Performance Analysis of MANET Routing Protocols by Varying Pause Time in the Network

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Abstract:- **A Mobile Ad-Hoc Network (MANET) is a collection of wireless mobile nodes forming a temporary network without using any centralized access point or administration. MANET protocols have to face high challenges due to dynamically changing topologies, low transmission power and asymmetric links of network. The widely accepted existing routing protocols designed to accommodate the needs of such self-organized networks do not address possible threats aiming at the disruption of the protocol itself. Simulation is the research tool of choice for a majority of the mobile ad hoc network community. MANET's are infrastructure less and can be set up anytime, anywhere An attempt has been made to compare the performance of two On-demand reactive routing protocols namely AODV and DSR which works on gateway discovery algorithm and a proactive routing protocol namely DSDV which works on an algorithm to constantly update network topology information available to all nodes for MANETs on different scenarios under CBR traffic patterns using NS-2. In this paper comparison is made on the basis of performance metrics such as throughput, packet loss and end-to-end delay, and the simulator used is NS-2 in Ubuntu operating system(Linux).The simulations are carried out by varying pause time and the results are analyzed**

General Terms- Mobile Ad-hoc Networks Routing Protocols.

Keywords :- MANET, DSDV, AODV, DSR, CBR.

I. INTRODUCTION

An Ad-Hoc network is a collection of wireless mobile nodes dynamically foarming a temporary network without the use of existing network infra-structure or centralized administration [1][2]. MANET is a kind of wireless network and self configuring network of moving routers associated with wireless network. The routers are free to move randomly and organize themselves arbitrarily, thus, the network's wireless topology may change rapidly and unpredictably. [1][3] Mobile Ad-Hoc network is an infra-structure less network due to mobile routers. Each node or router must forward the packets unrelated to its own use. [8][9][10] Main challenges to maintain the Mobile Ad-Hoc network are: No central controlling authority, limited power ability, continuously maintain the information required to properly route traffic.

This infra-structure less network is managed using the routing protocols. Routing is the process of selecting paths in a network along which to send data or physical traffic. Routing directs the passing of logically addressed packets from their source toward their ultimate destination through intermediary nodes. So routing protocol is the routing of packets based on the defined rules and regulations. Every routing protocol has its own algorithm on the basis of which it discovers and maintains the route. In every routing protocol, there is a data structure which stores the information of route and modifies the table as route maintenance is requires. A routing metric is a value used by a routing algorithm to determine whether one route should perform better than another. Metrics can cover such information as bandwidth, delay, hop count, path cost, load, reliability and communication cost. The routing table stores only the best possible routes while link-state or topological databases may store all other information as well [3][7][9].

The main objective of ad-hoc routing protocols is to deliver data packets among mobile nodes efficiently without predetermined topology or centralized control. The various mobile ad-hoc routing protocols have been proposed and have their unique characteristics. Hence, in order to find out the most efficient routing protocol for the highly dynamic topology in ad-hoc networks, the behavior of routing protocols has to be analyzed with varying node density and network load under different traffic patterns[4].

II. MOBILE AD-HOC ROUTING PROTOCOLS

There are two main approaches for routing process in ad-hoc networks. The first approach is a proactive approach which is table driven and attempt to maintain consistent, up-to-date routing information from each node to every other node in the network. Proactive protocols present low latency, but high routing overhead, as the nodes periodically exchange control messages and routing-table information in order to keep up-to-date route to any active node in the network. The second approach is re-active, source-initiated or on-demand. Reactive protocols create routes only when desired by the source node. When a node requires a route to a destination, it initiates a route discovery process within the network. Reactive protocols do not maintain up-to-date routes to any destination in the network and do not generally exchange any periodic control messages. Thus, they present low routing overhead, but high latency as compared to proactive protocols. The DSDV is a proactive protocol and AODV, DSR, and TORA are reactive protocols. The mobile ad-hoc routing protocols considered in this study are described below [4].

2.1 CLASSIFICATION OF ROUTING PROTOCOLS

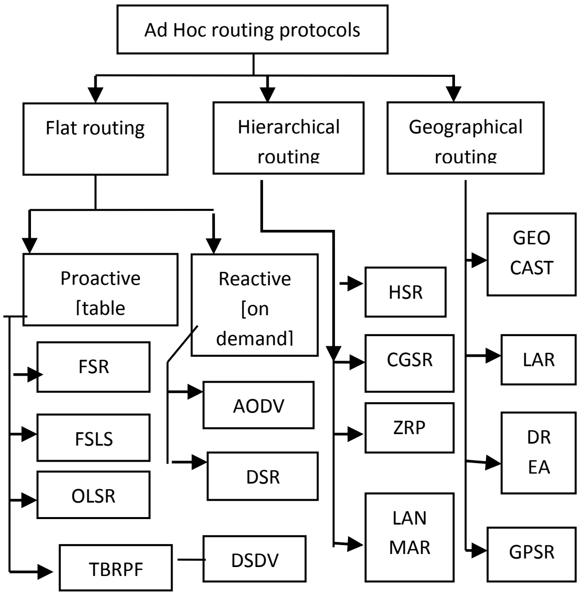

Figure 1: Classification of Ad Hoc Routing Protocol

Classification of routing protocols in mobile ad hoc network can be done in many ways, but most of these are done depending on routing strategy and network structure [1] [28] . The routing protocols can be categorized as flat routing, hierarchical routing and geographic position assisted routing while depending on the network structure [1] in figure 1.

2.2 FLAT ROUTING PROTOCOLS

Flat routing protocols are divided mainly into two classes [1]; the first one is proactive routing (table driven) protocols and other is reactive (on-demand) routing protocols. One thing is general for both protocol classes is that every node participating in routing play an equal role. They have further been classified after their design principles; proactive routing is mostly based on LS (link-state) while on-demand routing is based on DV (distance-vector).

2.2.1 PROACTIVE ROUTING PROTOCOLS

These types of protocols are also called as "Table driven routing protocols" [7]. This Maintains fresh lists of destinations and their routes by periodically distributing routing tables throughout the network. The main disadvantages of such algorithms are:

1. Respective amount of data for maintenance.
2. Slow reaction on restructuring and failures.

An example of this protocol is Destination Sequenced Distance Vector (DSDV)

2.2.2 REACTIVE ROUTING PROTOCOLS

These types of protocols are also called as "On- demand routing protocols" [7]. This finds a route on demand by flooding the network with Route Request packets. The main disadvantages of such algorithms are:

1. High latency time in route finding.
2. Excessive flooding can lead to network clogging.

Examples of On-demand routing protocol are Dynamic Source Routing (DSR), Ad-hoc On-demand Distance Vector Routing (AODV)[2].

III. DESCRIPTION OF PROTOCOLS: DSDV, AODV AND DSR

3.1 Destination Sequenced Distance Vector (DSDV)

DSDV [3][4][7] is considered to be successor of Distance Vector in wired routing protocol and guarantees a loop free path to each destination. It is based on the Bellman-Ford algorithm for calculation of shortest path. For this protocol, every node maintains routing table which contains all available destinations with associated next hop towards destination, distance and destination sequence number. Destination sequence number presents improvement of DSDV routing protocol compared to distance vector routing, and it is used to distinguish stale routes from fresh ones and avoid formation of route loops.
In order to maintain the consistency in dynamic environment, each node periodically broadcasts its routing table to its neighbors. Broadcasting of the information is done in Network Protocol Data Units (NPDU) in two ways: full dump and incremental dump. Full dump requires multiple NPDUs, while incremental requires only one NPDU to fit in all the information, to minimize the number of control messages disseminated in the network. When an information packet is received from another node, node compares the sequence number with the available sequence number for that entry. If the sequence number is larger, entry will be updated with the routing information with the new sequence number, else if the information arrives with the same sequence number, metric entry will be required. If the number of hops is less than the previous entry, new information will be updated. Update is performed periodically or when significant change in routing table is detected since the last update. If network topology frequently changes, full dump will be carried out, since incremental dump will cause less traffic in stable network topology. When such updating takes place each update is broadcasted in the network, which leads to a heavy network load situation and affects the bandwidth. With more number of nodes, traffic load increases. DSDV takes into account only bidirectional links between nodes.

3.2 Dynamic Source Routing (DSR)

Dynamic Source Routing (DSR) [3][4] is an on-demand routing protocol, which is based on the concept of source-based routing. DSR is a simple pure on-demand reactive protocol that does not periodically exchange any control packets. The main concept of the DSR protocol is "source routing", in which source nodes place the complete route that the packet must follow from a source to a destination in the header of a packet. DSR applies two on-demand processes, route discovery and route maintenance. The route discovery process is used to discover new routes and maintain them in the cache of nodes. The route maintenance process detects link failures, then repair route or find alternate route. Each node "caches" the routes to any destination it has recently used, or discovered by overhearing its neighbor's transmission. When there is not such route, a route discovery process is initiated. DSR applies on demand schemes for both route discovery and route maintenance. There by reducing network bandwidth overhead, conserving battery power and avoiding large routing updates throughout the mobile ad-hoc network. DSR is a loop free protocol and supports unidirectional links.

3.3 Ad-hoc On-demand Distance Vector (AODV)

Ad-hoc On-demand Distance Vector [11][13] is a reactive routing protocol, which mixes the properties of DSR and DSDV. Routes are discovered as on-demand basis and are maintained as long as they are required. Each node of AODV maintains a routing table but unlike the DSDV protocol it does not necessarily maintain route for any possible destination in network. However, its routing table maintains routing information for any route that has been recently used within a time interval; so a node is able to send data packets to any destination that exists in its routing table without flooding the network with new Route Request (ROUTE_REQ) messages.

Like DSDV it maintains a sequence number, which it increases each time it finds a change in the topology of its neighborhood. This sequence number ensures that the most recent route is selected for execution of the route discovery. All routing packets carry these sequence numbers. AODV stores routing information as one entry per destination in contrast to DSR, which cashes multiple entries per destination. Without source routing, AODV relies on routing table entries to propagate an ROUTE_REPLY back to the source and, subsequently, to route data packets to the destination. AODV supports for both unicast and multicast routing, and also supports both bidirectional and unidirectional links.

IV. PROBLEM STATEMENT

The objective of our work is to compare the performance of three routing protocols based on Table Driven and On-demand behavior, namely, Destination Sequenced Distance Vector (DSDV), Ad-hoc On- Demand Distance vector (AODV) and Dynamic Source Routing (DSR) [2][4], for wireless ad hoc networks based on the performance, and comparison has been made on the basis of their properties like throughput, packet delivery ratio (PDR), End to End Delay and data packet loss with respect to four different scenarios – one by varying the number of nodes, again by varying the mobility of the nodes**,** other by varying the number of connecting nodes at a time , by varying packet size and lastly by varying pause time.

The general objectives can be outlined as follows:

1. Study of Ad-Hoc Networks.
2. Get a general understanding of MANET.
3. Study on different types of MANET routing.
4. Detailed study of DSDV, AODV and DSR
5. Generate a simulation environment that could be used for simulation of protocols.
6. Simulate the protocols on the basis of different scenarios: by varying the number of nodes and by varying the traffic in the network.
7. Discuss the result of the proposed work and concluding by providing the best routing protocol.

V. METHODOLOGY

5.1 Selection Techniques for Network Performance Evaluation:

There are three techniques for performance evaluation, which are analytical modeling, simulation and measurement [13]. Simulation is performed in order to get the real-event results with no assumption as in case of analytical modeling.

5.2 Random Waypoint Mobility Model:

A node, after waiting a specified pause time moves with a speed between 0 m/s and vmax m/s to the destination and waits again before choosing a new way point and speed [13].

VI. SIMULATION ASSUMPTIONS

The following assumptions are considered when building the TCL [2][15] script:

1. For simplicity, all flows in the system are assumed to have the same type of traffic source. Each sender has constant bit rate (CBR) traffic with the rate of data rate/number of stations packet per second .
2. The source node is fixed to 100 nodes with maximum connection is 60 nodes (to show a density condition) and if the nodes are varied for the calculation it is mentioned in the area.
3. The implementation of grid and integrate between grid and routing protocols.

VII. PERFORMANCE METRICS [1][4] :-

A. Average end-to-end delay of data packets: It is defined as the average end-to-end delay of data packets within a network. The sum of all time differences between the packet sent and received divided by the number of packets, gives the average end-to-end delay. The lower the end-to-end delay the better the application performance [1].

AED= Σ (Received time – sent time)/Total data packets received

A. Throughput: It is measured as the ratio of amount of received data to the amount of simulation time and tells about how soon an end user is able to receive data. A higher throughput implies better QoS of the network [1].

Throughput = Total Received Bytes / Elapsed Time

B. Packet Delivery Ratio

Packet delivery ratio is calculated by dividing the number of packets received at the destination by the number of packets originated at the source. For the best performance packet delivery ratio of routing protocol should be as high as possible [23]. If the ratio is 1, it will be the best delivery ratio of the routing protocol.

PDR= No. of received packets/No. of sent packets.

VIII. SIMULATION RESULTS PERFORMANCE COMPARISON WITH DISCUSSION

Performance of DSDV, AODV, and DSR protocols is evaluated under both CBR traffic pattern. Extensive simulation is done by using NS-2 simulator [1][2][4].
Two On-demand (Reactive) routing protocols namely Ad hoc On-Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR) and one Table-driven (Proactive) namely Destination Sequenced Demand Vector (DSDV) is used. The mobility model used is Random waypoint mobility model because it models the random movement of the mobile nodes.
The parameters for analysis are set as shown in Table on Linux Ubuntu Operating System. Ns2 was installed on Ubuntu platform.

Table 1: Simulation Setup

Platform	Ubuntu
NS version	Ns-allinone-2.35
Pause time	0,40,80,120,160,200
Simulation time	200ms
Number of nodes	10,30
Traffic pattern	CBR(Constant Bit Rate)
Transmission Range	250m
Simulation Area Size	500 * 500
Node speed	20 m/s
Mobility model	Random way point
Interface type	LL

8.1 Scenario 1: In this scenario, number of nodes connected in a network at a time is varied and thus varying the number of connections, through which the comparison graphs of AODV, DSDV and DSR, is obtained. In this scenario, total number of nodes in the network at a time remains fixed and thus varying pause time of the network.

Table 2: Parameter Values for Varying the Pause Time in the Network.

PARAMETER	VALUE
Number of Nodes	50
Simulation Time	100 sec
Routing Protocol	AODV,DSDV,DSR
Simulation Model	Two Ray Ground
MAC Type	802.11
No. of connection	10
Link Layer Type	LL
Interface Type	Queue
Traffic Type	CBR or TCP
Packet size	512 MB
Queue Length	50
Pause Time	10,30,50,70,90 sec
Node speed	20 m/s

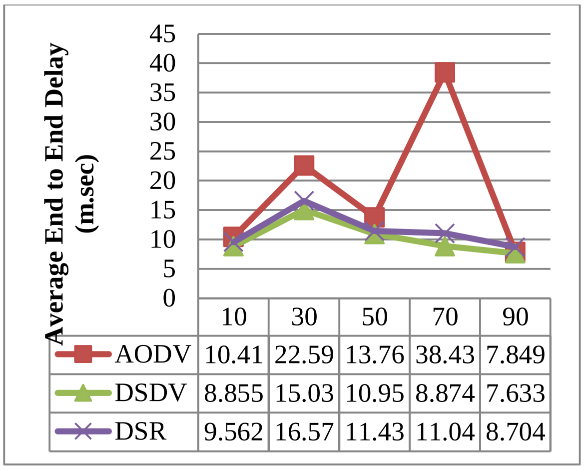

Figure 2: Average End To End Delay for AODV, DSR, and DSDV by varying pause time in the network.

Average End To End Delay: DSR & DSDV performs almost same almost same whereas AODV serves the best among all the protocols with decrease in increasing the variation of pause time.

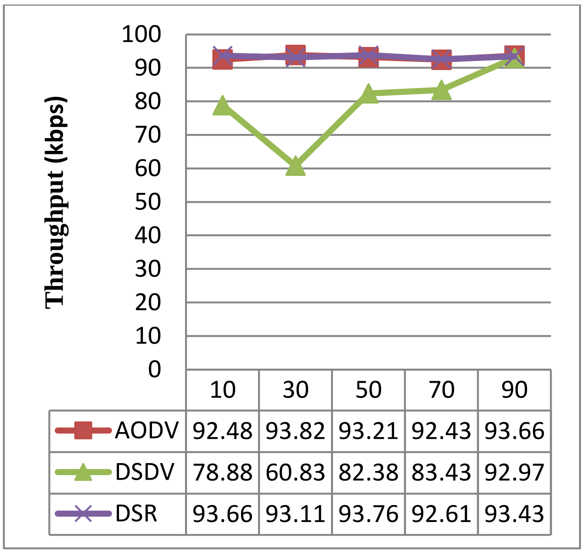

Figure 3: Throughput for AODV, DSR, and DSDV by varying pause time in the network.

Throughout: AODV & DSR performs same while varying the pause time. DSDV outperforms all the protocols in all condition. AODV & DSR shows better performance than DSDV routing protocols.

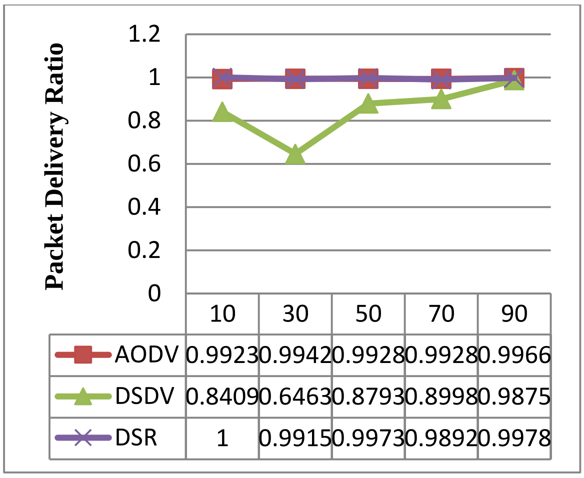

Figure 4: Packet Delivery Ratio for AODV, DSR, and DSDV by varying pause time in the network.

Packet Delivery Ratio: AODV & DSR serves the best among the DSDV protocols while varying the pause time. It performs constantly in all condition whereas DSDV performs better than both AODV & DSR routing protocols.

CONCLUSIONS AND FUTURE WORK

Conclusion: AODV shows the best performance with its ability to maintain connection by periodic exchange of information required for TCP network. AODV perform best in case of varying packet size and packet delivery fraction. DSDV outperform other in case of throughput. DSDV and DSR as in high mobility environment topology change rapidly and AODV can adapt to the changes, varying pause time. DSDV outperform other in case of throughput. At higher node mobility AODV is worst in case of end to end delay but performs best in packet delivery fraction. DSDV performs better than AODV for higher node mobility. In case of throughput DSR performs best but overall AODV outperforms DSDV and DSR as a high mobility environment topology change rapidly and AODV can adapt to the changes, but with taking everything in to account DSDV is better than other. Hence for real time traffic DSDV is preferred over DSR and AODV.

Finally, from the above research work performance of AODV is considered best for real time and TCP network. In all the parameters AODV outperforms other than two DSDV and DSR routing protocols.

Future work: In this research work for only three routing protocol and its scenario for different parameters are taken for the comparison of the AdHoc routing protocols. As day-to-day new challenges come with new technology and advancement in the ad-hoc networks fields. So, in future more simulation can be done to investigate, the performance of routing protocols also with multimedia, and HTTP and TCP traffic under different mobility models using more advance network simulators.. Simulation tool other than ns2 can be used and the windows platform can be used for implementing the simulation instead of Linux.

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