Chapter 5

Routing Protocols under different Transmission Range, Node Density & Node Speed

5.1 Introduction

Transmission power is an important parameter for MANET because each node has limited battery power and it is not easy to replace/recharge the battery. Hence, it is important to efficiently utilize the battery power to ensure longer network lifetime. If the transmission power is kept high, then although all the packets will be delivered but battery power consumption will be high. If it is kept less, then although power consumption will be low but the packets may not be able to reach destination. In order to maximize battery life, an optimum value of transmission power is to be chosen.

In this chapter, we have studied the effect of varying transmission range, node density and speed on three routing protocols namely OLSR [65], DSR [70] and ZRP [72] representing the three groups in which MANETs have been classified namely proactive, reactive and hybrid routing protocols respectively. The performance metrics considered were end to end delay and packet delivery ratio. There was an obvious impact on these metrics on variation of transmission range.

Organization of the rest of chapter is as follows. In section 5.2, state of the art is discussed followed by a description of the simulation setup in section 5.3. Results are given in section 5.4. Chapter is concluded in section 5.5.

5.2 State of the art

This study focuses on variation in transmission range. Along with that, node density and node speed is also varied, so as to have an estimate of performance in denser and dynamic networks. The studies done on transmission power are discussed below.

Rahman Et.al [29] presented a study for the performance of OLSR and DYMO routing protocols under varying data rate, node velocity and transmission range with variation of 512, 768, 1024, 1280, 1536 Bytes/sec for data rate, 1, 5, 10, 15 meters/sec for node velocity and 150, 200, 250, 300, 350 meters for transmission range. The metrics considered were Packet Delivery Fraction, Average end-to end delay of data packets and Normalized Routing Load. The protocols were simulated and compared with NS-2 under Gauss Markov mobility model. The authors concluded that along with other parameters, transmission range has significant effect on the metrics.

The effect of transmission range on ODMRP- On-Demand Multicast Routing Protocol for multicast communication was studied by Venkatalakshmi Et.al [30]. GloMoSim was used for the simulation purpose. Metrics considered were packet delivery ratio, collision and throughput. Variation was done for transmission range and mobility range. It was observed that, though increase in the transmission range enhances connectivity but it also increases the probability of collisions. Hence the effective bandwidth of individual nodes is reduced.

A study for the performance of probability-based routing protocols under different transmission ranges for AODV protocol was done by Yassein Et.al [31]. NS2 was used for simulating the scenario. Packet delivery ratio, end to end delay and routing overhead were the considered metrics. Along with different probabilities (Fixed, adjusted and smart), transmission range was varied as 100, 150, 200, 250, 300m. The authors concluded that, when the transmission range and probability was increased, the performance of algorithm was improved.

A simulator was designed in Matlab by C.K Nagpal Et.al [32] to study the impact of variable transmission range on power saving. Using Dijkstra's shortest path algorithm, minimum hop routing (MHR) and minimum total power routing (MTPR) was evaluated. The performance metrics considered was percentage power saving and average power consumption. The authors concluded that power saving of MTPR is always higher than MHR.

Das, M. Et.al [33] studied the effect of transmission power on performance of AODV. The metrics evaluated were packet delivery fraction, routing load, average energy consumption per node and hop count. Along with variation in transmission power, variation in number of sources was also considered. The author concluded that performance of the network is best for a specific transmission power (i.e. 15dBm).

The behavior and performance of DSDV, AODV and DSR protocols with respect to variation in transmission power of individual nodes was studied by Lalitha Et.al [34].

The performance metrics considered were: Packet Delivery Fraction/Ratio (PDF/PDR), Routing Load, End-to-End Delay, Dropped Packets, Throughput, Energy Consumption, MAC Load and Overhead. NS2 was deployed for simulation. Transmission range was chosen as 100, 150, 200, 250, 300,350, 400, 450, 500 and 550 meters. This range was derived from the transmission power. The authors observed that the multi hop routing protocols performs good only at particular levels of transmission ranges/powers.

Grover Et.al [35] studied the impact of variation in transmission range and scalability on ZRP protocol. The scenario was simulated on NS2. The performance metrics chosen were: Packet delivery ratio, Throughput, End to End Delay and Routing Overhead. The variation in transmission range was done as 200, 300, 400, 500 and 600 meters and the variation in scale (size) was chosen as 25 and 50 nodes. Along with these, variation was also done for node speed as100, 200 and 300 m/s. The conclusion from the study was: transmission range has inverse effect with scalability and mobility rate has inverse effect on throughput and packet delivery ratio.

Since efficient utilization of energy increases the network lifetime and capacity, it is a key performance metric. In the past the researchers have performed analysis of routing protocols as a function of transmission range. In this chapter, we have considered node density as a function along with the transmission range. Hence a broader analysis is observed when size of the network changes.

5.3 Simulation Setup

5.3.1Setup

To study the effect of variation in Node transmission range, density and speed, Qualnet simulator was used. The routing protocols under consideration were OLSR (proactive), DSR (reactive) and ZRP (hybrid). For placement of the nodes random waypoint mobility model was utilized and the nodes were confined to an area of 1000 x 1000 sq. m area. Constant bit rate (CBR) links were used between the randomly chosen source destination pair. The data rate was fixed at 2 Mbps, with packet size of 512 bytes. The speed of sending the data packets was fixed at 4 packets /sec. For the above discussed variations three scenarios are considered viz. transmission range scenario, node density scenario and node speed scenario.

- Node Density Scenario

It is the number of nodes in the network. It was modeled by varying the number of nodes in the fixed area. It was varied from 25 to 100 in steps of 25 i.e. 25, 50, 75 and 100.

- Transmission Range Scenario

It is the average maximum distance up to which a node can send data packets. It was modeled by varying the range of transmission. The transmission range was varied between 50 m to 500 m in steps of 100 i.e. 50, 150, 250, 350 and 450 m.

- Node Speed Scenario

It is the speed of a node in the network. It was modeled by varying the speed of the nodes in the fixed area. It was varied from 0 m/s to 20 m/s in steps of 4 i.e. 0, 4, 8, 12, 16 and 20 m/s.

The simulations parameters are given in table 5.1.

Parameter	Value
Terrain/ Simulation Area	1000m x 1000m
Data transfer rate	2 MBPS
Node Density	25, 50, 75, 100
Transmission Range (m)	50, 150, 250, 350, 450
Node Speed (m/s)	0, 4, 8, 12, 16, 20
Mobility Model	Random Waypoint
Channel Frequency	2.4 GHz
Packet size	512 Bytes
Data Transmission Speed	4 Packets/Second
Routing Protocol	OLSR, DSR and ZRP

Table 5.1: Simulation parameters

5.3.2Performance Metrics

The performance metrics considered are end to end delay and packet delivery ratio.

End to end delay: It is the average amount of time that is taken by a packet to reach final destination from source. It is the sum of delays at links. The delay at a link is the sum of the following components (if, retransmission is not considered).

a. Processing delay
b. Queuing delay
c. Transmission delay
d. Propagation delay

Average delay = Σ (tr - ts)/Pr, where ts is the packet send time and tr is the packet receive time.

Packet delivery ratio (**PDR**): It is the ratio of number of packets delivered to the destination and the number of packets sent at source. The source follows CBR (Constant bit rate) traffic. It depicts the loss rate.

PDR = Data packets delivered / Data packets sent

5.4 Results

5.4.1End to end delay

Figure 5.1 to Figure 5.4 shows the end to end delay for OLSR, DSR and ZRP with figure 5.1 showing delay for 25 nodes, figure 5.2 for 50 nodes, figure 5.3 for 75 nodes and figure 5.4 for 100 nodes. The speed of 0, 4, 8, 12, 16 and 20 m/s is shown as a, b, c, d, e and f respectively. It was observed that delay is decreasing with increase in speed and transmission range. We get the minimum values for DSR and maximum values for ZRP in all the cases. OLSR being a proactive protocol, stores route information in routing table. The amount of stored information increases with increase in transmission range as more nodes tend to be reachable. This results increased delay as compared to reactive protocol. DSR being a reactive protocol performs better than OLSR and ZRP. When we increase the node density then delay is decreased because more number of nodes brings more of them together, when confined to an area.

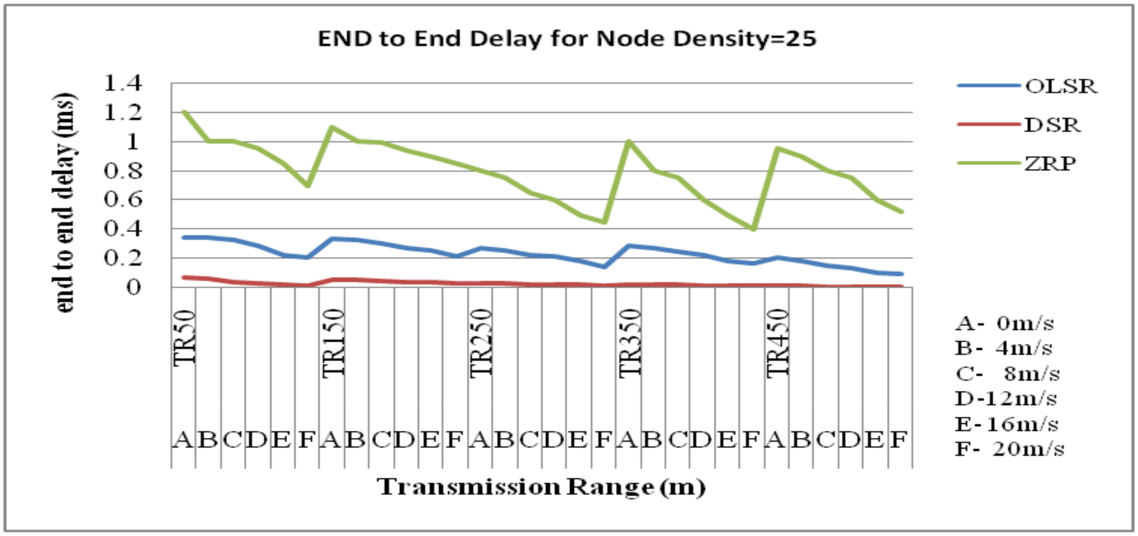

Figure 5.1: End to end delay for node density 25.

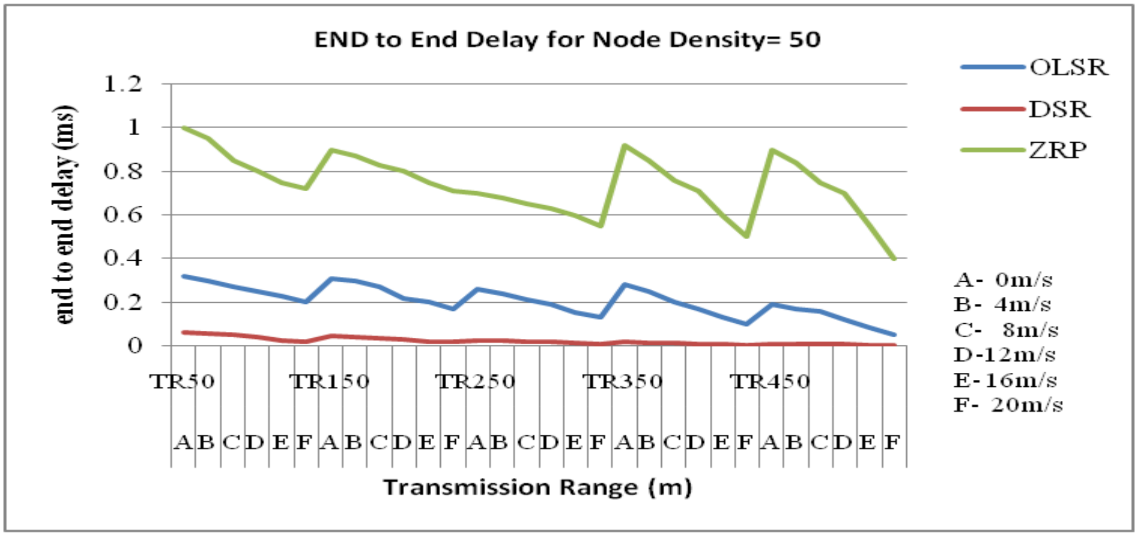

Figure 5.2: End to end delay for node density 50.

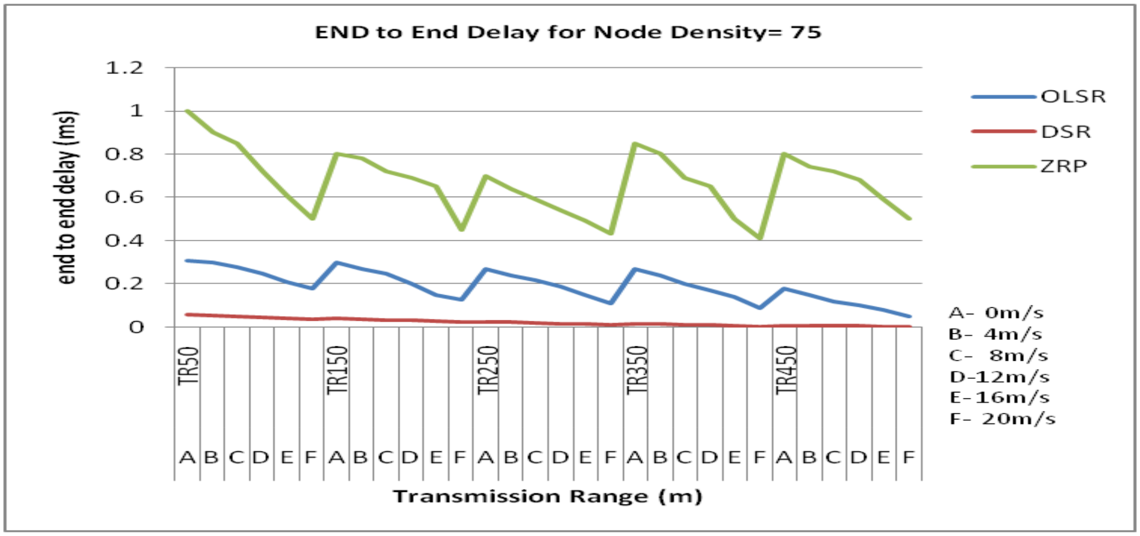

Figure 5.3: End to end delay for node density 75.

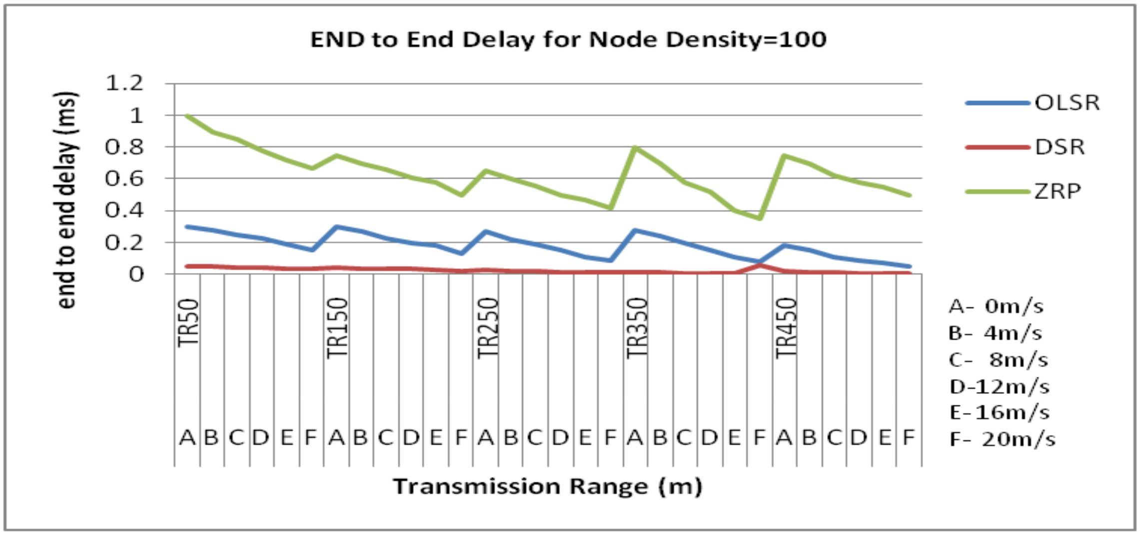

Figure 5.4: End to end delay for node density 100.

5.4.2 Packet Delivery Ratio

Figure 5.5 to Figure 5.8 shows the packet delivery ratio for OLSR, DSR and ZRP with figure 5.5 showing delay for 25 nodes, figure 5.6 for 50 nodes, figure 5.7 for 75 nodes and figure 5.8 for 100 nodes. The speed of 0, 4, 8, 12, 16 and 20 m/s is shown as a, b, c, d, e and f respectively. In all the cases DSR outperforms OLSR and ZRP. The reason is the reactive nature of DSR. With increase in transmission range the packet delivery ratio increases. When the speed of node is less than or equal to 8 m/s the packet delivery ratio decreases and when the speed is greater than 8 m/s, it increases. This phenomenon is valid, only if transmission range is less than 150 m. When the range is greater than 150m, the behavior reverts i.e. if the speed of node is less than or equal to 8 m/s the packet delivery ratio increases and when the speed is greater than 8 m/s, it decreases.

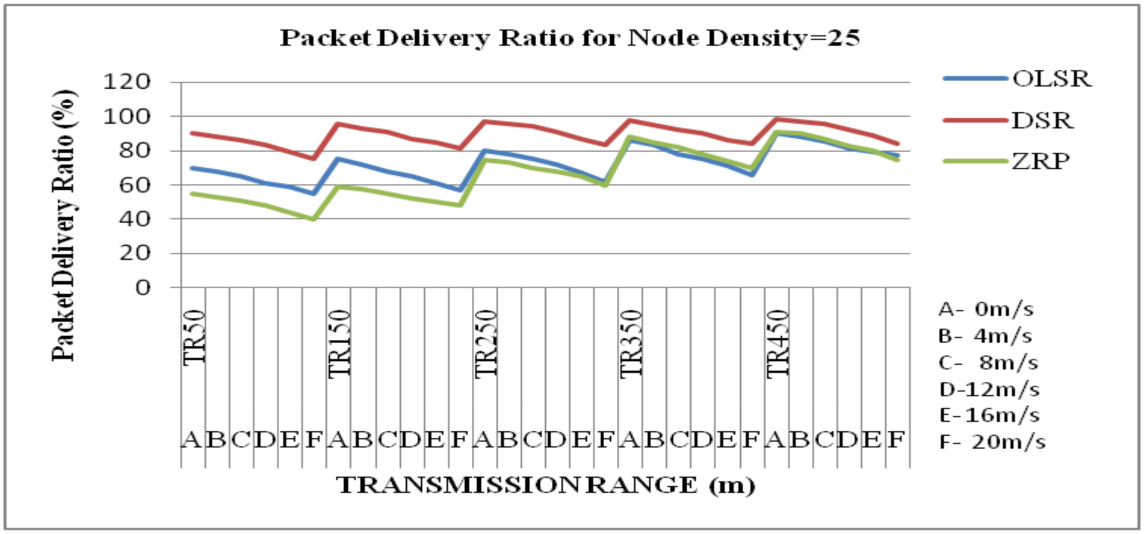

Figure 5.5: Packet Delivery Ratio for node density 25.

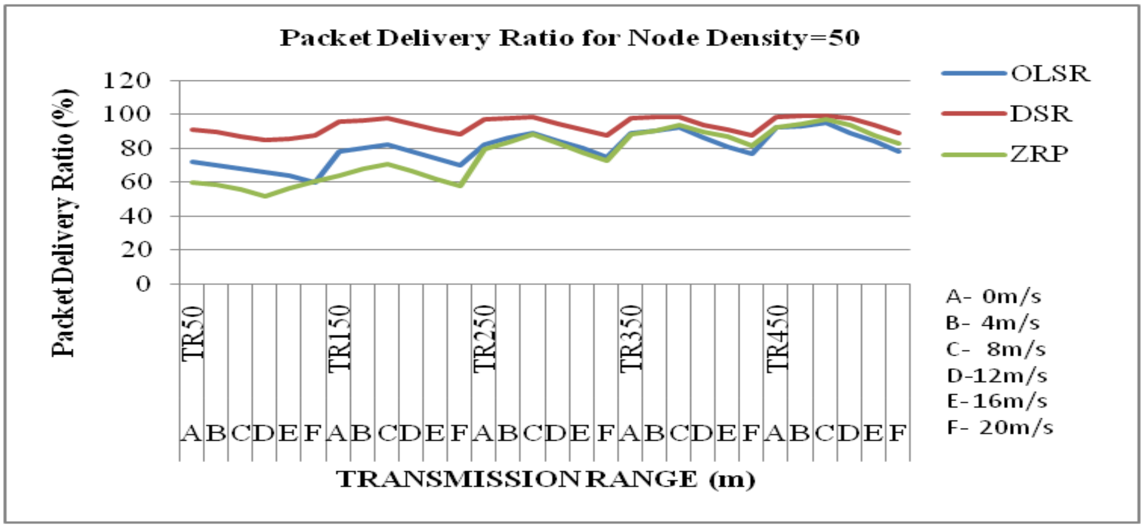

Figure 5.6: Packet Delivery Ratio for node density 50.

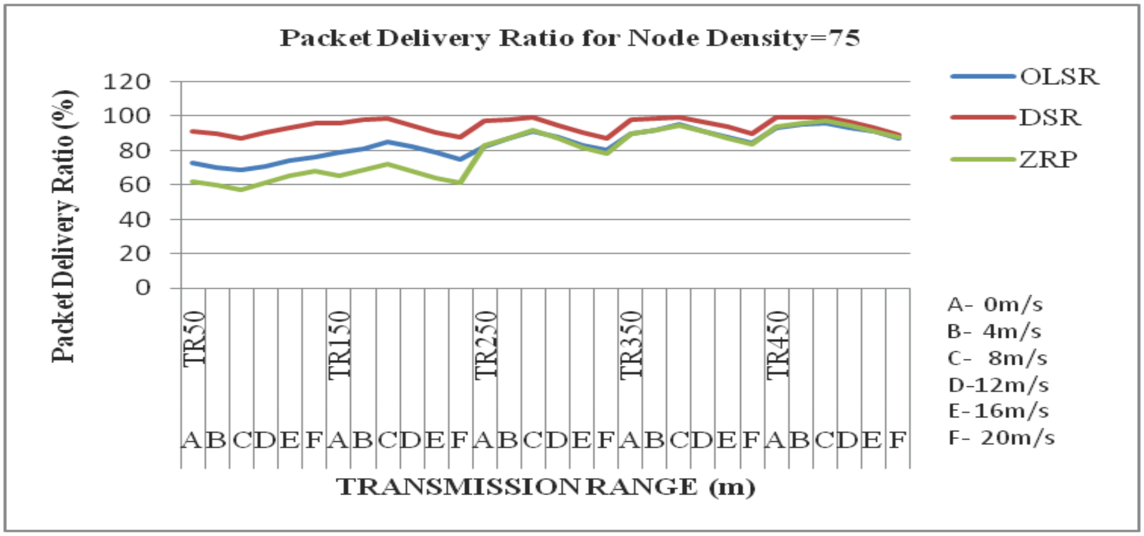

Figure 5.7: Packet Delivery Ratio for node density 75.

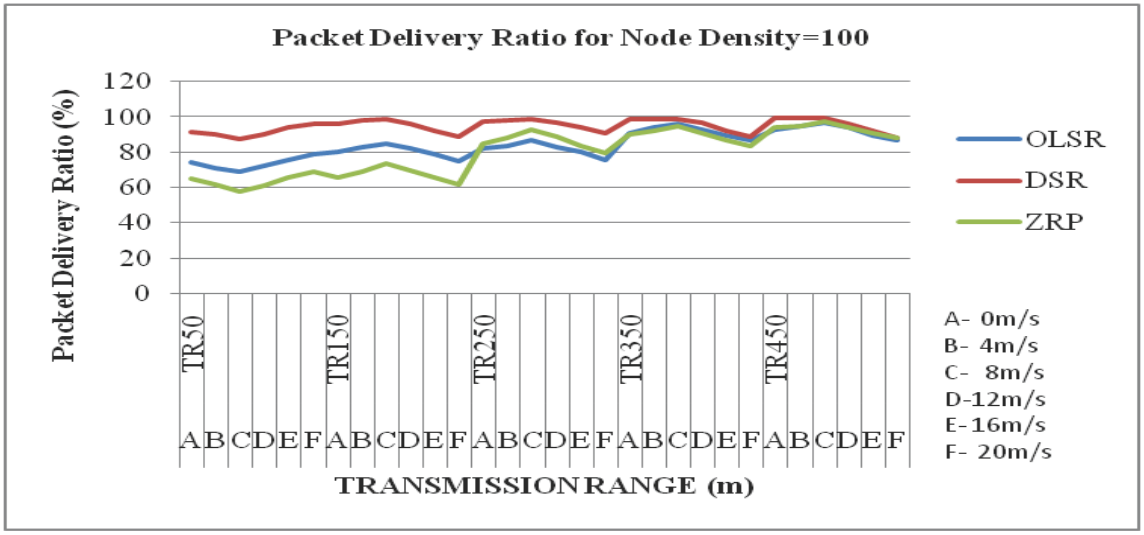

Figure 5.8: Packet Delivery Ratio for node density 100.

5.5 Conclusion

In this study, we have conducted simulation experiments to study the effect of variation in transmission range along with variation in node density. The routing protocols studied were OLSR (proactive), DSR (reactive) and ZRP (hybrid). We considered average end to end delay and packet delivery ratio as the performance metrics. The result shows that when the transmission range and node density increases, better performance is achieved. This applies commonly to all the protocols. ZRP outperformed the other protocols in almost all scenarios. Hence it can be concluded that hybrid protocols performs better than others, when transmission range and node density is increased. In future work, we will simulate the variations in node speed and mobility models along with the transmission range and node density.