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Comparative Study and Performance Analysis of DSDV, OLSR, AODV, DSR and MAODV Routing Protocols in MANETs

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ABSTRACT

Mobile Ad-Hoc Network (MANET) is a wireless network without infrastructure and decentralized network which need a robust dynamic routing protocol and it is becoming an important concept of modern communication technologies and services. There are various routing protocols available for MANETs. In this work, we focus on the most popular ones are Destination-Sequenced Distance Vector (DSDV), Optimized Link State Routing(OLSR), Ad-hoc On-demand Distance Vector (AODV), Dynamic Source Routing (DSR) and Multicast Ad Hoc On-Demand Distance Vector Routing Protocol (MAODV) routing protocol. This paper is an attempt to study, analysis and compare these five routing protocols on the basis of various performance metrics such as throughput of received packets, throughput of dropped packets, packet delivery ratio, end to end delays, jitter and normalizes routing load .This performance evaluation have been perform under different environments. The simulation results indicate that none of the routing protocols we selected have shown best performance in all the six different performance metric. Therefore, the efficiency of a network can be achieved by choosing the best suitable protocols based on the network requirement.

Key words: DSDV, OLSR, AODV, DSR, MAODV, MANETs.

INTRODUCTION

Wireless communications is, by any measure, the fastest growing segment of the communications industry. As such, it has captured the attention of the media and the imagination of the public. Cellular systems have experienced exponential growth over the last years and there are currently around two or more billion users worldwide.

Mobile ad hoc wireless networks (MANETs) consist of devices that are autonomously self-organizing in networks. In ad hoc networks, the devices themselves are the network, and this allows seamless communication, at low cost, in a self-organized fashion and with easy deployment. The large degree of freedom and the self-organizing capabilities make mobile ad hoc networks completely different from any other networking solution. It is one of the more

innovative and challenging areas of wireless networking and this technology promises to become increasingly present in everybody's life. Ad hoc networks are a key step in the evolution of wireless networks.

The routing is not the same as in the wired networks. In wired networks routers are the central elements. In MANETs, there is no such element, but all the nodes can perform as a router, transmitter or receiver element. Hence, the routing is made by the node executing a specific routing protocol for MANETs.

As it has been said, MANETs are necessary to have different routing protocols from the wired networks.

Analysis and study of routing protocols in MANETS

Routing protocols in MANETs can be classified as Proactive (Table driven), Reactive (On demand) and Hybrid.

Table-driven (Proactive protocols)

In the proactive protocols, each node has a routing table, updated periodically, even when the nodes don't need to forward any message. In this work, we focus on the two important and popular proactive routing protocols are DSDV and OLSR.

Destination-Sequenced Distance-Vector Routing (DSDV)

Is a distance-vector protocol with extensions to make it suitable to MANET. Every node maintains a routing table with one route entry for each destination in which the shortest path route (based on number of hops) is recorded. To avoid routing loops, a destination sequence number is used[5].

DSDV Advantages

- It does not bloat packets. Source routing algorithms, on the other hand, put the whole route in packets, adding to their size, increasing the chance of collisions, and reducing throughput.
- Routes to all destinations are always available.
- Less delay for route setup.

DSDV Disadvantages

- It discovers routes even if they are not needed.
- Heavy control overhead because of updates.
- Updates can choke the whole bandwidth.
- Not scalable.
- Very bad for large networks or high mobility[8].

Optimized link state routing (OLSR)

Is an optimization for MANET of legacy link-state protocols. The key point of the optimization is the multipoint relay (MPR). Each node identifies (among its neighbors) its MPRs. By flooding a message to its MPRs, a node is guaranteed that the message, when retransmitted by the MPRs, will be received by all its two-hop neighbors.

OLSR Advantages

- ´ It needs that each host periodically sends the updated topology information throughout the entire network. This increases the protocol bandwidth usage.
- ´ The use of MPRs minimizes the flooding in comparison with other proactive routing protocols.
- It is well suited for the application which does not allow the long delays in the transmission of the data packets.
- It does not require that the link is reliable for the control messages, since the messages are sent periodically and the delivery does not have to be sequential.
- It has also extensions to allow hosts to have multiple OLSR interface addresses and provide the external routing information giving the possibility for routing to the external addresses. Based on this information there is the possibility to have hosts in the ad hoc network which can act as gateways to another possible network.

OLSR Disadvantages

- As proactive routing protocol, a great number of periodical messages are sent. The use of MPRs solves in part that problem, but the overhead in terms of packets is still high in comparison with the reactive routing protocols[8].

Demand-driven (Reactive protocols)

In the reactive protocols, the routes are calculated only when required. When a source wants to send information to some destination, it calls on route discover mechanisms to find the best route to this destination. In this work, we study and analysis three of important and popular reactive routing algorithms: AODV, DSR, MAODV.

Ad-Hoc On-Demand Distance Vector algorithm (AODV)

Is based on hop-by-hop routing approach. To find a route to the destination, the source broadcasts a route request packet. This broadcast message propagates through the network until it reaches an intermediate node that has recent route information about the destination or until it reaches the destination. When intermediate nodes forwards the route request packet it records in its own tables which node the route request came from.

AODV Advantages

- Routes are established on demand and destination sequence numbers are used to find the latest route to the destination.
- Lower delay for connection setup[11].

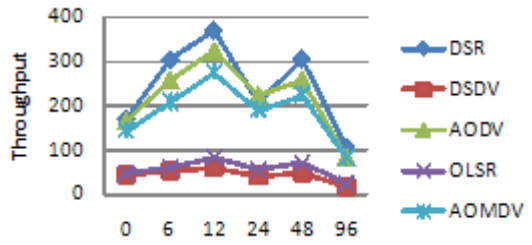

Fig. 1: (a) Throughput Vs Pause Time for 10 Nodes

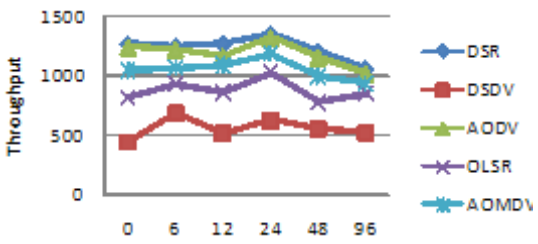

Fig. 1: (b) Throughput Vs Pause Time for 20 Nodes

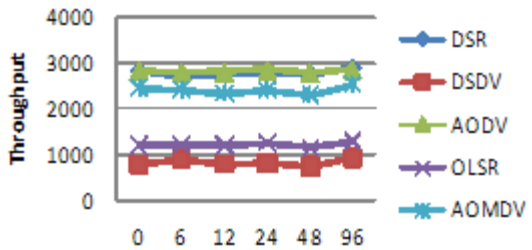

Fig. 1: (c) Throughput Vs Pause Time for 40 Nodes

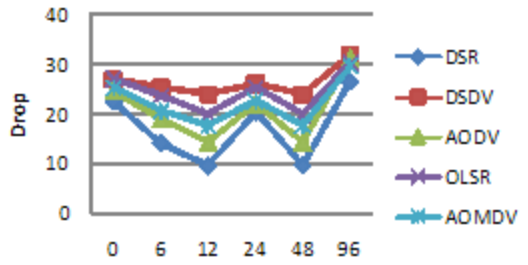

Fig. 2: (a) Throughput of dropped packets Vs pause time 10 Nodes

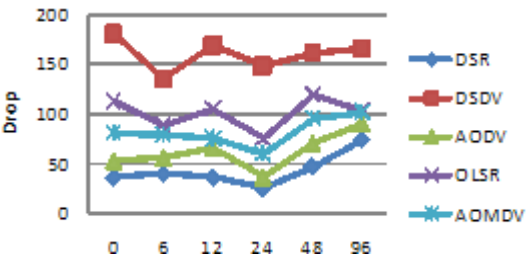

Fig. 2: (b) throughput of dropped packets Vs pause time 20 Nodes

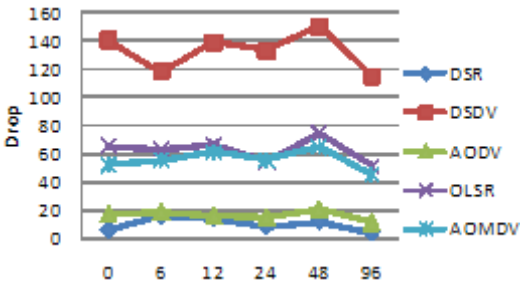

Fig. 2: (c) throughput of dropped packets Vs pause time 40 Nodes

AODV Disadvantages

- AODV doesn't allow handling unidirectional links.
- Multiple Route Reply packets in response to a single Route Request packet can lead to heavy control overhead.
- Periodic beaconing leads to unnecessary bandwidth consumption[11].

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 nodes. It allows the network to be completely self-organizing without the need for any existing network infrastructure or administration. It uses source routing to send packets which mean that the source must know the complete hop sequence to the destination. Each node maintains a route cache, where all routes it knows are stored. The route discovery process is initiated only if the desired route cannot be found in the route cache. To limit the number of route requests propagated, a node processes the route request message only if it has not already

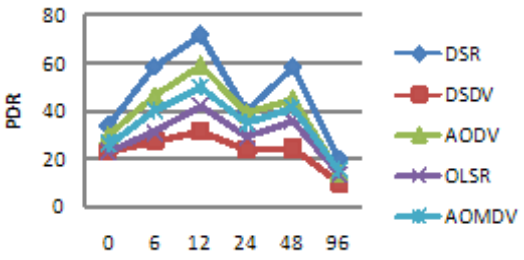

Fig. 3: (a) Packet delivery ratio Vs pause time 10 Nodes

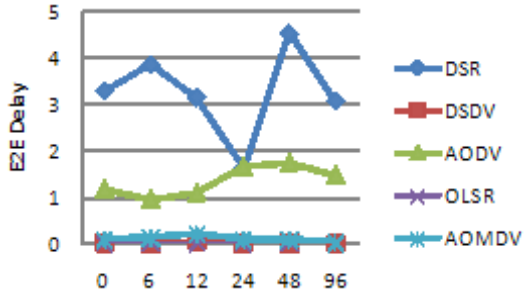

Fig. 4: (a) End to end delays Vs pause time 10 Nodes

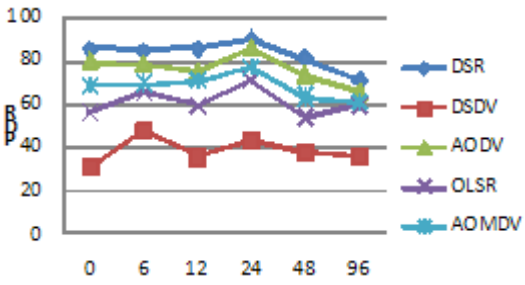

Fig. 3: (b) Packet delivery ratio Vs pause time 20 Nodes

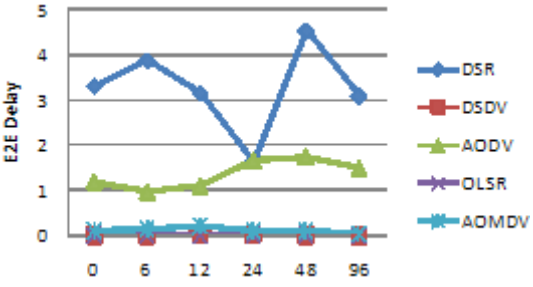

Fig. 4: (b) End to end delays Vs pause time 20 Nodes

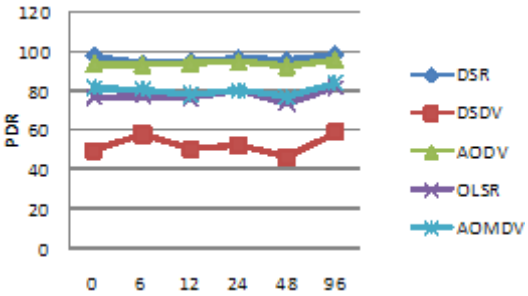

Fig. 3: (c) Packet delivery ratio Vs pause time 40 Nodes

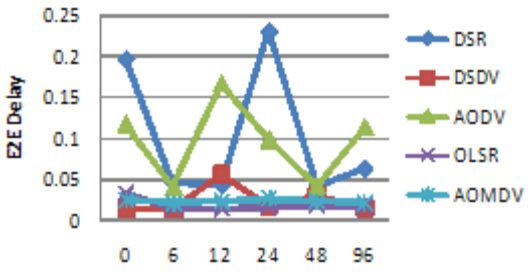

Fig. 4: (c) End to end delays Vs pause time 40 Nodes

received the message and its address is not present in the route record of the message[7].

DSR Advantages

- DSR uses a reactive approach which eliminates the need to periodically flood the network with table update messages which are required in a table-driven approach.
- The intermediate nodes also utilize the route cache information efficiently to reduce the control overhead.

DSR Disadvantages

The major disadvantages of DSR protocol is an implementing the route discovery process. Source will transmit the RREQ messages to all the neighboring nodes to find the route to destination. It is fair and good when there are few nodes in the network, it will easily find a route and it can receive a RREP message from the desired destination. But if in case the network size is very high and participating nodes are numerous, then

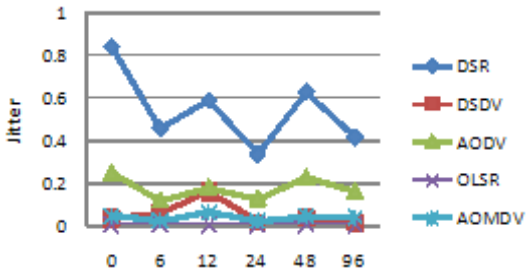

Fig. 5: (a) Jitter Vs pause time 10 Nodes

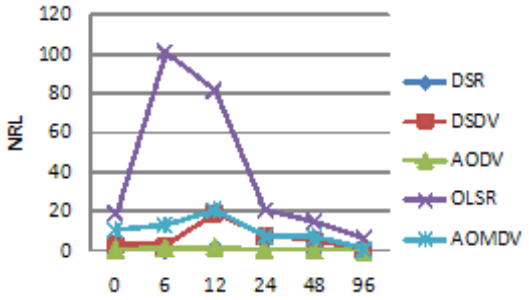

Fig. 6: (a) NRL Vs pause time 10 Nodes

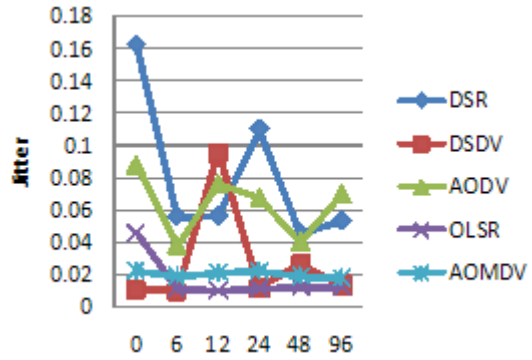

Fig. 5: (b) Jitter Vs pause time 20 Nodes

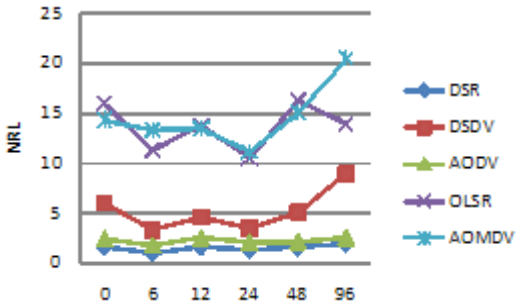

Fig. 6: (b) NRL Vs pause time 20 Nodes

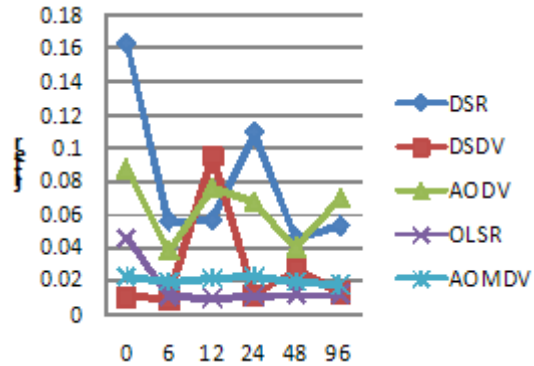

Fig. 5: (c) Jitter Vs pause time 40 Nodes

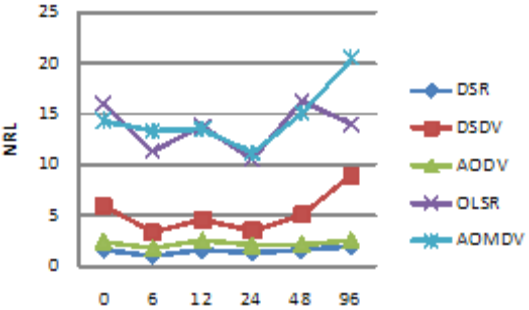

Fig. 6: (c) NRL Vs pause time 40 Nodes

there will be a possibility to have so many routes to the destination. It may result in the reply storms this may cause collision of packets and it may increase the congestion at the nodes while sending reply[11].

Multicast Ad Hoc On-Demand Distance Vector Routing Protocol (MAODV)

Is the extension of the AODV protocol. It uses sequence numbers to ensure most recent route to the multicast group. Two phases of this routing protocol are tree initialization phase and tree maintenance phase, where MAODV uses the notion of group leader which updates the sequence number periodically and broadcasts it using group hellos. The first node to join the group is the group leader. The new node that wish to join group, it sends a unicast a route request (RREQ) to the group leader. If it does not have the address of the group leader, they broadcast a RREQ packet to its neighbors and it is rebroadcasted by nodes which are not members of the multicast tree.

Simulation environment and parameters

For the simulation of our study, latest version of NS-2 has been used. Ns-2 is a discrete event simulator targeted at networking research.

The simulation parameters that used in this work show in the following:

No. of Nodes	10,20,40
Area	1000m*1000m
Simulation time	96 sec
Phy and MAC Model	802.11
Node Placement	Random
Mobility	Random Way point(0-25msec)
Bandwidth(B/S)	2000000
Radio Frequency	2.4e9 Hz
Routing Protocol	DSDV,OLSR,AODV, DSR and MAODV

Performance metrics for analysis and comparison

There are number of performance metrics that can be used to compare routing protocols. This performance metric determines the completeness and correctness of the routing protocol. We have used the important and popular metrics for analyzing the performance of mentioned routing protocols:

Throughput of received packets

This represents the number of packets received within a given time interval.

Throughput of dropped packets

This represents the number of packets dropped within a given time interval.

Packet Delivery Ratio (PDR)

It is the ratio of the number of data packets successfully delivered to destination nodes to the total number of data packets sent by source nodes.

End to End delays

It represents the delay encountered between the sending and receiving of the packets.

Jitter

It represents any unwanted variation in one or more signals generated during the packet transfer. The term jitter is often used as a measure of the variability over time of the packet latency across a network. However, jitter is the variation of the packet arrival time.

Normalizes Routing Load (NRL): is the number of routing packets transmitted per data packet delivered to the destination.

Simulation Results, Performance Evaluation & Analysis

The simulation results are shown in the

following sections in the form of line graphs which are show comparison between the five routing protocols by varying different number of parameters on the basis of the above mentioned performance metrics as a function of pause time.

Throughput of received packets

Figure 1(a,b,c) line graphs for throughput of received packets Vs pause time .This performance metric has been evaluated for DSDV , OLSR , AODV, DSR and MAODV of Ad-hoc routing protocols using 10 , 20 , 40 nodes respectively .

The throughput varies with increase the pause time. Where DSR performs better results, while DSDV routing protocol is the lowest in term of throughput.

Throughput of dropped packets

Figure 4-2(a,b,c) line graphs for throughput of dropped packets Vs pause time .Also this performance metric has been evaluated for DSDV , OLSR , AODV, DSR and MAODV of Ad-hoc routing protocols using 10 , 20 , 40 nodes respectively .

We see with increase the pause time of the mobile nodes, the number of dropped packets will vary according pause time. DSR is better than other routing protocols, while DSDV presents large number of dropped packets.

Packet Delivery Ratio (PDR)

Figure 4-3(a,b,c) line graphs for packet delivery ratio Vs pause time. This performance metric has been evaluated for DSDV , OLSR , AODV, DSR and MAODV of Ad-hoc routing protocols using 10 , 20 , 40 nodes.

The packet delivery fraction varies with increase the pause time. DSR routing protocol is the best in the packet delivery fraction. While DSDV presents low packet delivery fraction.

End to End delays

Figure 4 (a,b,c) line graphs for end to end delays Vs pause time .This performance metric has been evaluated for DSDV , OLSR , AODV, DSR and MAODV of Ad-hoc routing protocols using 10 , 20 , 40 nodes respectively .

End to End delays

Figure 4 (a,b,c) line graphs for end to end delays Vs pause time .This performance metric has been evaluated for DSDV , OLSR , AODV, DSR and MAODV of Ad-hoc routing protocols using 10 , 20 , 40 nodes respectively .

From the above figure , DSR and AODV show the best performance measure . While OLSR seems introduce the lowest performance in term of jitter.

Normalizes Routing Load (NRL)

Figure 6 (a,b,c) line graphs for Normalizes Routing Load Vs pause time .This performance metric has been evaluated for DSDV , OLSR , AODV, DSR and MAODV of Ad-hoc routing protocols using 10 , 20 , 40 nodes respectively As shown, DSR and AODV performs low normalize routing load than other routing protocols(the better), while OLSR introduces high range of it (the worse).

CONCLUSIONS

In this paper, we provide descriptions of several routing protocols for ad hoc mobile networks (MANETs). We also provide a classification of these schemes according to the routing strategy (i.e., table-driven and on-demand) and present a comparison and performance analysis of five prominent routing protocols i.e. DSDV,OLSR,AODV,DSR and MAODV on the basis various performance metrics such as throughput of received packets, throughput of dropped packets, packet delivery ratio, end to end delays, jitter and normalizes routing load under different network scenario environments such as no. of nodes ,simulation time, physical and MAC model, node placement mobility, bandwidth and others.

Also, we show that each mentioned protocol has definite advantages and

disadvantages, and is well suited for certain situations specially after the field of ad hoc mobile networks is rapidly growing and changing, and while there are still many challenges that need to be met, it is likely that such networks will see widespread use within the next few years. Finally, the results after analysis and performance evaluation have been reflected in many line graph figures.

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