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Performance and Analysis of Routing Protocols with TCP Traffic in Mobile Ad Hoc Network

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***Abstract*— Mobile Ad Hoc Network is a collection of multi-hop wireless mobile nodes that communicate with each other. There is no centralized control or established infrastructure in MANET. The wireless links in this network are prone to error and has a tendency to turn down frequently due to mobility of nodes, interference and no fixed infrastructure. Therefore, due to highly dynamic environment, routing in MANET is a critical task. In recent years, several routing protocols have been proposed for MANET and most widely used among them are DSR, AODV and DSDV. We have simulated AODV, DSR and DSDV in NS2 using TCP in MANET. We have analysed these routing protocols with Packet delivery ratio, throughput and end-to-end delay as metrics. Our results shows a clear results for former.**

I. INTRODUCTION

A Mobile ad hoc network (MANET)[1], is a scenario in which the mobile nodes communicate with each other using multi-hop wireless links without fixed infrastructure. Each node acts as an individual router, which forwards the data packets from one node to other nodes. The main challenge in the design of such networks is the use of dynamic routing protocols that can help find routes between two nodes efficiently. In MANET nodes doesn't follow a fix path and move randomly, therefore the network may experiences a sudden change in its topology. So there are many protocols that have been proposed for MANETs for obtaining routing efficiently. Every protocol uses a new searching methodology for new route or modify a known route, when hosts move.

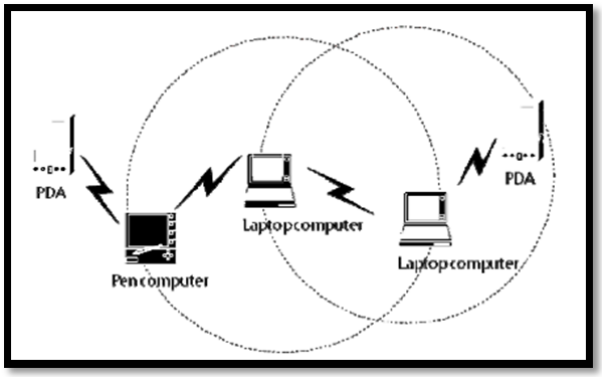


Fig 1. Infrastructure of Mobile Ad hoc Network [1]

The performance of the routing protocols AODV, DSDV and DSR were examined based on the performance metrics of Packet Delivery Ratio, Throughput and End to End Delay by using NS-2.35 simulator [15].

II. ROUTING PROTOCOLS IN MANET

A routing protocol [2],[11] comes in a picture whenever a packet needs to be transmitted to a destination via number of mobile nodes. Numerous routing protocols are proposed for MANET. First of all these protocols finds a route for packet delivery and then delivers the packet to the correct destination. The studies on these aspects of routing protocols have been an active and trending area of research for many years. Many protocols have been proposed keeping their applications and type of network in consideration.

In MANET routing protocols are divided into three categories namely:

- Proactive routing protocols/table driven routing protocols,
- Reactive routing protocols/demand routing protocols
- Hybrid routing protocols

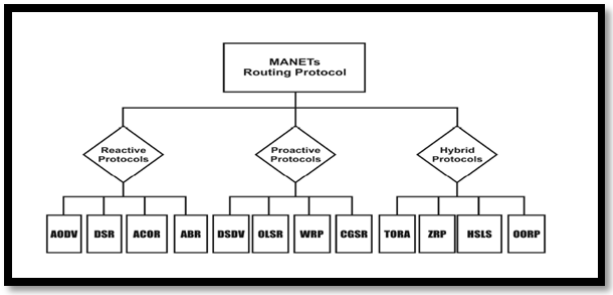


Fig 2. MANET Routing Protocol [16]

But, we will only discuss about proactive and reactive protocols.

A. Table Driven or Proactive Protocols

Proactive routing protocols, in this, every mobile node maintains one or more tables that represents the entire topology of the network. These tables get updated regularly intervals to maintain an up-to-date routing information that

is obtained from one node to every other node. One of the existing table driven or proactive protocols are: DSDV.

1. Destination Sequence Distance Vector [3][4][8]

Destination Sequence Distance Vector (DSDV) [3][4] takes Bellman Ford algorithm as its base. In this the packets are transmitted between mobile nodes with the use of routing tables situated in the mobile node. The routing table, at each of the mobile node has the list of all available destinations, and the number of hop count. Every route table entry is combined with a sequence number. For achieving the consistency in this changing topology based network, every mobile node has to periodically transmit updates that helps updating the routing tables. Routing information is obtained by broadcasting the packets which are transmitted at an interval and when any topological changes are detected.

In DSDV, each node transmits a sequence number, which increases periodically by two and is transmitted along with any other updated routing messages to all nodes in the scenario. On arrival of these update messages, the following algorithm is used by the neighbouring nodes to decide whether to accept or ignore the update and make the necessary changes in its routing table [14]:

Step 1: Receive the updated message

Step 2: Update the routing table if any one of the following condition satisfies:

1. Sn > Sp
2. Sn=Sp, Hop count is less

ELSE, ignore the updated message.

Here, Sn and Sp are the Sequence numbers of new message and existing message respectively.

B. On Demand or Reactive Protocols [8],[9],[10]

Reactive routing protocols, every node tries to set up routes on-demand. If a node wants to initiate communication with another node for which it has no connecting route, the routing protocol will try to establish such a route. Some of the existing and mainly used on demand routing protocols are: DSR and AODV.

1. Dynamic Source Routing (DSR) [3],[4],[5]

Dynamic Source Routing is an Ad Hoc routing protocol which is a source-based routing and not table-based. It is a source-initiated protocol rather than hop-by-hop. It is designed for use in MANET. Basically, DSR protocol does not need any fixed topology network or administered and allows the Network to be self-organizing and auto-configuring. DSR is composed of two important parts of route maintenance and route discovery. Every node is set to maintain a cache to store recently discovered routes. The node also checks whether the cache is fresh or not. As in Ad hoc network, any link or route might fail anytime. Therefore, route maintenance process constantly monitors and notifies the nodes and states if there is any failure in the path. Hence found, the nodes will change the entries of their route cache.

2. Ad Hoc on Demand Distance Vector [6], [7],[12]

Ad Hoc on Demand Distance (AODV) is an up gradation or a variation of DSDV routing protocol which is collectively based on both DSR and DSDV. The main aim is how to minimize the requirement of system-wide broadcasts to its maximum. It does not saves or maintain any paths from a node to every other node in the network. The only time it does is when they are discovered and when needed & are maintained till required. Whenever an AODV router or node gets a request for sending a message, it checks its routng table for path existence. Each routing table entry has destination address of all nodes, destination sequence number, next hop address and hop count. If a path is traced and found, the router simply forwards the message to the following hop. If not found, the message is saved in a message queue, and later it initiates a route request to obtain a route. When got the receipt of the routing information, it updates the routing table and sends the queued message(s).

Some benefits of AODV protocol that makes it efficient are due to it is biased behavior towards the least congested route and not the shortest route. The main thing is that it supports both multicast and unicast packet transmissions for nodes in constant movement. It also responds fast to the network changes that affects the active paths. AODV has a tendency of not putting any extra overhead on data packets as it does not use source routing.

III. PERFORMANCE METRICS AND SIMULATION

A. Performance Metrics [12]

To compare some of the protocols then, we need to consider some of the metrics for comparing the performance of these protocols. Some of the Performance metrics [7]-[9] that we have used to calculate the performance of the routing protocols are as follows:

1. Packet Delivery Ratio

The PDR is the ratio of the total data packets delivered to the destinations to those data packets generated by the sources.

PDR = (total data packets delivered/ data packets generated)

2. Throughput

Throughput of the routing protocol is defined as the total size of useful packets that received at all the destination nodes in a unit time. Throughput of node A to B is:

Throughput = (No of Bits from node A to Node B / Observation Duration)

3. Average End-To-End Delay

Average End-to-End delay (seconds) is the average time taken by a data packet to reach the destination.

End to End Delay = $\sum$ (Arrive time - Send Time)/ $\sum$ (No. of connection)

B. Simulation Model

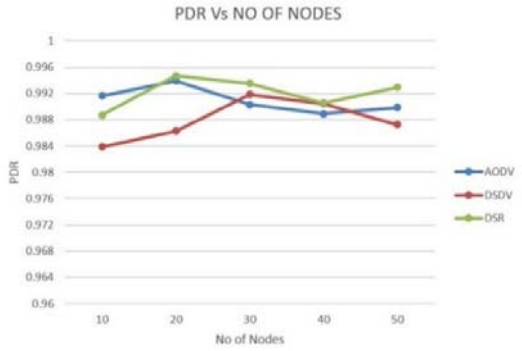
Network Simulator (Version 2.35), also known as NS2, is an event driven simulation tool that has been proved useful in studying the dynamic nature of communication networks. NS2 helps in simulating wired as well as protocol and wireless network (e.g., routing algorithms, TCP, UDP). We carried out the simulation and evaluated the performance of Mobile Ad hoc routing protocols such as AODV, DSR and DSDV based on the performance metrics i.e. packet delivery ratio, throughput and end-to-end delay with the following parameters:

TABLE 3 PARAMETER TABLE

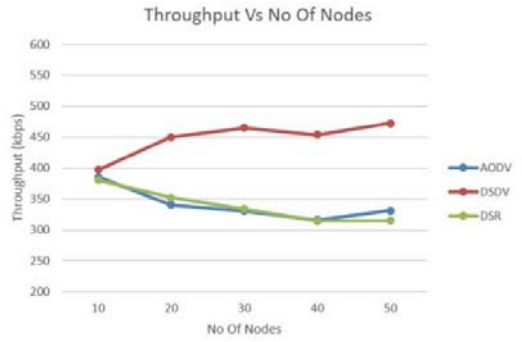
Parameter	Value
Radio Model	TwoRay Ground
Routing Protocol	AODV,DSDV,DSR
Agent	TCP/FTP
Packet Size	512
Area	600m x 600m
Application	FTP
MAC	Mac/802_11
Simulation Time	50 s
No. Of Nodes	10,20,30,40,50
Max Speed	10,20,30,40,50

IV. STIMULATION RESULT

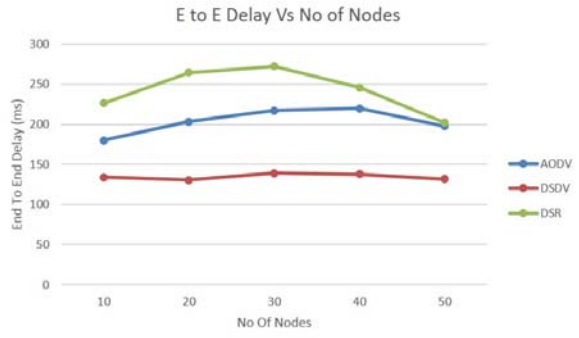
A. Calculating performance metrics by varying No of Nodes



[A] PDR



[B] Throughput



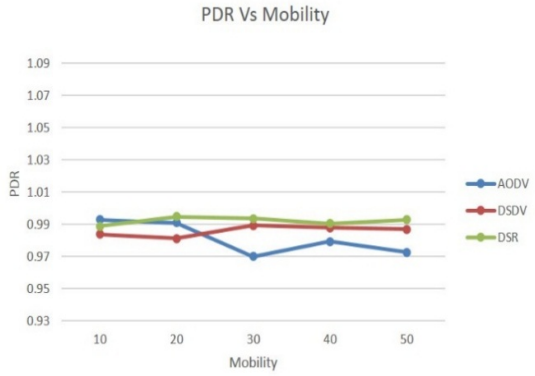
[C] End to End Delay

Fig 3 Comparison of PDR, Throughput and End to End Delay by varying No of Nodes

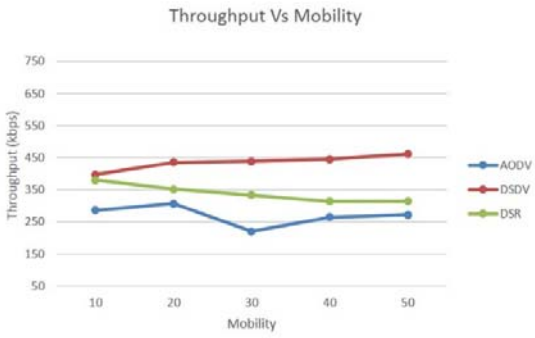
Fig A shows the ratio of the data packets of each protocol which was able to deliver at time. We observe that DSR performs slightly better than AODV. As No of nodes are increased, PDR of DSR increases by 20 %. DSDV drops rapidly by 40% then AODV when nodes are increased. Whereas DSDV gives best results and give almost 50 % better throughput than AODV (refer Fig B). DSR has a constant throughput although the no of nodes are increased. When E to E Delay is calculated (refer Fig C) clearly the performance of DSDV is two times better than DSR. Performance of AODV is average. Hence, when No. of Nodes is concerned, DSR gives the best PDR, DSDV give the best throughput and End to end Delay.

B. Calculating performance metrics by varying mobility

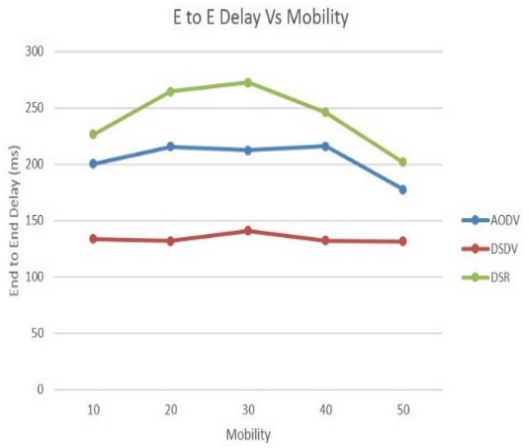
Fig D shows the ratio of the data packets of each protocol which was able to deliver at time. We observe that DSR performs slightly better DSR. AODV doesn't perform efficiently when dealt with mobility. PDR of DSR is constant whereas PDR of AODV drops by 25% when mobility is increased. DSDV has the best throughput and increases when mobility is increased. Throughput of DSDV is almost twice than that of AODV at high mobility. When E to E Delay is calculated, clearly performance of DSDV is two times better than DSR. Performance of AODV is average. Hence, when mobility is concerned, DSR gives the best PDR, DSDV give the best throughput and End to end Delay.



[D] PDR



[E] Throughput



[F] End to End Delay

Fig 4 Comparison of PDR, Throughput and End to End Delay by varying Mobility

V. CONCLUSION

This paper compares the three popular ad hoc routing protocols AODV, DSR and DSDV on basis of performance metrics. Simulation results shows that amongst all the protocols, DSDV has a stable and efficient End to End Delay as it is a Table Driven protocol and is more reliable. DSR has a higher PDR than the other two routing protocols in mobility. DSR has the highest End to End Delay. Based on the above simulation scenario, parameter, assumption and results DSDV could be considered as an efficient & faster routing protocol than DSR and AODV. But we know that DSDV is not efficient for large ad-hoc networks and nodes need to maintain a complete list of routes. So we can say that AODV gives average values and so is reliable. Further we would be comparing various TCP variants in MANET.

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