PERFORMANCE ANALYSIS OF AD-HOC NETWORK ROUTING PROTOCOLS USING NS2

G. Venkata Subba Rao, Assist. Professor. Dept. of ECE.
B. Karuna, Dept. of ECE.
D. Pragathi , Dept. of ECE.
CH. Shashikanth Reddy, Dept. of ECE.

Abstract

An ad hoc network is a collection of wireless mobile nodes dynamically forming a temporary network without the use of any existing network infrastructure or centralized administration. A number of routing protocols like Dynamic Source Routing (DSR), Ad Hoc On-Demand Distance Vector Routing (AODV) and Destination Sequenced Distance-Vector (DSDV) have been implemented. In this paper, an attempt has been made to compare the performance of two prominent on-demand reactive routing protocols for mobile ad hoc networks: DSR and AODV, along with the traditional proactive DSDV protocol. A simulation model with MAC and physical layer models is used to study interlayer interactions and their performance implications. The On-demand protocols, AODV and DSR perform better than the table-driven DSDV protocol. Although DSR and AODV share similar on-demand behavior, the differences in the protocol mechanics can lead to significant performance differentials. A variety of workload and scenarios, as characterized by mobility, load and size of the ad hoc network were simulated. The performance differentials are analyzed using varying network load, mobility, and network size. These simulations are carried out based on the Rice Monarch Project that has made substantial extensions to the ns -2 network simulator to run ad hoc simulations.

Keywords— AODV, DSDV, DSR, NS2, PERFORMANCE METRICS, SIMULATION MODEL

1.INTRODUCTION

Wireless networking is an emerging technology that allows user to access information and services electronically, regardless of their geographic position. The Wireless networks are classified as infrastructure networks and infrastructure less (ad-hoc) networks. Infrastructure networks consist of fixed and wired gateways. A mobile host communicates with a bridge in the network (called base station) within its Communicate radius. The mobile unit can move geographically while it is communicating. When it goes out of Range of one base station, it connects with new base station and start communicating through it. This is called handoff. In this approach the base station are fixed. Infrastructures less or Ad-hoc networks are basically self organizing and self configuring multi-hop mobile wireless networks where the structure of the network changes dynamically. This is mainly due to the mobility of nodes. Nodes in this network utilize the same random access wireless channel cooperating in friendly manner to engaging themselves in multi-hop forwarding. The node in this network not only acts as hosts but also as routers that route data to and from other nodes in the network. Therefore communication between mobile nodes always requires routing over multi-hop paths. In this paper an attempt has been made to evaluate the performance of three well known routing protocols DSDV, AODV and DSR on the basis of different performance metrics. Apart from that with the increase of portable of devices as well as progress in wireless communication, Ad-hoc network gaining importance with the increasing number of widespread application.

2.ROUTING PROTOCOLS:

Routing protocols for mobile ad-hoc networks can be broadly classified into two main categories:

A. TABLE DRIVEN ROUTING PROTOCOLS (PROACTIVE)

Proactive or table-driven routing protocols attempts to maintain consistent and up-to date routing information from each node to every other node in the network. These protocols require each node to maintain one or more tables to store routing information, and they respond to change in network topology by propagating route update throughout the network to maintain consistent network view [1]. Certain proactive routing protocols are Destination Sequenced Distance Vector (DSDV), Wireless Routing Protocol (WRP), Global State Routing (GSR) and Cluster-head Gateway Switch Routing (CGSR).

B. ON-DEMAND ROUTING PROTOCOLS (REACTIVE)

In reactive or on demand routing protocols, the routes are created as when required. When a source wants to send to a destination, it invokes the route discovery mechanism to find the path to the destination. This process is completed when once a source is found or all possible route permutation has been examined. Once a route has been discovered and established, it is maintained by some form of route maintenance procedure until either the destination becomes inaccessible along every path from the source or route is no longer desired [1]. Certain proactive routing protocols are Ad-hoc On-Demand Distance Vector (AODV), Dynamic Source Routing (DSR), Temporally Ordered Routing Algorithm (TORA), Associatively-Based Routing (ABR), Signal Stability Routing (SSR).

1.AODV:-

AODV is a reactive routing that uses routing tables, one entry per destination. To determine whether routing information is up-to-date and to avoid routing loops, sequence numbers are used. It helps in both multicasting and unicasting
AODV employ RREQ & RREP message pair to discover the route. By broadcasting the RREQ message to its neighbors, the source node finds the route to destination [3]. The RREQ message contains fields; the source and destination address, lifespan of the message, a unique identification request ID and the source and destination sequence numbers. The Destination Sequence Number is the most recent sequence number received by the source from any route and the Source Sequence Number is the present sequence number to be used for route entry of the source node for the route request[2]. If from a list of neighbors any node recognizes the route to the destination then it can send RREP message to the source node.

2.DSR:-

DSR is also a reactive routing protocol. It discovers the route only on demand like AODV. Unlike AODV, DSR stores the complete path to the destination in its routing cache instead of the next hop node. The packet header field contains the address of all the intermediate nodes through which the packet moves to the destination node. This type of routing is known as source routing hence DSR name is so called. RREQ RREP message pair is used to discover the route, like AODV. The Source node broadcasts the RREQ message and the node having a route to destination sends a RREP message. An intermediate node rebroadcasts the RREQ message after adding its address to source address if it doesn't have information regarding destination node.

3.DSDV:-

The Destination-Sequenced Distance-Vector (DSDV) Routing Protocol uses traditional Bellman-Ford Routing Algorithm in addition with some VANET related enhancements
Every vehicular node manages a routing cache which lists the destinations with the number of vehicular nodes or no. of hops. To prevent the establishment of loops, sequence number is used to separate the old routes from new ones.

3. SIMULATION TOOL :

In this paper the simulation of AODV, DSDV, and DSR routing protocols is done by using network simulator (NS2) software due to its simplicity and availability. NS is a discrete event Simulator targeted at networking research NS provides substantial support for simulation of TCP, routing and multicast routing protocols over a wired and wireless network.NS2 is written in C++ and OTCL. C++ for data per event packets and OTCL are used for periodic and triggered event [5]. NS2 includes a network animator called nam animator which provides visual view of simulation. NS2 preprocessing provides traffic and topology generation and post processing provide simple trace analysis. AWK programming is used for trace file analysis [6].

4.SIMULATION MODEL:

Data and traffic agent that takes the responsibility to transport the data in the network are of different types and offer different characteristics in the network. It is necessary to understand the characteristics and therefore the performance to find the suitability of each type in a network. The two types of data/traffic agent types used in the network are as follows:

4.1 TCP/FTP

In such a traffic scenario, TCP represents the data type and FTP represents the application traffic agent of any application which transports TCP data. Here TCP is a transport layer protocol and FTP is an application layer protocol. This scenario offers connection oriented transmission environment, where communication occurs in phases, namely, connection establishment, data transmission, connection termination. The three basic characteristics offered are:

Reliable: TCP/FTP offers reliable communication, as it offers guaranteed delivery of data by employing the acknowledgements which guarantees the delivery of data at a destination. In case acknowledgements are not received till the timeout period, retransmissions are made to ensure the delivery of data at the receiver. We can say that positive acknowledgements, timeouts, and retransmissions are required to guarantee the delivery of data in a network.

Conforming: The network while working with TCP/FTP, offers conforming nature. The network is conforming in the context of transmissions as it offers both flow and congestion control. Flow control by preventing overflow of recipient buffer, and congestion control by keeping the track of acknowledgements, time outs, and retransmissions.

4.2 UDP/CBR

This type of traffic implies data of UDP type and application traffic agent is CBR. Here, the former is a transport layer protocol and latter is application layer protocol. It offers transmission of data at constant bit rate and does not communicate in phases, and traffic moves in one direction from source to destination without any feedback from destination. It offers three basic characteristics mentioned below:

Unreliable: The network is quiet unreliable as it does not set up communication in phases and does not rely on acknowledgements to recover the lost messages. The sender node does not take the responsibility of the successful delivery of data.

Predictable: The UDP/CBR has predictable nature of transmission, as it offers constant bit rate, fixed and known packet size, fixed and known packet interval, and fixed and known packet stream duration.

5.PERFORMANCE METRICS:

The following performance metrics are used in this paper for the performance evaluation of AODV, DSDV and DSR Routing protocols.

Throughput: - It is the amount of data transferred over the period of time expressed in bits per second or bytes per second.

Packet delivery ratio: - It is the ratio of the number of data packets received by the destination node to the number of data packets sent by the source mobile node. It can be evaluated in terms of percentage (%)

Routing overheads: - The number of control packets generated by each routing protocols.

Packet drop: - The number of data packets that are not successfully sent to the destination.

Average end to end delay: - The average time between packet transmission from source node, until packet received at destination.

NETWORK TOPOLOGY :

The following topology and simulation parameters are used in this paper to analyze the performance of proactive (DSDV) and reactive (AODV and DSR) routing protocols as shown in the figure.

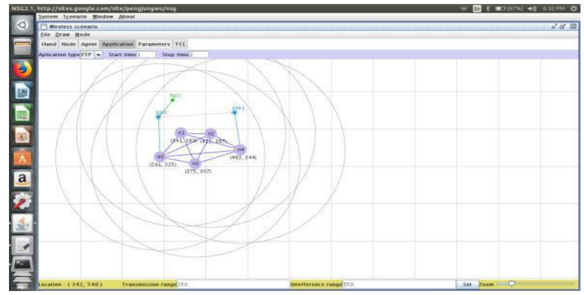

Fig :- Network topology

This topology consists of 5 nodes, the senders start the traffic at different-different time and share the channel bandwidth with other previous transmitting nodes. This topology is generated by the network animator tool, after running TCL script.

6.RESULTS:

The simulation results are shown in the following section in the form of comparative graphs. In this paper an attempt has been made to compare the performance of three well known routing protocol DSDV, AODV, and DSR according to his simulation results. The simulation results are generated through the excel graphs according to above mentioned topology.

6.1 MOBILITY MODEL:

6.1.1 AVERAGE END TO END DELAY FOR DSDV, AODV and DSR:-

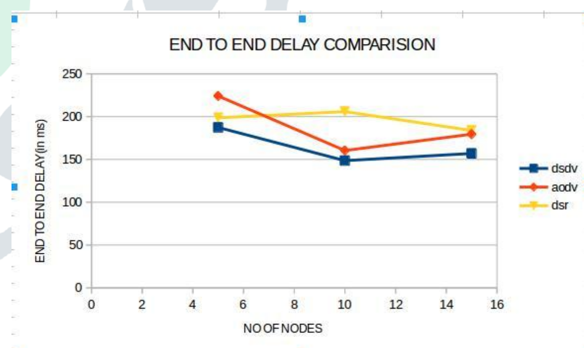

Fig.6.1.1:- Average end to end delay for DSDV, AODV and DSR

Average end to end delay comparison graph shown in fig.6.1.1. Average end to end delay of DSR is maximum, DSDV is minimum and AODV is between the DSDV and DSR for ‘5-nodes, 10-nodes and 15-nodes’ scenario.

6.1.2(a) NETWORK OVERHEADS FOR DSDV, AODV and DSR in TCP:-

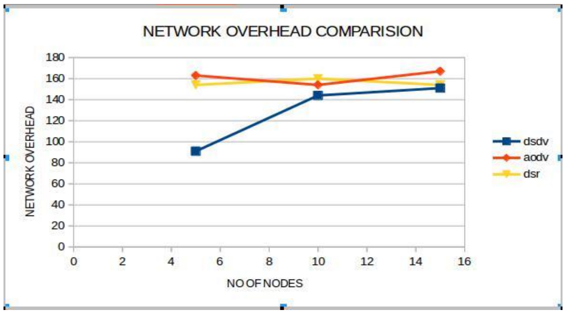

Fig.6.1.2(a):- Network overheads for DSDV, AODV and DSR in TCP

Network overheads comparison graph shown in fig.6.1.2(a). The Routing overheads of AODV is maximum, DSDV is minimum and DSR is between the DSDV and AODV for all the cases of ‘5-nodes, 10-nodes and 15-nodes’ scenario.

6.1.2(b) NETWORK OVERHEADS FOR DSDV, AODV and DSR in UDP:-

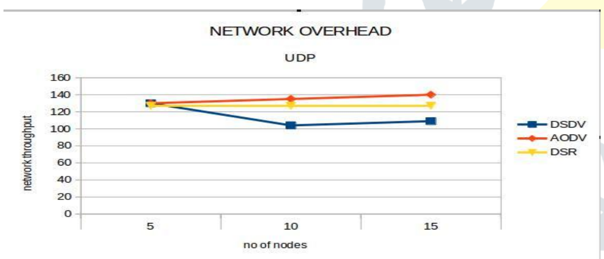

Fig.6.1.2(b):- Network overheads for DSDV, AODV and DSR in TCP

Network overheads comparison graph shown in fig.6.1.2(b). The Routing overheads of AODV is maximum, DSDV is minimum and DSR is between the DSDV and AODV for all the cases of ‘5-nodes, 10-nodes and 15-nodes’ scenario.

6.1.3(a) THROUGHPUT FOR DSDV, AODV and DSR in TCP:-

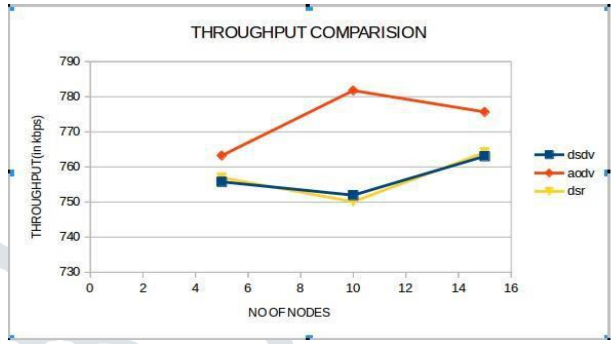

Fig.6.1.3(a):- Throughput for DSDV, AODV and DSR in TCP

Throughput is the amount of data per unit time that is delivered from one node to another node via communication link. The throughput is measured in bits/second. Efficient routing protocols must have a greater throughput. Fig.6.1.3(a) shows that, the throughput of AODV is better than ‘DSR and DSDV’ for 5-nodes, 10-nodes and 15-nodes scenario.

6.1.3(b) THROUGHPUT FOR DSDV, AODV and DSR in UDP:-

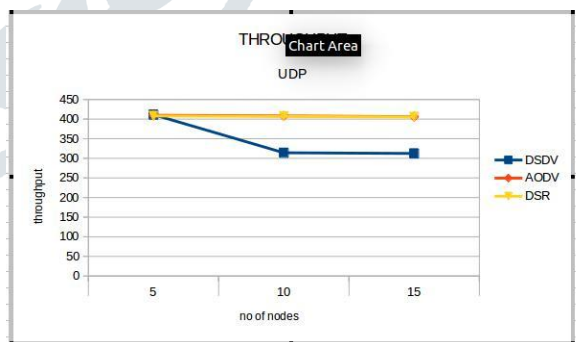

Fig.6.1.3(b):- Throughput for DSDV, AODV and DSR in UDP

Throughput is the amount of data per unit time that is delivered from one node to another node via communication link. The throughput is measured in bits/second. Efficient routing protocols must have a greater throughput. Fig.6.7 shows that, the throughput of AODV is better than ‘DSR and DSDV’ for 5-nodes, 10-nodes and 15-nodes scenario.

6.2 TRAFFIC MODEL:

6.2.1(a) PACKET DELIVERY RATIO COMPARISONS for DSDV, AODV and DSR in TCP:-

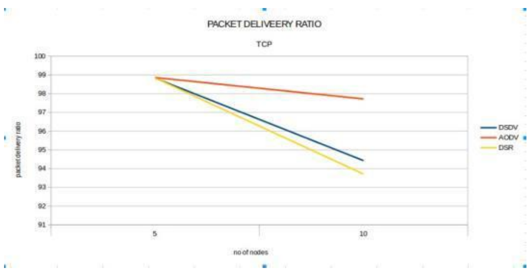

Fig.6.2.1(a):-Packet Delivery Ratio Comparisons for DSDV, AODV and DSR in TCP

The Packet delivery ratio is expressed as the percentage of number of received packets by the destination node to the number of packets sent by the source node with in the period of simulation time. It is an essential performance metrics of routing protocols. According to simulation results the Packet delivery ratio of AODV is maximum, DSR is minimum and DSDV is between the DSR and AODV for '5-nodes, 10-nodes and 15-nodes' scenario in TCP.

6.2.1(b) PACKET DELIVERY RATIO COMPARISONS for DSDV, AODV and DSR in UDP:-

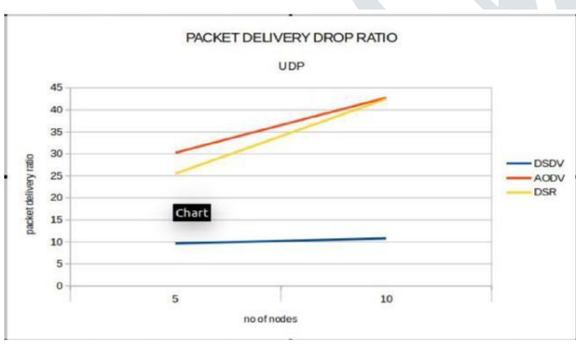

Fig.6.2.1(b):-Packet Delivery Ratio Comparisons for DSDV, AODV and DSR in UDP

The Packet delivery ratio is expressed as the percentage of number of received packets by the destination node to the number of packets sent by the source node with in the period of simulation time. It is an essential performance metrics of routing protocols. According to simulation results the Packet delivery ratio of AODV is maximum, DSDV is minimum and DSR is between the DSDV and AODV for '5-nodes, 10-nodes and 15-nodes' scenario in UDP.

6.2.2(a) PACKET DROP COMPARISION FOR DSDV, AODV and DSR in TCP:-

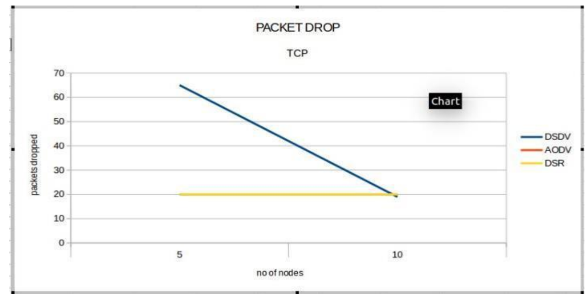

Fig.6.2.2(a):- Packet Drop Comparison for DSDV, AODV and DSR in TCP

A packet is dropped in two cases: the buffer is full when the packet needs to be buffer and the time that packets have been buffer exceeds the limit. Packet drop comparison graph show in fig.6.8. The packet drop for DSDV is maximum, DSR and AODV is minimum(almost equal) 'for 5-nodes, 10-nodes and 15-nodes' scenario in TCP.

6.2.2(b) PACKET DROP COMPARISION FOR DSDV, AODV and DSR in UDP:-

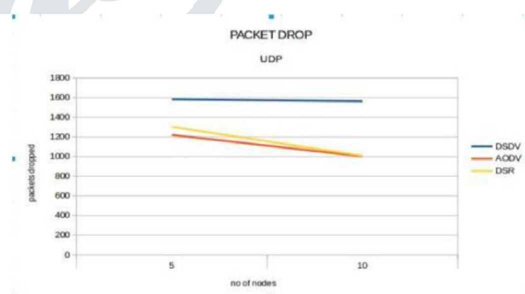

Fig.6.2.2(b):- Packet Drop Comparison for DSDV, AODV and DSR in UDP

A packet is dropped in two cases: the buffer is full when the packet needs to be buffer and the time that packets have been buffer exceeds the limit. Packet drop comparison graph show in fig.6.8. The packet drop for DSDV is maximum, AODV is minimum and DSR is between the DSDV and AODV 'for 5-nodes, 10-nodes and 15-nodes' scenario in UDP.

CONCLUSION

In this paper, the performance evaluation of DSDV, AODV and DSR routing protocols is done through the simulation tool NS2 which gives the knowledge how to use routing schemes in dynamic network. Simulation results show that, as the number of nodes increases in the network, the performance of routing protocols decreases. In the above simulation results:

AODV has maximum throughput.
AODV has minimum packet drop.
AODV has maximum network overheads.
AODV provides highest packet delivery ratio.
DSDV has minimum average end to end delay.

In the analyzed scenario, it is found that, the AODV is performing better than DSR and DSDV in all the cases.

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G. Venakata Subba Rao, received his B.Tech degree in Electronics and Communication Engineering from Jawaharlal Nehru technological University, yderabad in 2011, and he did his Master of Technology in VLSI System Design from Jawaharlal Nehru technological University, Hyderabad in 2013. Currently he is working as Assistant professor in TKR College of engineering and technology, Hyd.

B. Karuna is pursuing her B.E. degree in Electronics and Communication Engineering from T.K.R College of Engineering and Technology, Hyderabad under Jawaharlal Technological University, Hyderabad.

D. Pragathi is pursuing her B.E. degree in Electronics and Communication Engineering from T.K.R College of Engineering and Technology, Hyderabad under Jawaharlal Technological University, Hyderabad.

CH. Shashikanth Reddy is pursuing his B.E. degree in Electronics and Communication Engineering from T.K.R College of Engineering and Technology, Hyderabad under Jawaharlal Technological University, Hyderabad.