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Performance Comparison of Standardized Ad-Hoc Routing Protocols AODV, DSDV and DSR Using NCTUns Simulator

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***Abstract*:** A Mobile Ad-hoc Network is a kind of wireless network, and is a self configuring network of mobile nodes connected by wireless links. Various research organizations are working in the field of MANET and trying to adopt the protocols and technology in other applications as well. The mobility of nodes or power consumption are main concern in the Ad-hoc networks so The main aim of any ad-hoc network routing protocol is to meet the challenges of the dynamically changing topology and establish a correct and an efficient communication path between any two nodes with minimum routing overhead and bandwidth consumption. In this paper, an attempt has been made to compare three well know protocols AODV, DSR and DSDV by using three performance metrics Packet Collision, Packet Dropped and Throughput, the comparison has been done by using simulation tool NCTUns which is the main simulator.

Keywords: MANET, AODV, DSDV, DSR, NCTUns, Throughput

I. INTRODUCTION

A wireless ad-hoc network is a collection of mobile nodes with no pre-established infrastructure or centralized administration. Mobile Ad-hoc networks are self-organizing and self-configuring multihop wireless networks where, the structure of the network changes dynamically. This is mainly due to the mobility of the nodes. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Each must forward traffic unrelated to its own use, and therefore be a router. Routing in ad-hoc networks has been a challenging task ever since the wireless networks came into existence. The major reason for this is the constant change in network topology because of high degree of node mobility. A number of protocols have been developed for accomplish this task. Nodes should be able to enter and leave the network as they wish. Because of the limited transmitter range of the nodes, multiple hops are generally needed to reach other nodes. Every node in an ad-hoc network must be willing to forward packets for other nodes. Thus every node acts both as a host and as a router.

II. DESCRIPTION OF PROTOCOLS

A. Dynamic Source Routing (DSR) :

Dynamic Source Routing (DSR) is a routing protocol for wireless mesh networks. It's an on-demand, source routing protocol [1]. Whereby all the routing information is maintained at mobile nodes. DSR allows the network to be completely self-organizing and self-configuring, without the need for any existing network infrastructure or administration. The protocol is composed of the two main mechanisms of "Route Discovery" and "Route Maintenance" which work together to allow nodes to discover and maintain routes to arbitrary destinations in the ad hoc network [2]. An optimum path for a communication between a source node and target node is determined by Route Discovery process. Route Maintenance ensures that the communication path remains optimum and loop-free according the change in network conditions. Route Reply would only be generated if the message has reached the projected destination node.

To return the Route Reply, the destination node must have a route to the source node. If the route is in the route cache of target node, the route would be used. Otherwise, the node will reverse the route based on the route record in the Route Reply message header. In the event of fatal transmission, the Route Maintenance Phase is initiated whereby the Route Error packets are generated at a node. The incorrect hop will be detached from the node's route cache; all routes containing the hop are reduced at that point. Again, the Route Discovery Phase is initiated to determine the most viable route. It does not have need of periodic hello packet (beacon) transmissions, which are used by a node to inform its neighbors of its presence. The fundamental approach of this protocol during the route creation phase is to launch a route by flooding RouteRequest packets in the network. The destination node, on getting a RouteRequest packet, responds by transferring a RouteReply packet back to the source, which carries the route traversed by the RouteRequest packet received.

A destination node, after receiving the first RouteRequest packet, replies to the source node through the reverse path the RouteRequest packet had traversed. Nodes can also be trained about the neighboring routes traversed by data packets if operated in the promiscuous mode. This route cache is also used during the route construction phase. If an intermediary node receiving a RouteRequest has a route to the destination node in its route cache, then it replies to the source node by sending a RouteReply with the entire route information from the source node to the destination node.

B. Ad-hoc On Demand Distance Vector Routing (AODV) :

It is an on-demand and distance-vector routing protocol, meaning that a route is established by AODV from a destination only on demand [3]. AODV is capable of both unicast and multicast routing [4]. It keeps these routes as long as they are desirable by the sources. The sequence numbers are used by AODV to ensure the freshness of routes. It is loopfree, self-starting, and scales to large numbers of mobile nodes [4][5].

AODV defines three types of control messages for route maintenance:

a. RREQ –

A route request message is transmitted by a node requiring a route to a node. As an optimization AODV uses an expanding ring technique when flooding these messages. Every RREQ carries a time to live (TTL) value that states for how many hops this message should be forwarded. This value is set to a predefined value at the first transmission and increased at retransmissions. Retransmissions occur if no replies are received. Every node maintains two separate counters: a node sequence number and a Broadcast_id. The RREQ contains the following fields.

Source Address	Broad cast ID	Source Sequence No.	Destination Address	Destination Sequence No.	Hop Count

The pair <source address, broadcast ID> uniquely identifies a RREQ. Broadcast_id is incremented whenever the source issues a new RREQ [6].

b. RREP –

A route reply message is unicasted back to the originator of a RREQ if the receiver is either the node using the requested address, or it has a valid route to the requested address. The reason one can unicast the message back, is that every route forwarding a RREQ caches a route back to the originator.

c. RERR –

Nodes monitor the link status of next hops in active routes. When a link breakage in an active route is detected, a RERR message is used to notify other nodes of the loss of the link. In order to enable this reporting mechanism, each node keeps a - precursor list', containing the IP address for each its neighbors that are likely to use it as a next hop towards each destination.

C. Destination Sequenced Distance Vector (DSDV) :

This protocol is based on classical Bellman-Ford routing algorithm designed for MANETS. Each node maintains a list of all destinations and number of hops to each destination. Each entry is marked with a sequence number. DSDV solve the problem of routing loops and count to infinity by associating each route entry with a sequence number indicating its freshness [7]. In DSDV, a sequence number is linked to a destination node, and usually is originated by that node (the owner). The only case that a non-owner node updates a sequence number of a route is when it detects a link break on that route. An owner node always uses even-numbers as sequence numbers, and a non-owner node always uses odd-numbers. With the addition of sequence numbers, routes for the same destination are selected based on the following rules:

i. A route with a newer sequence number is preferred.
ii. In the case that two routes have a same sequence number, the one with a better cost metric is preferred.

Each row of the update send is of the following form:
<Destination IP address, Destination sequence number, Hop count>

The sequence number is used to distinguish stale routes from new ones and thus avoid the formation of loops. The stations periodically transmit their routing tables to their immediate neighbors. A station also transmits its routing table if a significant change has occurred in its table from the last update sent. So, the update is both time-driven and event-driven.

As stated above one of “full dump" or an incremental update is used to send routing table updates for reducing network traffic. A full dump sends the full routing table to the neighbors and could span many packets whereas in an incremental update only those entries from the routing table are sent that has a metric change since the last update and it must fit in a packet. If there is space in the incremental update packet then those entries may be included whose sequence number has changed. When the network is relatively stable, incremental updates are sent to avoid extra traffic and full dump are relatively infrequent. In a fast-changing network, incremental packets can grow big so full dumps will be more frequent.

III. EXPERIMENTAL SETUP

As NCTUns is open source and Linux based, the present work is carried out in NCTUns 6.0 and Fedora 12. It can work with lower versions as well but for that some patches have to be installed first. Each protocol is evaluated against three performance metrics mentioned below. The results are plotted against varying number of network nodes 10, 30 and 60. The nodes participating in the simulation are wireless Ad-hoc nodes with IEEE 802.11(b) standard. The traversal path for each node is generated randomly.

The packet size is fixed. Initially the nodes are placed at some positions and then they move according to the randomly generated traversal path by the simulator. The moving speed of each node is constant throughout the simulations. Identical mobility and traffic scenarios are used for fairness purposes across different simulations. The simulation parameters are summarized in Table as follows:

Table - 1. Simulation Parameters

Parameter	Value
Simulation time	180 Sec.
PHY-MODEL	802.11 b
Number of Nodes	10,30,60
Node Movement	Random
Channel Frequency	2.4 GHz

In this paper I have taken the mobile nodes that moves randomly in the group of 10, 30 and 60 for all the three protocols named as AODV, DSDV and DSR. Three screen shots of the simulation are shown below that I used to compare the three routing protocols (AODV, DSDV, DSR). Firstly I took 10 nodes and applied AODV, DSDV and DSR protocols on all the 10 nodes. Then I took 30 nodes and applied again AODV, DSDV and DSR protocols to all the nodes and at last I took 60 nodes and applied again all the three protocols.

In order to evaluate the performance of ad-hoc network routing protocols, the following metrics were considered**:**

A. Packet Collision –

When two or more stations attempt to transmit a packet across the network at the same time, a packet collision occurs. When a packet collision occurs the packets are either discarded or sent back to their originating stations and then retransmitted in a timed sequence to avoid further collision. Packet collisions can result in the loss of packet integrity or can impede the performance of a network.

B. Packet Drop –

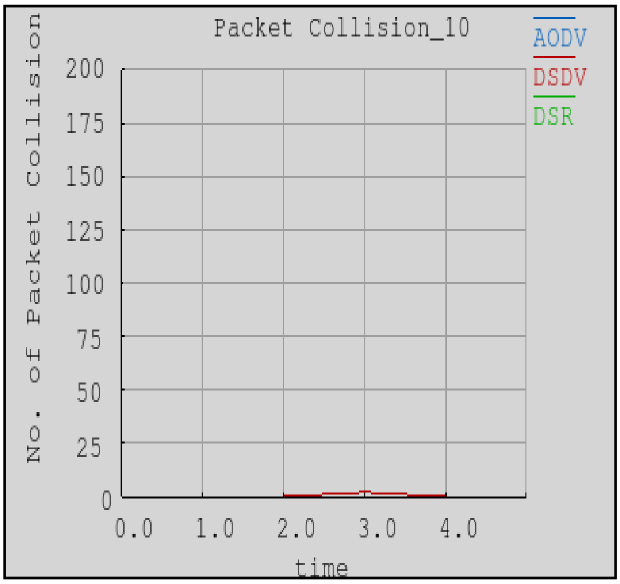
Packet drop occurs when one or more packets of data travelling across a computer network fail to reach their destination. Packet drop can be caused by a number of factors including signal degradation over the network medium due to multi-path fading, channel congestion, corrupted packets rejected in-transit, faulty networking hardware, faulty network drivers or normal routing routines (such as DSR in ad-hoc networks). In addition to this, packet loss probability is also affected by signal-to-noise ratio and distance between the transmitter and receiver.

C. Throughput –

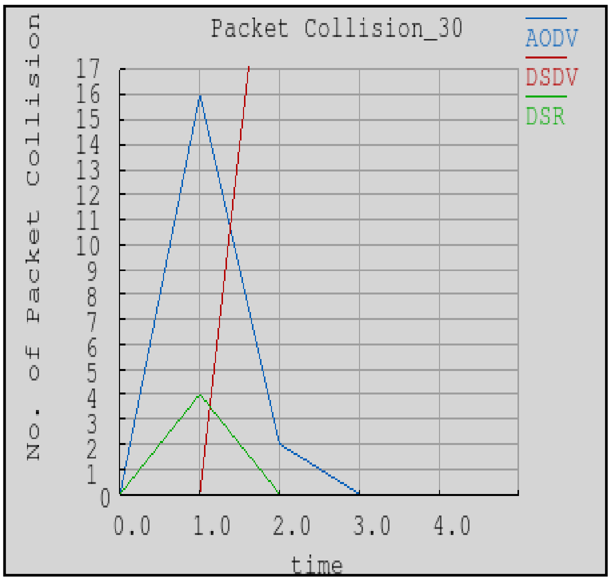
Throughput is the average rate of successful message delivery over a communication channel. The throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot.

IV. PERFORMANCE RESULT OF AODV, DSDV AND DSR.

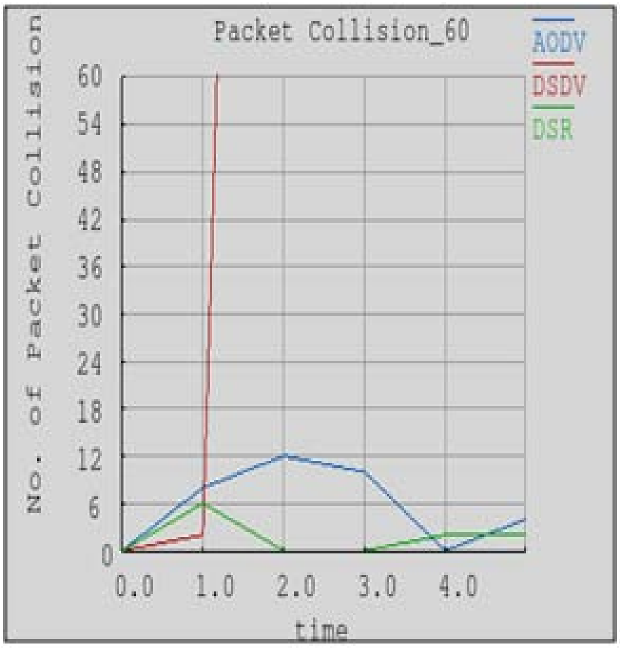
A. Performance Evaluation of AODV, DSDV and DSR on the basis of Packet Collision:



Packet Collision when no. of mobile nodes are 10.



Packet Collision when no. of mobile nodes are 30.

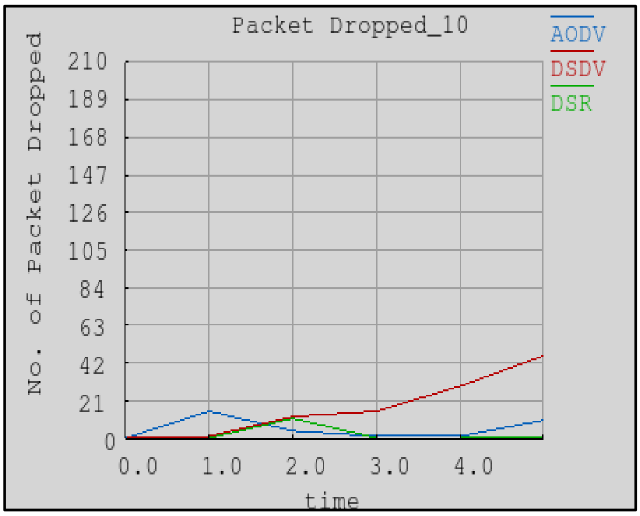


Packet Collision when no. of mobile nodes are 60.

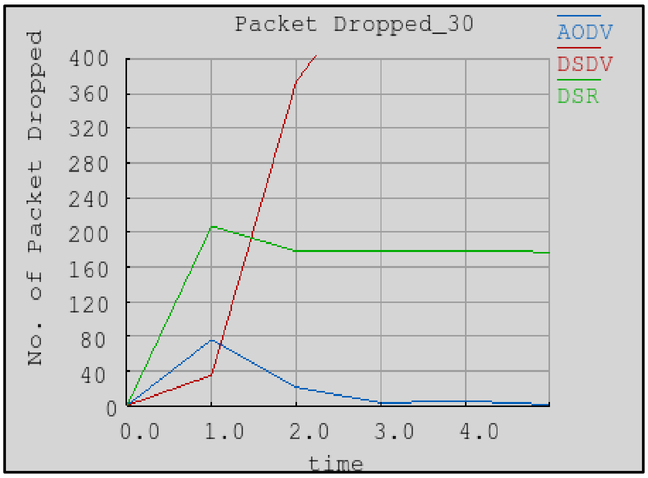
Figure-1. Packet Collision of AODV, DSDV and DSR when the number of nodes are 10,30 and 60.

In terms of Packet collision DSR performs well as compared to DSDV and AODV, when the number of nodes is less as the load will be less. However the number of packet collision decreases when we increase the nodes. The number of packet collision increases in DSDV when we increase the number of nodes. As the graph shows that the no. of packet collisions in DSDV is very high as compared to AODV and DSR. So we can say that the performance of DSDV is worst among all the three protocols. The performance of AODV is initially very high but consistent as the number of packet increases. So from the graph it is clear that the overall performance of DSR is better.

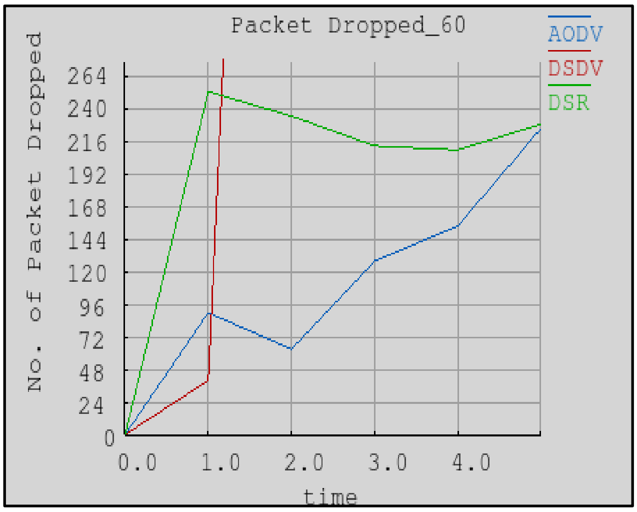
B. Performance Evaluation of AODV, DSDV and DSR on the basis of Packet Drop:



Packet Dropped when no. of mobile nodes are 10.



Packet Dropped when no. of mobile nodes are 30.

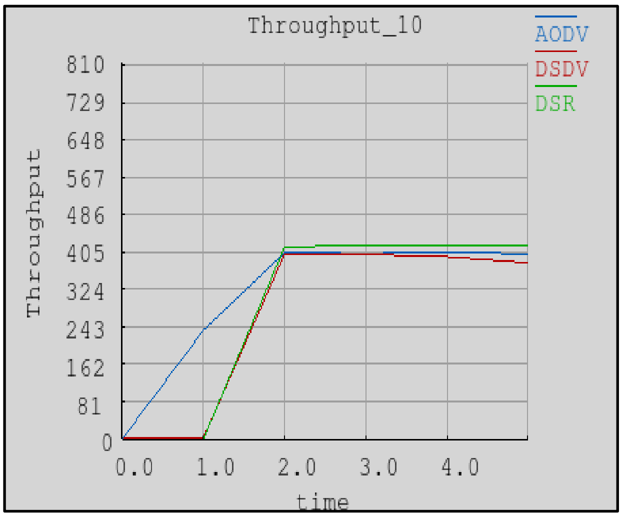


Packet Dropped when no. of mobile nodes are 60.

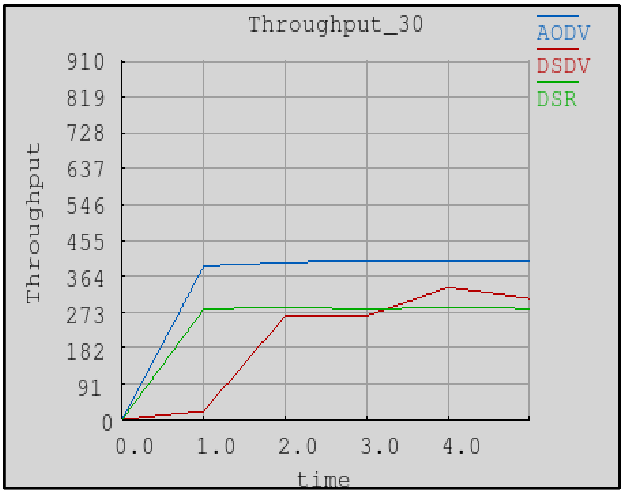
Figure-2. Packet Drop of AODV, DSDV and DSR when the number of nodes are 10,30 and 60.

In terms of packets dropped DSDV's performance is the worst as compared to AODV and DSR. The performance degrades with the increase in the number of nodes. The performance of AODV is better than the DSDV and DSR when the number of nodes are less but decreases when we increase the number of nodes. DSR performs consistently well with increase in the number of nodes.

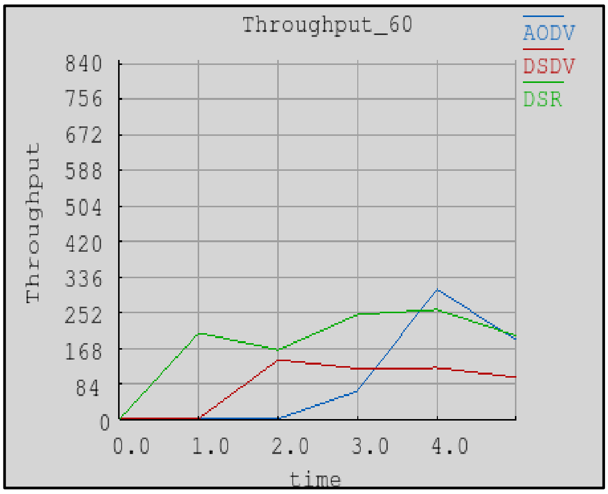
C. Performance Evaluation of AODV, DSDV and DSR on the basis of Throughput:



Throughput when no. of mobile nodes are 10.



Throughput when no. of mobile nodes are 30.



Throughput when no. of mobile nodes are 60.

Figure-3. Throughput of AODV, DSDV and DSR when the number of nodes are 10, 30 and 60.

In terms of throughput the performance of DSR and AODV are almost uniform and better than the DSDV. The performance of DSDV is degrading due to increase in the number of nodes the load of exchange of routing tables becomes high and the frequency of exchange also increases due to the mobility of nodes. So from the graph it is clear that the performance of DSDV is worst.

V. CONCLUSION

In this Thesis, I have presented simulation studies and compared the On-Demand (DSR and AODV) and Table-Driven (DSDV) routing protocols by varying the number of nodes and measured the metrics like Packet Collision, Packet Dropped, and Throughput. Our results indicate that the performance of the two on demand protocols namely DSR and AODV is superior to the table driven DSDV in conformance with the work done by other researchers. It is also observed that DSR outperforms AODV in less stressful situations, i.e smaller number of nodes. As far as packet collision and packets dropped ratio are concerned, DSR and AODV performs better than DSDV with large number of nodes. Hence for real time traffic AODV is preferred over DSR and DSDV. For less number of nodes and less mobility, DSDV's performance is superior. A general observation is that protocol performance is linked closely to the type of MAC protocol used. For example, if MAC protocol sends packets in bursts, it is observed that many route error packets are being sent in response to bursts of packets moving on invalid paths. In conclusion, the design of the routing protocol must take into consideration the features of the lower layer protocols.

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