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Impact of Connectionless & Connection Oriented Communication with Variable Transmission Range and Mobility on Routing Protocols Over Manets

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ABSTRACT
Effective transmission power control is a critical issue in the design and performance of wireless ad hoc networks. Today, the design of packet radios and protocols for wireless ad hoc networks are primarily based on common-range transmission control. Connection oriented (TCP) and Connectionless (UDP) transmission also affects the performance of the networks. In this paper, we have analyzed AODV, DSDV & DSR with varying transmission range, connection type, number of nodes & different mobility speeds in a collective environment. We analyzed QoS parameters such as packet delivery ratio, end-to-end delay, routing overhead and throughput. The proposed work has been simulated using NS-2.34.
***Keywords* -** MANETs, QoS, Transmission range, TCP, UDP.

I. INTRODUCTION

Mobile Ad-hoc Network (MANET) is a collection of wireless mobile nodes and connected in dynamic manner. Nodes forming a temporary & short-lived network without any fixed infrastructure where all nodes are free to move. Nodes must behave as routers; take part in discovery and maintenance of routes for other nodes in the network [1]. The goal of QoS provisioning is to achieve a more deterministic network behaviors, so that information carried by the network can be better delivered and network resources can be better utilized. The QoS parameters differ from application to application e.g. in case of multimedia application bandwidth, jitter and delay are the key QoS parameters [2].

The Transmission Control Protocol (TCP) is one of the most widely used end -to-end transport layer protocol in the Internet today. The TCP ensure reliable data transfer over unreliable networks. The TCP is a complex protocol and it performs congestion and flow control algorithms. The TCP establishes a connection between two applications and once connection is established between two applications, it provides many useful services to the application layer such as reliable delivery of data packets, end-to-end connection [3]. On the other hand, User Datagram Protocol (UDP) is a connectionless protocol. UDP has less complex mechanism than TCP because there in no connection establishment phase in UDP. Generally UDP is used to send less number packets to the destination like one or two. Packets in UDP do not follow a fixed path from source to destination so congestion control in UDP is not very easy. UDP is less reliable than TCP in the absence of acknowledgement.

Power control affects the performance of the network layer. A high transmission power increases the connectivity of the network by increasing the number of direct links seen by each node but this is at the expense of reducing network capacity. The type of power control used can also affects the connectivity and performance of the network layer. Choosing a higher transmission power increases the connectivity of the network. In addition, power control affects the signalling overhead of routing protocols used in mobile wireless ad hoc networks. Higher transmission power decreases the number of forwarding hops between source-destination pairs, therefore reducing the signalling load necessary to maintain routes when nodes are mobile. Existing routing protocols discussed in the mobile ad hoc networks (MANET) working group of the IETF [5] are designed to discover routes using flooding techniques at common-range maximum transmission power. These protocols are optimized to minimize the number of hops between source destination pairs. Modifying existing MANET routing protocols to promote lower transmission power levels in order to increase network capacity and potentially higher throughput seen by applications, is neither a trivial nor viable solution [6]. For example, lowering the common transmission power forces MANET routing protocols to generate a prohibitive amount of signalling overhead to maintain routes in the presence of node mobility. Similarly, there is a minimum transmission power beyond which nodes may become disconnected from other nodes in the network. Because of these characteristics MANET routing protocols do not provide a suitable foundation for capacity-aware and power-aware routing in emerging wireless ad hoc networks.

II. RELATED WORK

In [7], authors compared AODV, DSDV and DSR using NS-2 simulator. It is observed that because of high mobility speed, frequent link failures occurred and the overhead in updating all the nodes with new routing information also increases. AODV performed best out of all three protocols compared. Evaluation of four routing protocol DSDV, AODV, TORA and DSR is done in [8] using NS-2 with varying pause time. Performance proactive routing protocol DSDV is poor, indicating that it is not suitable for adhoc network. DSR on demand use of cache memory performs better than all the remaining protocols. In [9], authors analyzed the performance of AODV, DSDV and DSR with varying pause time and scalability in the network using NS-2. On the basis of scalability, for smaller networks DSR performed best but for bigger networks DSDV outperformed DSR and AODV. In [10], authors compared the performance of AODV, DSDV and DSR with varying pause time and number of connections in the network using NS-2. It is observed that the DSR and AODV protocol performed well because of the reactive nature of these protocols having less routing overhead. The performance of AODV and DSR routing protocols in wireless sensor network with varying load by varying number of sources and mobility speeds on 50 and 100 nodes scenario has been simulated in [11]. Their results indicate AODV perform better than DSR when node density and traffic load is low otherwise DSR delivers good performance. In [12] a simulation based performance comparison of DSDV and DSR routing protocols with variation in number of nodes with fixed transmission range 250m has been analyzed and it has observed from their results that DSR outperforms DSDV. The throughput and delay comparison of AODV, FISHEYE, DYMO and STAR routing protocols with varying number of nodes has been simulated in [13]. Their results show that AODV, DYMO and Bellman ford protocols are having higher end to end delays than others. A simulation based performance analysis on AODV, TORA, OLSR and DSR routing protocols for voice communication support over hybrid MANETs has been conducted in [14]. The result shows that overall performance of OLSR is best as all QoS parameters has favorable results. The performance of TORA is less than OLSR and AODV but its performance is better than the performance of DSR. DSR protocol has minimum throughput and maximum end-to-end-delay with highest jitter and all these factors make this protocol unsuitable for voice transmission. The impact of mobility with all parameters on DSR and DSDV by varying mobility speeds and number of nodes with 250m transmission range has been analyzed in [15]. The result shows that DSR outperforms DSDV in all QoS parameters. The performance of AODV, DSDV and DSR routing protocols by varying pause time and mobility speed is analyzed in [16]. The observations of simulation analysis show that AODV is preferred over DSR and DSDV. In [17] impact of scalability on QoS Parameters such as packet delivery ratio, end to end delay, routing overhead, throughput and jitter has been analyzed by varying number of nodes, packet size, time interval between packets and mobility rates on AODV,DSR and DSDV has been analyzed.

The performance of AODV, DSDV and DSR routing protocols in different mobility speeds with fixed nodes has been analyzed in [18]. After analyzing in different situations of network, it is observed that AODV performs better than DSDV and DSR. In [19] the performance of AODV and DSDV routing protocols by varying transmission range and simulation time has been analyzed. It is observed that the transmission range as a system parameter affects the overall energy consumption of wireless ad hoc networks. In [20] the performance comparison of AODV, DSDV and DSR routing protocols by varying number of nodes, pause time, mobility speed and fixed transmission range 250m has been evaluated. The result shows that AODV and DSR are proved to be better than DSDV. In [21] the performance of transport layer protocols TCP and UDP on AODV, DSDV, TORA and DSR routing protocols in multicast environment by varying pause time with 50 nodes scenario has been simulated. The result indicates that TCP is not appropriate transport protocol for highly mobile multi hop networks and UDP is preferred. In this paper, we have analyzed the impact on certain QoS parameters by taking variation in transmission range, mobility and number of nodes on routing protocols (AODV, DSR and DSDV).The rest of this paper is organized as follows. Section 2 covers an overview of routing protocols, Section 3 describes QoS based performance metrics, Section 4, simulation analysis and result discussion is presented and Section 5 concludes this paper with discussions.

III. OVERVIEW OF ZONE ROUTING PROTOCOLS

Routing protocols for MANETs have been classified according to the strategies of discovering and maintaining routes into three classes: proactive, reactive and Hybrid [22].

Destination Sequenced Distance Vector (DSDV): DSDV [23] is a proactive or table-driven routing protocol. In DSDV, each node maintains a routing table that has an entry for each destination in the network. The attributes for each destination are the next hop ID, hop count metric and a sequence number which is originated by the destination node. DSDV uses both periodic and triggered routing updates and guarantees loop freedom. Upon receiving a route update packet, each node compares it to the existing information regarding the route. Routes with old sequence numbers are simply discarded.

Dynamic Source Routing Protocol (DSR): The Dynamic Source Routing (DSR) [24] protocol is an on-demand routing protocol based on source routing. In the source routing technique, a sender determines the exact sequence of nodes through which to propagate a packet. The list of intermediate nodes for routing is explicitly contained in the packet's header. In DSR, every mobile node in the network needs to maintain a *route cache* where it caches source routes that it has learned. When a host wants to send a packet to some other host, it first checks its route cache for a source route to the destination. In the case a route is found, the sender uses this route to propagate the packet. Otherwise the source node initiates the route discovery process. In route discovery, the source floods a query packet through the ad-hoc network, and the reply is returned by either the destination or another host that can complete the query from its route cache. Upon reception of a query packet, if a node has already seen this ID (i.e. it is a duplicate) or if it finds its own address already recorded in the list, it discards the copy and stops flooding; otherwise, it appends its own address to the list and broadcasts the query to its neighbours. For route maintenance when a route failure is detected the node detecting the failure sends an error packet to the source, which then uses the route discovery protocol to find a new route.

Ad hoc On-demand Distance Vector Routing (AODV): The AODV [25] is a reactive protocol, which combines both DSR and DSDV characteristics. AODV borrows the basic route discovery and route-maintenance of DSR as well as hop-by-hop routing, sequence numbers and beacons of DSDV. When a source node desires to establish a communication session, it initiates a route discovery process by generating a route request (RREQ) message, which might be replied by the intermediate nodes in the path to destination or the destination node itself with the route reply (RREP) message contains the whole path to destination. Failure of a link can be detected via hello messages. Failure to receive three consecutive HELLO messages from a neighbor is taken as an indication that the link to the neighbor in question is down.

IV. QOS BASED PERFORMANCE METRICS

The performance metrics includes the QoS parameters such as Packet Delivery Ratio (PDR), Throughput, End to End Delay, Routing Overhead and Jitter.

Packet Delivery Ratio (PDR): PDR also known as the ratio of the data packets delivered to the destinations to those generated by the CBR sources. This metric characterizes both the completeness and correctness of the routing protocol.

$$PDR = \frac{\sum_{1}^{n} CBRrece}{\sum_{1}^{n} CBRsent} * 100$$

Average End to End Delay: Average End to End delay is the average time taken by a data packet to reach from source node to destination node. It is ratio of total delay to the number of packets received.

$$Avg\_End\_to\_End\_Delay = \frac{\sum_{1}^{n}(CBRrecetime - CBRsenttime)}{\sum_{1}^{n} CBRrece} * 100$$

Throughput: Throughput is the ratio of total number of delivered or received data packets to the total duration of simulation time.

$$Throughput = \frac{\sum_{1}^{n} CBRrece}{simulationtime}$$

Normalized Protocol Overhead/ Routing Load: Routing Load is the ratio of total number of the routing packets to the total number of received data packets at destination.

$$Routing\_Load = \frac{\sum RTRPacket}{\sum CBRrece}$$

V. SIMULATION RESULTS AND DISCUSSION

The performance of AODV, DSDV and DSR has been analyzed with varying transmission range, connection type (TCP, UDP), mobility and number of nodes. The parameters used for simulation are summarized in Table 1 and positioning of 75 and 100 nodes is illustrated in Figure 1 and Figure 2. The performance metrics comprises of QoS parameters such as packet delivery ratio, end to end delay, routing overhead and throughput.

TABLE I. Simulation Parameters

Parameters	**Values**
No of Node	75,100
Simulation Time	100 sec
Environment Size	1200x1200
Traffic Type	CBR (Constant Bit Rate)
Queue Length	50
Source Node	Node 0
Destination Node	Node 7
Mobility Model	Random Waypoint
Antenna Type	Omni Directional
Connection Type	TCP, UDP
Simulator	NS-2.34
Mobility Speed	10,20, 30, 40 ,50 m/s
Transmission Range (in meters)	200, 300 and 400
Operating System	Linux Enterprise Edition-5

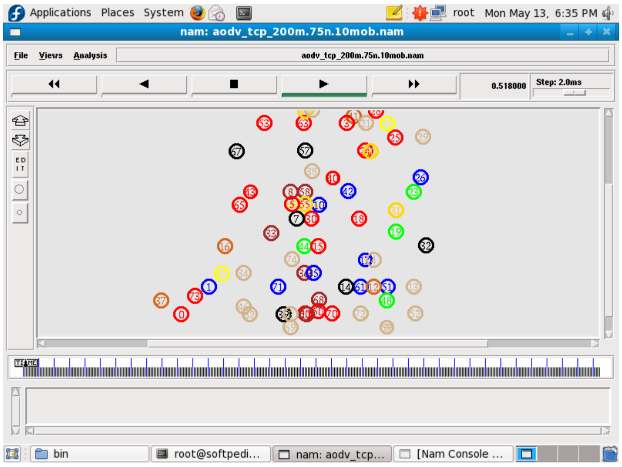

Fig 1 Initial Positioning of 75 Nodes

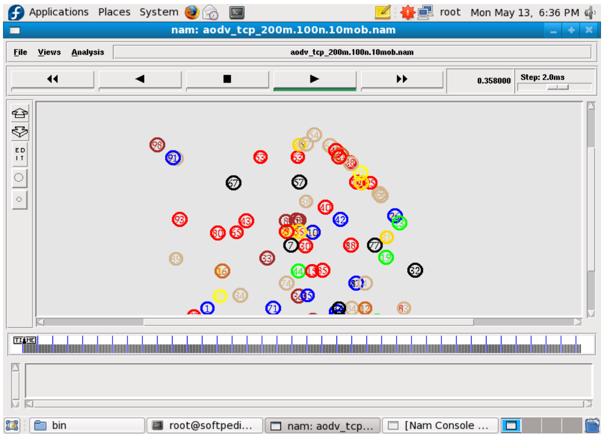

Fig 2 Initial Positioning of 100 Nodes.

A Packet Delivery Ratio

Packet Delivery Ratio (PDR) of all routing protocols is shown in Figure 3-5 for 75 nodes and in Figure 6-8 for 100 nodes. It has been observed that AODV with TCP & UDP both is having the highest packet delivery ratio as compared to other protocols DSR and DSDV. On the other hand DSDV shows poorest PDR in the simulated environment. Result shows that as Mobility speed is increasing PDR is increasing for all the protocols. In most cases performance of UDP is better than TCP for all three protocols. DSR with UDP performed best when transmission range and mobility speed is set to maximum.

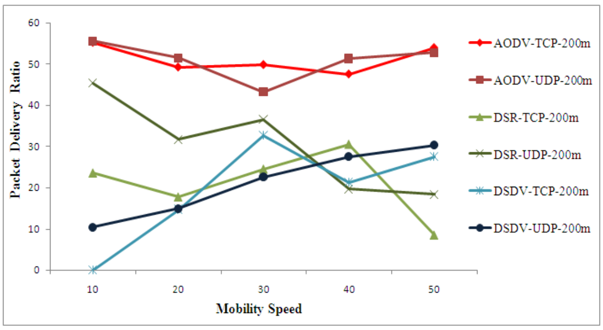

Fig 3 Impact of Varying Transmission Range and Mobility Rate on the Packet Delivery Ratio for 200 Transmission Range with 75 nodes.

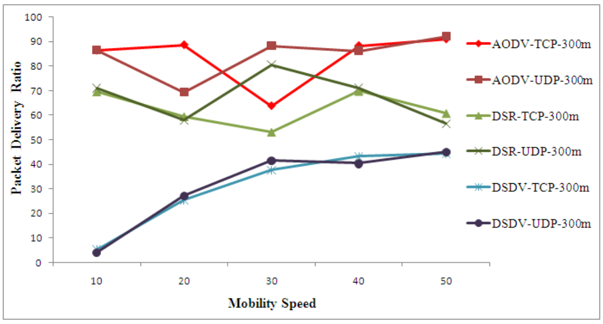

Fig 4 Impact of Varying Transmission Range and Mobility Rate on the Packet Delivery Ratio for 300 Transmission Range with 75 nodes.

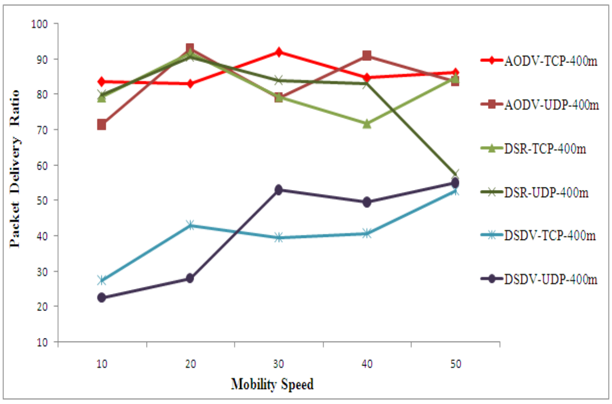

Fig 5 Impact of Varying Transmission Range and Mobility Rate on the Packet Delivery Ratio for 400 Transmission Range with 75 nodes.

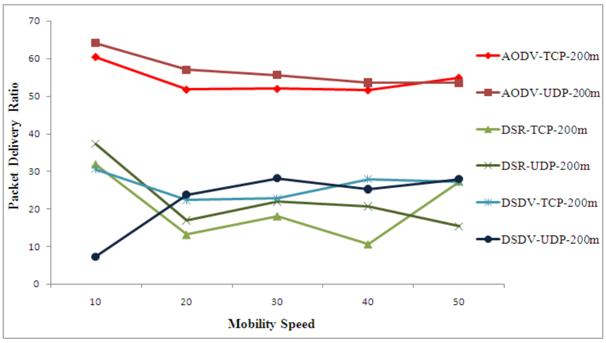

Fig 6 Impact of Varying Transmission Range and Mobility Rate on the Packet Delivery Ratio for 200 Transmission Range with 100 nodes.

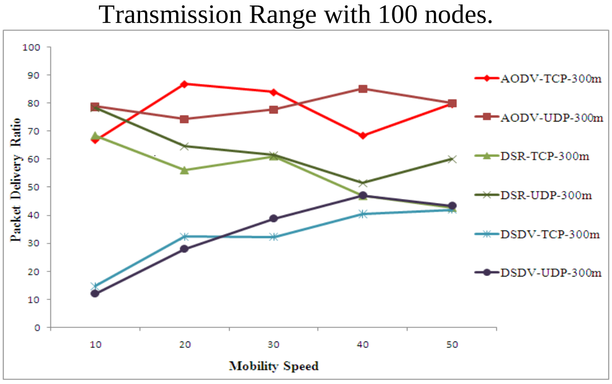

Fig 7 Impact of Varying Transmission Range and Mobility Rate on the Packet Delivery Ratio for 300 Transmission Range with 100 nodes.

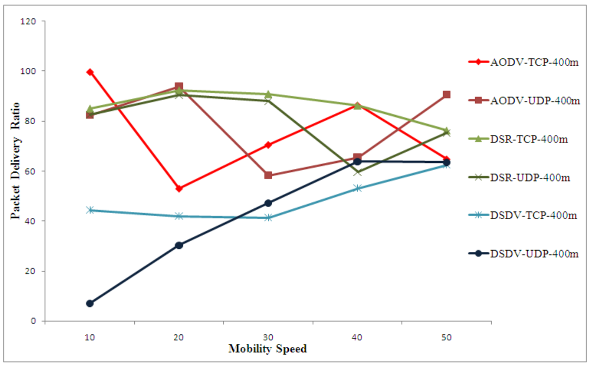

Fig 8 Impact of Varying Transmission Range and Mobility Rate on the Packet Delivery Ratio for 400 Transmission Range with 100 nodes.

B End to End delay

End to End delay of all routing protocols is shown in Figure 9-11 for 75 nodes and in Figure 12-14 for 100 nodes. It has been observed that Average End to End delay of DSDV with TCP & UDP protocol remains very high for almost all transmission ranges and mobility speeds in both 75 and 100 nodes scenario. In AODV with TCP & UDP protocol it is lower than the other protocols in both 75 and 100 node scenario. For 75 nodes DSR with TCP protocol shows high average end to end delay on range 200m. DSR with TCP & UDP protocol shows low average end to end delay on all ranges from 200m to 400m. In 100 nodes scenario DSR protocol shows very low average end to end delay on range 400m in highly mobile environment. It is observed that Average Delay with TCP is better than UDP for all the protocols.

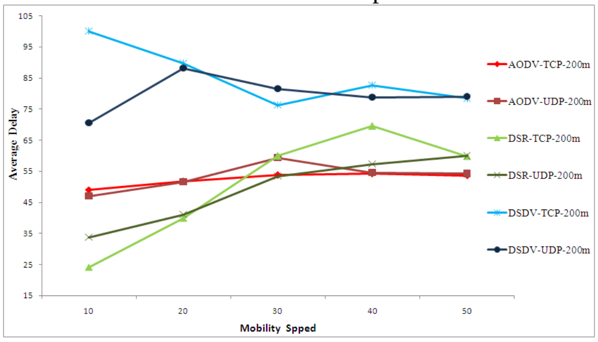

Fig 9 Impact of Varying Transmission Range and Mobility Rate on the Average End to End Delay for 200 Transmission Range with 75 nodes.

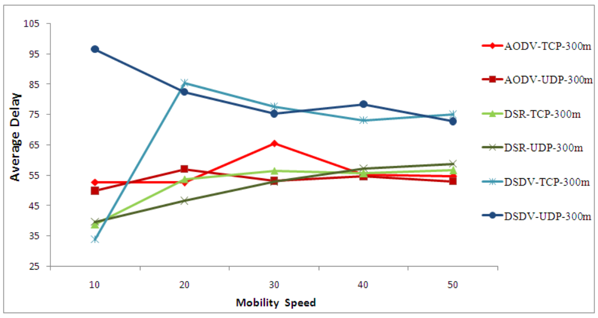

Fig 10 Impact of Varying Transmission Range and Mobility Rate on the Average End to End Delay for 300 Transmission Range with 75 nodes.

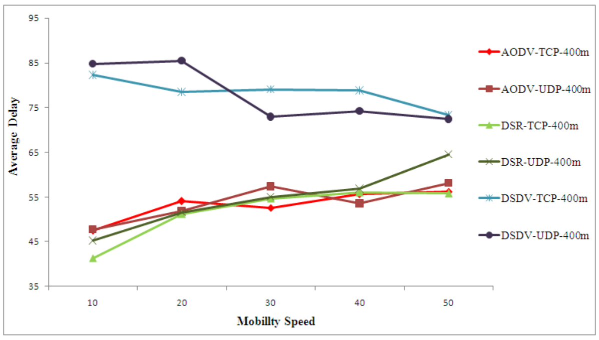

Fig 11 Impact of Varying Transmission Range and Mobility Rate on the Average End to End Delay for 400 Transmission Range with 75 nodes.

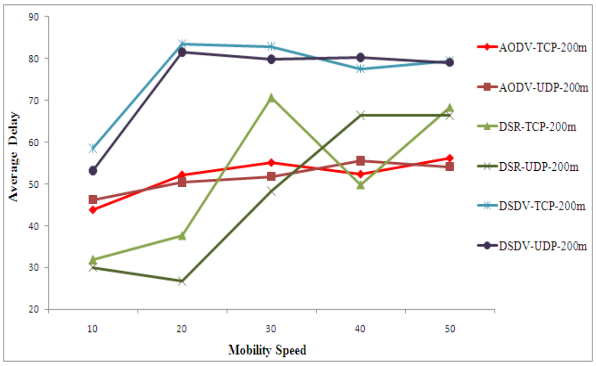

Fig 12 Impact of Varying Transmission Range and Mobility Rate on the Average End to End Delay for 200 Transmission Range with 100 nodes.

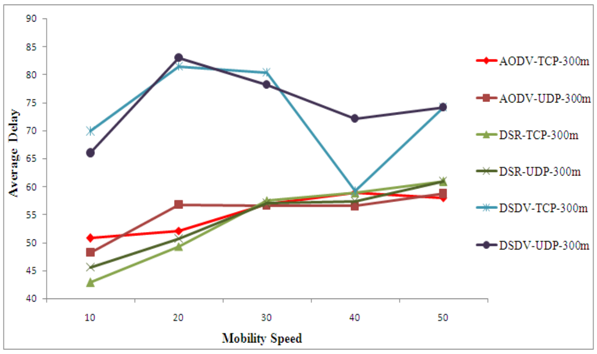

Fig 13 Impact of Varying Transmission Range and Mobility Rate on the Average End to End Delay for 300 Transmission Range with 100 nodes.

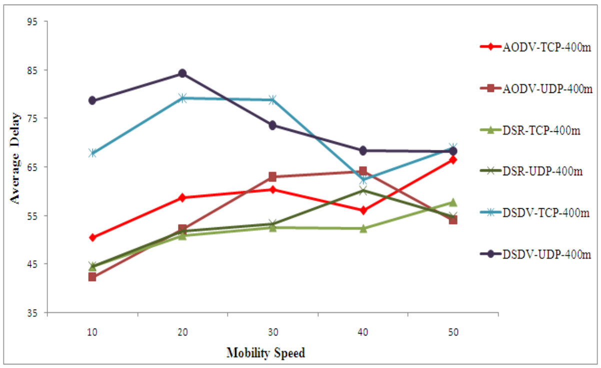

Fig 14 Impact of Varying Transmission Range and Mobility Rate on the Average End to End Delay for 400 Transmission Range with 75 nodes.

C Throughput

Throughput of all routing protocols is shown in Figure 15-17 for 75 nodes and in Figure 18-20 for 100 nodes. The results analyzed indicate that with highest mobility and 500m transmission range AODV with TCP & UDP having the highest average throughput as compared to DSDV and DSR routing protocols in both 75 nodes and 100 nodes scenario. It is analysed that in most cases DSDV performed worst out of all three protocols compared. Figure 20 shows that DSR with UDP performed best with maximum transmission range. In most cases Throughput of DSDV with UDP is poorest as compared to DSDV with TCP otherwise in other two protocols performance with UDP is better than TCP.

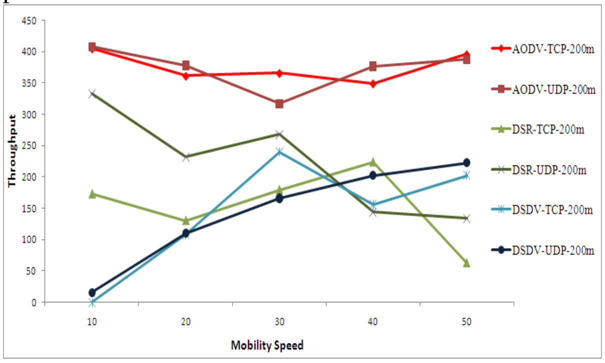

Fig 15 Impact of Varying Transmission Range and Mobility Rate on the Average End to End Delay for 500 Transmission Range with 75 nodes.

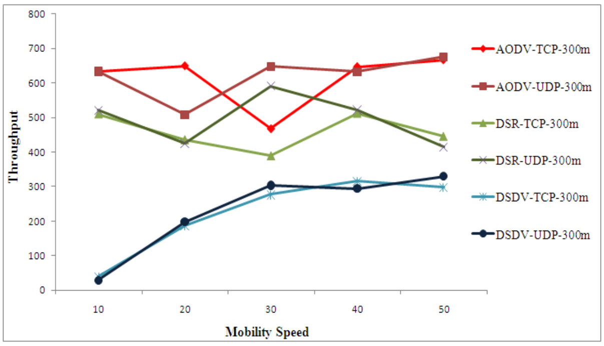

Fig 16 Impact of Varying Transmission Range and Mobility Rate on the Average End to End Delay for 300 Transmission Range with 75 nodes.

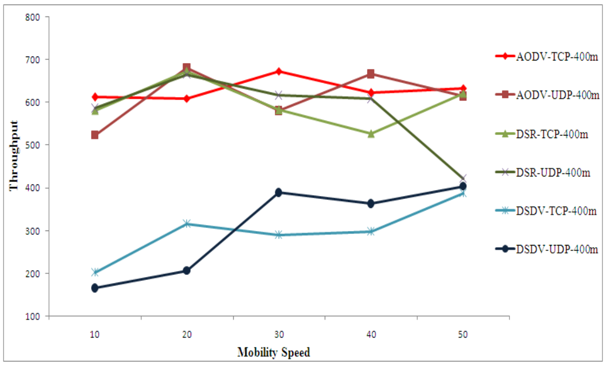

Fig 17 Impact of Varying Transmission Range and Mobility Rate on the Average End to End Delay for 400 Transmission Range with 75 nodes.

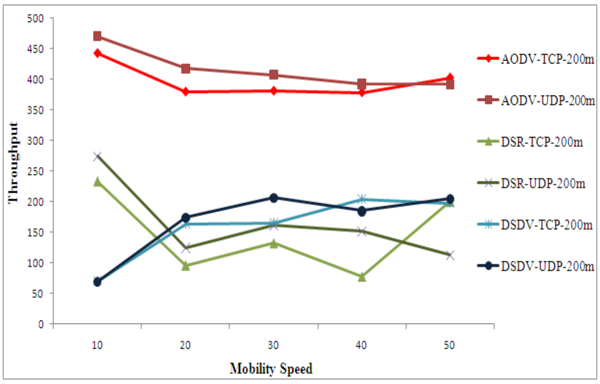

Fig 18 Impact of Varying Transmission Range and Mobility Rate on Throughput for 200Transmission Range with 100 nodes.

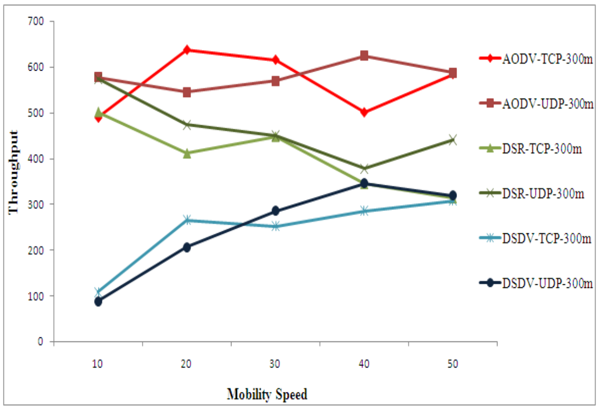

Fig 19 Impact of Varying Transmission Range and Mobility Rate on Throughput for 300Transmission Range with 100 nodes.

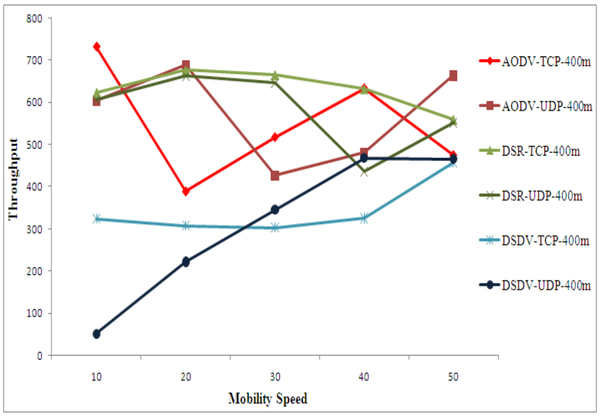

Fig 20 Impact of Varying Transmission Range and Mobility Rate on Throughput for 400Transmission Range with 100 nodes.

D Routing Overhead

Routing Overhead of all routing protocols is shown in Figure 21-23 for 75 nodes and in Figure 24-26 for 100 nodes. The results analyzed indicate that in both 75 nodes and 100 nodes scenario we can see that DSDV TCP & UDP Protocol has highest routing overhead unless it uses transmission range more than 400m. DSR is better than DSDV because it is reactive but shows high routing overhead as compared to

AODV. On different protocols the routing overhead depending on their internal efficiency and thus protocol efficiency may or may not directly affect data routing performance. If control and data traffic share the same channel and the channels capacity is limited, then excessive control traffic often impacts data routing performance. Routing overhead in AODV Protocol is inversely proportional to transmission range. When the transmission range is highest, routing overhead is minimum and at lowest transmission range routing overhead in maximum. In most cases we can analyse that routing overhead with UDP is lesser than TCP for AODV and DSDV but not in the case of DSR.

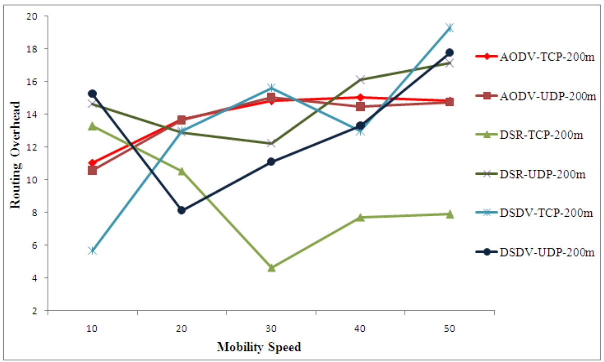

Fig 21 Impact of Varying Transmission Range and Mobility Rate on Routing Overhead for 200 Transmission Range with 75 nodes.

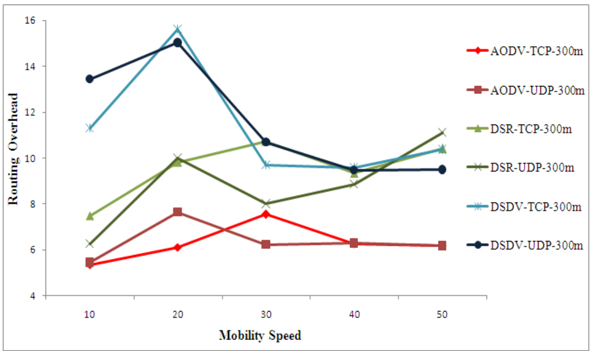

Fig 22 Impact of Varying Transmission Range and Mobility Rate on Routing Overhead for 300 Transmission Range with 75 nodes.

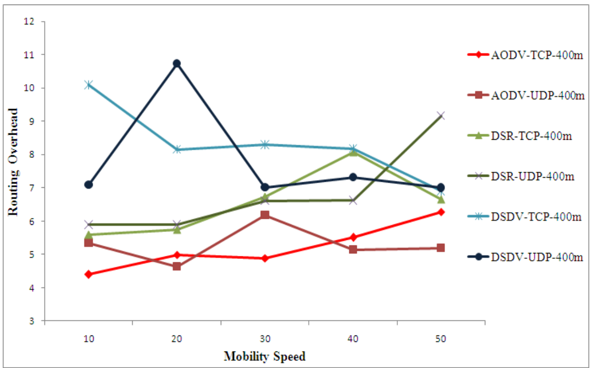

Fig 23 Impact of Varying Transmission Range and Mobility Rate on Routing Overhead for 400 Transmission Range with 75 nodes.

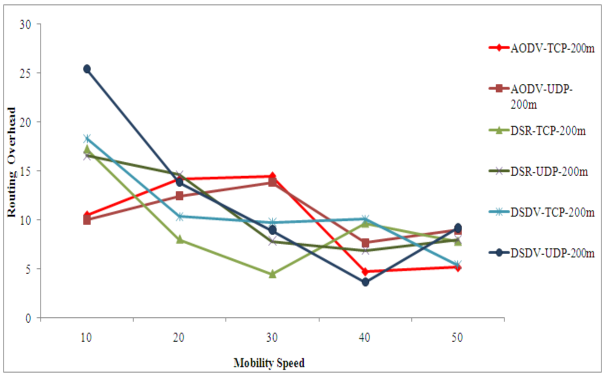

Fig 24 Impact of Varying Transmission Range and Mobility Rate on Routing Overhead for 200 Transmission Range with 100 nodes.

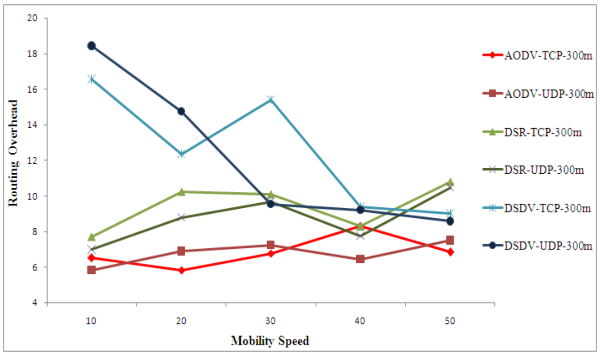

Fig 25 Impact of Varying Transmission Range and Mobility Rate on Routing Overhead for 300 Transmission Range with 100 nodes.

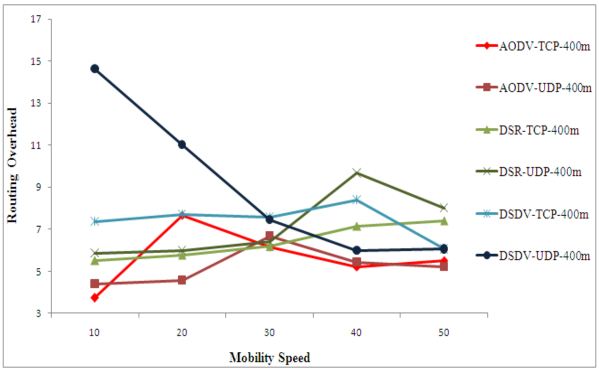

Fig 26 Impact of Varying Transmission Range and Mobility Rate on Routing Overhead for 400 Transmission Range with 100 nodes.

VI. CONCLUSION

The transmission range, connection type, mobility and different number of nodes as a system parameter affects the overall energy consumption and performance of wireless ad-hoc networks. The performance of these three routing protocols shows some differences by varying transmission range, mobility speed and number of nodes. From our experimental analysis we conclude that AODV with TCP & UDP has maximum packet delivery ratio and maximum throughput and it is directly proportionate to transmission range. AODV has lesser routing overhead than DSR and DSDV but average end to end delay is maximum in AODV for both TCP & UDP which decreases its performance to some extent. DSR with TCP & UDP is the best protocol as compared to AODV and DSDV protocols when transmission range is 500m with highest mobility. DSR with TCP & UDP has maximum routing overhead except highest or lowest transmission range. Performance of DSDV is poor throughput because of its table driven approach and periodic table exchange. We compare the three protocols in the analyzed scenario, we found that overall performance of AODV is better than DSR and DSDV routing protocols. The performance enhanced with higher transmission range and higher mobile environment. It is also analysed that the performance of connectionless communication (UDP) is better than connection oriented communication (TCP). Our results can be used to determine the proper radio transmission range in different mobility speed environments for the proactive routing protocol such as DSDV and reactive routing protocols such as AODV and DSR in wireless ad hoc networks without degrading a system performance.

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