Performance Evaluation of Reactive and Proactive Routing Protocols over MANET

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ABSTRACT

Mobile devices are the fundamental requirement of communication network where user wants to freely move without breaking the signal. The Mobile devices today are capable enough to communicate independently. A Mobile Ad Hoc Network (MANET) is a group of wireless mobile nodes which can communicate without any pre-existing infrastructure by creating dynamic network. This paper discusses Mobile Ad-Hoc Network (MANET) environment with the varying number of nodes. The research presents the three reactive routing protocols i.e. Dynamic Source Routing (DSR), Destination Sequence Distance Vector and Ad hoc On Demand Distance Vector (AODV) with their results to the MANET in terms of packet delivery ratio, delay, routing load and throughput. Simulation is carried out by NS2 (Network Simulation). The experiment results reflect that AODV performance is better than DSR DSDV.

Keywords

MANET, NS2, DSDV, DSR, AODV, PDR, NRL, Routing protocols.

1. INTRODUCTION

The term 'MANET' stands for Mobile Ad hoc Network. It is a special collection of independent wireless mobile nodes that can communicate each other via radio waves. The advantage of MANET is, one can connect any wireless physical device like computer, PDA, Laptops and our cell phones. Infrastructure of MANET is not fixed. One can establish it, at any time. The major advantage of MANET is, one can create infrastructure at real time and destroy it after completion work. Military and disaster areas are the application example of MANET. MANET provides each node to freely move in any arbitrary fashion, independently. The topology changes frequent and Multi-hop wireless links. Data routed via the intermediate nodes, so each mobile node can be react either as endpoint or as a router to forward the packets to the next node. In contrast to fixed infrastructure networks, MANET requires some fundamental changes to network routing protocols [1] [2].

The Heading-2 defines the Routing protocols of MANET to discover the route between nodes. And Heading-3, defines Performance Metrics (packet delivery ratio, delay, routing load and throughput) in terms of evaluating the performance of three routing protocols. The Heading-4 discusses about the analysis of simulation results.

Fig 1: A Simple Mobile Ad hoc Network

2. ROUTING PROTOCOLS IN MOBILE AD HOC NETWORK

The routing protocols in Mobile Ad-hoc Network can be broadly divided into three categories:

2.1 Proactive or Table-driven routing protocols

Pro-active routing protocol is also known as Table-driven routing protocol because routing protocol requires each node to maintain routing information to the every other node in the network which should be consistent up-to-date routing information. On-demand routing protocols are mainly designed for the purpose is to reduce the overheads in table-driven protocols by maintaining information for active routes and each node to maintain one or more tables to store routing information and responds to changes in network topology by propagating updates throughout the network.

2.1.1 Destination-Sequenced Distance-Vector Routing (DSDV)

The Destination-Sequenced Distance-Vector Routing protocol (DSDV) is a Proactive Routing Protocol. This Proactive routing protocol algorithm is based on the classical Bellman-Ford routing mechanism.

Each node stores information about all destinations and number of hops to each destination in table. Each entry is marked with a unique sequence number. DSDV uses two mechanisms such as full dump and incremental update to reduce network traffic generated by rout updates.

A full dump sends the full routing table to the neighbors whereas in case of incremental update, only those entries are sent from the routing table that has a metric change since the last update and must be fit in a packet. In Incremental update those entries may be included whose sequence number has changed if space is available.

There may be two cases are possible about incremental update and full dump such as -

1. If the network is relatively stable, then incremental updates are sent to avoid extra traffic and full dump relatively refer as infrequent.
2. If the network is changing fast, then incremental packets can grow big and full dumps will refer as more frequent.

DSDV solves the problem of routing loops and count to infinity by associating each route entry with a unique sequence number which indicates that the packet is fresh means same packet is not transmitted again. In DSDV, a sequence number is linked to a destination node, and usually is originated by that node refer as owner. The list which maintained all information about route is called routing table. The routing table consist important information such as IP address of all destinations, hop IP address (which prefers as next), total number of hops to reach the destination, sequence number assigned by the destination node and last it consist the install time.

Updating sends in a proper form of-

<Destination IP address, Destination sequence number, Hop count>

Neighbor nodes utilize receiving updates to compute the routing table entries. If there are any fluctuations or breaks the link between two nodes which shown as in figure 2 “resolving failed links” due to periodic updates then Routing will updates for a given destination. It broadcast to all neighbors and then link will be established to transfer the packet. To prevent a node from announcing a routing path change for a given destination DSDV requires node to wait a settling time before announcing a new route with higher metric for a destination [3].

Fig 2 (a) Link from E to F Breaks

Fig 2(b) F broadcast route request to its neighbor

Fig 2 (c) Links established

2.2 Reactive or On-demand routing protocols

A Reactive routing protocol is also known as On-Demand Routing Protocol. On-Demand is the sense that discovers the routes on demand. It reduces the overheads of Proactive routing protocol such as maintaining the route table or reduces the signaling overhead.

A proactive routing is on-demand routing. This type of routing mainly used to create the route, only when the source node wants to send the data to destination. If a source node does not find the route to the destination then it initiates route discovery process within the network. Once a route has found or established, it is maintained by the form of route maintenance procedure.

Route maintenance check for the destination that is inaccessible along the path from the source or until the route is no longer desired then maintains the route or sends this break information to every other intermediate node for recovery.

Reactive routing protocol consist one drawback of route acquisition latency. Route acquisition latency refers that when corresponding entry is not found then route discovery mechanism takes place due to this it takes a very large amount of time, and for that time the packet should wait till updating of the table [4] [5] [6].

2.2.1 Dynamic Source Routing (DSR)

Dynamic Source Routing is a Reactive routing protocol. The main feature of DSR is to use the source routing. DSR makes very aggressive use of source routing and route caching. It means sender knows the complete route to the destination. These routes are stored in a route cache. When a source node wants to send the data to a destination and it does not know the route then it uses a route discovery process to determine a route. Route discovery works by flooding the network with route request (RREQ) packets. Each node which receives an RREQ it rebroadcasts to the next intermediate nodes unless it reach to the destination. Such a node replies to the RREQ with a route reply (RREP) packet that is routed back to the original source.

For the Route Discovery Route Request and Route Reply both are shown as in figure 3 (a) and (b). RREQ and RREP packets are also source routed. RREQ (S creates route request from S to D (destination node) and RREP (from D Destination to source S). Now another Mechanism of DSR is Route Maintenance. In case of Route Maintenance recover the failure links. If any link on a source route is broken, the source node is notified using a route error (RERR) packet. The source removes that route from cache which consist error then, a new route discovery process must be initiated by the source if this route is still needed which shown as in figure 4 (a) and (b) [7] [8] [9].

Fig. 3 (a) For Route Discovery initiates Route Request (RREQ) in DSR

Fig. 3 (b) For Route Discovery Route Reply (RREP) in DSR

Fig. 4 (a) For Route Maintenance Route Error (RERR) in DSR

Fig. 4 (b) For Route Maintenance broadcast Route Error (RERR) in DSR

2.2.2 Ad hoc On-Demand Distance Vector Routing (AODV)

The Ad-hoc On-Demand Distance Vector (AODV) routing protocol is a Reactive routing protocol which build on the DSDV algorithm. AODV is an just an advancement of DSDV because it minimizes the number of required broadcasts by creating routes on-demand basis, in case of DSDV maintaining a complete list of routes.

Main features of AODV consist such as: each route has a lifetime after which the route expires if it is not used and a route is maintained only when it is used and old and expired routes are never used and AODV maintains only one route between a source-destination pair. AODV does not retransmit data packets that are lost. The overhead packets in AODV are due to RREQ (Route Request), RREP (Route Reply) and RERR (Route Error) messages.

AODV needs less number of overhead packets as compared to proactive protocol such as DSDV.

With increased mobility, the number of overhead packets will also increase due to this it give rise to frequent link breaks and route discovery. AODV uses traditional routing tables, one entry for per destination. AODV relies on routing table entries to propagate an RREP back to the source and, subsequently, to route data packets to the destination. AODV uses sequence numbers maintained at each destination to determine freshness of routing information and to prevent routing loops. All routing packets carry these sequence numbers [10] [11].

2.3 Hybrid routing protocols

Hybrid routing protocol is a combination of both Reactive and Proactive routing protocol. Firstly it performs proactive after that it performs reactive only if route does not exist in routing table so performs route discovery. For this we need to use reactive routing protocol.

3. Performance Metrics

The main goal of this research paper is to evaluate the performance of DSR, DSDV and AODV routing protocols using following metrics:

3.1 Packet Delivery Ratio

The Packet delivery ratio is the ratio of the number of delivered data packet to the destination.

$$PDR = \frac{\sum \text{No. of packet receive}}{\sum \text{No. of packet send}}$$

3.2 End -to-End Delay

End-to-end Delay is referred as the average time taken by a data packet to arrive in the destination. It also includes the delay caused by route discovery process and the queue in data packet transmission. Only the data packets that successfully delivered to destinations that counted.

$$\text{End-to-End Delay} = \frac{\sum (\text{arrive time} - \text{send time})}{\sum \text{No. of connections}}$$

3.3 Normalized Routing Load

The number of routing packets transmitted per data packet delivered at the destination. Each hop-wise transmission of a routing packet is counted as one transmission.

3.4 Throughput

Throughput refers that number of jobs completed in the given unit time. Throughput of the routing protocol means that how many packets are received in particular time interval. The unit of throughput measure in Kilobits per second (Kbps).

(a) PDR v/s No of Nodes for DSR, DSDV & AODV

(b) Delay v/s No of Nodes for DSR, DSDV & AODV

(c) Packet Routing Load v/s No of Nodes for DSR, DSDV & AODV

(d) Throughput v/s No of Nodes for DSR, DSDV & AODV

Fig 5: Graph Results

4. Simulation

The simulations are carried out using Network Simulator-2 (Ns-2.35). Constant bit rate (CBR) traffic was used in the simulation. Simulation was done according to the number of nodes which vary from up to 10, 20, 30, 60, 90 and 120.

One need scenario file or traffic generation file for evaluating the performance of DSR, DSDV & AODV protocol [12].

Traffic generation is achieve by running the CBR generation tcl file consist some parameters. The following line writes in terminal such as:

```
ns cbrgen.tcl
ns cbrgen.tcl -type cbr -nn 10 -seed 1.0 -mc 8 -rate 4.0 >
cbr-10-test.
```

Whereas -

- type – refer as traffic /connection type
- nn –number of nodes
- seed – seed for generating random number .it is used to generate the random starting time of the traffic.
- mc – max. Number of connections
- rate – packet rate = 1/ packet interval.

The our main tcl-script will run, which evaluate the performance metrics –

```
ns wirelessseg.tcl AODV cbr-10-test scen-1-test
```

```
ns wirelessseg.tcl DSR cbr-10-test scen-1-test
```

```
ns wirelessseg.tcl DSDV cbr-10-test scen-1-test
```

Then simulation result will be displayed on terminal. The following table deals with the simulation Parameters which is used during the simulation [13] [14] [15].

TABLE I
SIMULATION PARAMETER

Parameter	Value
Simulator	NS-2.35
Simulator Area	500mX500m
No. of Mobile	10, 20, 30, 60,
Pause Time	80sec
Packet Size	512
Routing Protocols	DSR,DSDV&AOD
Traffic Sources	CBR
Simulation Time	900 Sec.

4.1 Packet Delivery Ratio (PDR)

Figure 5 shows that the Packet delivery ratio for reactive protocols. AODV and DSR were better than the proactive protocol DSDV according to the given table II results. From table II of PDR analysis, one can easily get the result i.e. DSDV Packet delivery ratio is smaller than DSR and AODV. In the given table II PDR analysis for AODV is varies when the number of nodes varies.

TABLE II
PDR ANALYSIS OF DSR DSDV AND AODV

No. of Nodes	DSR	DSDV	AODV
10	99.9963	99.9872	99.9945
20	99.9963	99.989	99.9963
30	99.9963	99.989	99.9982
60	99.9963	99.989	99.9963
90	99.9965	99.989	99.9982
120	99.9945	99.9872	99.6948

4.2 End to End Delay

It is clear from the figure 6 that the lower value of end to end delay means the better performance of the protocol. Here, the DSR consist the better performance as comparisons of other two protocols i.e. DSDV and AODV which is shown as in Table III. From the given table “Delay Analysis of DSR DSDV and AODV” and the graph, one can easily get the delay in AODV is highest among DSR and DSDV. But the values of DSDV are slightly different from DSR so that the result proves the DSR is better than both Reactive (AODV) and Proactive (DSDV) Protocols over varying nodes.

TABLE III
DELAY ANALYSIS OF DSR DSDV AND AODV

No. of Nodes	DSR	DSDV	AODV
10	0.00737725	0.0074916	0.00778237
20	0.00735951	0.00749215	0.00774765
30	0.00735983	0.00751723	0.00742061
60	0.00735772	0.00751006	0.00772536
90	0.00733839	0.00748284	0.00743711
120	0.00733738	0.00749437	0.0122205

4.3 Normalized Routing Load (NRL)

As shown as in figure 7, normalized routing load for DSR is smaller as compare with DSDV and AODV routing protocol. The Routing load for AODV was better than the DSDV protocol because AODV values are smaller then DSDV. Here DSR and AODV perform better result in normalized packet routing Load and DSDV performs higher load as we can see in figure 7.

TABLE IV
NRL ANALYSIS OF DSR DSDV AND AODV

No. of Nodes	DSR	DSDV	AODV
10	0.000146991	0.0653548	0.0100862
20	0.000146797	0.0657169	0.00824689
30	0.000146908	0.0654633	0.0101056
60	0.000147064	0.0653715	0.00824563
90	0.000146897	0.0656368	0.00826386
120	0.000147005	0.0653632	0.00734808

4.4 Throughput

Figure 8 evaluate the performance of three protocols in respect to throughput analysis. So, it is clear from the table statistics that lowest throughput received from the proactive routing protocols. According to results AODV react better in case of throughput analysis.

TABLE V
THROUGHPUT OF DSR, DSDV AND AODV

No. of Nodes	DSR	DSDV	AODV
10	248.404	249.11	248.885
20	248.73	248.912	249.05
30	248.547	248.566	248.441
60	248.278	248.556	249.097
90	248.571	248.177	249.108
120	248.38	249.074	247.478

5. CONCLUSION

In research paper, the evaluation is done by calculating the performance reactive (DSR and AODV) and proactive (DSDV) routing protocols in the terms of four performance metrics i.e. packet delivery ratio, end-to-end delay, normalized routing load and throughput. The results showed that the performance of the two reactive protocols (DSR and AODV) was better than proactive protocol (DSDV). The overall performance of DSR was better than the other two protocols except in the case of throughput. DSR consist lower throughput value which mainly due to caching and lack of mechanisms to expire stale routes. The performance of AODV was comparable to DSR in case of packet delivery ratio and throughput; it was better in case of end to end delay and inferior in case of normalized routing load.

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