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# IMPACT OF NODE MOBILITY ON THE PERFORMANCE OF AODV, BELLMAN FORD AND ZRP ROUTING PROTOCOLSIN MANET

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***Abstract*:**
The performance of routing protocols can be evaluated in naturalistic conditions of any Mobile Ad-hoc network (MANET) using simulation method. The performance of MANET depends on various parameters and network scenario such as number of nodes, mobility speed, routing protocols, mobility model and energy models etc. In this paper, researchers made an effort to evaluate the impact of node mobility on the performance of AODV, Bellman Ford and ZRP routing protocols with varying mobility speed under random waypoint mobility model in the MANET. Detailed simulations have been carried out using QualNet simulator for 50 nodes. Performance of AODV, Bellman Ford and ZRP routing protocols has been evaluated under the premise of performance metrics namely average throughput, average end to end delay and average jitter using CBR traffic patterns.

**Keywords:** MANET, QualNet, Throughput, End to End Delay, Jitter and Routing Protocols

## 1. INTRODUCTION:

All the nodes present in Mobile Ad-hoc Network (MANET) are movable and can be connected with each other dynamically according to the requirement for the communication from one node to another node without any centralized control (Upadhyay, Kumar, and Rana, 2019). In MANET, the routes are not fixed and get change with the movement of nodes (Larsson and Hedman, 1998, Kanimozhi, Ganesh, Karthikeyan, 2023). In this paper, researchers have evaluated the performance of AODV, Bellman Ford and ZRProuting protocolsin terms of Average Throughput (bits/s), Average End to End Delay (s) and Average Jitter (s) withnode mobility using random waypoint mobility model to demonstrate the Mobile Ad-hoc Network using simulation method (Kumar, Agrawal and Sharma, 2014).

## 2. PERFORMANCE METRICS:

The following performance metrics have been used to evaluate the performance of MANETs routing protocols in presented study (Kumar, Agrawal and Sharma, 2017, Varshney, Agrawal and Sharma, 2016).

**1) Average Jitter(s)**

The time variation between arrival of data packets due to change in route and congestion etc. is known as average jitter. The average jitter is normally used as an indicator to evaluate the stability and consistency of a network. The average jitter should be small for a routing protocol to perform better.

**2) Average Throughput (bit/s)**

The average rate of data packet received by the node per unit time successfully is known as throughput. High average throughput is always desirable in a communication system.

**3) Average End-to-End Delay(s)**

The average time consumed by the network when packets are sent from any source node to destination node is called average end to end delay. The average end-to-end delay should be small for a routing protocol to perform better.

## 3. SIMULATION SCENARIO AND RELATED PARAMETERS:

The following Table-1 represents the simulation parameters that have been used to evaluate the performance of AODV, Bellman Ford and ZRProuting protocols during the simulation in presented work.

Fig. 1 shows the animation view of the simulation carried out using 5 CBR connections using 50 nodes for a MANET under the varying mobility speed.

**Table 1 Simulation Scenario and Parameters**

| **Parameters** | **Value** |
|---|---|
| Routing Protocols | AODV and DSR |
| No. of Nodes | 50 |
| Node Placement Strategy | Random |
| Terrain Size | 500 m x 500 m |
| Radio Type | 802.11b |
| Mobility Model | Random Waypoint |
| Shadowing Model | Constant |
| Fading Model | Rayleigh |
| Speed | 10-50 meter/second |
| Application Layer Traffic Source | CBR Traffic (5 Connections) |
| Antenna Model | Omni-Directional Antenna |
| Simulation Time | 120 seconds, seed 5 |
| Packet Size | 512 bytes |

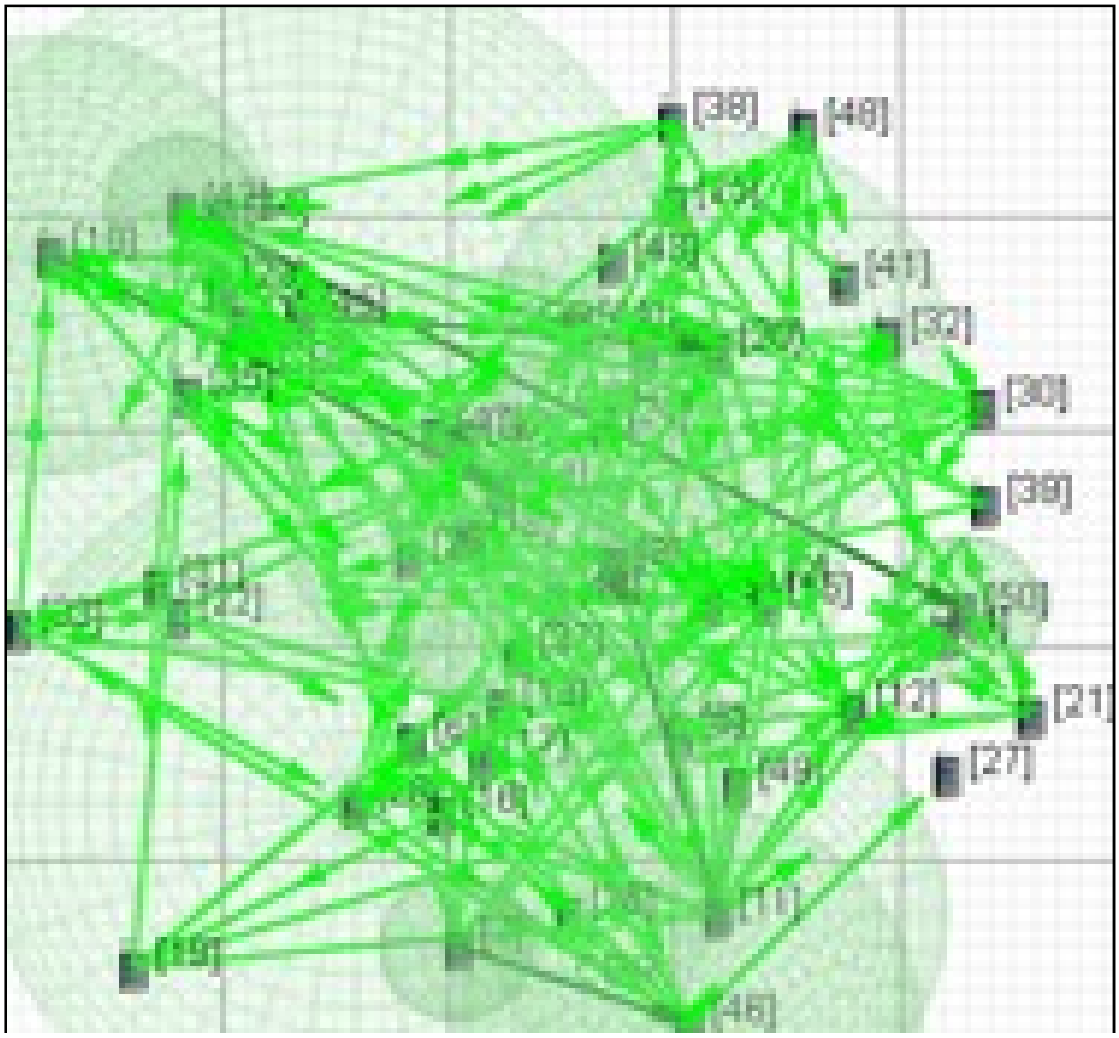


**Figure 1 Animations view of simulation carried out**

## 4. Results and Discussion

Impact of node mobility on the performance of MANET routing protocols under the random waypoint mobility model has been evaluated. AODV, Bellman Ford and ZRP routing protocols from each category of reactive, proactive and hybrid protocolsrespectively have been used in this investigation. Simulations have been performed for 50 nodes randomly placed in 500x500 $m^2$ terrain size with and without mobility of nodes. In case of mobility, variable node speed of 10-50 meter/s has been used.

Performance of routing protocols has been tested in terms of performance metrics namely Average Throughput (bits/s), Average End to End Delay (s) and Average Jitter (s).

### 1) Average Throughput

The performance of three routing protocols namely AODV, Bellman Ford and ZRP has

**Table 2 Average Throughput for AODV, Bellman Ford and ZRP routing protocols with and without mobility of nodes**

| Routing Protocol | Average Throughput (bits/second) |
|---|---|
| AODV_M | 4.20E+03 |
| AODV_WM | 4.36E+03 |
| Bellman Ford_M | 4.19E+03 |
| Bellman Ford_WM | 4.33E+03 |
| ZRP_M | 3.52E+03 |
| ZRP_WM | 4.28E+03 |

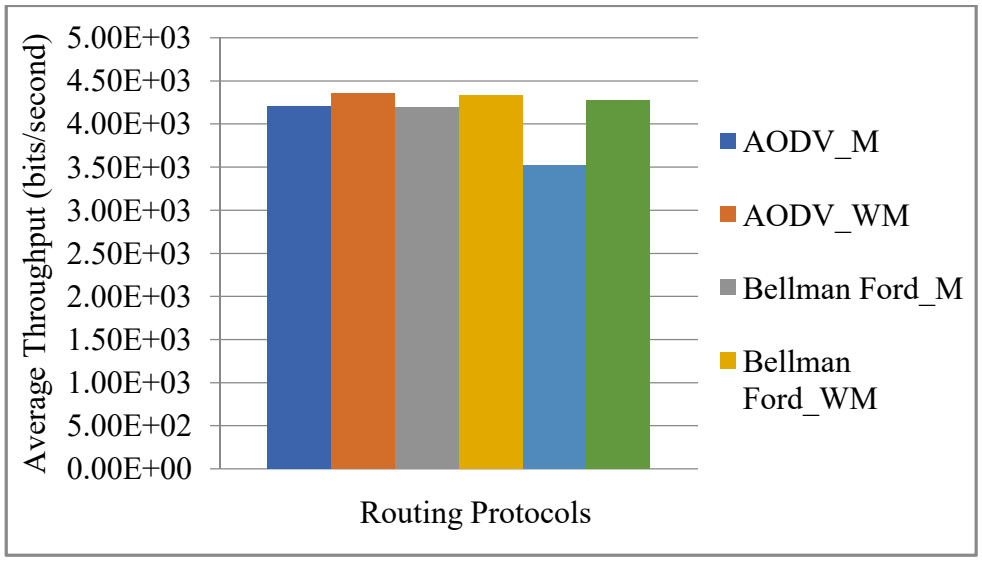


**Figure 2 Average Throughput for AODV, Bellman Ford and ZRP routing protocols with and without mobility of nodes**

analyzed in term of Average Throughput (bits/s) in presence and absence of mobility of nodes. The Average Throughput indicates that mobility of nodes is having a directimpact on the Average Throughput of the routing protocols. However, ZRP routing protocol has lowest Average Throughput and AODV routing protocol has highest Average Throughput (bits/s) among the three routing protocols in presence of mobility of nodes(Fahmy, Nassef and Hefny, 2014,Acharekar, Mehta and Panbude, 2016). The results of Average Throughput have been shown in Table 2 and Figure 2.

### 2) Average End to End Delay

In has been observed from the results that all three routing protocols namely AODV, Bellman Ford and ZRP performed better in terms of Average End to End Delay (s) in absence of mobility of nodes. This indicates that mobility of nodes directly impacts End to End Delay in the routing protocols It is also supported by previous studies (Chen and Chang 2003, Djenouri, Derhab and

Badache, 2006, Maan and Mazhar, 2011). However, AODV routing protocol has highest End to End Delay and Bellman Ford routing protocol has lowest End to End Delay among the three routing protocols in presence of mobility of nodes. In absence of mobility ZRP routing has performed best with lowest Average End to End Delay as compares to AODV and Bellman Ford routing protocols. On the other side, AODV routing protocol has highest End to End Delay as compared to Bellman Ford. The results illustrated in Table 3 and Figure3.

**Table 3 Average End to End Delay for AODV, Bellman Ford and ZRP routing protocols with and without mobility of nodes**

| Routing Protocol | Average End to End Delay (s) |
|---|---|
| AODV_M | 2.56E-02 |
| AODV_WM | 2.38E-02 |
| Bellman Ford_M | 1.37E-02 |
| Bellman Ford_WM | 1.13E-02 |
| ZRP_M | 1.64E-02 |
| ZRP_WM | 1.04E-02 |

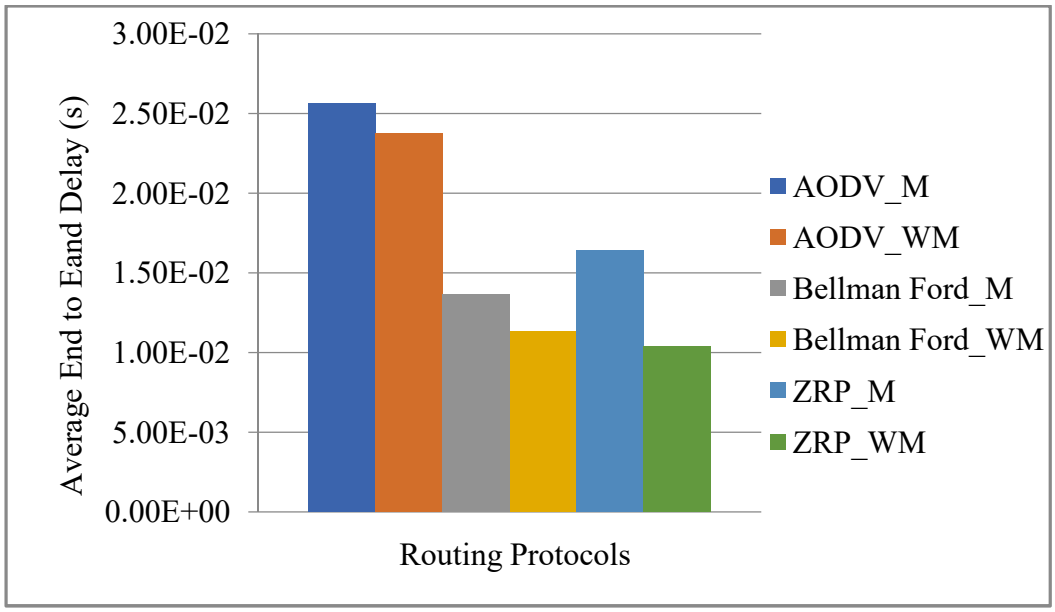


**Figure 3 Average End to End Delay for AODV, Bellman Ford and ZRP routing protocols with and without mobility of nodes**

### 3) Average Jitter

Itis clear from the results that all three routing protocols namely AODV, Bellman Ford and ZRP performed better in terms of Average Jitter (s) in absence of mobility of nodes. This indicates that mobility of nodes is directly impacted Average Jitter in the routing protocols. However, AODV routing protocol has highest Average Jitter and Bellman Ford routing protocol has lowest Average Jitter (s) among the three routing protocols in presence

**Table 4 Average Jitter for AODV, Bellman Ford and ZRP routing protocols with and without mobility of nodes**

| Routing Protocol | Average Jitter (s) |
|---|---|
| AODV_M | 5.10E-03 |
| AODV_WM | 3.03E-03 |
| Bellman Ford_M | 3.88E-03 |
| Bellman Ford_WM | 2.39E-03 |
| ZRP_M | 4.27E-03 |
| ZRP_WM | 2.85E-03 |

of mobility of nodes. In absence of mobility Bellman Ford routing has performed best with lowest Average Jitteras compared to AODV and ZRP routing protocols. AODV routing protocol has highest Average Jitter in comparison of Bellman Ford and ZRP in absence of mobility of nodes. The simulation results have been illustrated in Table 4 and Figure 4.

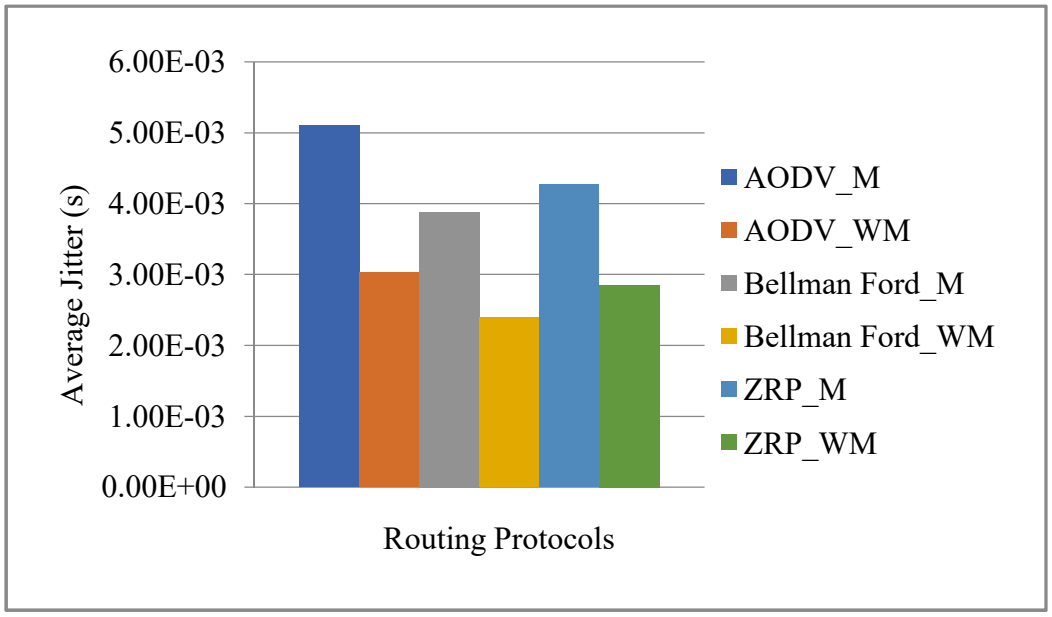


**Figure 4 Average Jitter for AODV, Bellman Ford and ZRP routing protocols with and without mobility of nodes**

## 5. CONCLUSION:

Performance analysis of routing protocols have been discussed by the researchers under the mobility and without mobility condition of mobile nodes. It is clear from the results that mobility of nodes affected performance of routing protocols in term of throughput, end to end delay and average jitter.

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