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A Mobility Model Performance Comparison in OLSR and DSDV Proactive Routing Protocols

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Abstract: ***This paper presents performance analysis of proactive routing protocols using TCP and UDP connection. This document describes the Optimized Link State Routing (OLSR) and Destination Sequence Distance Vector (DSDV) protocol for mobile ad hoc networks. The protocol is an optimization of the classical link state algorithm tailored to the requirements of a mobile wireless LAN. The key concept used in the protocol is that of multipoint relays (MPRs). MPRs are selected nodes which forward broadcast messages during the flooding process. This technique substantially reduces the message overhead as compared to a classical flooding mechanism, where every node retransmits each message when it receives the first copy of the message. In OLSR and Destination Sequence Distance Vector (DSDV), link state information is generated only by nodes elected as MPRs. Thus, a second optimization is achieved by minimizing the number of control messages flooded in the network. As a third optimization, an MPR node may chose to report only links between itself and its MPR selectors. Hence, as contrary to the classic link state algorithm, partial link state information is distributed in the network. This information is then used for route calculation. OLSR and Destination Sequence Distance Vector (DSDV) provides optimal routes (in terms of number of hops). The protocol is particularly suitable for large and dense networks as the technique of MPRs works well in this context. In this paper two Proactive Routing protocols including Optimized Link State Routing (OLSR) and Destination Sequence Distance Vector (DSDV).***

Keywords: ***Manets, OLSR, DSDV, TCP, UDP***

I. INTRODUCTION ON OPTIMIZED LINK STATE ROUTING

It describes the Optimized Link State Routing (OLSR) protocol for mobile ad hoc networks. The protocol is an optimization of the classical link state algorithm tailored to the requirements of a mobile wireless LAN. The key concept used in the protocol is that of multipoint relays (MPRs). MPRs are selected nodes which forward broadcast messages during the flooding process. This technique substantially reduces the message overhead as compared to a classical flooding mechanism, where every node retransmits each message when it receives the first copy of the message. In OLSR, link state information is generated only by nodes elected as MPRs. Thus, a second optimization is achieved by minimizing the number of control messages flooded in the network. As a third optimization, an MPR node may chose to report only links between itself and its MPR selectors. Hence, as contrary to the classic link state algorithm, partial link state information is distributed in the network. This information is then used for route calculation. OLSR provides optimal routes (in terms of number of hops). The protocol is particularly suitable for large and dense networks as the technique of MPRs works well in this context.

II. PROTOCOL OVERVIEW

The protocol inherits the stability of a link state algorithm and has the advantage of having routes immediately available when needed due to its proactive nature. OLSR is an optimization over the classical link state protocol, tailored for mobile ad-hoc networks. OLSR minimizes the overhead from flooding of control traffic by using only selected nodes, called MPRs, to retransmit control messages. This technique significantly reduces the number of retransmissions required to flood a message to all nodes in the network. Secondly, OLSR requires only partial link state to be flooded in order to provide shortest path routes. The minimal set of link state information required is, that all nodes, selected as MPRs, MUST declare the links to their MPR selectors.

OLSR does not require sequenced delivery of messages. Each control message contains a sequence number which is incremented for each message. Thus the recipient of a control message can, if required, easily identify which information is more recent - even if messages have been re-ordered while in transmission

III. Link Sensing

Link Sensing is a local link set, describing links between "local interfaces" and "remote interfaces" - i.e., interfaces on neighbor nodes. If sufficient information is provided by the link-layer, this may be utilized to populate the local link set instead of HELLO message exchange.

IV. Neighbor Detection

Given a network with only single interface nodes, a node may deduct the neighbor set directly from the information exchanged as part of link sensing: the "main address" of a single interface node is, by definition, the address of the only interface on that node. In a network with multiple interface nodes, additional information is required in order to map interface addresses to main addresses (and, thereby, to nodes).

V. Route Calculation

Given the link state information acquired through periodic message exchange, as well as the interface configuration of the nodes, the routing table for each node can be computed.

The following procedure is given as an example to calculate (or recalculate) the routing table:

1 All the entries from the routing table are removed.

2 The new routing entries are added starting with the symmetric neighbors (h=1) as the destination nodes. Thus, for each neighbor tuple in the neighbor set where:

N_status = SYM

(there is a symmetric link to the neighbor), and for each associated link tuple of the neighbor node such that L_time >= current time, a new routing entry is recorded in the routing table with:

R_dest_addr = L_neighbor_iface_addr, of the associated link tuple;

R_next_addr = L_neighbor_iface_addr, of the associated link tuple;

R_dist = 1;

R_iface_addr = L_local_iface_addr of the associated link tuple.

If in the above, no R_dest_addr is equal to the main address of the neighbor, then another new routing entry with MUST be added, with:

R_dest_addr = main address of the neighbor;

R_next_addr = L_neighbor_iface_addr of one of the

associated link tuple with L_time >= current time;

R_dist = 1;

R_iface_addr = L_local_iface_addr of the associated link tuple.

for each node in N2, i.e., a 2-hop neighbor which is not a neighbor node or the node itself, and such that there exist at least one entry in the 2-hop neighbor set where N_neighbor_main_addr correspond to a neighbor node with willingness different of WILL_NEVER, one selects one 2-hop tuple and creates one entry in the routing table with:

R_dest_addr = the main address of the 2-hop neighbor;

R_next_addr = the R_next_addr of the entry in the

routing table with:

R_dest_addr == N_neighbor_main_addr of the 2-hop tuple;

R_dist = 2;

R_iface_addr = the R_iface_addr of the entry in the routing table with:

R_dest_addr == N_neighbor_main_addr of the 2-hop tuple;

The following table specifies the component of the core functionality of OLSR, as well as their relations to this document:

OLSR ALGORITHM;

1 Initialization:

2 **S** = {**A**};

3 for all nodes ***v***

4 if ***v*** adjacent to ***A***

5 then D(v) = c(A,v);

6 else D(v) = ;

7 wait

8 ***Loop***

9 find **w** not in **S** such that D(w) is a minimum;

10 add **w** to **S**;

11 update D(v) for all **v** adjacent to **w** and not in **S**:

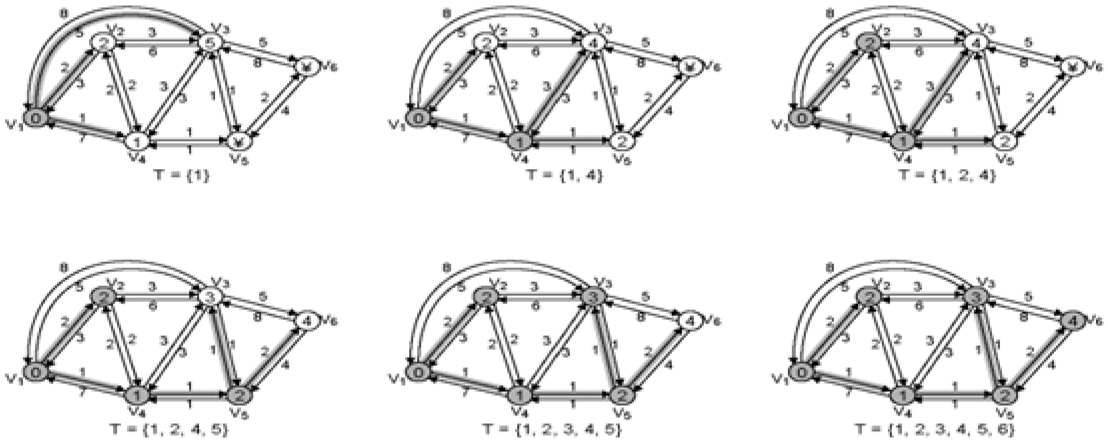
12 if D(w) + c(w,v) < D(v) then

// ***w*** *gives us a shorter path to* ***v*** *than we've found so far*

13 D(v) = D(w) + c(w,v); p(v) = w;

14 ***until all nodes in S;***

- » c(i,j): link cost from node *i* to *j*
- » D(v): current cost source → *v*
- » p(v): predecessor node along path from source to *v*, that is next to *v*
- » S: set of nodes whose least cost path definitively known



Feature	Section
Packet format and forwarding	3
Information repositories	4
Main addr and multiple if	5
Hello messages	6
Link sensing	7
Neighbor detection	8
Topology discovery	9
Routing table computation	10
Node configuration	11

VI. PACKET FORMAT AND FORWARDING

OLSR communicates using a unified packet format for all data related to the protocol. The purpose of this is to facilitate extensibility of the protocol without breaking backwards compatibility. This also provides an easy way of piggybacking different "types" of information into a single transmission, and thus for a given implementation to optimize towards utilizing the maximal frame-size, provided by the network. These packets are embedded in UDP datagrams for transmission over the network. The present document is presented with IPv4 addresses. Considerations regarding IPv6 are given in each packet encapsulates one or more messages. The messages share a common header format, which enables nodes to correctly accept and (if applicable) retransmit messages of an unknown type. Messages can be flooded onto the entire network, or flooding can be limited to nodes within a diameter (in terms of number of hops) from the originator of the message. Thus transmitting a message to the neighborhood of a node is just a special case of flooding. When flooding any control message, duplicate retransmissions will be eliminated locally (i.e., each node maintains a duplicate set to prevent transmitting the same OLSR control message twice) and minimized in the entire network through the usage of MPRs as described in later sections. Furthermore, a node can examine the header of a message to obtain information on the distance (in terms of number of hops) to the originator of the message. This feature may be useful insituations where, e.g., the time information from a received control messages stored in a node depends on the distance to the originator.

Packet Format

The basic layout of any packet in OLSR is as follows (omitting IP and UDP headers):

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Packet Length         |    Packet Sequence Number     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Message Type |     Vtime     |         Message Size          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Originator Address                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Time To Live |   Hop Count   |    Message Sequence Number    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
:                            MESSAGE                            :
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Message Type |     Vtime     |         Message Size          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Originator Address                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Time To Live |   Hop Count   |    Message Sequence Number    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
:                            MESSAGE                            :
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Destination Sequenced Distance Vector (DSDV)

The Destination Sequenced Distance Vector (DSDV) is a proactive routing protocol, which works on the basis of Bellman Ford algorithm. DSDV is a protocol that develops routing table for the whole topology. Each node is familiar with information such as number of nodes, next hop, available paths and sequence number required to pass information to the required destination [5,9,4,10,3]. DSDV protocol is used to eliminate routing loops. It selects path having latest sequence number and considers number of hops if two routes have same sequence number. The two types of routing updates in DSDV algorithm [3] are Full dump and incremental dump. In Full dump complete routing table is sent out to the network while in incremental dump only information being changed after the last full dump is passed on [4,11].

Bellman-Ford Algorithm process for DSDV:

1. find the shortest paths from a source to all possible destinations using only one link
2. then using max. two links by adding appropriate links to the paths of step 1
3. then using max. 3 links on top of paths with two links
4. so on .. until no improvement is gained by adding more links
5. S = source node
6. w(i, j) = link cost from node i to node j
7. w(i, i) = 0
8. w(i, j) = ∞ if nodes are directly connected
9. w(i, j) $\geq$ 0 if nodes directly connected
10. h = maximum number of links in path at current stage
11. $L_h(n)$ =cost of least-cost path from s to n such that path contains no more than h links

Bellman-Ford Algorithm for DSDV:

[Initialization]

$L_0(n) = \infty$, for all n $\neq$ s

h=0

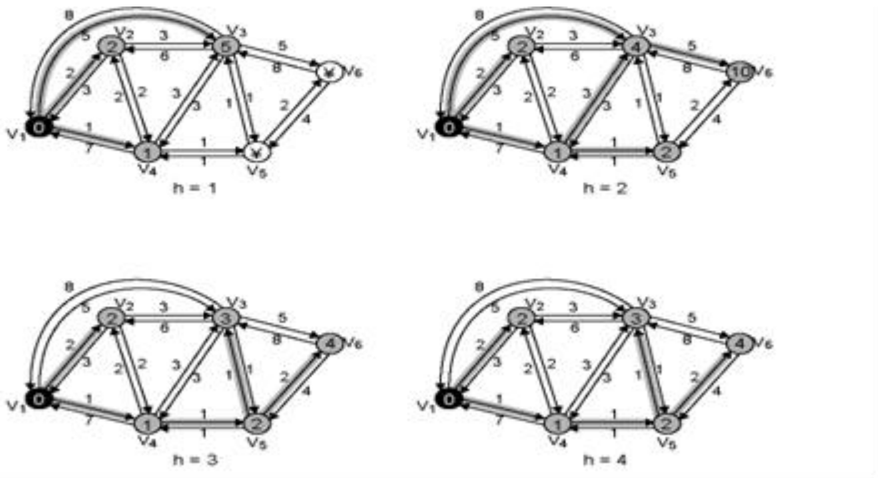
Loop until no more improvements

For each n $\neq$ s, compute

$$L_{h+1}(n) = \min_{j} \left[L_h(j) + w(j, n)\right]$$

If s-to-n cost reduced, then path also changes to s -…- j – n

h=h+1



Comparisons with OLSR and DSDV:

Evaluation of the performance of DSDV protocol using TCP and UDP traffic has been conducted in [3]. Performance parameters such as throughput, end-to-end delay and packet loss are used for TCP and UDP traffic by varying Node Density, Node Speed and Pause Time for different scenarios. From [3] it has been concluded that UDP performs better in denser network with low or no mobility while TCP outperform UDP in high mobility scenarios when DSDV protocol is used in MANETs. Similar performance metrics used in [3] used for performance comparison are used in this paper to compared two proactive (DSDV, OLSR) protocols under various mobile scenarios The performance for OLSR protocol has been analyzed in [20] using average end-to-end delay, packets sent and received, jitter, throughput, cumulative distribution, frequency distributions under different node scenarios and position with a constant simulation environment. From [20] OLSR performs better in denser network and high sporadic traffic. Secondly it is conclude in [20] that OLSR requires a continuous bandwidth for receiving topology update messages. From [22], in low mobility and low traffic load with CBR traffic pattern DSDV has good PDR and throughput as compared to OLSR. But at high traffic load DSDV performance become worst with increase in pause time. Secondly DSDV performance become degraded due to high delay and normalized routing overhead as compared to OLSR. In [22] PDF, Throughput, end-to-end delay, normalized routing overhead and pause time are used as performance metrics.

SIMULATION ENVIRONMENT:

All the experimental work has carried out in a uniform environment.

Parameters	Values
Simulator	NS-2
Protocol	OLSR,DSDV
Simulation Time	500 s
Simulation Area	500x500
Transmission Time	500 s
Traffic Type	UDP, TCP
Data Payload	0.01Mbps
No of Connections	8 connections
Mobility Model	Random Way Point

To study the performance of routing protocols we evaluated throughput, end to end delay and ratio of packet loss. The metrics are described as follows.

- Throughput: It is the ratio of number of packets received at destination to the number of packets originated at source. The source follows CBR (Constant bit rate) traffic. It depicts the loss rate.

  Throughput = Data packets received / Data packets sent

- End to end delay: It is the average amount of time that is taken by a packet to reach final destination from source. It includes the route discovery wait time, which a node may experience in case a route is not available.

  Average delay = $\sum$ (tr - ts) /Pr, where ts is the packet send time and tr is the packet receive time.

- Packet loss: It is the fraction of packet lost on their route to destination. The loss is usually due to congestion on the network and buffer overflows.

  Packet loss = Number of lost packets / number of received packets

To generate mobility patterns for MG, RWP, GM and RPGM. We have studied the impact of speed and node density on performance of the network. To compare the protocols, same set of scenarios is utilized for each one.

Parameter Name	Value
Speed of node	0 to 20 m/s
Density of node	5 to 200
Number of CBR sources	10
Speed of CBR link	10 packets per second
Packet Size	512 bytes
Wireless Radio	802.11
Transmission Range	50 m
Transmission rate	1 Mbps
Area of simulation	1500m x 1500m
Simulation time	300 seconds

The parameters chosen for mobility models are as follows:

Random Way point Mobility (RWM):

RWM [10] model is the commonly used mobility model in which every node randomly chooses a destination and moves towards it from a uniform distribution (0, Vmax) at any moment of time, where Vmax is the maximum allowable velocity for every node. Each node stops for a duration defined by the 'pause time' parameter when it reaches the destination. After the pause time it again chooses a random destination and repeats the whole process until the end of the simulation.

Mobility:

Mobility models describe the movement pattern of the mobile users, their location; velocity and acceleration [9,10]. They play a vital role in determining the performance of a protocol and also differentiated in terms of their spatial and temporal dependencies.

1. Spatial dependency is a measure of how two nodes are dependent in their motion. When the two nodes are moving in the same direction, then they have high spatial dependency.

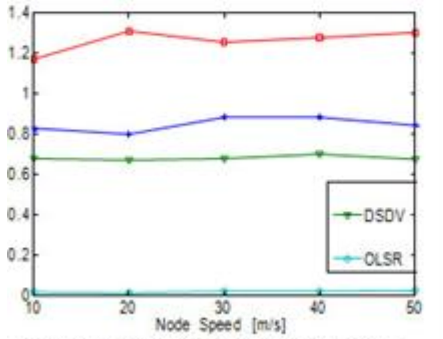
2. Temporal dependency is a measure of how current velocity (magnitude and direction) are related to previous velocity. The two nodes are having the same velocity and direction means that they have high temporal dependency. The commonly used mobility model in MANET is RWM.

Model	Parameter	Value(s)
RWP (Random Way Point)	Pause time	0 sec
	Min. speed	0 m/s
	Max. Speed	20 m/s
RPGM (Reference Point Group Mobility)	Average no. of nodes per group	5
	Max. distance to center of group	5 m
	Min. Speed	0 m/s
	Max. Speed	20 m/s
GM (Gauss Markov)	Min. Speed	0 m/s
	Max. Speed	20 m/s

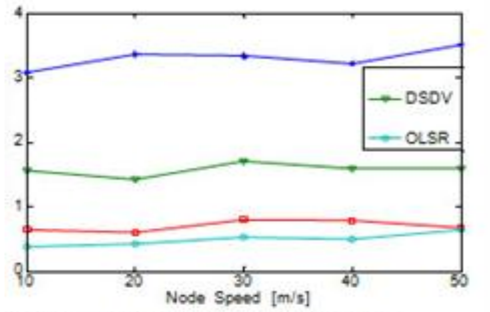
Performance Metrics:

Well known performance metrics are used to analyze the selected protocol in this paper for MANETs. The parameters used include throughput, end-to-end delay and packet loss. Before using these parameters in our performance evaluation they are shortly described in the following paragraph.

Throughput is a one dimensional parameter to measure the performance of a network by providing the average rate of successful delivery of packets towards destination. End-to-end delay can simply be defined as the time taken by the packets when it is sent by source in a network until it reaches its destination. The routing protocols used in networks always aim to reduce this delay. Lastly another well- known performance parameter used in this paper is Packet loss which actually represents the number of packets not reaching the destination out of the total packets sent. Low packet loss would result in better performance of any given network.



ıy comparison of proactive & reactive protocols over TCP connection in case of node speed



ʼacket loss comparison of proactive protocols over TCP connection in case of node speed

VII. Conclusion

In this paper we present comparison of proactive (OLSR, DSDV) ad hoc routing protocols in MANETs by varying network conditions. Results have been presented by comparing performance metrics such as throughput, end to end delay and packet loss. According to all by observing the results presented it can be concluded that using TCP connections for wireless devices in MANETs would perform better as compared to UDP connections for any ad hoc protocol. Secondly a thorough study lead to the conclusion that for a highly dynamic network topology performance in terms of throughput and packet loss is badly affected in almost all of the protocols used. For individual protocols OLSR performs considerably well for all performance metric using either TCP or UDP connection as compared to other protocols. DSDV protocol behaves consistent in both TCP and UDP in all scenarios except for highly mobile environment.

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