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Research Article

Comparative Analysis of Routing Protocols in AD- HOC Network: AODV, DSDV, DSR

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Abstract

An ad-hoc wireless network consists of a set of mobile nodes (hosts) that are connected with wireless links. The network topology (the physical connectivity of the communication network) in such a network may keep changing randomly. Routing protocol that find a path to be followed by data packets from a source node to a destination node used in traditional wired networks cannot be directly applied in ad-hoc wireless network due to highly dynamic topology. There are various issues in designing a routing protocol for ad-hoc wireless network. This paper focuses on three routing protocol – AODV, DSR, DSDV of ad-hoc network. The main aim is to find the routing protocol giving best result at different data rates.The simulation platform used for evaluating the proposed approach is GloMoSim , a discrete event detailed simulator for wireless network systems.

Keywords*: Ad-hoc, DSDV, DSR, AODV, datarate.*

1. Introduction

An ad-hoc wireless network consists of a set of mobile nodes (hosts) that are connected with wireless links. The network topology (the physical connectivity of the communication network) in such a network may keep changing randomly. Routing protocol that find a path to be followed by data packets from a source node to a destination node used in traditional wired networks cannot be directly applied in ad-hoc wireless network due to highly dynamic topology. There are various issues in designing a routing protocol for ad-hoc wireless network. The major challenges that come across while designing a routing protocol for ad-hoc wireless network are mobility of nodes ,resource constraints, error prone channel state and hidden and exposed terminal problem.

An ad hoc network typically refers to any set of networks where all devices have equal status on a network and are free to associate with any other ad hoc network device in link range. Ad hoc network often refers to a mode of operation of IEEE 802.11 wireless networks. It also refers to a network device's ability to maintain link status information for any number of devices.Ad hoc networks alone may not support a routeable IP network environment without additional Layer 2 or Layer 3 capabilities. The earliest wireless ad hoc networks were the packet radio networks (PRNETs) from the 1970s, sponsored by DARPA (en.wikipedia.org/wiki/DARPA) after the ALOHAnet(en.wikipedia.org/wiki/ALOHAnet) project.

The decentralized nature of wireless ad hoc networks makes them suitable for a variety of applications where central nodes can't be relied on and may improve the scalability of networks compared to wireless managed networks, though theoretical and practical limits to the overall capacity of such networks have been identified.

One key problem in Wireless Ad Hoc networks is foreseeing the variety of possible situations that can occur. As a result, Modeling and Simulation using extensive parameter sweeping and what-if analysis becomes an extremely important paradigm for use in ad hoc networks. Traditional M&S tools include NS2,(and recently NS3), OPNET Modeler and GloMoSim. However, these tools focus primarily on the simulation of the entire protocol stack of the system. Although this can be important in the proof-of-concept implementations of systems, the need for a more advanced simulation methodology is always there. Agent-based modeling and simulation offers such a paradigm. Not to be confused with multi-agent systems and intelligent agents, agent-based modeling originated from social sciences, where the goal was to evaluate and view large-scale systems with numerous interacting AGENT or components in a wide variety of random situations to observe global phenomena. Unlike traditional AI systems with intelligent agents, agent-based modeling is similar to the real world. Agent-based models are thus effective in modeling bio-inspired and nature-inspired

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systems. In these systems, the basic interactions of the components the system, also called Complex Adaptive System, are simple but result in advanced global phenomena such as emergence.

This paper focuses on three routing protocols of ad-hoc network, the aim is to find the routing protocol giving best result at different data rates. The simulation platform used for evaluating the proposed approach is GloMoSim , a discrete event detailed simulator for wireless network systems.

The rest of the paper is organised as follows: In section 2 we report the relevant literature in this area ; in section 3 present the simulation setup for the proposed work; setion 4 will focus on the various result obtained, finally in section 5 we will present the conclusion.

2. Related Work

An ad-hoc wireless network is a collection of wireless mobile nodes that self-configure to construct a network without the need for any established infrastructure or backbone. Ad hoc networks use mobile nodes to enable communication outside wireless transmission range. With the advancement in wireless communications, more and more wireless networks appear, e.g., Mobile Ad Hoc Network (MANET), Wireless Sensor Network (WSN), etc.

K. Kiran Reddy et al. (K. Kiran Reddy et al,2012) discusses ad -hoc Networks along with its energy issues, applications, QoS and challenges. Guoyou He (Guoyou He et al) reviews the DSDV protocol, and analyzes the properties of DSDV when it is used for ad hoc networks routing. Yi Lu et al.(Yi Lu et al, 2003) investigated packet loss in mobile ad hoc networks via simulation. Their results indicated that DSDV loses 10% to 20% more packets than AODV does for UDP traffic. For TCP traffic, the packet loss for DSDV is a half of that for AODV. Anders Nilsson(Anders Nilsson et al, 2002) explains the effect different traffic loads have on the network performance when the transmission power is varied. Bijan Paul et al.(Bijan Paul et al, 2011) explains the performance of two on-demand routing protocols AODV & DSR has been analyzed by means of packet delivery ratio, loss packet ratio & average end-to-end delay with varying speed limit and node density under TCP & CBR connection.

3. Simulation Environment

The simulation platform used for evaluating the proposed approach is GloMoSim (Lokesh Bajaj et al, 1999) , a discrete event detailed simulator for wireless network systems. It is based on C-based parallel simulation language PARSEC (R. Bagrodia et al, 1998). In our experiments all the layers are implemented using default characteristics of IEEE 802.11(IEEE Computer Society LAN MAN Standards Committee, 1997). The objective of this standard is to provide wireless connectivity to wireless devices/ nodes that require rapid deployment, which may be portable, or which may be mounted on moving vehicles within local area. The IEEE 802.11 also aids the regulatory bodies in standardising access to one or more radio frequency bands for the purpose of local area communication. The interfaces offered by 802.11 to the higher layers are the same as those offered in other 802.x standards.

3.1. Propagation Model

A radio propagation model, also known as the Radio Wave Propagation Model or the Radio Frequency Propagation Model, is an empirical mathematical formulation for the characterization of radio wave propagation as a function of frequency, distance and other conditions. A single model is usually developed to predict the behavior of propagation for all similar links under similar constraints. Created with the goal of formalizing the way radio waves are propagated from one place to another, such models typically predict the path loss along a link or the effective coverage area of a transmitter. As the path loss encountered along any radio link serves as the dominant factor for characterization of propagation for the link, radio propagation models typically focus on realization of the path loss with the auxiliary task of predicting the area of coverage for a transmitter or modeling the distribution of signals over different regions.

3.2 Routing Protocol

The aim of a routing protocol is to find a path followed by the data packets from a source node to a destination node. A variety of routing protocols for ad-hoc wireless network has been proposed in the recent past. The routing protocol for ad-hoc wireless networks can be broadly classified into four categories:

a) Routing information update mechanism
b) Use of temporal information for routing
c) Routing topology
d) Utilization of specific resources

The routing protocol discussed here belongs to the first category. Ad-hoc routing protocols belonging to this category can be broadly classified into three major categories, they are:

1. Proactive or Table driven routing protocols: In table driven routing protocol , every node mainrains the network topology information in the form of routing tables by periodically exchanging routing information. Example- DSDV,WRP,CGSR, STAR,OLSR, etc..(C.Ramamurthy e al, 2013)
2. Reactive or On-Demand routing protocol: Prrotocol that fall under this category do not maintain the network topology information . They obtain the necessary path when it is required. Example- DSR, AODV,ABR , SSA, etc..(C.Ramamurthy e al, 2013).
3. Hybrid routing protocol: Protocol belonging to this category combine the best feature of the above two categories . Nodes within a certain distance from the node concerned , or within a particular geographical region , are said to be within the routing zone of the given node. For routing within this zone , a table

driven approach is used . For nodes located beyond this zone , an on demand approach is used. Example-CEDAR,ZRP,ZHLS(C.Ramamurthy e al, 2013).

Here the protocols that are considered are AODV, DSDV and DSR.

3.3 Mobility Model

Since MANETs are not currently deployed on a large scale, research in this area is mostly simulation based. Among other simulation parameters, the mobility model plays a very important role in determining the protocol performance in MANET. Thus, it is essential to study and analyze various mobility models and their effect on MANET protocols. Thus, it is essential to study and analyze various mobility models and their effect on MANET protocols. Beside the commonly used Random Waypoint model and its variants.

The mobility model used for simulation is Random Waypoint model .The Random Waypoint Model was first proposed by Johnson and Maltz. Soon, it became a 'benchmark' mobility model to evaluate the MANET routing protocols, because of its simplicity and wide availability. Each node randomly selects a direction in which to travel , where a direction is measured in degrees. The node then randomly selects a speed and destination along with the direction and travels there. Once it reaches the destination , it remains stationary for some predefined time called as pause time. Two variants, the Random walk model and the Random direction model are variants of the Random waypoint model. Two variants, the Random walk model and the Random direction model are variants of the Random waypoint model.

3.4 Simulation setup

QualNet is a discrete-event simulator. In discrete-event simulation, a system is modeled as it evolves over time by a representation in which the system state changes instantaneously when an event occurs, where an event is defined as an instantaneous occurrence that causes the system to change its state or to perform a specific action. Examples of events are: arrival of a packet, a periodic alarm informing a routing protocol to send out routing update to neighbors, etc. Examples of actions to take when an event occurs are: sending a packet to an adjacent layer, updating state variables, starting or restarting a timer, etc.

Whole simulation is carried out on GloMoSim 5.0 version. Four different amount of traffic rates 1 Mbps, 2 Mbps,5.5 Mbps and 11 Mbps are injected in to the network. The simulation simulates for 30 seconds and the network of 100 nodes in a 1000 x 1000 m area is modelled .

The total amount of traffic is varied and this is done by varying the number of sources in the network. Number of 512 byte data packets sent per second. The type of traffic injected into the network is 10 short-lived CBR sources spread randomly over the network. When one session ends , a new source-destination pair is randomly selected. Thus the input traffic is constantly maintained.

The experiment is carried considering all the data rates 1 Mbps, 2 Mbps, 5.5 Mbps and 11 Mbps for all the three routing protocols AODV , DSDV and DSR separately.

The main aim is to find the routing protocol giving best result at different data rates. Following is the specifications taken into consideration for the experimental work.

Area	1000 x 1000 m area
Number of nodes	100
Routing protocol	DSDV, DSR, AODV
Mobility model	Random Way Point
Simulation time	30 seconds
Data rate	1 Mbps, 2 Mbps, 5.5 Mbps, 11 Mbps
Start time	1 second
End time	101 seconds
CBR sources	10
Interval	1
Pause time	10 second
Max velocity	10 m/s
Min velocity	0 m/s
Shadowing model	Constant Model

4. Results

4.1 Throughput

Throughput or network throughput is the average rate of successful message delivery over a communication channel. This data may be delivered over a physical or logical link, or pass through a certain network node. The throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot. The throughput is the real performance value of the system given to you.

Here we had focused on three routing protocols AODV, DSDV, DSR when they are transferring data at Constant Bit Rate(CBR). Constant bit rate means that the rate at which a codec's output data should be consumed is constant. CBR is useful for streaming multimedia content on limited capacity channels since it is the maximum bit rate that matters, not the average, so CBR would be used to take advantage of all of the capacity.

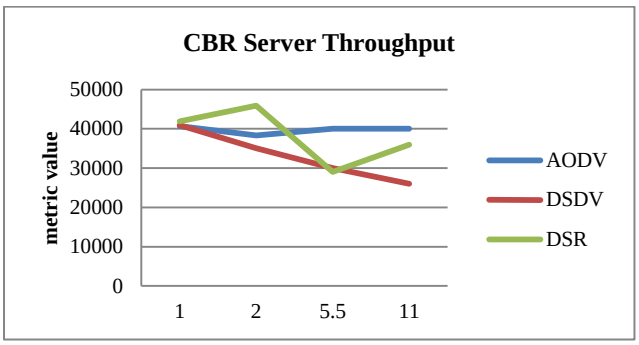
Throughput is generally accepted as one of the most important metrics to evaluate the performance of a routing protocol. Several simulation-based performance comparisons have been done for ad hoc routing protocols in the recent years.As Every source is associated with a constant bit rate (CBR) traffic generator, which sends out packets at the given rate, so thiscomes under the category of Unresponsive traffic The packet size is fixed at 512 bytes. In order to increase the throughput the server to client throughput should be increased .From figure 1 we can say that the throughput of routing protocol DSDV is showing the increase when transferring the information

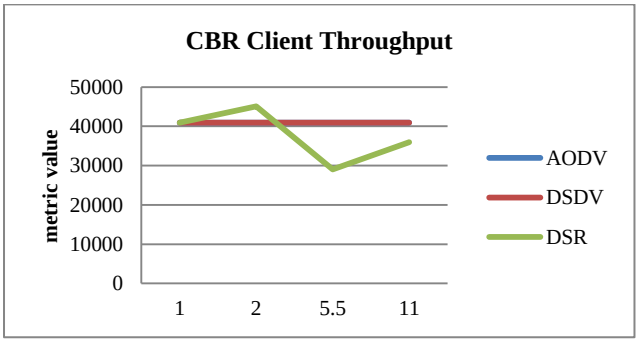
from server to client. As It can be seen from figure that client throughput remains constant as the data rate is increasing even though the throughput at the sever side is decreasing with the increase in data rate. The reason behind this improvement from server to client is compression of data, as it reduces the time taken to transmit the data from one end to another end. The throughput of the network itself isn't improved by compression. From the end-to-end (server to client) perspective compression does improve throughput. That's because information content for the same amount of transmission is increased through compression of files. Compressing files at the server and client takes more processor resources at both the ends. The server has to use its processor to compress the files, if they aren't already done. The client has to decompress the files upon receipt. This can be considered an expense (for the server and client) for the benefit of increased end to end throughput(although the throughput hasn't changed for the network itself).

4.2 Average end to end delay

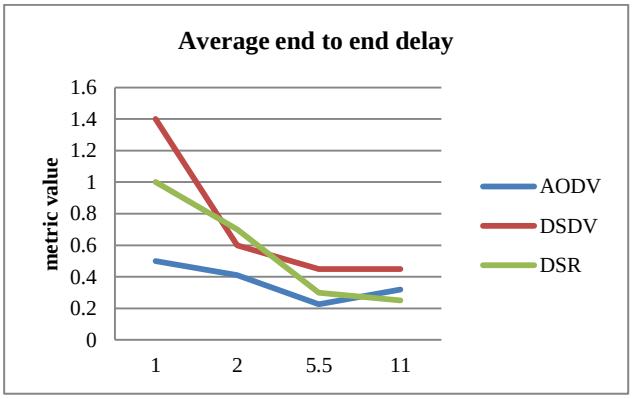
End-to-end delay refers to the time taken for a packet to be transmitted across a network from source to destination.

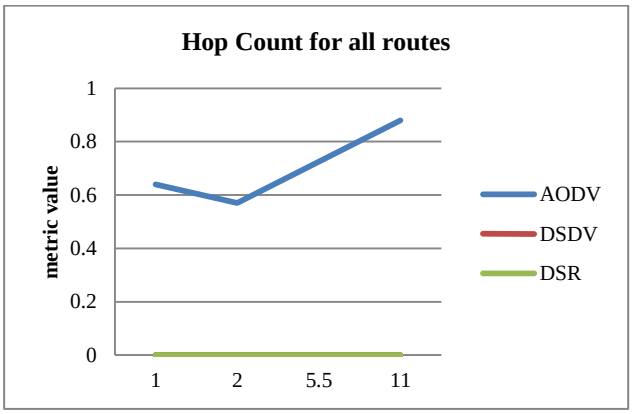
dend-end = N[dtrans+dprop+dproc]





Where dend-end is end-to-end delay, dtrans is transmission delay, dprop is propagation delay, dproc is processing delay and N is number of links. From figure it can be seen that the average delay of DSDV is highest as compared to the other two. The end to end delay of DSDV is 1.4 sec , AODV is .5 sec and that of DSR is 1 sec at a data rate of 1 Mbps. The performance is better when packet end to-end delay is low.





4.3 Hop Count

Hop count is a rough measure of distance between two hosts. A hop count of n means that n gateways separate the source host from the destination host. By itself, this metric is, however, not useful for determining the optimum network path, as it does not take into consideration the speed, load, reliability, or latency of any particular hop, but merely the total count. Here we can see that AODV is showing the maximum hop count as compared to the other two. The Dynamic-Adjusting AODV(DA-AODV) based on max hop count first calculates the value of max hop of the networks and then intelligently and dynamically adjusts its parameters based on the value of max hop to enhance the network performance.

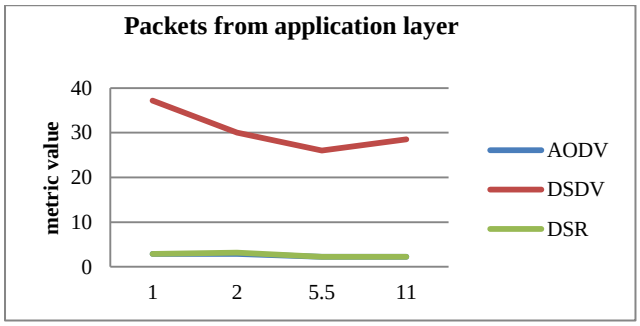
4.4 Packets delivery in Application Layer

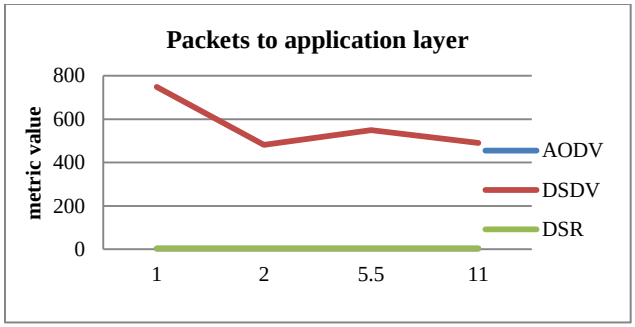
In computer network programming, the application layer is an abstraction layer reserved for communications protocols and methods designed for process-to-process co munications across an Internet Protocol (IP) computer network. Application layer protocols use the underlying transport layer protocols to establish host-to-host connections.

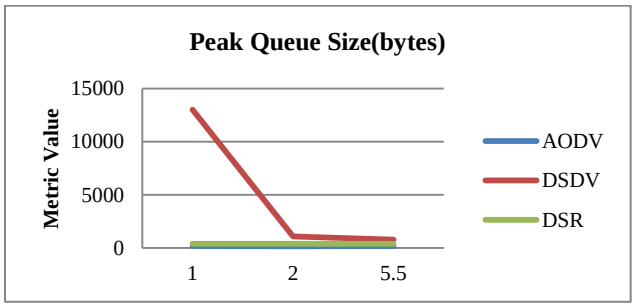
In the OSI model, the definition of its application layer is narrower in scope. The OSI model defines the application layer as being the user interface. The OSI application layer is responsible for displaying data and images to the user in a human-recognizable format and to interface with the presentation layer below it.

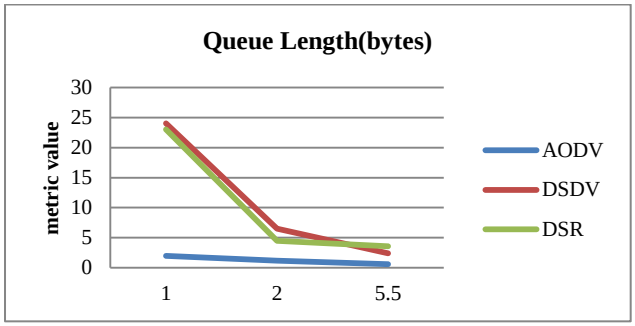
4.5 Queue Size and Queue Length

A queue is a particular kind of abstract data type or collection in which the entities in the collection are kept in order and the principal (or only) operations on the collection are the addition of entities to the rear terminal position, known as enqueue, and removal of entities from the front terminal position, known as dequeue. This makes the queue a First-In-First-Out (FIFO) data structure. In a FIFO data structure, the first element added to the queue will be the first one to be removed. Queueing is the study of traffic behavior near a certain section where demand exceeds available capacity.









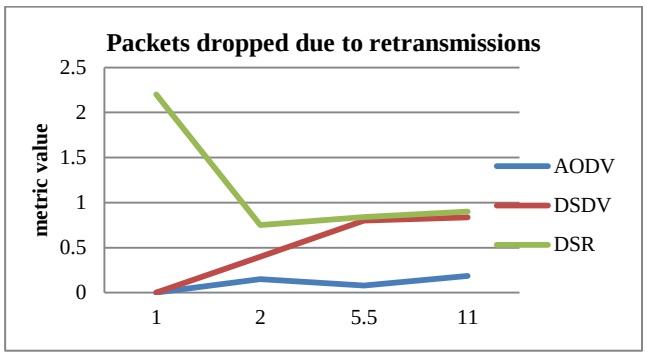
4.6 Packets dropped due to retransmission

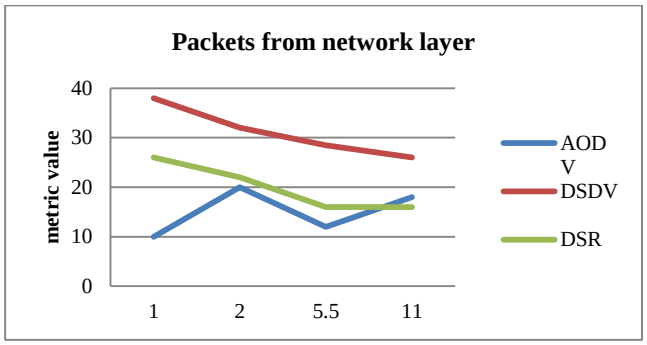
When caused by network problems, lost or dropped packets can result in highly noticeable performance issues or jitter with streaming technologies, voice over IP, online gaming and videoconferencing, and will affect all other network applications to a degree. However, it is important to note that packet loss does not always indicate a problem.If the latency and the packet loss at the destination hop are acceptable then the hops prior to that one don't matter. As it can be seen from the figure that packet drop is less in AODV and it is slightly more in DSDV while it is very high in DSR.

4.7 Packets from network layer

The network layer is responsible for packet forwarding including routing through intermediate routers, whereas the data link layer is responsible for media access control, flow control and error checking. The network layer provides the functional and procedural means of transferring variable length data sequences from a source to a destination host via one or more networks, while maintaining the quality of service functions.

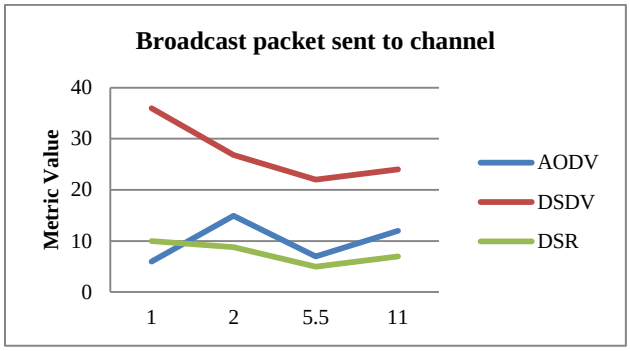
It is clear from figure 3 that packets from network layer is more in DSDV and least in AODV, Packets from network layer in DSR is in between DSDV and AODV.

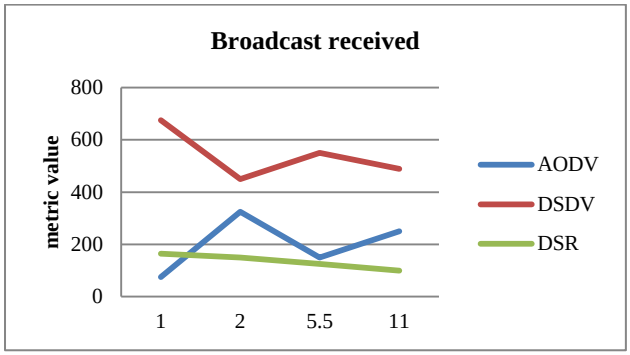




Broadcast traffic, in computer networking, is traffic that is simultaneously addressed to all computers connected to the network, as opposed to unicast or multicast traffic. There is no direction associated with an IP packet, as both the client and the server send and receive packets. From the above figure it can be seen that the packets send and

received in a channel is more in DSDV as compared to AODV and DSR.





4. Conclusion

With the increasing popularity of ad-hoc network, it is important to understand the characteristics of these networks so that they can be tuned to achieve optimum performance. As already being told three routing protocols are concentrated upon which are AODV, DSDV and DSR. The various parameters which will decide their performance are: CBR client and server throughput, end to end delay, packets from and to application layer , hop count , queue size and queue length, longest time in queue, data packets forwarded at network , packets dropped due to retransmission , broadcast packet sent and received in channel. In order to analyze the performance of ad-hoc network all these parameters are need to be taken into consideration.

It can be concluded from the above simulation that the throughput of routing protocol DSDV is showing the increase when transferring the information from server to client. Average delay of DSDV is highest as compared to the other two. The packets send and received in application layer is more in DSDV as compared to AODV and DSR and it can also be seen that it is high at 1 Mbps of data rate and keep on decreasing when the data rate increases. As far as the hop count is concerned AODV is showing the maximum hop count as compared to the other two. The queue size and queue length is better in DSDV than in AODV and DSR. As it can be seen from the figure that packet drop is less in AODV and it is slightly more in DSDV while it is very high in DSR. Packets from network layer is more in DSDV and least in AODV, Packets from network layer in DSR is in between DSDV and AODV. At last the packets send and received in a channel is more in DSDV as compared to AODV and DSR .

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