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# Evaluation of Mobile nodes over Different Density Models using MANET Routing Protocols

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*Abstract*— **A mobile ad hoc network (MANET) is a collection of wireless dynamic mobile nodes forming a network Topology without the use of any existing network infrastructure or centralized administration. Each node participating in the network acts both as host and a router and must therefore is willing to forward packets for other nodes. Random waypoint is the most common mobility model in most of the simulation based studies of various MANET routing protocols. The existence of number of nodes in a square are can define the density of node. In the present communication PDR, Average End to End delay, Average Throughput, Normalized Routing Load and number of Drop packets in CBR traffic model with Low, Medium and High Density Models are measured using routing protocols namely AODV and OLSR. Research efforts have focused much in evaluating their performance when applied to different density (number of nodes in a area) and constant pause times, We perform extensive simulations using NS-2 simulator**

*Keywords- **MANET, CBR Traffic, Low Density, Medium Density, High Density, PDR, NS-2.***

## 1. INTRODUCTION

A Mobile Ad hoc Networks (MANET) represents a system of wireless mobile nodes that can freely and dynamically self-organize in to arbitrary and temporary network topologies, allowing people and devices to seamlessly communicate without any pre-existing communication architecture. Such infrastructure less networks are usually needed in battlefields, disaster areas, and meetings, because of their capability of handling node failures and fast topology changes. The most important characteristics are dynamic topology, where nodes can change position quite frequently, so we require such routing protocol that quickly adapts to topology changes.

Normal routing protocol, which works well in fixed networks does not show same performance in Mobile ad-hoc Networks. In MANET routing protocols should be more dynamic so that they quickly respond to topological changes[1].

MANET routing protocol must have the following characteristics:

1) Keep the routing table up-to-date and reasonably small,
2) Select the best route for given destination and
3) Converge within an exchange of a small amount of messages[2].

Hassan et. al.[3] have studied performance of mobility speed over MANET routing protocols with random waypoint model. In the present paper, we have compared two routing protocols (AODV and OLSR) with CBR traffic under Low, Medium and High density models. PDR, Average End to End delay, Average Throughput, Normalized Routing Load and number of Drop packets has been evaluated as the function of density and constant pause time..

This paper is organized in five sections. Section 2 gives brief description of studied routing protocols. Section 3 describes simulation environment, CBR traffic, density models and performance metrics. Simulation results are discussed in section 4. Section 5 describes our conclusion and future scope.

## 2. DESCRIPTION OF MANET ROUTING PROTOCOLS

Description of routing protocols AODV and OLSR in brief are as follows:

### 2.1. AODV (Ad-hoc On demand Distance Vector)

AODV[4] is a reactive protocol, which performs Route Discovery using control messages route request (RREQ) and route reply (RREP) whenever a node wishes to send packets to destination. To control network wide broadcasts of RREQs, the source node uses an expanding ring search technique. The forward path sets up an intermediate node in its route table with a lifetime association RREP. When either destination or intermediate node using moves, a route error (RERR) is sent to the affected source node. When source node receives the (RERR), it can reinitiate route if the route is still needed. Neighborhood information is obtained from broadcast Hello packet. As AODV protocol is a flat routing protocol it does not need any central administrative system to handle the routing process. AODV tends to reduce the control traffic messages overhead at the cost of increased latency in finding new routes. The AODV has great advantage in having less overhead over simple protocols which need to keep the entire route from the source host to the destination host in their messages. The RREQ and RREP messages, which are responsible for the route discovery, do not increase significantly the overhead from these control messages. AODV reacts relatively quickly to the topological changes in the network and updating only the hosts that may be affected by the change, using the RRER message. The Hello messages, which are responsible for the route maintenance, are also limited so that they do not create unnecessary overhead in the network. The AODV protocol is a loop free and avoids the counting to infinity problem, which were typical to the classical distance vector routing protocols, by the usage of the sequence numbers [5].

### 2.2. OLSR (Optimized Link State Routing Protocol)

OLSR is a proactive routing protocol, so the routes are always immediately available when needed. It is an optimization version of a pure link state protocol. So the topological changes cause the flooding of the topological information to all available hosts in the network. To reduce the possible overhead in the network protocol uses Multipoint Relays (MPR). The idea of MPR is to reduce flooding of broadcasts by reducing the same broadcast in some regions in the network, another reduce is to provide the shortest path. The reducing the time interval for the control messages transmission can bring more reactivity to the topological changes. OLSR [6] uses two kinds of the control messages: Hello and Topology Control (TC). Hello messages are used for finding the information about the link status and the host's neighbors. TC messages are used for broadcasting information about own advertised neighbors which includes at least the MPR Selector list. OLSR protocol requires each host periodically to send the updated topology information throughout the entire network. This increases the protocols bandwidth usage.

## 3. SIMULATION ENVIRONMENT

The simulation is done with the help of NS-2 simulator version 2.34 [7]. The network contains 10, 30 and 50 nodes randomly distributed in a 800m X 800m area with speed of 2m/s, 20m/s and 50m/s as basic scenario. The simulation time is 100s.

| Parameter | Value |
|---|---|
| No. of nodes | 10, 30, 50 |
| Simulation Time | 100s |
| Mobility Speed | 2m/s, 20m/s, 50m/s |
| Traffic Type | CBR |
| Packet Size | 512byte |
| Wireless Range | 250m |

**Table 1: Basic Simulation Scenario**

### 3.1. CBR Traffic

CBR generates traffic at a deterministic rate. It is not an ON/OFF traffic. It consists of randomly chosen source-destination pairs as the traffic pattern.

### 3.2. Density Model

Density means number of node in a square area. In our studies we have considered two models, defined as –

#### 3.2.1. Low Density Model

Low density model uses 10 nodes in 800m X 800m area.

#### 3.2.2. Medium Density Model

Medium density model uses 30 nodes in 800m X 800m area.

#### 3.2.3. High Density Model

High density model uses 50 nodes in 800m X 800m area.

### 3.3. Performance Metrics

In present performance metrics, that we have been used for performance evaluation of ad-hoc network protocols. The following metrics are applied to comparing the protocol performance. These metrics are suggested by MANET working group for routing protocol evaluation [8].

**Average Throughput:** The sum of the data packets generated by every source, counted by k bit/s.

**Average End to End Delay:** This includes all possible delays caused by buffering during routing discovery latency, queuing at the interface queue, and retransmission delays at the MAC, propagation and transfer times.

**Packet Delivery Ratio:** The ratio between the number of data packets originated by the "application layer" CBR sources and the number of data packets received by the CBR sink at the final destination [9].

**Normalized Routing Load:** The sum of the routing control messages such as RREQ, RREP, RRER, HELLO etc, counted by k bit/s.

**Number of Drop Packets:** The number of the data packets originated by the sources failure to deliver to the destination.

## 4. RESULTS

We have made an attempt to evaluate the performance of one reactive routing protocol, AODV and one proactive routing protocol, OLSR over low, medium and high density in a area of 800m x 800m with node mobility speed of 2m/s, 20m/s and 50m/s. The results, which obtain are as discussed.

The Average Throughput with mobility speed of AODV and OLSR with Low, Medium and High density are shown in the figure 1.

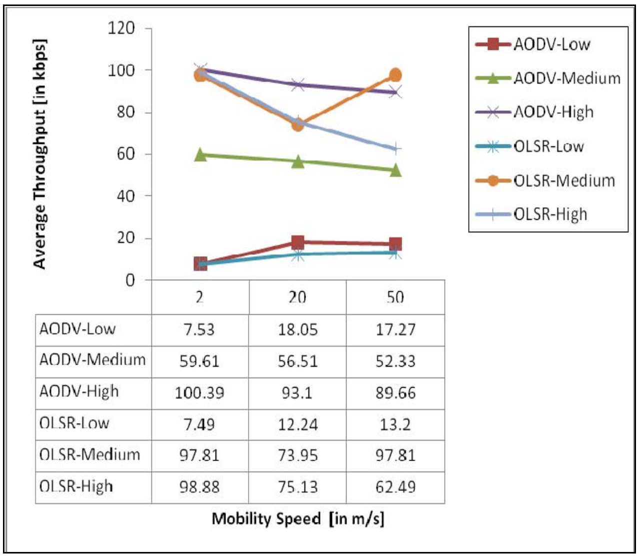
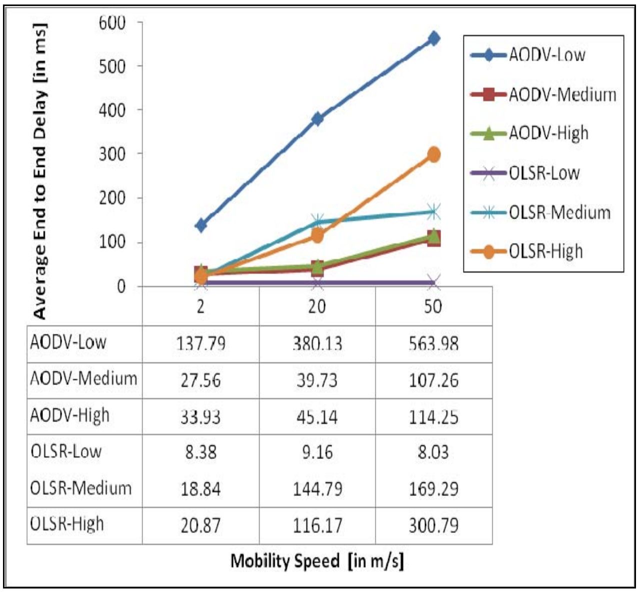



**Figure 1: Average Throughput with mobility speed of AODV and OLSR with Density Models**

Figure 1 shows that Average throughput performance of AODV with Low Density is more than the OLSR with Low Density with increasing mobility speed. The Average throughput performance of AODV with Medium Density is less than the OLSR with Medium Density with increasing mobility speed. The Average Throughput with Low Density is less than High Density along with both the protocols. In Low Density Average Throughput is slightly increased with increasing mobility speed, which becomes nearly constant with high mobility speed. In High Density Average Throughput is decreased with increasing mobility speed. At Low and High Density AODV perform well over the OLSR in terms of Average Throughput while at Medium Density OLSR perform well over the AODV.

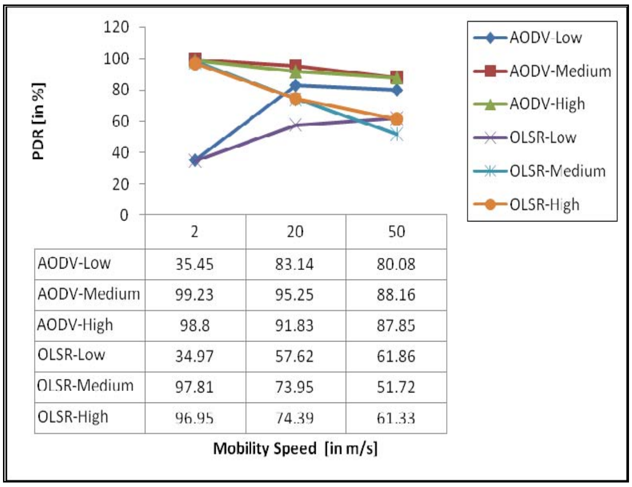



| | 2 | 20 | 50 |
|---|---|---|---|
| AODV-Low | 137.79 | 380.13 | 563.98 |
| AODV-Medium | 27.56 | 39.73 | 107.26 |
| AODV-High | 33.93 | 45.14 | 114.25 |
| OLSR-Low | 8.38 | 9.16 | 8.03 |
| OLSR-Medium | 18.84 | 144.79 | 169.29 |
| OLSR-High | 20.87 | 116.17 | 300.79 |

**Figure 2: Average End to End Delay with mobility speed of AODV and OLSR with Density Models**

Figure 2 shows that Average End to End Delay performance of both AODV and OLSR with Low, Medium and High Density. The Average End to End delay of AODV and OLSR with Low and High Density are contrast with each other. In Medium Density OLSR perform well over AODV in term of Average End to End Delay at low mobility, but increasing mobility shows that AODV perform well over OLSR. Average End to End Delay of OLSR with Low Density is less and remains similar with increasing mobility speed. Both the protocols with High Density and AODV with Low Density shows increment in Average End to End Delay with increment in mobility speed. The OLSR protocol performs well over the AODV because it performs less End to End Delay along with Low mobility. The AODV protocol performs well over the OLSR because it performs less End to End Delay with Medium and High density along with increasing mobility.

The Packet Delivery Ratio with mobility speed of AODV and OLSR with different density are shown in the figure 3.

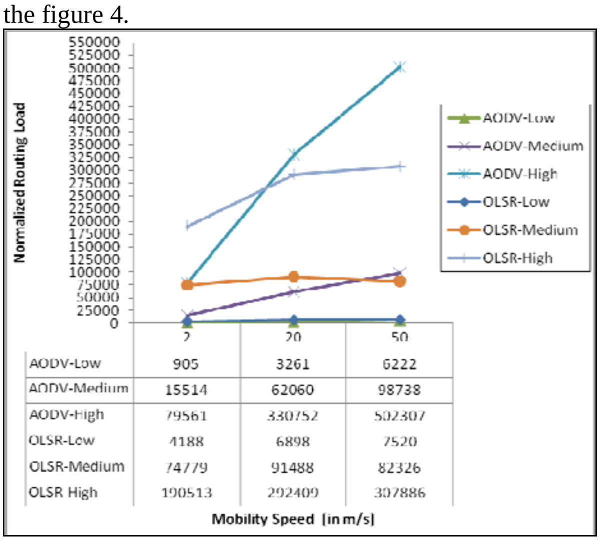



| | 2 | 20 | 50 |
|---|---|---|---|
| AODV-Low | 35.45 | 83.14 | 80.08 |
| AODV-Medium | 99.23 | 95.25 | 88.16 |
| AODV-High | 98.8 | 91.83 | 87.85 |
| OLSR-Low | 34.97 | 57.62 | 61.86 |
| OLSR-Medium | 97.81 | 73.95 | 51.72 |
| OLSR-High | 96.95 | 74.39 | 61.33 |

**Figure 3: Packet Delivery Ratio with mobility speed of AODV and OLSR with Density Models**

Figure 3 shows that Packet Delivery Ratio of both AODV and OLSR with Low Density is less with low mobility speed and increased with increasing mobility speed. The Packet Delivery Ratio of both AODV and OLSR with Medium and High Density is more with low mobility speed and decreased with increasing mobility speed. The Packet Delivery Ratio of OLSR with Medium and High Density is decreases rapidly with increasing mobility speed because due to high mobility, the chances of link breaks are high. In all Density Models, AODV perform well over the OLSR in terms of Packet Delivery Ratio, due to its on demand source initiated route discovery mechanism.

The Normalized Routing Load with mobility speed of AODV and OLSR with Low, Medium and High density are shown in the figure 4.

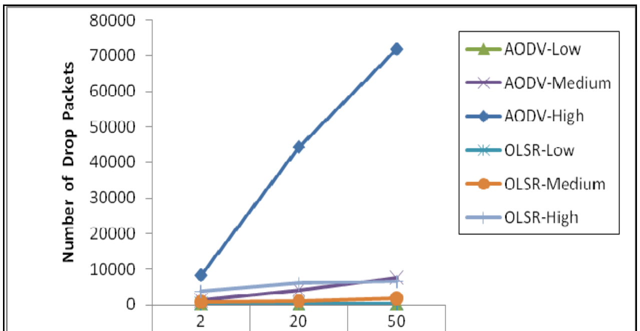



| | 2 | 20 | 50 |
|---|---|---|---|
| AODV-Low | 905 | 3261 | 6222 |
| AODV-Medium | 15514 | 62060 | 98738 |
| AODV-High | 79561 | 330752 | 502307 |
| OLSR-Low | 4188 | 6898 | 7520 |
| OLSR-Medium | 74779 | 91488 | 82326 |
| OLSR High | 190513 | 292409 | 307886 |

**Figure 4: Normalized Routing Load with mobility speed of AODV and OLSR with Density Models**

Figure 4 shows that Normalized Routing Load of both AODV and OLSR protocol with Low Density is nearly same and slightly increased with increasing mobility speed. At slow mobility speed the Normalized Routing Load of AODV protocol is less than OLSR protocol with High Density. At fast mobility speed the Normalized Routing Load of AODV protocol is more than OLSR protocol with Medium and High Density. The Normalized Routing Load of both AODV and OLSR protocol with Low Density is very less than the Medium and High Density. In Low Density AODV perform well over the OLSR in terms of Normalized Routing Load; while in Medium and High Density OLSR perform well over the AODV in terms of Normalized Routing Load with increasing mobility.

Figure 5 shows Number of Drop Packets with mobility speed of AODV and OLSR with Low, Medium and High density. It shows that Number of Drop Packets in both AODV and OLSR protocol with Low Density is nearly same and slightly decreased with increasing mobility speed. In Medium and High density the Number of Drop Packets in OLSR protocol is slightly increased along with increasing mobility speed while the Number of Drop Packets in AODV protocol is rapidly increased. In Low Density AODV perform well over the OLSR in terms of Number of Drop Packets whereas in Medium and High Density OLSR perform well over the AODV protocol.




| | 2 | 20 | 50 |
|---|---|---|---|
| AODV-Low | 236 | 165 | 138 |
| AODV-Medium | 1315 | 4243 | 7708 |
| AODV-High | 8338 | 44402 | 71894 |
| OLSR-Low | 331 | 324 | 306 |
| OLSR-Medium | 819 | 1129 | 1831 |
| OLSR-High | 3740 | 5867 | 6491 |

**Figure 5: Number of Drop Packets with mobility speed of AODV and OLSR with Density Models**

## 5. Conclusion and Future Scope

From the above simulation results, we observe that Average throughput performance of both AODV and OLSR with Low Density are nearly the same and High Density AODV perform well over the OLSR. In Medium Density OLSR perform well over the AODV.

The Average End to End delay of AODV and OLSR with Low and High Density are contrast with each other. The OLSR protocol performs well over the AODV protocol in case of End to End Delay along with Low Density and AODV performs well over the OLSR with Medium and High density models along with increasing mobility.

In all Density Models AODV perform well over the OLSR in terms of Packet Delivery Ratio.

The Normalized Routing Load of both AODV and OLSR protocol with Low Density is nearly same. At slow mobility speed the Normalized Routing Load of AODV protocol is less than OLSR protocol with High Density. In Low Density AODV perform well over the OLSR in terms of Normalized Routing Load; while in Medium and High Density OLSR perform well over the AODV in terms of Normalized Routing Load.

In Low Density AODV perform well over the OLSR in terms of Number of Drop Packets whereas in Medium and High Density OLSR perform well over the AODV protocol.

The conclusion is presented in following tables :

| ***Parameter with Increasing Mobility Speed*** | ***Performance with Low Density*** | |
|---|---|---|
| | ***OLSR*** | ***AODV*** |
| Average Throughput | Same | Same |
| Average End to End Delay | Better | Less |
| Packet Delivery Ratio | Less | Better |
| Normalized Routing Load | Less | Better |
| Number of Drop Packets | Less | Better |

**Table 2: Performance of AODV and OLSR with Low Density**

| ***Parameter with Increasing Mobility Speed*** | ***Performance with Medium Density*** | |
|---|---|---|
| | ***OLSR*** | ***AODV*** |
| Average Throughput | Better | Less |
| Average End to End Delay | Less | Better |
| Packet Delivery Ratio | Less | Better |
| Normalized Routing Load | Better | Less |
| Number of Drop Packets | Better | Less |

**Table 3: Performance of AODV and OLSR with Medium Density**

| ***Parameter with Increasing Mobility Speed*** | ***Performance with High Density*** | |
|---|---|---|
| | ***OLSR*** | ***AODV*** |
| Average Throughput | Less | Better |
| Average End to End Delay | Less | Better |
| Packet Delivery Ratio | Less | Better |
| Normalized Routing Load | Better | Less |
| Number of Drop Packets | Better | Less |

**Table 4: Performance of AODV and OLSR with High Density**

We observed that OLSR perform well in case of End to End Delay with Low Density, while. AODV perform better with Medium and High density Model. OLSR perform better with Medium and High density Mode in case of Normalized Routing Load and Number of Drop Packets, where as AODV perform better with Low Density. In future we will try to evaluate and measure performance of various other MANET routing protocols with these Density Models.

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