by using alternative MANET routing protocols

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