Comparison between Routing Protocols of MANET using NS2 with and without queuing parameters

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Abstract*— *This paper investigates the difference between the performances of different routing protocols in MANET through NS2 simulation. The simulation study carried out in two buffer centric schemes (a) The queue parameters are considered at node with finite buffer, this scheme called as Buffer Node (BN) (b) A node without buffer is considered, this scheme is called No Buffer Node (NBN). In this simulation study the reactive protocols AODV and DSR and the Proactive protocol DSDV are being considered for comparison. These protocols are topology based routing protocols and each node contains a finite buffer in a realistic nature So the simulation experiments are conducted for BN and NBN environment to identify the protocols performance as well as QoS in a realistic manner. To evaluate this simulation experiments three performance metrics are considered, they are Packet Delivery Ratio, End to End Delay, and Average Routing Load. The effects of different metrics are shown on three protocols of two schemes. The simulations results are evaluated with various configurations are selected for ten runs. Finally performance justifications of the simulation results are presented.

***Keywords*— MANET, AODV, DSDV, DSR, Queuing Parameters, QoS, CBR, PDR, BN, NBN.**

I. INTRODUCTION

MANET (Mobile Ad hoc Network) is a wireless network which is basically infrastructure less and no centralized controller. It consists of mobile nodes which have more mobility without any centralized administration and they can join or leave the network at their own time. Mobile nodes are in the state of mobility in the network so that communication between source and destination nodes can be possible if they are in same radio transmission range or indirectly by using multi-hopping technique. The neighboring nodes act as intermediate nodes in which source and destination nodes are not within the same radio transmission range multi-hop concept will be used. It is very difficult to maintain the connectivity between the nodes in MANETS because of the intrinsic complexity of routing between a any given pair of nodes. Because of dynamic topology of MANET, there are new challenges for routing protocols researchers are comparing and improving existing routing protocols using simulations.

These networks can operate autonomously or may be connected with the help of Internet and then transmitted information with one or more hops between the nodes. In this decade the growth of laptops and Wi-Fi utilization has made more complexity in routing mechanisms. The mobility is an essential characteristic of MANETS which necessitates the study of the performance of protocols for designing/developing new protocols.

The performance analysis of several routing protocols in MANET was developed using various queuing models [1, 2, 4, 5, and 7]. To find the performance metrics of routing protocols of a MANET is difficult to analyze or measure the metrics without using a queuing model. The limited buffer size in queuing model will be more realistic in calculating Packet Delivery Ratio (PDR), End to End (E-E) Delay and

Average Routing Load (ARL). If the buffer size has no limitation then the nodes keep bundles in their buffer and relay them to the nodes they encounter until they deliver them to the destination, in that case they drop them from their buffers. Also when a bundle reaches TTL, it is also dropped from the buffer. Now that the buffer has a limited size, we implement the following management policy: when a new bundle arrives at a node and if the buffer does not have room for it, it later buffers[4]. It eliminates the oldest bundle it has in the stock and which has been not relayed until that point and replaces the new one. As per the dynamic nature of the nodes it is important to study the performance of routing protocols through simulation.

MANET mobility model is considered in two different schemes namely BN and NBN. There is a need to simulate and study the creation of real time Mobile Ad Hoc Networks with, 99% Packet Delivery Ratio, very less End to End Delay for transmission of data, and very low Average Routing Load at each node.

To achieve this objective the following contributions have to be done for comparison.

- It explores the comparison between the performance of two schemes BN & NBN and also amongst the protocols.
- In BN scheme the packet arrival rate at the node is considered as poison process and the service rate is considered as exponential with finite buffer.
- Simulation of AODV, DSR, and DSDV routing protocols performance measures PDR, E-E Delay and Average Routing Load are studied in 3 scenarios i.e. varying Number of Nodes, arrival rate and service rate for buffer scheme. The scenario of varying number of nodes is only evaluated for without buffer scheme.

This paper is organized as: Section 2 discusses the related research work in routing protocols, MANET Models and Queuing System; Section 3 explains about the Preliminaries in four parts as MANET Topology, Buffered Node, No Buffer Node and Mobility Model; Section 4 discusses about the Simulation Methodology which describes about simulation parameters as Queuing Parameters; In Section 5 in depth it describes about Simulation Result Analysis and performance of different protocols in the Network using with and without Queuing Approach and; Section 6 describes about Conclusion and Future Work of the Research Paper.

II. RELATED WORK

There are different types of performance analysis studies that are performed in MANETs for the routing protocol enhancement and observation. The major component of any MANET model is establishing a secure routing with a better performance metrics i.e., high throughput and low end to end delay.

S.Mohapatra,[1] has performed performance analysis of AODV, DSR, OLSR and DSDV Routing protocols using NS2. These protocols were analyzed in three Scenarios by using number of nodes vs Throughput, End to End Delay and Control Over Head. Finally it was found and observed that the DSR protocol is the best in Packet Delivery Ratio and OLSR is the optimum at high mobility ratio.

A.Lee [2] has developed an adaptive-gossip algorithm with probability pn for reducing the routing overhead, over the flooding based routing method in a queuing network model based on ad hoc routing networks for multimedia communications. Pan Li[3] has employed a practical restricted random mobility

model by proposing a new multi hop relay scheme for smooth trade-offs between throughput and delay by controlling the nodes mobility independent of network size. Saad Talib [4] designed a model for queuing approach of two queue mechanisms (Drop tail and Random Exponential Marking) at each node of network for evaluating the performance of certain MANET parameters. When simulation area is increased it is observed that low throughput with REM and Drop tail, REM gives low delay compared with Drop tail, but in packet loss drop tail is better than REM.

A.H.Zakaria [5] has performed performance analysis in MANETs using queuing theory by determining its arrival times, average waiting times and response time for DSR protocol by varying the input arrival rates using the queuing system M/G/1. They observed that if the number of hops increase then there is an increase in the values of waiting time and average response time. Mouna A.[6] have identified two important issues namely encounter and exchange using a limited buffer management constraint for performance of DTMN if there is ill behaved mobility schemes and its improvement by introducing relay nodes for poor performance factor of DTMN. Rekha[7] has considered AODV, DSDV, and DSR for comparison of MANET parameter in Packet Delivery Ratio fraction and End to End Delay such that increase in density of nodes yields to an increase in the Mean E-E Delay and increase in the pause time leads to a decrease in the E-E Delay and finally the increase in number of nodes will cause an increase in the mean time for loop detection without using any queuing model.

Prachi Jain [8] has developed a new scheme of buffer management to handle the packet queues in MANET and applied the concept of RED(Random Early Discard) algorithm on TCP to maintain the packets in the buffer and also reaches the destination node with low packet delivery time.

III. PRELIMINARIES

MANET topology is an arbitrary model in which the nodes are having independent mobility with a dynamic network model N, which is a finite set of mobile nodes (1,2,3,…N) and the nodes are independently placed in a freeway scenario with an area of A(a X b) where a is the length and b is the width of the rectangular freeway scenario area. Each node is assumed to have the transmission range Tr. Let “d” denote the distance between nodes i and j. Nodes i and j are said to be neighbors if they can directly communicate with each other, that is if d< Tr . There are N Nodes in the mobile ad hoc network where node S is the source and node D is destination for the packet transmission. The protocols AODV, DSR, and DSDV are chosen for the study and they follow the same configurations. The buffer centric schemes are explained below.

A. BN

At each node, a queuing system with a limited buffer is created. This queue maintains the packets during the transmission of data from source node to destination node. All the nodes in between the source and destination may act as intermediate nodes for the successful transmission of data, so it is necessary to maintain the packets at each node that are travelling in the mobile ad hoc network. Each packet in the queue is very helpful in maintaining the transmission of node for reducing the packet dropping and also improving the packet delivery ratio. It is purely developed by using the technique drop tail in the queue. Therefore, if the queue was full then the packets will be lost or dropped at the tail of the queue.

The arrival rate can be considered as λ and Service rate as $\boldsymbol{\mu}$. Arrival rate and Service rate follows exponential distribution. λ_n is mean arrival rate (expected number of arrivals per unit time) of new packet where “n” packets are waiting in the system. When λ_n is a constant for all “n”, this constant is denoted by

λ. $1/\lambda$ is the expected interval time. $\boldsymbol{\mu}_n$ is the mean service rate for overall system (Expected number of packets transmitting service per unit time) when n packets are waiting in the system. $\boldsymbol{\mu}_n$ represents combined rate at which all busy services achieve service completions. Where the mean service rate per busy server is a constant for all $n \geq 1$, this constant is denoted by $\boldsymbol{\mu}$. $1/\boldsymbol{\mu}$ is the expected service time. Here λ can be considered as arrival rate i.e. arrival packets per second, where as $\boldsymbol{\mu}$ can be taken as service rate i.e. service packets per second.

In this paper number of nodes (N), λ and $\boldsymbol{\mu}$ are varied for different scenarios and protocols (AODV, DSDV, and DSR) in three cases. In these three parameters one is varied and the other two are kept constant resulting three different cases they are Node Density, Varied Service Rate and Varied Packet Arrival Rate.

B. NBN

For conducting simulation runs without queue of each node for comparison of three protocols, assume that each packet arrived at node for transmission may be transmitted to the neighbor node as per the routing mechanism. The same drop and tail mechanism is considered in all scenarios. In this scheme only Node Density case exists.

RANDOM WAYPOINT MODEL (RWP):

Mobility model describes the way of mobile nodes travel in the network area. In this, nodes may travel in any direction and at any speed based on pause time, speed and other characteristics. The random way point mobility model is used as network node mobility model for the mobile ad hoc network. The mobility model plays a vital role in the evaluation of the performance metrics of MANET. In Random way mobility model every node has speed and pause time attributes. Initially the nodes are positioned randomly in the mobile ad hoc network area. The nodes are moving in the network based on the pause time and speed of each node until the end of the simulation time. Normally mobile nodes travel near the center of mobile ad hoc network area or simulation area. This mobility model happens to be widely used one hence chosen.

C. NETWORK SIMULATOR:

NS is a Network Simulator tool for performing general research work in computer networks. It is really a tough task of implementation of large networks and establishment of routers. Assembling is cost effective for researchers to do their experiments in a real time network. So by using a network simulator it is easy for getting the simulated results, implementation of real time experiments and research in computer networks. NS2 is a network simulator tool version 2 used for simulation of real time networks, designing of network protocols, monitoring of node parameters, network establishment and their implementation. It is much easier to get the results by using NS (Network Simulator), there are series of network simulators are available as ns1, ns2, ns3. There are different computer network simulators available other than NS versions are primarily used in research and teaching. NS2 is an open source software, any user can access NS2 for research, development, and work outs without any financial overhead. The real & simulation results typically match hence no need of infrastructure as a cost effective metric.

IV. SIMULATION METHODOLOGY

The objective of simulation is to observe and quantify the effects of various factors and their interactions on the overall performance before correlating it to the exact image of today's real applications. Each run of the network simulator accepts input scenario file that describes the exact motion of each node and transmission of data using BN and NBN schemes. The evaluation of the performance at a particular factor can be measured as the average of 10 random simulation runs for the 10 generated random scenario patterns. Performance of the considered factor is the average of these 10 output simulation runs. In all the simulation runs each one takes 10 sample points of particular factors and verified three different protocols i.e. AODV, DSR, and DSDV. Hence 150 simulation runs for each case were performed to analyze each performance factor for these three protocols. The Parameters that are to be taken in the simulation are divided into two types namely Queuing Parameters and Simulation Parameters and these were presented in table I. Queuing Parameters are arrival rate, service rate and buffer size of the queue. Whereas the simulation parameters are area of the network, number of nodes, speed of the nodes, pause time, transmission rate, packet size, simulation time, routing protocols, mobility model and CBR traffic generation. The simulation parameters are common to both BN and NBN Schemes where as queue parameters are exclusively considered in BN scheme.

TABLE I
SIMULATION PARAMETERS

Queuing Parameter	Value
Arrival Rate (λ)	6, 7, 8, 9, 10 packets per second
Service Rate (μ)	11, 12, 13, 14, 15 packets per second
Buffer Size(K)	10
Simulation Parameter	Value
Area(A)	1000 m X 500 m.
Number of Nodes(NN)	10,20,30,40,50
Speed	10 m/sec
Pause Time	10 sec
Transmission Rate	10 packets/sec
Packet Size	512 Bytes
Simulation Time	200 sec
Routing Protocols	AODV, DSR, DSDV
Mobility Model	Random Way Point Mobility Model
Traffic Generation	CBR

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A. *PERFORMANCE METRICS:*

The performance metrics are used to quantify the affect of routing protocol to reach the QoS. To calculate the performance and Quality of Service issues in MANET, the performance metrics are identified as Packet Delivery Ratio, End to End Delay, and Average Routing Load.

Packet Delivery Ratio (PDR) is the ratio of successfully delivered packets to the destination compared to the total number of packets that are generated or sent from the sender can be given as

PDR=(Received Pkts / Generated Pkts)*100 (1)

End to End Delay is the difference between the received time of the packet and the sent time of the packet.

ETE Delay [Pkt Id]=Received Time[Pkt Id]-Sent Time [Pkt Id] (2)

Average Routing Load defined as the total number of routing packets (Control packet sent + Forward) transmitted per data packet delivered at the destination.

ARL=((Control Pkts Sent+Control Pkts Forward)/Data Pkts Received)*100 (3)

V. RESULTS AND DISCUSSIONS

The simulation experiments are carried out for three cases of BN Scheme and Node Density Case is only with NBN Scheme. The results are presented in graphs and the observations are as follows.

A. *NBN Scheme with Node Density Case:*

In this case, number of nodes is varied from 10 to 50 with 10 interval time, and can be observed the performance metrics for the three protocols .The remaining parameters are fixed as usual for this case as per parameter table. It can be observed from fig. 1, if the number of nodes are increasing the packet delivery ratio also increases linearly from number of nodes 10 to 20 and then get stabilize at a constant value from 20 to 50 nodes for AODV and DSDV protocols. Packet Delivery Ratio increases gradually from nodes 10 to 30 where as from nodes 30 to 60 a little negative inclination is observed in DSR protocol. So it is stated that the Packet Delivery Ratio is not constant in DSR where as it is constant in AODV and DSDV from nodes 20 to 50.

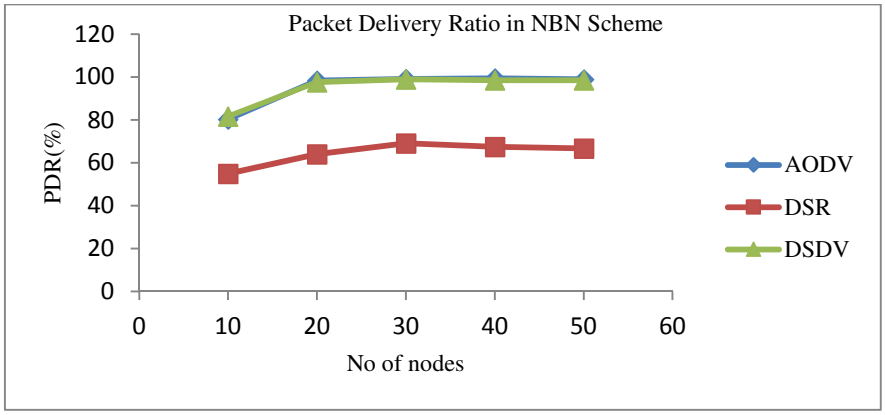

Fig.1: Number of Nodes vs Packet Delivery Ratio

In fig.2, it is identified that if the number of nodes increases then the end to end delay remains constant in DSR routing protocol from nodes 10 to 50. In DSDV if number of nodes increases from 10 to 20 then it gradually decreases the end to end delay and then it remains approximately constant from nodes 20 to 50. The end to end delay varies according to number of nodes in AODV. In this case it is observed that DSR protocol is best in terms of minimum end to end delay.

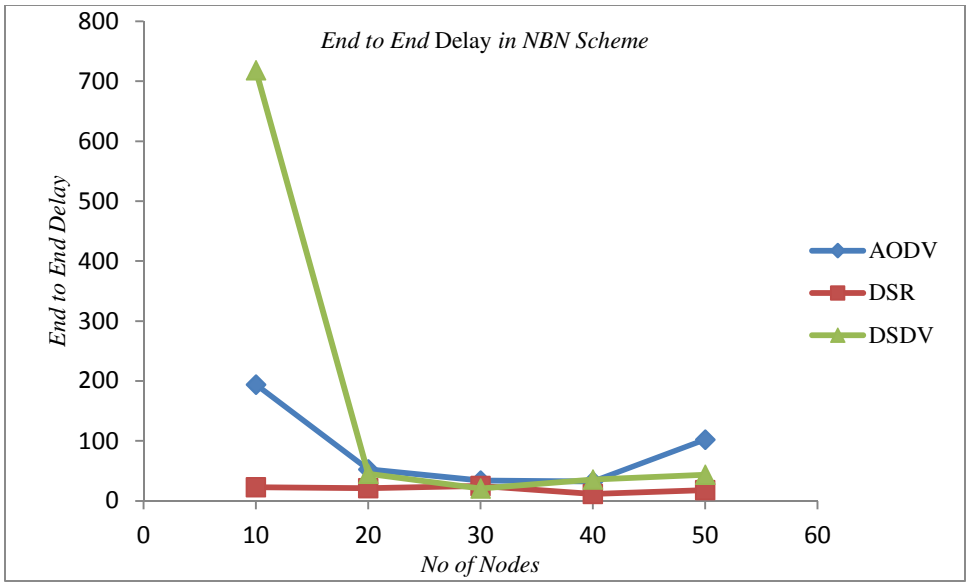

Fig. 2: Number of Nodes vs End to End Delay

In Fig.3, if number of nodes increases from 10 to 50 the average routing load increases in all the routing protocols. It is observed from these three protocols DSDV has the lower average routing load. From this perspective one can say that DSDV works with a very low average routing load.

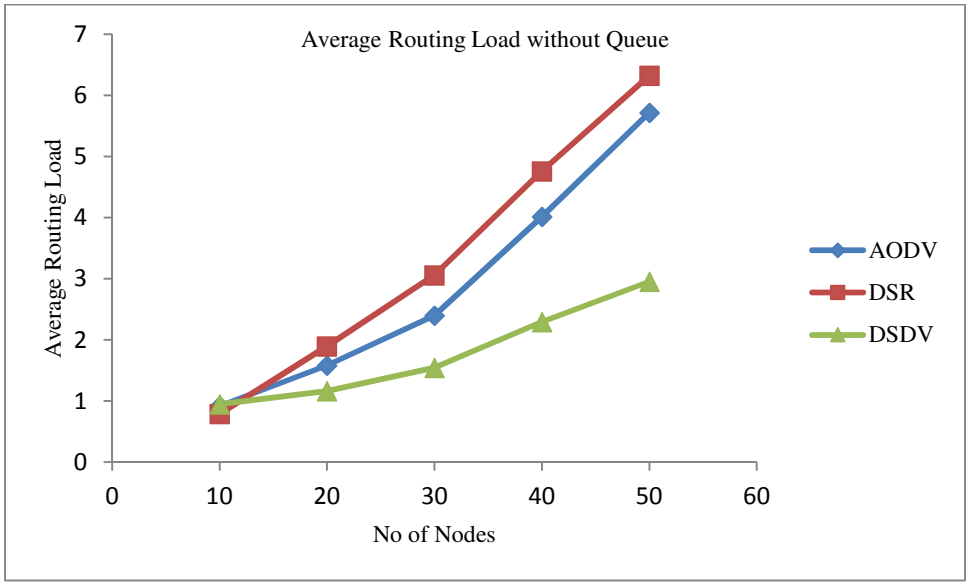

Fig. 3: Number of Nodes vs Average Routing Load

B. *BN Scheme*:

Node Density Case:

In this case, number of nodes is varied from 10 to 50 with 10 interval time where as arrival rate is fixed at 6 packets per second and the service rate is fixed at 15 packets per second. The remaining parameters are fixed as usual for this case as per parameter table.

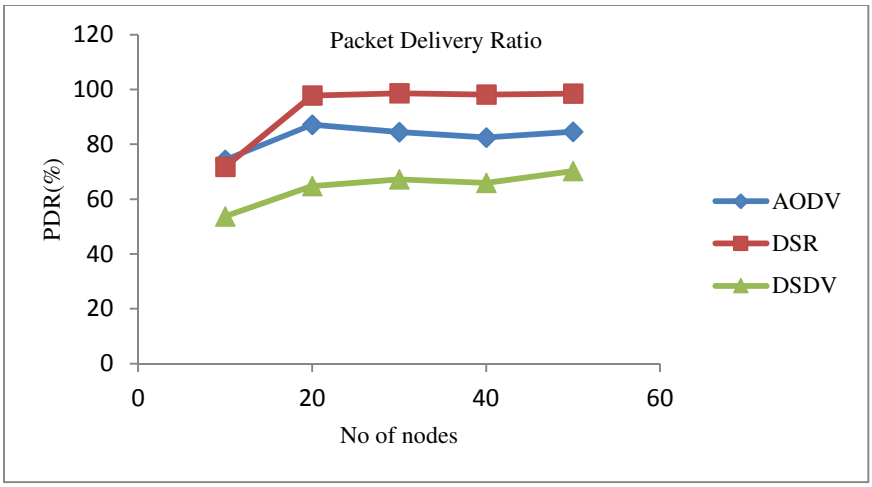

Fig. 4: Number of Nodes vs Packet Delivery Ratio

In Fig. 4 if there is an increase in the number of nodes then the Packet Delivery Ratio increases from 10 to 20 nodes for all the three protocols. The DSR protocol is fixed at 100% Packet Delivery Ratio after 20 nodes to 50 nodes where as AODV is marginally above 80% and DSDV is above 60%. In this case DSR protocol provides without loss of packet transmission for the number of nodes ranging from 20 to 50.

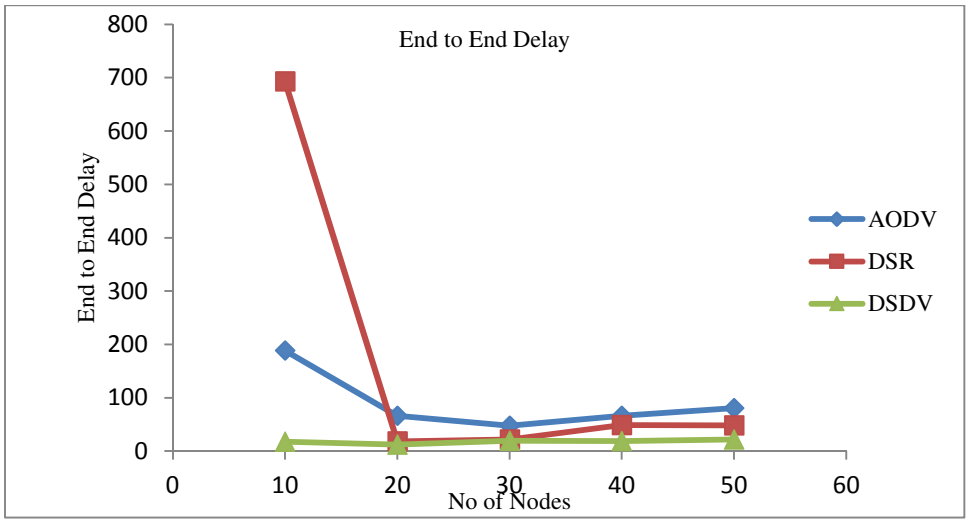

Fig. 5: Number of Nodes vs End to End Delay

In Fig.5, if there is an increase in the number of nodes the End to End Delay decreases for the values of number of nodes ranging between 10 and 20 for both AODV and DSR protocols. In the DSDV protocol the End to End Delay is more or less below 25 sec for the varied range of number of nodes. After 20 nodes to 50 nodes in AODV it varies from 50 to 80 sec and for DSR changes from 18 to 50 sec. For End to End Delay DSDV is better compared to other protocols.

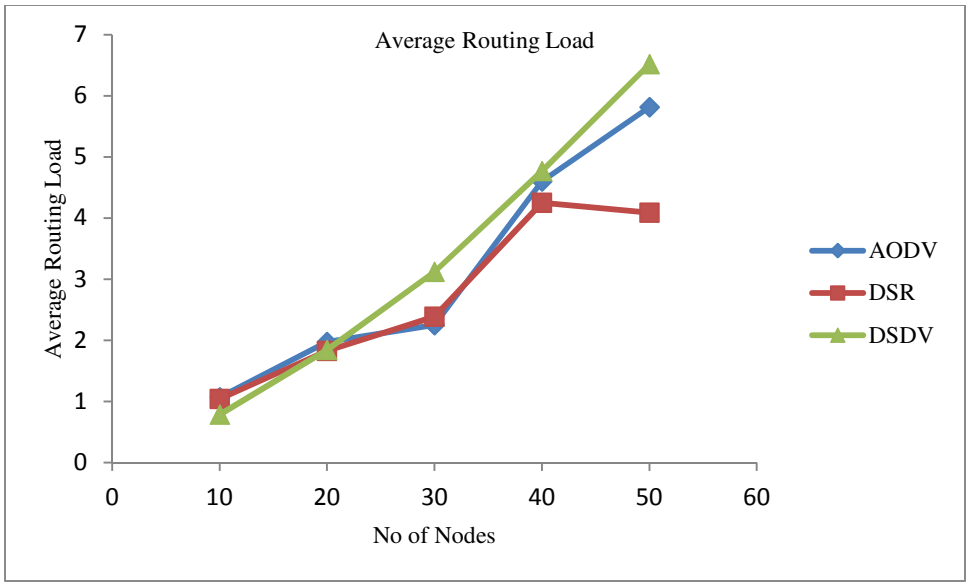

Fig. 6: Average Routing Delay vs Number of Nodes

In Fig. 6, it is observed that if there is an increase in the number of nodes the Average Routing Load increases linearly in DSDV protocol for all the nodes. AODV and DSR protocols increase differently step by step from 10 to 50 nodes. For Average Routing Load DSR is optimal when compared to other protocols.

Varied Arrival Rate Case:

In this case, Arrival rate is varied from 6 to 10 with an interval of 1 packet where as a number of nodes are kept constant at 30 nodes and service rate is also kept constant at 15 packets per second. The remaining parameters are fixed as usual for all this case as per parameter table.

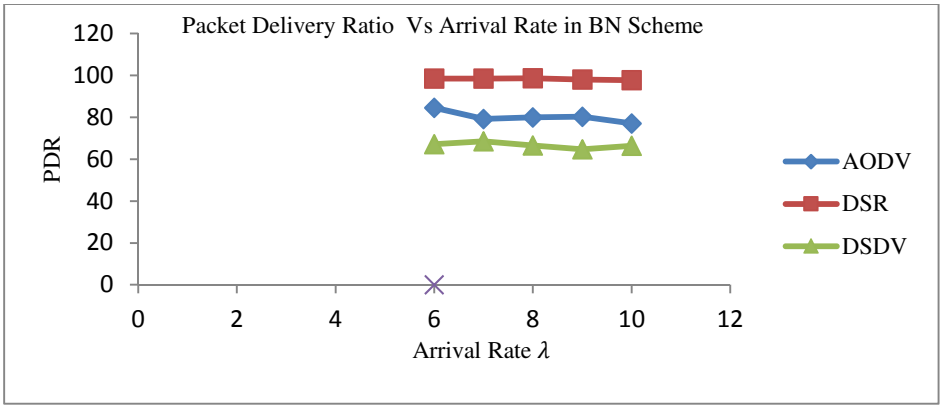

Fig. 7: Packet Delivery Ratio vs Arrival rate

In Fig. 7, it is identified that if an increase in Arrival rate ranging from 6 to 10 packets per second then the Packet Delivery Ratio is remains constant at 100%, above 80% and marginally above 60% for DSR, AODV and DSDV protocols respectively. for Packet Delivery Ratio DSR is identified as best when compared to other protocols.

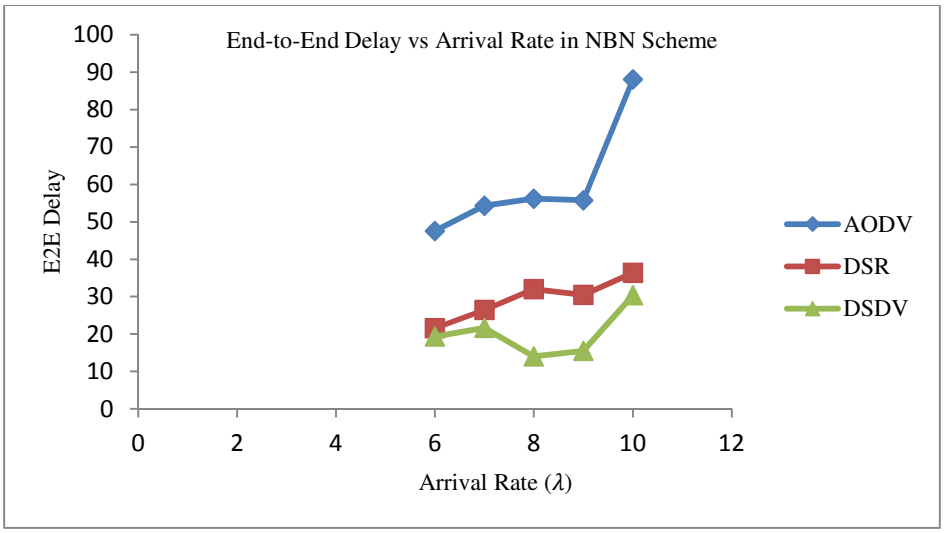

Fig. 8: End to End Delay vs Arrival rate

In Fig .8 if there is an increase in the arrival rate then the End to End Delay increases from 6 to 9 packets per second for AODV and DSR protocols. The DSDV protocol is increasing up to 7 packets per second, after that it decreases at 8 packets and then again it increases from 8 to 10 packets per second. In this case 2, for End to End Delay DSDV is optimal when compared to other protocols.

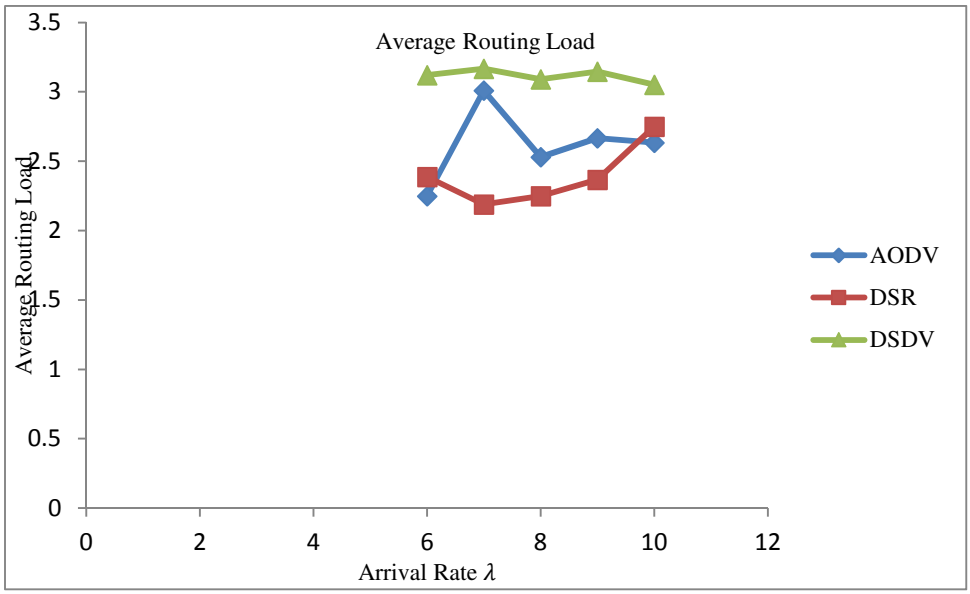

Fig. 9: Average Routing Delay vs Arrival rate

In Fig. 9 if there is an increase in the arrival rate, it results the Average Routing Load increases linearly in DSR protocol for all the nodes. AODV and DSR protocols increase differently step by step from 6 to 10 packets per second. For this case the Average Routing Load DSR is optimal when compared to other protocols.

Packet Service Rate CASE:

In Packet service case the service rate varies from 11 to 15 with 1 interval packets per second, where as the number of nodes is fixed at 30 nodes and Arrival rate is fixed at 6 packets per second. The remaining parameters are fixed as usual for this case as per our parameter table.

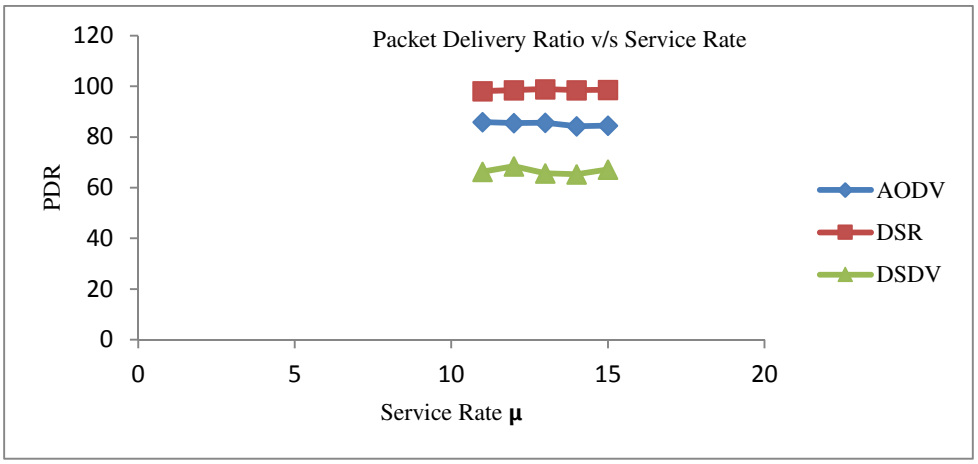

Fig. 10: Packet Delivery Ratio vs Service rate

In Fig. 10, if an increase in service rate it results the Packet Delivery Ratio is constant near to 100% from 11 to 15 packets per second for DSR protocol. The AODV and DSDV protocols are varied very limitedly from 11 to 15 packets per second. In this case, for Packet Delivery Ratio DSR is optimal when compared to other protocols.

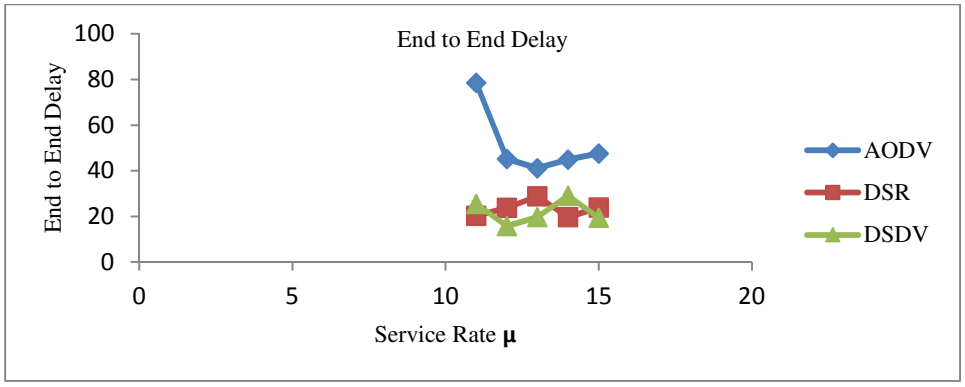

Fig. 11: End to End Delay vs Service rate

In Fig. 11, if there is an increase in the service rate results the End to End Delay decreases from 11 to 12 packets per second for AODV and DSDV protocols. The DSR protocol is increasing from to 11 to 13 packets per second further end to end delay decreases at 14 packets and then again it increases from 14 to 15 packets per second. In this case, for End to End Delay, DSDV is observed to be optimal when compared to other protocols.

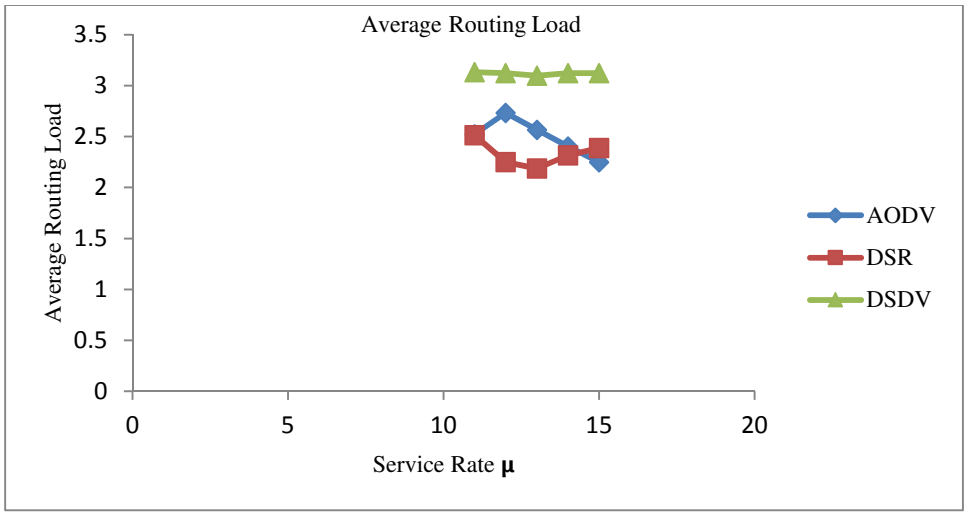

Fig. 12: Average Routing Delay vs Service rate

In Fig. 12, if an increase in the service rate then it results the Average Routing Load is constant in DSDV protocol from 11 to 15 packets per second. AODV and DSR protocols decrease in average routing load differently step by step from 11 to 15 packets per second. In this case the Average Routing Load DSR is optimal when compared to other protocols.

The total Experimental Analysis of routing protocols can be done by using the NS2 Simulator. However in the overall observation DSR protocol is optimal in any case or in any scenario. The advantage over the queuing approach results in 99% of Packet Delivery Ratio when DSR protocol used as a routing protocol.

VI. CONCLUSION

In the recent years, Mobile Ad Hoc Networks (MANETs) are high in research and topology of MANETs usually changes with time. The prime idea about the change in routing protocols or designing of new protocols has been done in recent years. Because of the dynamic nature of MANETs and involved complexity to arrive at performance metrics without assumptions, there is always a need to explore the performance of routing protocols through simulation. The simulation characteristics used in this research paper are Packet Delivery Ratio, End to End Delay and Average Routing Load, of BN and NBN schemes. The summarization of these results and final conclusions from simulated results by using NS2 are as follows:

- The increase in the density of nodes leads to an increase in the Packet Delivery Ratio, decrease in the End to End Delay and increase in the Average Routing Load. Increase in the density would obviously mean reduced node to node distance which would have a positive impact on all the dependant parameters.
- The increase in the arrival rate will give 100% of Packet Delivery Ratio in DSR protocol .Where as in the case of AODV & DSDV protocols the PDR remains more or less constant at 80% and 60% respectively. The End to End Delay and Average Routing Load do have the similar kind of influence.
- The increase in the service rate leads to 99.99% of Packet Delivery Ratio in DSR protocol and increase in service rate for AODV & DSDV protocols the PDR remains at 80% and 60% respectively. In AODV protocol linear increase or decrease in the End to End Delay and also in Average Routing Load.

There were different models are available in the market. But this paper presents reality based model and idealistic model for the real time implementation considering all the requirements and metrics for the

better performance. The REM queuing model may be used for the better performance in MANETs and real time estimations may be done in future work.

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