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Comparative Analysis of DSDV and OLSR Routing Protocols in MANET at Different Traffic Load

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ABSTRACT
Mobile Ad hoc networks are the collection of wireless nodes that can exchange information dynamically among them without pre existing fixed infrastructure. There are different protocols for handling the routing in the mobile environment. Because of highly dynamic in nature, performance of routing protocols is an important issue. This paper will focus on two well known protocols: Destination Sequenced Distance Vector (DSDV) and Optimized Link State Routing (OLSR) Protocols. In this paper the simulation result presents the best routing protocol which gives the highest performance when the routing protocols are implemented using ns-2. The simulation compares the two ad hoc routing protocols named destination-sequenced distance vector and optimized link state routing protocols. This paper presents simulation based comparison and performance analysis on different parameters like Packet delivery fraction, Average end-to-end delay, Throughput and Normalized routing overhead.

Keywords
MANET, MPR set, MPR selector set, HELLO message, TC message.

1. INTRODUCTION
In the last few years, thanks to the proliferation of wireless devices, the use of mobile networks is growing very fast. In particular, a very large number of recent studies focused on Mobile Ad-hoc Networks (MANETs) [1]. The performance of a mobile ad hoc network depends on the routing scheme employed, and the traditional routing protocols do not work efficiently in a MANET. This kind of network, in fact, has a dynamic topology (every node can move randomly and the radio propagation conditions change rapidly over the time) and a limited bandwidth [2]. Ad hoc wireless network must be capable to self-organize and self-configure due to the fact that the mobile structure is changing all the time. Mobile hosts have a limited range and sending the message to another host, which is not in the sender's host transmission range, must be forwarded through the network using other hosts which will be operated as routers for delivering the message throughout the network. The mobile host must use broadcast for sending messages and should be in promiscuous mode for accepting any messages that it receives [3].

Routing protocols for existing networks have not been designed specifically to provide the kind of dynamic, self-starting behavior needed for ad-hoc networks. Most protocols exhibit their least desirable behavior when presented with a highly dynamic interconnection topology. Although we thought that mobile computers could naturally be modeled as routers, it was also clear that existing routing protocols would place too heavy a computational burden on each mobile computer. Moreover, the convergence characteristics of existing routing protocols did not seem good enough to fit the needs of ad-hoc networks. Lastly, the wireless medium differs in important ways from wired media, which would require that we make modifications to whichever routing protocol we might choose to experiment with. For instance, mobile computers may well have only a single network interface adapter, whereas most existing routers have network interfaces to connect two separate networks together, besides, wireless media are of limited and variable range, in distinction to existing wired media. Since we had to make lots of changes anyway, we decided to follow our ad-hoc network model as far as we could and ended up with a substantially new approach to the classic distance-vector routing [4]. The main objective of this paper is to study the routing protocols [11] in a mobile ad-hoc network using a network simulator-2 [12]. This paper carry out the analysis of the results for two proactive routing protocols to find out which protocol is best between DSDV and OLSR.

2. PROACTIVE ROUTING PROTOCOLS
Routing protocols are divided into two categories based on how and when routes are discovered, but both find the shortest path to the destination. Proactive routing protocols are table-driven protocols; they always maintain current up-to-date routing information by sending control messages periodically between the hosts which update their routing tables.

When there are changes in the structure then the updates are propagated throughout the network. The proactive routing protocols use link-state routing algorithms which frequently flood the link information about its neighbors. In proactive or table driven routing protocols every node maintains the network topology information in the form of routing tables by periodically exchanging the routing information. Routing information is generally flooded in the whole network. Whenever a node requires a path to a destination, it run a appropriate path-finding algorithm on the topology information it maintains.

2.1 Destination Sequenced Distance-Vector Routing Protocol
The destination sequenced distance-vector routing protocol (DSDV) [5] is one of the first protocol proposed for ad-hoc wireless networks.

It is the improved form of Bellman-Ford routing mechanism. Every node in this maintains a routing table which contains list of all known destination node within the network along with number of hops [13] required to reach a particular node.

It incorporates table updates with increasing sequence number tags to prevent loops, to counter the count-to-infinity problem, and for faster convergence. 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 route. An owner node always uses even-numbers as sequence numbers, and a non-owner node always uses odd-numbers. With the addition of sequence numbers, routes for the same destination are selected based on the following rules:

1. A route with a newer sequence number is preferred;
2. In the case that two routes have a same sequence number, the one with a better cost metric is preferred [5].
3. The list which is maintained is called routing table. The routing table contains the following:
4. All available destinations' IP address
5. Next hop IP address
6. Number of hops to reach the destination
7. Sequence number assigned by the destination node
8. Install time

The sequence number is used to distinguish stale routes from new ones and thus avoid the formation of loops. The stations periodically transmit their routing tables to their immediate neighbors.

A station also transmits its routing table if a significant change has occurred in its table from the last update sent. So, the update is both time-driven and event-driven.

One of "full dump" or an incremental update is used to send routing table updates for reducing network traffic. A full dump sends the full routing table to the neighbors and could span many packets whereas in an incremental update only those entries from the routing table are sent that has a metric change since the last update and it must fit in a packet.

If there is space in the incremental update packet then those entries may be included whose sequence number has changed. When the network is relatively stable, incremental updates are sent to avoid extra traffic and full dump are relatively infrequent. In a fast-changing network, incremental packets can grow big so full dumps will be more frequent [5].

2.2 Optimized Link State Routing Protocol

OLSR [9] is a proactive routing protocol, so the routes are always immediately available when needed. OLSR is an optimization version of a pure link state protocol. So the topological changes cause the flooding of the topological information to all available hosts in the network.

To reduce the possible overhead in the network protocol uses Multipoint Relays (MPR). MPRs are selected nodes which forward broadcast messages during the flooding process. MPRs provide the shortest path to a destination by declaring and exchanging the link information periodically for their MPR's selectors. By doing so, the nodes maintain the network topology information.

The MPR is used to reduce the number of nodes that broadcasts the routing information throughout the network. To forward data traffic, a node selects its one hop symmetric neighbors, referred to as MPR set that covers all nodes that are two hops away. The MPR set is calculated from information about the node's symmetric one hop and two hop neighbors.

This information in turn is extracted from HELLO messages. Similar to the MPR set, a MPR Selectors set is maintained at each node. A MPR Selector set is the set of neighbors that have chosen the node as a MPR. Upon receiving a packet, a node checks its MPR Selector set to see if the sender has chosen the node as a MPR.

If yes, the packet is forwarded, otherwise the packet is processed and discarded. This technique substantially reduces the message overhead as compared to a classical flooding mechanism (where every node retransmits each message received). T

he MPR set is calculated from information about the node's symmetric one hop and two hop neighbors. This information in turn is extracted from HELLO messages Hello messages are interchanged at 0.5 sec and Topology Control (TC) messages at 2 sec interval [10] OLSR uses two kinds of the control messages: Hello and Topology Control.

Hello messages are used for finding the information about the link status and the host's neighbors. With the Hello message the MPR Selector set is constructed which describes which neighbors has chosen this host to act as MPR and from this information the host can calculate its own set of MPRs. the Hello messages are sent only one hop away but the TC messages are broadcasted throughout the entire network.

TC messages are used for broadcasting information about own advertised neighbors which includes at least the MPR Selector list. The TC messages are broadcasted periodically and only the MPR hosts can forward the TC messages [9].

3. SIMULATION SETUP AND RESULTS

3.1 Simulation Environment

Simulation environment is as follows:

Table: Simulation Parameters

Parameter	Values
Traffic type	CBR
Simulation time	600 seconds
Number of nodes	50
Pause time	0, 240 and 600 sec
Maximum connections	10
Maximum speed of nodes	20 meter per second
Transmission rate	10 and 0.1 packets per sec
Area of the network	1000m X 1000m

3.2 Performance Metrics

We report four performance metrics for the protocols:

- *Packet delivery fraction (PDF):* The ratio between the number of data packets received and the number of packets sent.
- *Throughput:* Throughput is total packets successfully delivered to individual destination over total time divided by total time.
- *End-to-end delay:* It is the ratio of time difference between every CBR packet sent and received to the total time difference over the total number of CBR packets received.
- *Normalized routing load:* The Normalized routing loads measures by the total number of routing packets sent divided by the number of data packets delivered successfully.

3.2.1 *Packet Delivery Fraction*

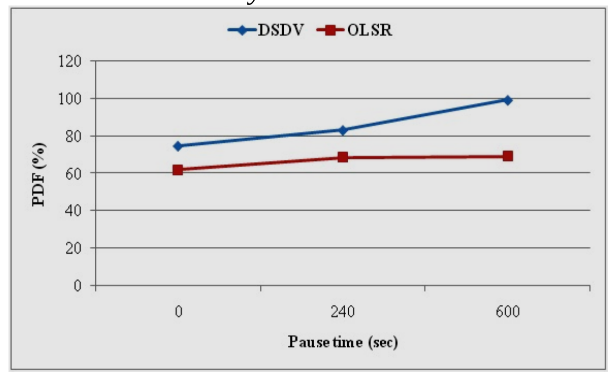

Fig 1 PDF v/s Pause time at low traffic load (0.1 Packet/sec)

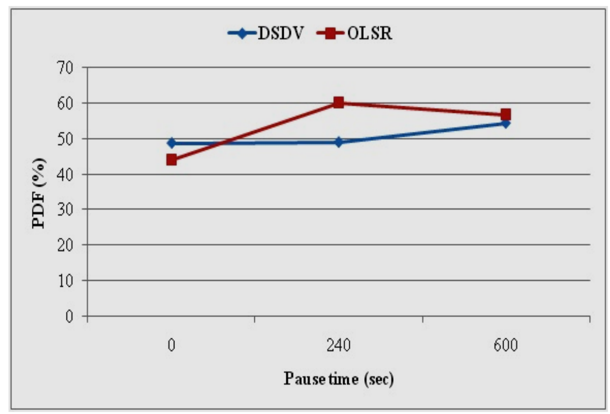

Figure 2 PDF v/s Pause time at high traffic load (10 Packets/sec)

Analysis of results: In less stressful conditions (low traffic and mobility), DSDV only have a small fraction of packets that have been dropped because of collision and routes are valid for longer time. So, DSDV has a better PDF value compared to OLSR under low traffic load conditions. However DSDV's inability to converge when mobility is high, especially at high traffic loads. Therefore the fraction of received packets goes down in stressful environment. The main reason for dropping the packets in DSDV is the routes are not always accurate as it

depends only periodic and trigger message to updates the routes. Sending packets on a broken route that it thinks is valid and packets in the buffer are dropped because of congestion and timeouts. On the other hand OLSR uses TC message in addition to Hello message to exchange latest updates of routes. This will eliminate the possibility of stale routes and hence OLSR delivers more packets in stressful conditions and end up in efficient utilization of the bandwidth.

3.2.2 Throughput

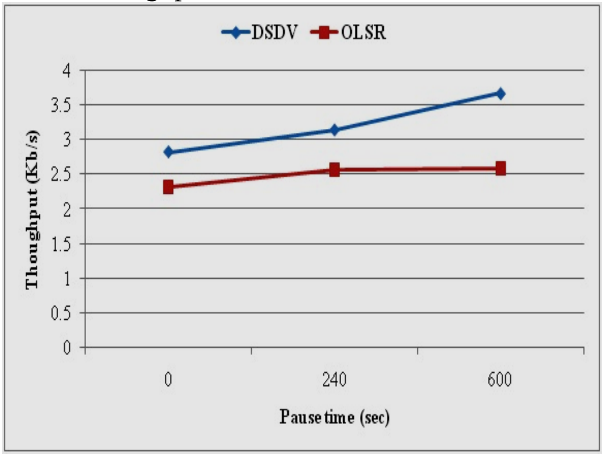

Figure 3 Throughput v/s Pause time at low traffic load (0.1 Packet/sec)

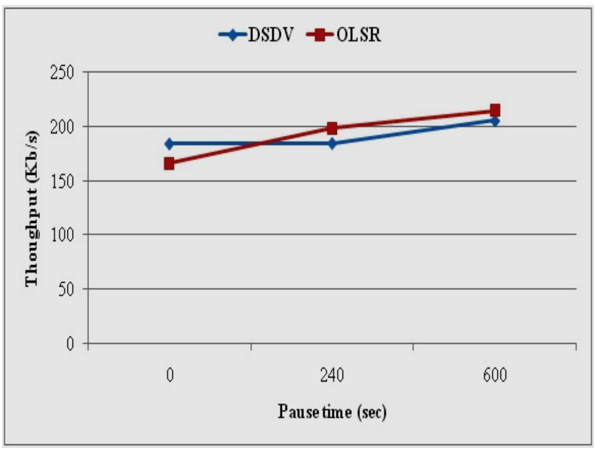

Figure 4 Throughput v/s Pause time at high traffic load (10 Packets/sec)

Analysis of results: It can be seen that at low load, DSDV delivers more packets as compared to OLSR because DSDV is dependent on periodic broadcasts and it needs some time to converge before a route can be used. This converge time is low for less stressful network, where the topology is not changing so frequently. But at high load and mobility environment, where the topology is expected to be very dynamic DSDV takes more time to converge which will be results in lots of dropped packets (low throughput) before a valid route is detected.

3.2.3 End-to-End Delay

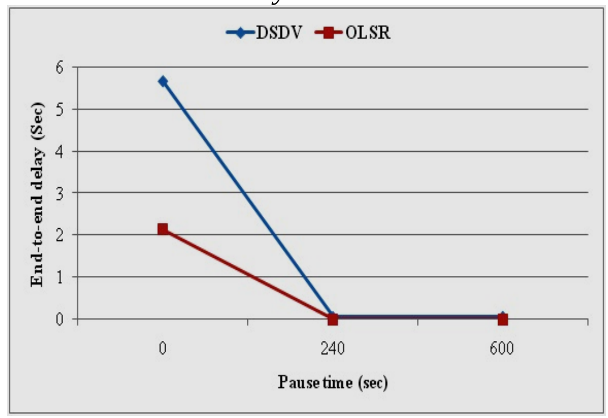

Figure 5 End to end delay v/s Pause time at low traffic load (0.1 Packet/sec)

Analysis of results: Refer to figures 5 and 6; OLSR has low end to end delay compared to DSDV in all simulation scenarios. The reason behind this is OLSR's TC message helps to avoid the stale route problem thereby facilitates wider bandwidth and hence faster delivery of packets. Whereas in case of DSDV, whenever the topology of the network changes, a new sequence number is necessary before the network reconverges. Also DSDV needs more time to converge before the packets can be sent. The buffers will therefore be congested almost all the time.

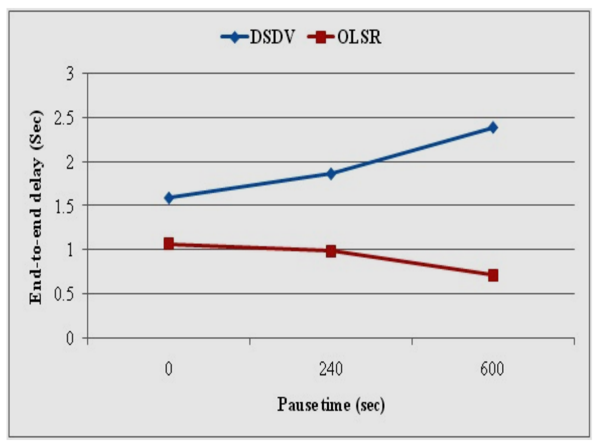

Figure 62 End to end delay v/s Pause time at high traffic load (10 Packets/sec)

3.2.4 Normalized Routing Overhead Analysis of results

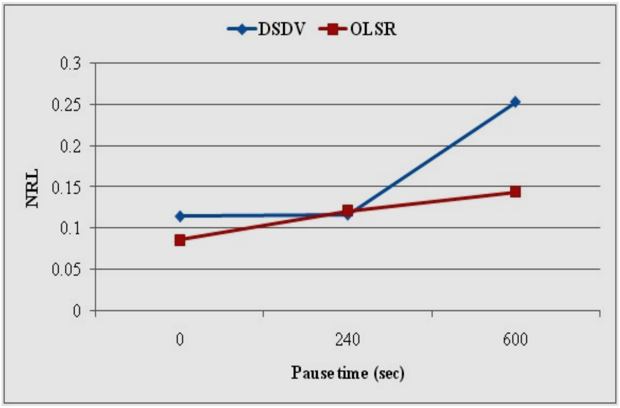

Figure 7 NRL v/s Pause time at low traffic load (0.1 Packet/sec)

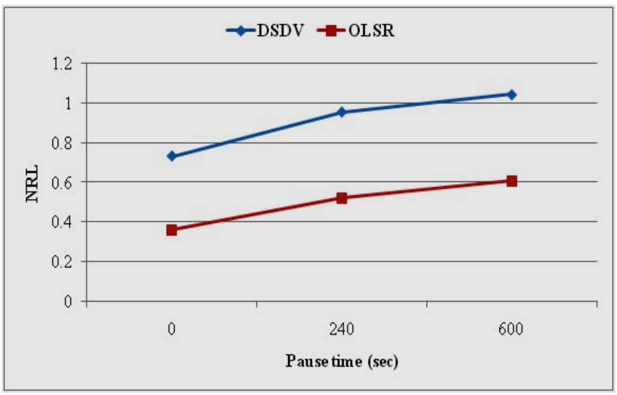

Figure 8 NRL v/s Pause time at high traffic load (10 Packets/sec)

Analysis of results: DSDV has high routing load compared to OLSR in all simulations because DSDV requires that each node maintain two tables and updates are transmitted to neighbors periodically or scheduled as needed. As growing of mobility and traffic load the size of bandwidth and routing tables requires to update these tables grows simultaneously. The periodic broadcast also add large amount of routing overhead into the network. The reason for this is that the amount of information sent in each update message will be larger as amount of link changes increases (with increase in mobility). On the other hand, OLSR uses multipoint relays (MPR) to reduce possible overhead in the network. The idea of MPR is to reduce flooding (broadcast) by redirecting the same broadcast in same regions in the network. MPR reduce the number of host which broadcast the information throughout the network.

4. CONCLUSION

In this paper there is realistic comparison between two MANET protocols Namely DSDV and OLSR protocols. The comparison is done on the basis of parameters like PDF, Throughput, end-to-end delay and normalized routing overhead by taking the pause time 0, 40% and 100% of simulation time. It is clear that in less stressful environment (Low traffic load and mobility) DSDV gives better throughput and PDF value compared to OLSR. But at high traffic load the performance of DSDV degrades with increases in pause time. Also, DSDV suffers from large delay and normalized routing overhead compared to OLSR.

5. FUTURE WORK

DSDV suffers from a large number of control packets, so our future work concentrates on minimizing the overhead. Also, we plan to test DSDV and OLSR with varying node densities and number of traffic sources.

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