Performance Comparison of DSDV, OLSR, DSR and AODV MANET Routing Protocols in Traffic Conditions

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Abstract: ***The mobile Ad hoc networks (MANETs) are wireless networks where a collection of mobile nodes may dynamically vary the topological structure. With respect to the more widely used mobile cellular networks (GSM), MANETs do not use any form of fixed infrastructure or central co-coordinator. The characteristics of MANETs are dynamic topology rather than a static or fixed, constrained bandwidth, variable-capacity links, limited physical security and energy-constrained operations. Since MANETs are self-configured, and allow ubiquitous service access, irrespective of time and place without any fixed infrastructure they can have several types of applications like rescue operations, military, law enforcement and security operation, home network and conferencing . Apart of these the challenging issue of MANETs is routing, where in many different protocols have been proposed in the literature papers, each one based on different characteristics and properties. Basically MANETs protocols are classified based on routing table maintenance i.e., Table driven and on demand. Table driven Maintain routes with every host at all time, where on demand Creates routes to remote host's on-demand. Therefore focus in this paper is to compare the performance of four routing protocols DSDV, OLSR (Proactive) and DSR, AODV (reactive) for CBR, FTP traffic by varying no. of nodes in terms of throughput, end to end delay and packet loss. The simulation is carried out on NS2.***

Keywords: MANET, Routing Protocols, DSDV, OLSR, DSR, AODV, NS2

1. Introduction

Mobile ad hoc networks or "short live" networks operate in the absence of fixed infrastructure. They offer both quick and easy deployment of network in situations where it is not possible. Ad hoc is a Latin word and means "for this purpose ". A Mobile ad hoc network is a continuously self-configuring system of mobile nodes which are connected by wireless links; each node operates as an end system and a router for all other nodes in the network.

A mobile ad hoc network is a collection of mobile nodes forming an ad-hoc network without the assistance of a centralized structure. These networks introduced a new art of network establishment and can be well suited for an environment where either the infrastructure is lost or where deployed an infrastructure is not very cost effective.

The popular IEEE 802.11 "WI-FI" protocol is capable of providing ad-hoc networks at low level, when access point is not available. However in this case, the nodes are limited to send and receive information but do not route anything across the network. A Mobile ad hoc networks can operate in a stand-alone fashion or could possibly be connected to a larger network such as the Internet.

Mobile ad hoc networks can turn the dream of getting connected "anywhere and at any time" in real situations. Typical application examples include a disaster recovery or a military operation. These are not bound to specific situations; these networks may equally show better performance in other places. For an example, we can imagine a group of people working with computer systems or laptops, in a business meeting at a place where no network services is present. They can easily connect their machines by forming an ad hoc network. This is one of the most used examples where these ad hoc networks may possibly be used.

2. Background and Related Work

The limited resources in MANETs have made designing an efficient and reliable routing strategy a very challenging predicament. An intelligent routing strategy is required to use the limited resources efficiently while at the same time be adaptable to the changing network conditions such as network size, traffic density, and network partitioning. Corresponding with this, the routing protocol may need to provide different levels of QoS to different types of applications and users.

A number of routing protocols have been proposed for MANET's. These protocols can be categorized into three different groups: global or proactive, on demand or re-active, and hybrid. In proactive routing protocols, the routes to all the destinations (or parts of the network) are determined at the start-up and maintained by using a periodic routing update process. In re-active protocols, routes are determined when they are required by the source using a route discovery process. In Hybrid routing, protocols combine the basic properties of two categories of protocols into one. This makes, they are both reactive and proactive in nature. Fig.1 shows various routing protocols that come under three types.

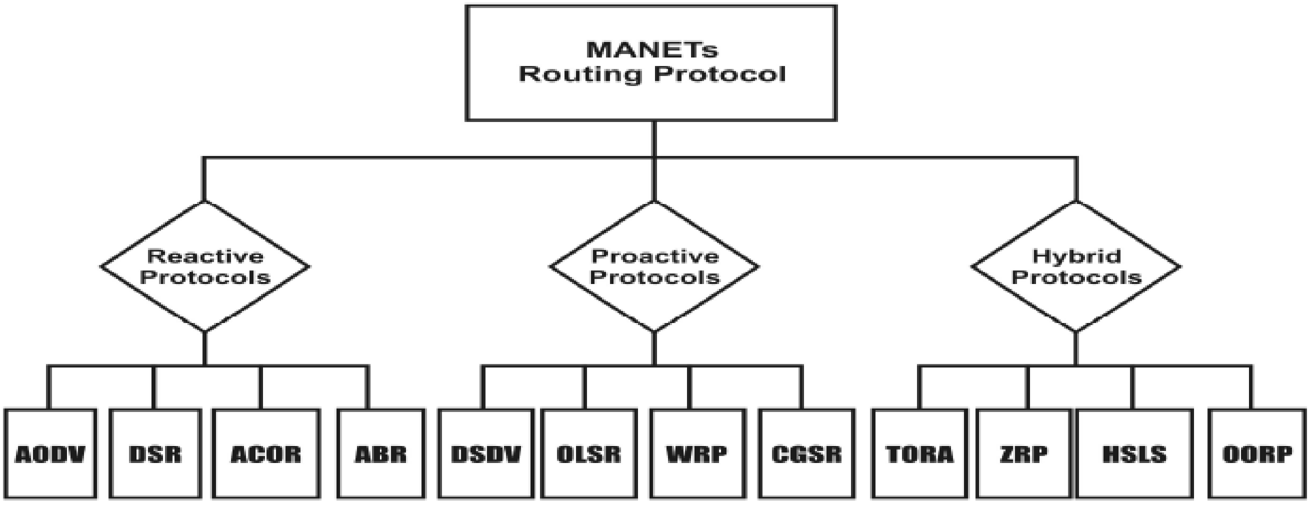


Figure 1: MANET Routing protocols

2.1 Scope of the Paper

The ad hoc routing protocols DSDV, OLSR, DSR and AODV are the promising routing protocols. They can be used in mobile ad hoc networks to route packets between mobile nodes. The main objectives are:
(1) Implementing the DSDV, OLSR, DSR and AODV routing protocols in NS2.
(2) Comparing the performance of four protocols under following metrics:

- Throughput
- End-to-End Delay
- Packet Loss

(3) Traffic conditions considered:

- Constant Bit Rate(CBR) with TCP and UDP source Routing
- FTP with TCP and UDP routing.

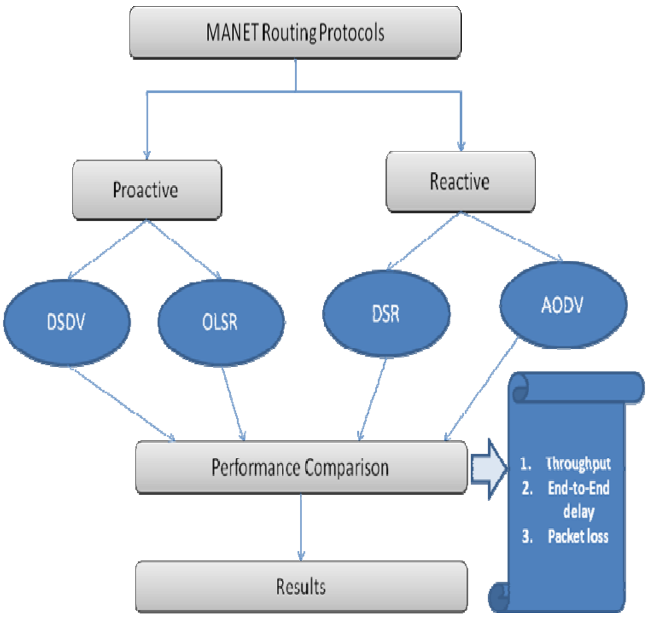


Figure 2: Scope of the Paper

3. Routing Protocols

3.1 Destination Sequence Distance Vector Protocol (DSDV)

This protocol is based on classical Bellman-Ford routing algorithm designed for MANET'S. Each node maintains a list of all destinations and number of hops to every destination. Each entry is marked with a sequence number. It uses full dump or incremental update to reduce network traffic generated by route updates. The broadcast of route updates is delayed by settling time. The only improvement made here is avoidance of routing loops in a mobile network of routers. With this improvement, routing information can always be readily available, regardless of whether the source node requires the information or not.

DSDV solved the problem of routing loops and count to infinity by associating each route entry with a sequence number indicating its freshness. In DSDV, a sequence number is linked to a destination node, and usually is originated by that node (the owner).). The only case that a non-owner node updates a sequence number of a route is when it detects a link break on that particular route. An owner node always uses even numbers as sequence numbers, and a non-owner node always uses odd-numbers.
The list which is maintained is called routing table. This routing table contains the following:
(1) Available IP address at all destinations
(2) Next hop IP address
(3) Number of hops required to reach the destination
(4) A Sequence Number assigned by the destination node
(5) Install time

3.2 Optimized Link State Routing Protocol (OLSR)

The Optimized Link State Routing (OLSR) is a table driven, pro-active routing protocol developed for MANET's. It is an optimization of pure link state protocols in that it reduces the size of control packet as well as the number of control packets transmission required.

OLSR reduces the control traffic overhead by using Multipoint Relays (MPR), which is the key idea behind OLSR. A MPR is a node's one-hop neighbour which has been chosen to forward the packets. Instead of pure flooding of the network, packets are just forwarded by MPRs of each node. This delimits the network overhead, and thus being more efficient than pure link state routing protocols. OLSR is well suited to large and dense mobile networks. Because of the use of MPR's, the larger and more dense network, the more optimized link state routing is achieved. MPRs helps providing the shortest path to a destination. The network topology information is maintained by periodically exchange of link state information. If it is more reactivity to topological changes than it is necessary, the time interval for exchanging of link state information can be reduced.

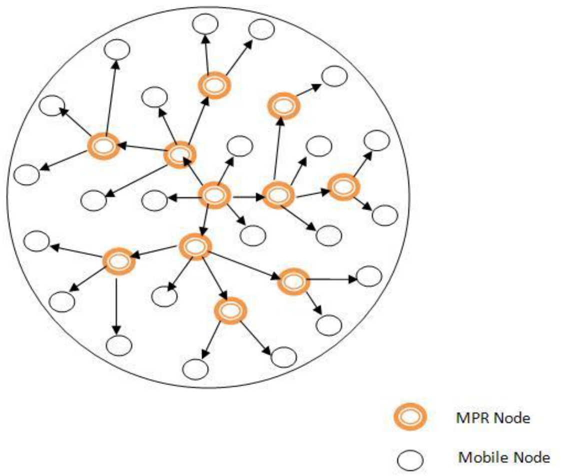


Figure 3: MPR node sends the TC message

3.3 Topology Information

Information about the network topology is extracted from topology control (TC) packets. These packets contain the MPR Selector set of a node, and are broadcasted by every node in the network, both periodically and when changes in the MPR Selector set is detected. The packets are flooded in the network using the multipoint relaying mechanism. Every node in the network receives such TC packets, from where they extract information to build a topology table.

3.4 Dynamic Source Routing Protocol (DSR)

The Dynamic Source Routing protocol (DSR) is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile node. A DSR allows network to be completely self-organizing and self-configuring, without need for any existing network infrastructure or administration. Dynamic Source Routing, DSR, is a reactive routing protocol that uses source routing to send packets. It uses source routing which means that the source must know the complete hop sequence to the destination. DSR uses source routing, i.e. the source determines the complete sequence of hops that each packet should traverse. This requires a sequence of hops is included in each packet header. A negative consequence of this is that, the routing overhead every packet has to carry. However, a big advantage is that intermediate nodes can learn routes from where the source routes in the packets they receive. Since, finding a route is generally a costlier in terms of time, bandwidth and energy ; and this is a strong argument for using source routing. Another advantage of this source routing is, it avoids the need for "up-to-date" routing information in the intermediate nodes through which the packets are forwarded as all necessary routing information is included in the packets itself. Finally, it avoids routing loops easily because the complete route is determined by a single node instead of making the decision hop-by-hop. The protocol is composed of the two main mechanisms of "Route Discovery" and "Route Maintenance" which needs to work together to enable the nodes to discover and maintain routes to arbitrary destinations in the ad hoc networks.

3.5 Ad-hoc on demand Distance Vector Protocol (AODV)

AODV is an on-demand routing algorithm in that it determines a route to a destination only when a node wants to send a packet to that destination. It is a relative of Bellman-Ford distant vector algorithm, but it is adapted to work in a mobile environment. Routes are to be maintained as long as they are needed by the source. AODV is capable of both uni-cast and multi-cast routing.

AODV differs from other on-demand routing protocols in that uses sequence numbers to determine an up-to-date path to a destination. Every entry in the routing table is associated with a sequence number. The sequence number act as a route timestamp, ensuring freshness of the route. Upon receiving a RREQ(route request) packet, an intermediate node compares its sequence number with the sequence number in the RREQ packet. If the sequence number already registered is greater than that in the packet, the existing route is more up-to-date.

Because the AODV protocol is a flat routing protocol it does not need any central administrative system to handle the routing process. In addition, AODV tries to keep the overhead of the messages small. The AODV protocol is a loop free and avoids the counting to infinity problem which were typical to the classical distance vector routing protocols by the usage of the sequence numbers.

4. Implementation

To evaluate the performance of MANET routing protocols DSDV, OLSR, DSR and AODV simulation is carried out in NS2.35 with Linux operating system. The aim of the simulation is to analyze the performance of routing protocols for its efficiency in terms of throughput, delay and packet loss. The following table shows the parameters chosen for the NS2 simulation:

Table 1: Simulation parameters

Simulation Parameter	*Value*
Simulator	NS 2.35
Simulation Area	1000mx1000m
Simulation Duration	10sec, 20sec
Number of nodes	5,8,10,15,20
Traffic Type	CBR,FTP
Source Type	UDP,TCP
Routing Protocols	DSDV,OLSR,DSR and AODV

Mobility	Random
Packet Size(in bytes)	512,1024
Data rate(in kbps)	200,600,1024, 0.5mbps, 1mbps
Channel Type	Channel/Wireless Channel
Radio-propagation model	Propagation/TwoRayGround
Network interface type	Phy/WirelessPhy
MAC type	Mac/802_11
Interface queue type	Queue/DropTail/PriQueue
Link layer type	LL
Antenna model	Antenna/OmniAntenna
Max packet in ifq	50

5. Performance Parameters

Throughput performance, Throughput is measured by sending data from the source to destination using ping. Throughput increases with increases in packet size up to some particular level and then increases in packet size not effected on throughput.But at the same time large packet size cause a higher probability of packet fraud. The interval has no significant impact on throughput performance moving data packet over multiple links results in greater delay, hence affecting the communication throughput.
Throughput can be calculated as:
Throughput<= Number of packets Reached/Round Trip Time*8Mbytes

End-to-End Delay (EED) The delay experienced by the packet from it was sent by source to destination till it was received at destination. It depends on packet size and beaconing interval and route length. Varying the packet size is directly depending on the EED of MANET. In the case when beaconing is performed in at very high frequencies at that situation EED increases.
End-to-end delay is that time taken for a packet to be transmitted across a network from source to destination.
$$d_{end-end} = N[d_{trans} + d_{prop} + d_{proc}]$$
where
$d_{end-end}$= end-to-end delay
d_{trans}= transmission delay
d_{prop}= propagation delay
d_{proc}= processing delay
N= number of links (No. of routers + 1)

Packet loss performance, In MANET the channel is subjected to noise, fading; interference and less bandwidth effect packet loss. it tends to increase at large packet size at the same time at low beaconing frequencies packet size has a lesser effect on packet loss performance .At high beaconing frequencies packet loss performance almost independent of packet size determine the packet loss ratio using the following formula to determine packet loss ratio:
Number of lost packet / (Number of lost packet + Number of packets received successfully.)

6. Routing Types

Routing has two basic types, which are as under.
(1) Static routing is done by the administrator manually to forward the data packets in the network and it is permanent. This settings will not changed by any administrator. These static routers are configured by the administrator, which means there will be control on routing tables by the router itself.
(2) Dynamic routing is automatically done by the router itself. It will route the traffic depend on the routing table.which allows the routers to know about the networks and the interesting thing is to add this information in their routing tables. This is shown in the below figure 4. In dynamic routing the routers exchange the routing information if there is some change in the topology. Exchanging information between these dynamic routers learn to know about the new routes and networks. Dynamic routing is more flexible than static routing. In dynamic routing it have the potential to overcome the overload traffic by using different paths to forward the data packets,it is better than static routing.

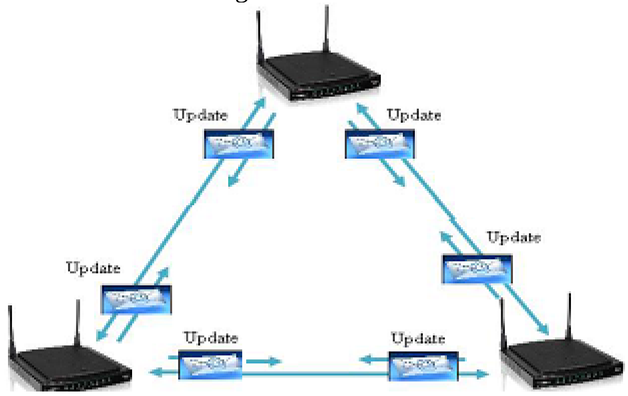
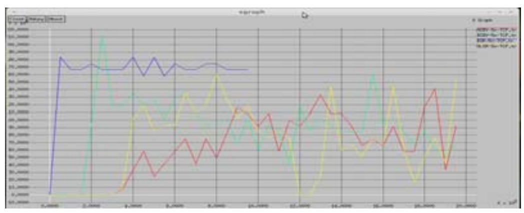


Figure 4: Routes updates

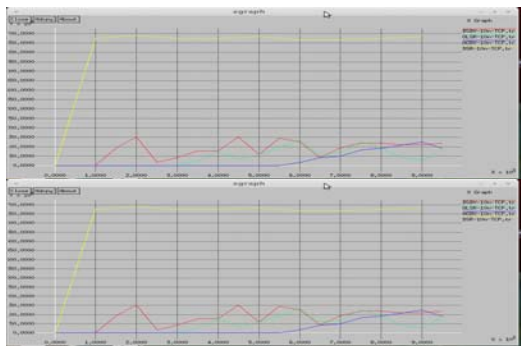
7. Results & Analysis

7.1 Throughput

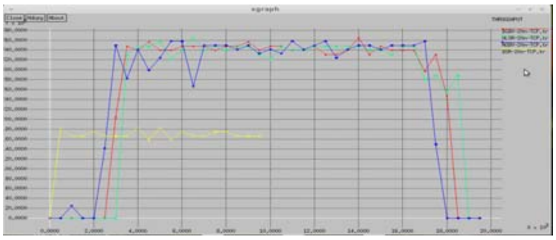
It is observed from the results that throughput of AODV is higher than the other protocols, but when compared among only reactive protocols OLSR throughput is greater than DSDV, finally DSDV protocol throughput increases even with the increase of number of nodes both in TCP and UDP traffic conditions.



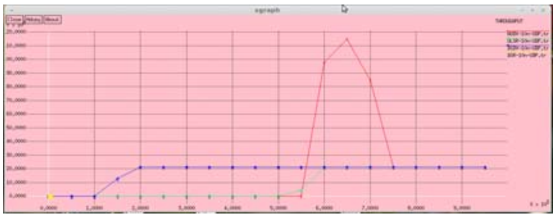
Graph 1: Dynamic,Random, 5 nodes with TCP implementation



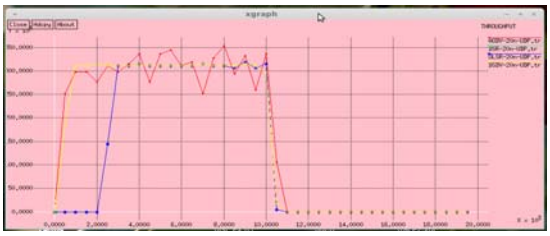
Graph 2: Static,Random, 10 nodes with TCP implementation



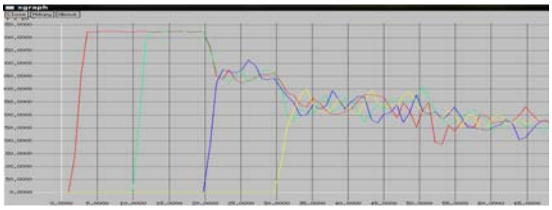
Graph 3: Dynamic,Random, 20 nodes with TCP implementation



Graph 4: Dynamic,Random,10 nodes with UDP implementation



Graph 5: Dynamic,Random,20 nodes with UDP implementation

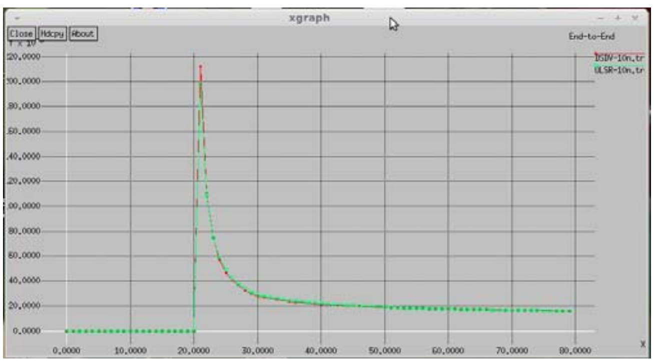


Graph 6: Dynamic,Random,20 nodes with CBR traffic implementation

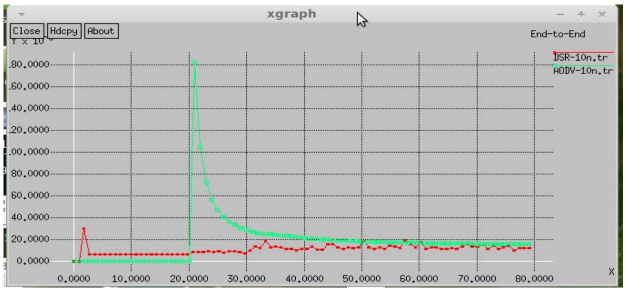
7.2 End-to-End Delay

It is evident from the results that the delay is higher in DSDV and less in OLSR among proactive protocols, and among reactive protocols the delay is less in DSR. But with the increase of nodes and when compared all the four together OLSR has got higher efficiency in delay.

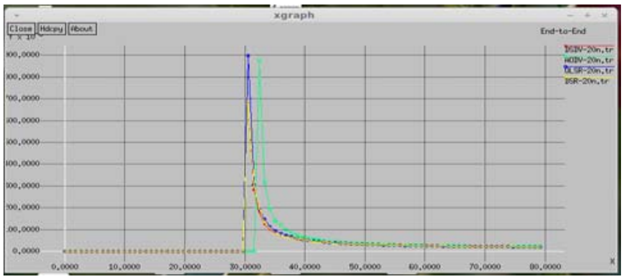
The results are shown below:



Graph 7: DSDV,OLSR,10 nodes TCP comparision



Graph 8: DSR,AODV- 10 nodes with TCP implementation

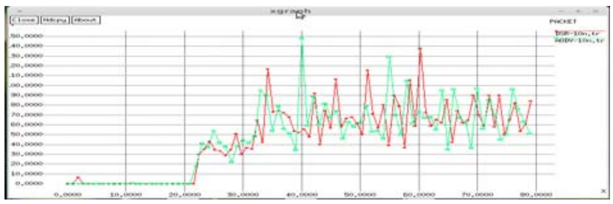


Graph 9: DSR,AODV,DSDV,OLSR- 20 nodes with random motion, UDP implementation

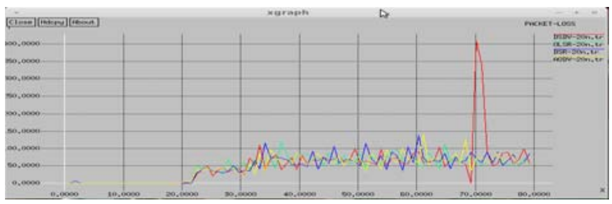
7.3 Packet Loss

Among proactive protocols OLSR performed better than DSDV, as the number of nodes increased the random motion is also highly varied and because of that the packet drop rate is high in DSDV and less in OLSR, and when it comes to reactive protocols AODV packet drop rate is less, even as the number of nodes increased the drop rate remained constant in AODV. But among all the four the packet loss rate is less in OLSR because most of the Packets sent and received is among the MPR nodes

Graph 10: DSDV,OLSR 10 nodes with random motion, TCP implementation.



Graph 11: DSR,AODV- 10 nodes with Dynamic and random motion



Graph 12: Reactive,Proactive- 20 nodes with Dynamic and random motion

8. Conclusion

In the present Scenario the performance of MANET routing protocols is examined with respect to the following parameters namely throughput, end-to-end delay and packet loss. DSDV and OLSR protocols come under proactive where as DSR and AODV come under reactive protocols. Every individual protocol has got its own advantages and disadvantages and performed well at their peer level, but for the purpose of efficiency when they are compared using the tool NS2 with the help of TCL scripts, the simulation results are observed as AODV has got higher performance in throughput and OLSR gives better performance in both packet loss rate and also in delay. Although DSR and DSDV has got less end to end delay beyond to them OLSR performance is better than the rest. It can also be concluded from the simulation results that the efficiency of AODV and OLSR is better than DSDV and DSR.

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