# Simulation and Performance Analysis of CORMAN, AODV and DSR Routing Protocol in MANET

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## ABSTRACT

A Mobile Ad-hoc Network (MANET) consists of a number of mobile wireless nodes, the communication between these mobile nodes is carried out without any centralized control. MANET is a self organized, self configurable and multihop network where the mobile nodes move arbitrarily. The mobile nodes can receive and relay packets as a router. Routing is a critical issue and an efficient routing protocol makes the MANET reliable and utilize the broad cast nature of the Manet for the same. There are two features of MANET - absence of fixed infrastructure. & absence of central administration. In this paper we discuss about simulation & comparison of the performance between three types of routing protocols, CORMAN (Co-operative Opportunistic Routing Scheme in MANET) , AODV (Ad hoc On-Demand Distance Vector ) & DSR (Dynamic Source Routing) using the NS-2 (2.26) simulation tool. These routing protocols compared in terms of packets delivery ratio, average delay, Delay variance and speed.

**Keywords :** Ad hoc Network, Manet, CORMAN, AODV and DSR routing Protocol, cooperative communication, opportunistic forwarding, Proactive source routing , Forward List Adaption.

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## 1 INTRODUCTION

A Mobile ad hoc network is decentralized form of network. The network is ad hoc because it does not rely on a preexisting infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks. Instead, each node participates in routing by forwarding data for other nodes, so the determination of which nodes forward data is made dynamically on the basis of network connectivity. Each node will be able to communicate directly with any other node that resides within its transmission range. For communicating with nodes that reside beyond this range, the node needs to use intermediate nodes to relay the messages hop by hop [1].

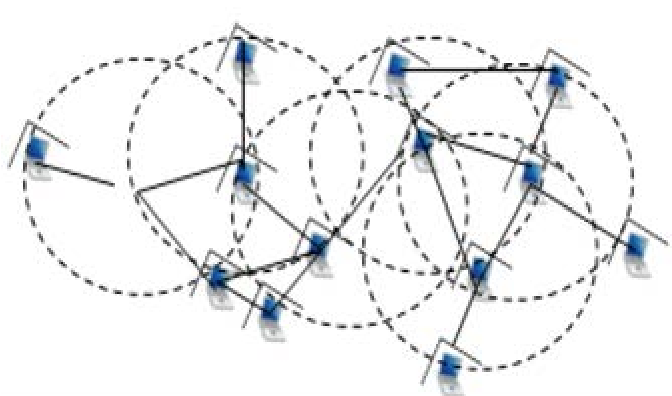

FIG [1] Infrastructureless Networks (MANETS)

Nodes in the ad hoc network also functions as routers that discover and maintain routes to other nodes in the network. Thus, the primary goal of the MANET is to establish a correct and efficient route between a pair of correct and efficient route between a pair of nodes and to ensure the correct and timely delivery of packets. A *routing protocol* is needed whenever a packet needs to be transmitted to a destination via number of nodes and numerous routing protocols have been proposed for such kind of ad hoc networks. These routing protocols find a route for packet delivery and deliver the packets to the correct destination.

## 2 ROUTING PROTOCOLS IN MANET

There are several routing protocols proposed in the MANET but here we are considering the new opportunistic routing scheme CORMAN, the widely adopted AODV protocol and the DSR protocol in MANET.

### 2.1 CORMAN

CORMAN [2], the novel cooperative opportunistic scheme in MANET forwards data in a similar batch-operated fashion as ExOR [3]. A flow of data packets are divided into batches. All packets in the same batch carry the same forwarder list when they leave the source node. CORMAN is supported by an underlying routing protocol, *Proactive Source Routing* (PSR), which provides each node with the complete routing information to all other nodes in the network. Thus, the forwarder list contains the identities of the nodes on the path from the source node to the destination. As packets progress in the network, the nodes listed as forwarders can modify the forwarder list if any topology change has been observed in the

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network. This is referred as *large-scale live update.* In addition, CORMAN also allow some other nodes that are not listed as forwarders to retransmit data if this turns out to be helpful, referred to as *small-scale retransmission.*

### 2.1.1 Proactive Source Routing (PSR)

PSR runs in the background so that nodes periodically exchange network structure information. It converges after the number of iterations equal to the network diameter. At this point, each node has a spanning tree of the network indicating the shortest paths to all other nodes. PSR is inspired by path finding [4], [5] and link-vector [6] algorithms but is lighter weight. Technically, PSR can be used without CORMAN to support conventional IP forwarding.

### 2.1.2 Large-Scale Live Update

When data packets are received by and stored at a forwarding node, the node may have a different view of how to forward them to the destination from the forwarder list carried by the packets. Since this node is closer to the destination than the source node, such discrepancy usually means that the forwarding node has more updated routing information. In this case, the forwarding node updates the part of the forwarder list in the packets from this point on towards the destination according to its own knowledge. When the packets with this updated forwarder list are broadcast by the forwarder, the update about the network topology change propagates back to its upstream neighbor. The neighbor incorporates the change to the packets in its cache. When these cached packets are broadcast later, the update is further propagated towards the source node. Such an update procedure is significantly faster than the rate at which a proactive routing protocol disseminates routing information.

### 2.1.3 Small Scale Retransmission

A short forwarder list forces packets to be forwarded over long and possibly weak links. To increase the reliability of data forwarding between two listed forwarders, CORMAN allows nodes that are not on the forwarder list but are situated between these two listed forwarders to retransmit data packets if the downstream forwarder has not received these packets successfully. Since there may be multiple such nodes between a given pair of listed forwarders, CORMAN coordinates retransmission attempts among them extremely efficiently.

## 2.3 DSR

The key distinguishing feature of DSR [7] is the use of *source routing*. That is, the sender knows the complete hop-by-hop route to the destination. 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 a 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 routes itself back to the source by traversing this path backwards.1 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. No special mechanism to detect routing loops is needed. Also, any forwarding node caches the source route in a packet it forwards for possible future use. Several additional optimizations have been proposed and have been evaluated to be very effective by the authors of the protocol [8], as described in the following. (i) *Salvaging*: An intermediate node can use an alternate route from its own cache, when a data packet meets a failed link on its source route. (ii) *Gratuitous route repair*: A source node receiving a RERR packet piggybacks the RERR in the following RREQ. This helps clean up the caches of other nodes in the network that may have the failed link in one of the cached source routes. (iii) *Promiscuous listening*: When a node overhears a packet not addressed to itself, it checks whether the packet could be routed via itself to gain a shorter route. If so, the node sends a *gratuitous* RREP to the source of the route with this new, better route. Aside from this, promiscuous listening helps a node to learn different routes without directly participating in the routing process.

## 2.4 AODV

AODV [9, 10] shares DSR's on-demand characteristics in that it also discovers routes on an "*as needed*" basis via a similar route discovery process. However, AODV adopts a very different mechanism to maintain routing information. 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 a 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 [9]. These sequence numbers are carried by all routing packets. 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 neighboring nodes that 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

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the leaves. The recent specification of AODV includes an optimization technique to control the RREQ flood in the route discovery process. It uses an *expanding ring search* initially to discover routes to an unknown destination. In the expanding ring search, increasingly larger neighborhoods are searched to find the destination. The search is controlled by the Time To-Live (TTL) field in the IP header of the RREQ packets. If the route to a previously known destination is needed, the prior hop-wise distance is used to optimize the search. This enables computing the TTL value used in the RREQ packets dynamically, by taking into consideration the temporal locality of routes.

## 3 Proposed Problem and solution

The objective of this paper is to study the comparison in mobile ad hoc networks and evaluate proposed routing protocols for wireless ad hoc networks based on performance. This evaluation could be done through simulation. The work comprises to simulate and implement Mobile Ad Hoc Routing protocol and detect the various possible properties of various protocols. The simulation environment that could be used as a platform is based on Network Simulator ns2 (2.26). The IETF currently has a working group named Mobile Ad hoc Network (MANET) that is working on routing specifications for Ad hoc Networks. Mobile networks that meet the demand for instantaneous communications establishment are called Mobile Ad hoc Networks [10]. Like the Internet, datagram in an ad hoc network may travel along multiple hops until they reach their destination. In adhoc networks, routing is a major challenge. Several routing protocols for ad hoc networks emphasis on stable and shortest routes while ignoring major issue of delay in response whenever break occurs. Some other areas of consideration are:-

- A general understanding of ad- hoc networks.
- Security issues in ad hoc networks
- Implement some of the proposed routing protocols for wireless networks
- Analyze the protocols through simulation in different mobility scenarios.

## 4 Comparison Performance Analysis of CORMAN, AODV and DSR.

In this section we perform the simulation of the three proposed routing protocol and do the comparison analysis for the proposed protocols.

### 4.1 Experiment setting

In this analysis we choose the Two-Ray Ground reflection model for channel propagation model which has been the predominant model. In ns-2, when a node has received a packet, it first calculates the received power using path loss based on the Frii Free-Space model which then is used to decide either to receive the packet or discard the same. We configure the nominal data rate 802.11 links to 1 Mbps In modeling node motion, we adopt the random waypoint model to generate the simulation scenarios. In this model, each node moves towards a series of target positions. The rate of velocity for each move is uniformly selected from [0, *v*max]. Once it has reached a target position, it may pause for a specific amount of time before moving towards the next position. In our tests, we have two series of mobile scenarios using this mobility model. The first series of scenarios have a fixed *v*max, a constant number of nodes, but varying network dimensions. The second series have the same network size and dimension but varying *v*max. We inject CBR (constant bit rate) data flows in the network, which are carried by UDP. Specifically, a source node generates 50 packets every second, each has a payload of 1000 bytes. This translates to a traffic rate of 400 kbps injected by a node. When comparing CORMAN to AODV and DSR we record the packet delivery ratio (PDR), *i.e.* the fraction of packets received by the destination out of all the packets injected, and end-to-end delay average and variance. We observe that AODV outperforms DSR and CORMAN outperforms both AODV, DSR in terms of all of these metrics.

### 4.2 Performance Verses Network Density

We first compare the performance of CORMAN, AODV and DSR with different network Density. Specifically, we have network topographies of $l \times l$ (m2), where $l = 300$. We deploy varying node initially from 50 nodes in the network dimensions to test the protocols with differing node densities. These nodes move following the random waypoint model with *v*max = 10 m/s. For each dimension scenario, we test CORMAN AODV's and DSR's capabilities in transporting CBR data flows between a randomly selected source-destination pair. We repeat this process 5 times for a given scenario. We measure the PDR and end-to-end delay for all three protocols and average them over the 5 repetitions of each scenario, as plotted in Figures 2, 3 respectively. We observe that CORMAN has a PDR (Figure 3) of about 90% for dense networks. In contrast, AODV's PDR ranges between 68% and 70% for dense networks and DSR is having very low PDR which is about 52% to 57%.

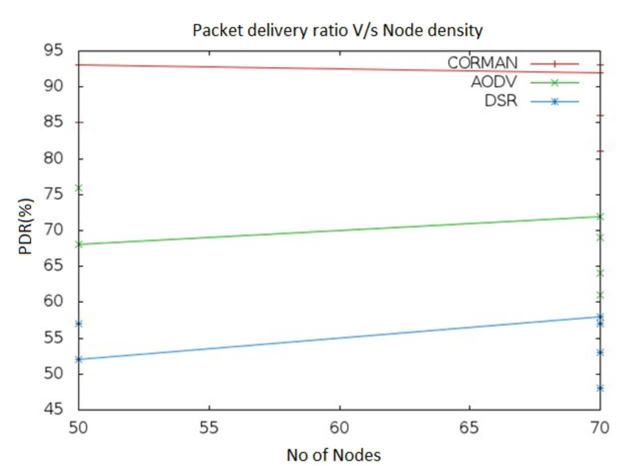


Fig. 2. Packet delivery ratio v/s Network Density

(We use a red plotting series to indicate the relative perfor-

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mance of CORMAN over PDR in all of our figures.) There are two reasons for the PDR penalty for AODV to operate in sparse networks. First, data packets are forwarded using traditional IP forwarding in AODV. When channel quality a packet may be lost at the link layer. After a few failed retransmits, it will be dropped by the network layer. CORMAN, however, is designed to utilize such link effects so that at least one downstream node would be available despite the link variation. Hence the CORMAN has the high PDR when compared to AODV, which has better PDR than DSR. Figure 3 presents the end-to-end delay of these protocols in different node density scenarios. We see that, when the node density is higher, CORMAN has a shorter delay than AODV and DSR.

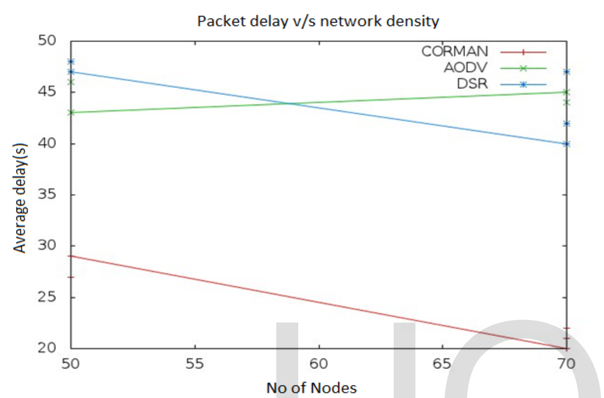


Fig. 3. Packet Delay v/s Network Density

## 4.3 Performance Verses velocity

We also study comparison of CORMAN's, AODV and DSR performance to AODV in different rates of node velocity.

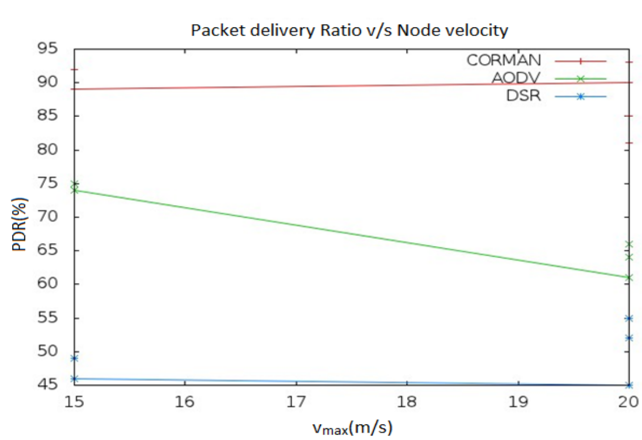


Fig. 4. Packet Delivery ratio v/s Node velocity

We conduct another set of tests in a network of 50 nodes deployed in a 300 × 300 (m2) space with a varying *v*max, where *v*max = 15, 16, 17. . . 20 (m/s). For each velocity scenario, we test CORMAN's, AODV's and DSR's performance in transporting CBR data flows again between a randomly selected source destination pair. We repeat this process 5 times for a given scenario. We collect the PDR, end-to-end delay, and delay jitter for both protocols averaged over each scenario, and plot them in Figures 4, 5, and 6, respectively. From Figure 6, we observe that CORMAN's PDR is constantly around 90% while that of AODV varies between 75% and 57% and that of DRS's is very low PDR around 30% to 45%. Compared to AODV and DSR, CORMAN has only a fraction of the end-to-end delay and variance (Figures 5 and 6) for two reasons. First, the opportunistic data forwarding scheme in CORMAN allows some packets to reach the destination in fewer hops than AODV and DSR. Second, the proactive routing (PSR) in CORMAN maintains full-on route information.

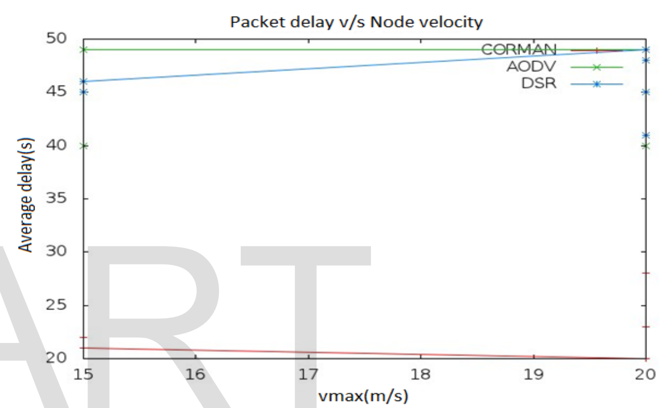


Fig. 5. Packet Delay v/s node velocity.

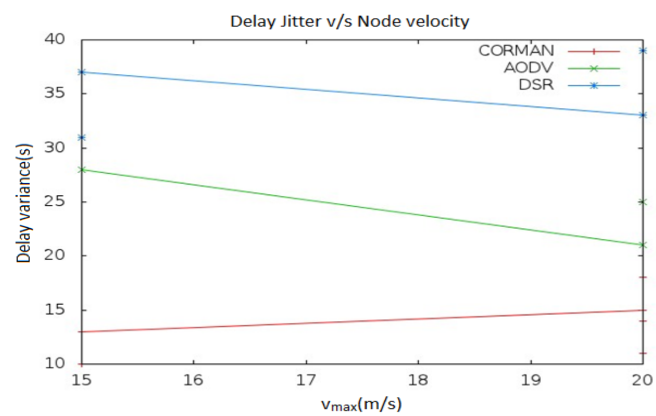


Fig. 6. Delay variance v/s Node velocity

## 5 CONCLUSION

This paper presents a comparison of performance by simulation of routing protocols CORMAN, AODV and DSR which are proposed for ad-hoc mobile networks and reveals their

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packet delivery ratio, delay, and Delay variance. The performance of these protocols is analyzed with NS2 simulator. The observations are made with variation in number of nodes and node speed in network. After analysis in different situations of network it is to be observed that CORMAN perform better than AODV and DSR in terms of Packet delivery ratio and average delay.

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