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# Evaluation of Routing Protocols in MANETs with Varying Network Scope

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**Abstract.** Mobile ad hoc networks (MANETs) consist of mobile wireless nodes connected in such a manner so that the communication between nodes is carried out without any centralized control. MANETs are self-organized and self-configurable network where mobile nodes move arbitrarily. Routing is a crucial issue in MANETs. Therefore, emphasis in this paper is to evaluate the performance of three routing protocols DSDV, DSR and AODV for Constatnt Bit Rate (CBR) traffic by varying network scope i.e. number of participating nodes. The parameters used for evaluation are packet delivery ratio(PDR), end to end delay(Delay), routing overhead and throughput. The simulations are carried out using Network Simulator NS2.

**Keywords:** MANETs, performance evaluation routing protocols, DSDV, DSR, AODV, NS2.

## 1. Introduction

Mobile Adhoc Networks (MANETs) are a collection of wireless nodes, connected without any infrastructure or any centralized control. In MANETs each node can be used as a router to forward packet to next node. MANETs require fundamental changes to network routing protocols when compared with fixed infrastructure networks. The main characteristics of MANETs are the mobility of nodes, i.e. nodes can move in any direction and at any speed which leads to arbitrary topology and frequent partitioning of the network. This characteristic of the MANETs makes the routing a challenging task.

The organisation of the rest paper is as follows:

Section II discusses the basics of routing protocols in MANETs. Section III describes different parameters used for evaluation of performance of routing protocols. Section IV presents the simulation environment followed by performance evaluation results of routing protocols. Finally section V concludes the paper.

## 2. Routing Protocols in Mobile ADHOC Network

Routing protocols in mobile ad-hoc networks can broadly be divided into two categories [1]:

- Proactive or table-driven routing protocols
- Reactive or on-demand routing protocols

Pro-active or table-driven routing protocols require each node to maintain up-to-date routing information to every other node (or nodes located within a specific region) in the network. On-demand routing protocols on the other hand are designed to reduce the overheads of table-driven protocols by maintaining information for active routes only as and when required.

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## 2.1. Table-Driven routing protocols

The table-driven routing protocols attempts to maintain consistent, up-to-date routing information from each node to every other node in the network [2]. These protocols require 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 in order to maintain a consistent network view.

**Destination-Sequenced Distance-Vector Routing (DSDV).** The Destination-Sequenced Distance-Vector Routing protocol (DSDV) is a table driven algorithm based on the classical Bellman-Ford routing mechanism [3]. The improvements made to the Bellman-Ford algorithm include freedom from loops in routing tables. Every mobile station maintains a routing table that lists all available destinations, the number of hops to reach the destination and the sequence number assigned by the destination node. 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 neighbours. A station also transmits its routing table if a significant change has occurred in its table from the last updates communicated earlier. So, the updates are both time-driven and event-driven. The routing table updates can be circulated in two ways: a "full dump" or an incremental update. A full dump sends the full routing table to the neighbours 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 updated 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.

## 2.2. Source-Initiated on-demand routing protocols

A different approach from table-driven routing is source-initiated on-demand routing. This type of routing creates 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. This process is completed once a route is found or all possible route permutations have been examined. Once a route has been established, some form of route maintenance procedure maintains it until either the destination becomes inaccessible along every path from the source or until the route is no longer desired.

**ADHOC On-Demand Distance Vector Routing (AODV).** The Ad-hoc On-Demand Distance Vector (AODV) routing protocol is build on the DSDV algorithm as described previously. AODV is an improvement on DSDV because it typically minimizes the number of required broadcasts by creating routes on an on-demand basis, as opposed to maintaining a complete list of routes in the DSDV [4]. It uses traditional routing tables, one entry per destination. This is in contrast to DSR, which can maintain multiple route cache entries for each destination. Without source routing, 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 [9]. An important feature of AODV is the maintenance of timer-based states in each node, regarding utilization of individual routing table entries. A routing table entry is expired if not used recently. A set of predecessor nodes is maintained for each routing table entry, indicating the set of neighbouring nodes which use that entry to route data packets. These nodes are notified with RERR packets when the next-hop link breaks. Each predecessor node, in turn, forwards the RERR to its own set of predecessors, thus effectively erasing all routes using the broken link. In contrast to DSR, RERR packets in AODV are intended to inform all sources using a link when a failure occurs. Route error propagation in AODV can be visualized conceptually as a tree whose root is the node at the point of failure and all sources using the failed link as the leaves.

**Dynamic Source Routing (DSR).** The key distinguishing feature of DSR is the use of source routing [6]. That is, the sender knows the complete hop- by-hop route to the destination [10]. These routes are stored in a route cache. The data packets carry the source route in the packet header. When a node in the ad hoc network attempts to send a data packet to a destination for which it does not already know the route, it uses a route discovery process to dynamically determine such a route. Route discovery works by flooding the network with route request (RREQ) packets. Each node receiving an RREQ rebroadcasts it, unless it is the destination or it has a route to the destination in its route cache. Such a node replies to the RREQ with a route reply (RREP) packet that is routed back to the original source. RREQ and RREP packets are also source routed. The RREQ builds up the path traversed across the network. The RREP route itself backs to the source by traversing this path backward. The route carried back by the RREP packet is cached at the source for future use. If any link on a source route is broken, the source node is notified using a route error (RERR) packet. The source removes any route using this link from its cache. A new route discovery process must be initiated by the source if this route is still needed. DSR makes very aggressive use of source routing and route caching.

## 3. Performance METRICS:

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

### 3.1. End-to-End delay

Network delay is the total latency experienced by a packet to traverse the network from the source to the destination. At the network layer, the end-to-end packet latency is the sum of processing delay, transmission delay, queuing delay and propagation delay [7]. The end-to-end delay of a path is the sum of the node delays at each node plus the link delay at each link on the path.

### 3.2. Throughput

Throughput of the routing protocol means that in certain time the total size of useful packets received at all the destination nodes. The unit of throughput is Kilobits per second (Kbps).

### 3.3. Packet delivery fraction

The ratio of the data packets delivered to the destinations to those generated by the Constant Bit Rate (CBR) source is known as packet delivery fraction.

### 3.4. Routing overhead

It gives the total number of routing packets transmitted during the simulation. It is the ratio of routing packets to the total number of packets generated by the source.

## 4. Simulation

The simulations were performed using Network Simulator 2 (Ns-2.34)[8]. traffic used in simulation was Constant bit rate (CBR). Simulations were done by varying number of nodes from 10, 20, 30, 40, 60  to 80. The pause time was kept constant at 100 sec in a simulation area of 500mX500m. During the simulation, each node started its journey from a random spot to a random destination. Once the destination was reached, the node took a rest period in second and another random destination was chosen after that pause time. This process was repeated throughout the simulation, causing continuous changes in the topology of the underlying network. The following table gives the simulation parameters used during the simulation.

Table. 1: Simulation Parameters

| Parameter | Value |
|---|---|
| Simulator Area | 500mX500m |
| No. of Mobile Nodes | 10, 20, 30, 40, 60, 80 |
| Packet Size | 512 |
| Pause Time | 100sec |
| Routing Protocols | DSDV, AODV & DSR |
| Traffic Sources | CBR |
| Max. Speed | 20 m/s |

### 4.1. Packet delivery ratio

Figure 1 depicts that the packet delivery ratio for reactive protocols were better than the proactive protocol. The packet delivery ratio for reactive protocols gradually started from 0.95 for 10 number of nodes and later approached to unity for higher node density. The value of PDR for DSDV also increased proportionally with number of nodes. Further the PDR for DSR was slightly higher than the AODV protocol.

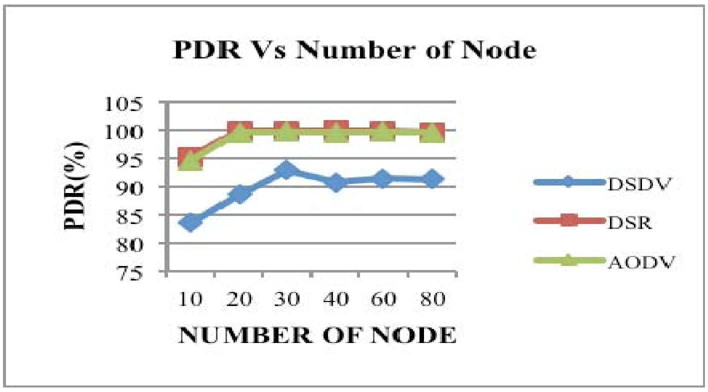


Fig. 1: Packet Delivery Ratio Vs Number of nodes for DSDV, DSR and AODV

## 4.2. End to end delay

Figure 2 represents the end to end delay results. AODV protocol has the lowest delays, although the delays for DSDV was better than the DSR protocol. In DSDV protocol, routes to every destination were always available and up-to-date hence, end-to-end delay was better than DSR.

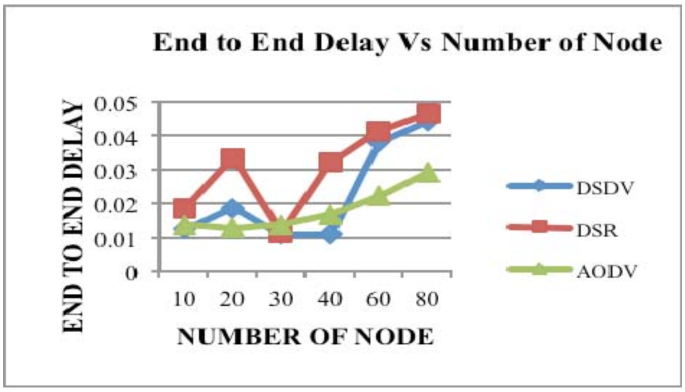


Fig. 2: End to End Delay Vs Number of Nodes for DSDV, DSR and AODV

## 4.3. Routing overhead

Figure 3 shows that routing overhead for DSR was minimum when compared with other two protocols. Though the routing overhead for AODV was better than the DSDV protocol. The routing overhead was low for lesser number of nodes. The overhead increased with increased number of nodes.

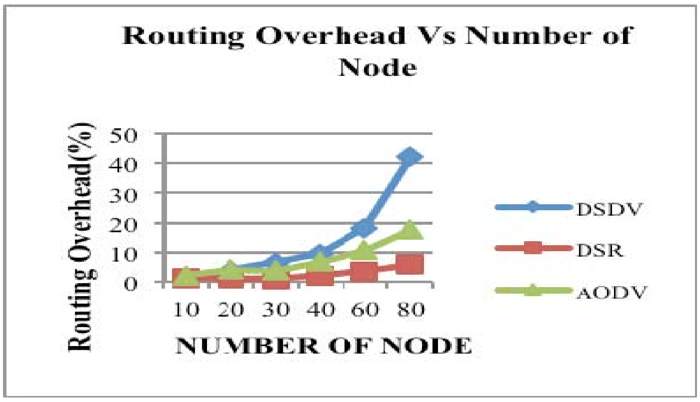


Fig. 3: Routing Overhead Vs Number of Nodes for DSDV, DSR and AODV

## 4.4. Throughput

Figure 4 presents the comparison of three protocols for throughput metrics. The figure depicts that throughput was lowest for proactive protocols than reactive protocols. Further, the throughput was more for DSR protocol when compared with AODV protocol.

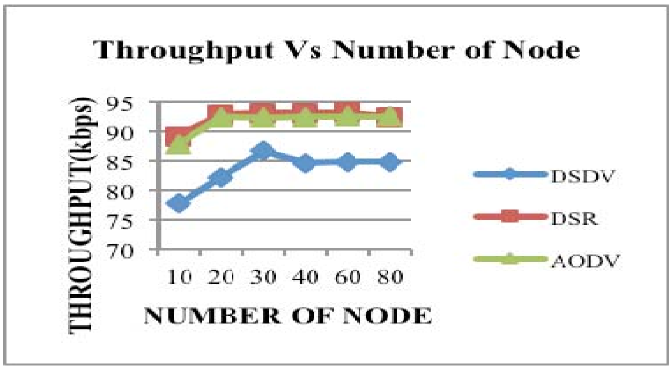

Fig. 4: Throughput Vs Number of Nodes for DSDV, DSR and AODV

## 5. Conclusion

In this research analysis the simulations are performed to compare the performance of on-demand routing protocols (DSR and AODV) and table driven (DSDV) routing protocols on different performance parameters i.e. packet delivery ratio, end-to-end delay, routing overhead and throughput. The results showed that the performance of the reactive protocols (DSR and AODV) was better than DSDV. The higher value of delay in DSR was mainly due to caching and lack of mechanisms to expire stale routes. The performance of AODV was comparable to DSR in metrics of packet delivery ratio and throughput.

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