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Comparision of QoS Parameters for DSDV and DSR in Hybrid Scenario

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***Abstract*—Mobile Multi-hop Ad Hoc Networks are collections of mobile nodes connected together over a wireless medium. These nodes can freely and dynamically self-organize into arbitrary and temporary, "ad-hoc" network topologies, allowing people and devices to seamlessly internetwork in areas with no pre-existing communication infrastructure. It is, however, possible to combine an infrastructure-less ad hoc network with a fixed one to form a hybrid network which can cover a wider area with the advantage of having less fixed infrastructure. Due to the hybrid nature of these networks, routing is considered a challenging task. Several routing protocols have been proposed and tested under various traffic conditions. However, the simulations of such routing protocols usually do not consider the hybrid network scenario. In this work we have carried out a systematic simulation based performance analysis of the two prominent routing protocols: Destination Sequenced Distance Vector Routing (DSDV) and Dynamic Source Routing (DSR) protocols in the hybrid networking environment using NS2. The performance of the DSDV is better than the performance of the DSR routing protocol. To compare the performance of DSDV and DSR routing protocol, the simulation results were analyzed by graphical manner and trace file based on Quality of Service (QOS) metrics: such as , packet delivery fraction, average end-to-end delay and normalized routing load under varying pause time with different number of sources.**

***Keywords:*--DSDV, DSR, MANET, QoS, Network Simulator-2 (NS-2)**

I. INTRODUCTION

In recent years there has been a huge influx of laptops, handheld computers , PDAs and mobile phones in our daily lives. To combat this huge flow of highly portable devices the mobile ad hoc networks (MANET) came into being. These networks are ad hoc because there is no fixed infrastructure or centralized server support. Each node acts both as the host as well as the router. In the early 1970s DARPA sponsored the earliest wireless ad hoc networks called "packet radio" networks (PRNET) [15].

Later in the 1980s DARPA made experiments in the Survival Radio Network (SURAN) [16] project. The routing protocols for ad hoc networks can be divided into two broad categories: proactive and reactive. In protocols following the proactive approach like DSDV [17] , CGSR [18] , STAR [19], OLSR [20],HSR [21],

GSR it is necessary for the nodes in the ad hoc network to maintain consistent routing information from each node to all other nodes. In order to keep the information up-to-date, the nodes need to exchange the routing information periodically. In case of reactive routing protocols such as DSR [23], AODV [24], ABR[25,26] , SSA [27], FORP [28] ,PLBR [29] a lazy approach is followed. Here the nodes need not maintain the routes to all

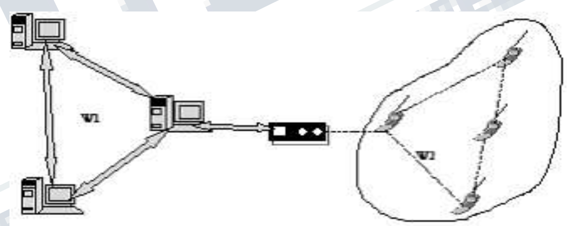

Figure 1. Hybrid network of wired domain W1 and wireless domain W2

Other nodes. Routes to the destinations are determined by flooding the whole network with route query packets only when required. In order to claim the advantage from both of these types, protocols like CEDAR, ZRP and ZHLS combine both the proactive and the reactive approach. Sometimes a hybrid network can be formed by combining the ad hoc network with the wired network. In non-mobile nodes and vice-versa. We need the base stations for this purpose, which act as the gateways between the wired and wireless domains. By using this combination we can cover a larger area with less fixed infrastructure, less number of fixed antennas and base station and can reduce the overall power consumption. In this paper we carry out a systematic performance evaluation of the two major routing protocols for mobile ad hoc network – Destination Sequenced Distance Vector Routing (DSDV) and Dynamic Source Routing (DSR) protocol in the hybrid networking

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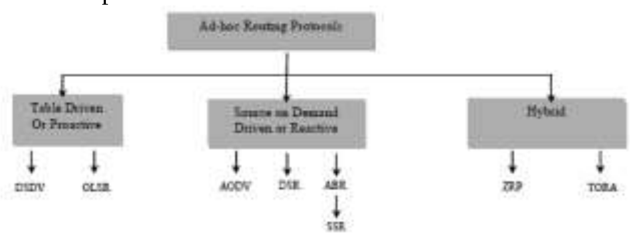
environment. We have used the means of simulation using NS-2 to gather data about these routing protocols in order to evaluate their performance. The rest of the paper is organized as follows.

II. ROUTING PROTOCOLS

The existing routing protocols in MANETs can be classified into three categories. Figure 1 shows the classification along with some examples of existing MANET protocols.



III. STUDY OF DSDV AND DSR ROUTING PROTOCOLS

A. Destination-sequenced distance vector

DSDV is one of the most well known table-driven routing algorithms for MANETs. The DSDV routing algorithm is based on the classical Bellman-Ford Routing Algorithm (BFRA) with certain improvement [15]. Every mobile station maintains a routing table with all available destinations along with information like next hop, the number of hops to reach to the destination, sequence number of the destination originated by the destination node, etc. DSDV uses both periodic and triggered routing updates to maintain table consistency. Triggered routing updates are used when network topology changes are detected, so that routing information is propagated as quickly as possible. Routing table updates can be of two types – „full dump‟ and „incremental‟. „Full dump‟ packets carry all available routing information and may require multiple Network Protocol Data Units (NPDU); „incremental‟ packets carry only information changed since the last full dump and should fit in one NPDU in order to decrease the amount of traffic generated. Mobile nodes cause broken links when they move from place to place. When a link to the next hop is broken, any route through that next hop is immediately assigned infinity metric and an updated sequence number. This is the only situation when any mobile node other than the destination node assigns the sequence number. Sequence numbers assigned by the origination nodes are even numbers, and sequence numbers assigned to indicate infinity metrics are odd numbers. When a node receives infinity metric, and it has an equal or later sequence number with a finite metric, it triggers a route update broadcast, and the route with infinity metric will be quickly replaced by the new route. When a mobile node receives a new route update packet; it compares it to the information already available in the table and the table is updated based on the following criteria:

If the received sequence number is greater, then the information in the table is replaced with the information in the update packet.

- Otherwise, the table is updated if the sequence numbers are the same and the metric in the update packet is better.

Advantages:

- DSDV was one of the early algorithms available. It is quite suitable for creating ad hoc networks with small number of nodes.

Disadvantages:

- DSDV requires a regular update of its routing tables, which uses up battery power and a small amount of bandwidth even when the network is idle.
- Whenever the topology of the network changes, a new sequence number is necessary before the network re-converges; thus, DSDV is not suitable for highly dynamic networks.

B. Dynamic Source Routing

The Dynamic Source Routing Protocol (DSR) is a reactive routing protocol. The main feature of DSR is the use of source routing technique. In this technique the source node knows the complete hop-by-hop route towards the destination node. The source node lists this entire sequence in the packet's header. If a node wants to send a packet to a destination, the route to which is unknown, in that case a dynamic route discovery process is initiated to discover the route. DSR consists of the Route Discovery and Route Maintenance phase, through which it discovers and maintains source routes to arbitrary destinations in the network.

C. Route Discovery

If a node A wants to send a packet to a destination node B, it searches its Route Cache. If the Route Cache contains a valid route, node A inserts this route into the header of the packet and sends the data packet to the destination B. In case when no route is found in the Route

Cache, a Route Discovery is initiated. Node A initiates the Route Discovery by broadcasting a ROUTE REQUEST message. All nodes within the transmission range receive this message. The nodes which are not in the route add their address to the route record in the packet and forward the packet when received for the first time. They check the request id and source node id to avoid multiple retransmissions. The destination node B sends a ROUTE REPLY when it receives a ROUTE REQUEST. If the link is bidirectional, the ROUTE REPLY propagates through the reverse route of the ROUTE REQUEST. If the link is unidirectional, in that case B checks its own Route Cache for a route to A and uses it to send the ROUTE REPLY to the source A. If no route is found, B will start its own Route Discovery. In order to avoid infinite numbers of Route Discoveries it piggybacks the original ROUTE REQUEST message to its own. The route information carried back by the ROUTE REPLY message is cached at the source for future use. In addition to the destination node, other intermediate nodes can also send replies to a ROUTE REQUEST using cached routes to the destination.

D. Route Maintenance

The node which sends a packet using a source route is responsible for acknowledging the receipt of the packet by the next node. A packet is retransmitted until a receipt is received or the maximum number of retransmissions is exceeded. If no confirmation is received, the node transmits a ROUTE ERROR message to the original sender indicating a broken link. The ROUTE ERROR packet causes the intermediate nodes to remove the routes containing the broken link from their route caches. Ultimately the sender will remove this link from its cache and look for another source route to the destination in its cache. If the route cache contains another source route, the node sends the packet using this route. Otherwise, it needs to initialize a new route discovery process. DSR makes very effective use of source routing and route\ caching. In order to improve performance any forwarding node caches the source route contained in a packet forwarded by it for possible future use.

IV. SIMULATION ENVIRONMENT

The protocol evaluations are based on the simulation using ns2 [16] and the graphs are generated using X-graph. NS2 is a discrete event simulator developed by the University of California at Berkeley and the VINT project. NS2 supports two languages, system programming language C++ for detail implementation and scripting language TCL for configuring and experimenting with the different parameters quickly. NS2 has all the essential features like abstraction, visualization, emulation, and traffic & scenario generation. X-graph draws a graph on a display with data given either from data files or standard input.

V. COMPARISON OF ROUTING PROTOCOL

The following table summarizes the simulation parameters that we have selected in order to evaluate the performance of the two routing protocols.

Simulation Parameters	
Protocols	DSDV, DSR
Number of mobile nodes	50
Number of fixed nodes	10
Simulation area size	800 m x 500 m
Simulation duration	800 seconds
Mobility model	Random way point
Traffic type	Constant bit rate(CBR)
Packet size	512 bytes
Max speed	20m/sec
Connection rate	4packets/sec
Pause time	0, 100, 200, 300, 400, 500, 600, 700, 800
Number of sources	15,25

A. Packet Delivery Fraction

The ratio between the number of packets received by the TCP sink at the final destination and the number of packets originated by the "application layer" sources. It is a measure of efficiency of the protocol

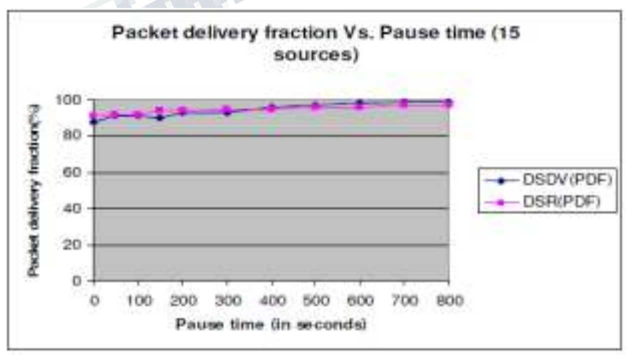


Figure 3. Packet Delivery Fraction vs. Pause Time for 15 sources

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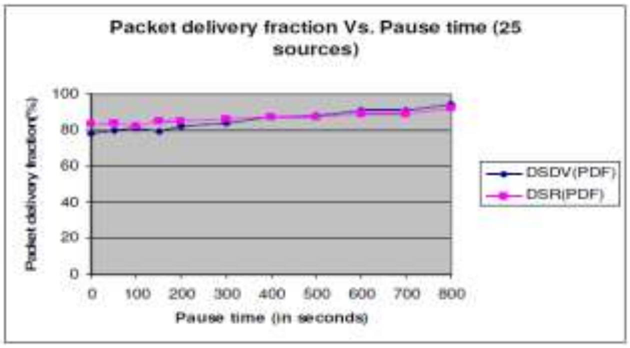

Figure 4. Packet Delivery Fraction vs. Pause Time for 25 sources

We have measured the packet delivery fraction of these two protocols by varying the pause time with respect to 15 and 25 numbers of sources. From the graphs we see that DSDV shows better packet delivery performance than DSR at lower mobility. This is due to the fact that, at low mobility all the routes are already available due to the proactive nature of DSDV. Therefore, most of the packets will be delivered smoothly. Whereas, DSR, being a source routing protocol, a significant time will be required for initial path setup. During this time, no packets can be delivered to the destination due to unavailability of routes.
With high mobility there will be frequent and high volume of changes in the network topology. The proactive nature of DSDV makes it less adaptive to this frequent change. In DSDV, with these major changes in network topology, greater number of full dumps needs to be exchanged between the nodes in order to maintain up-to-date routing information at the nodes. This huge volume of control traffic consumes a significant part of the channel bandwidth and lesser channel capacity is left for the data traffic which results in reduced packet delivery fraction of DSDV at higher mobility. Moreover, in DSDV packets are dropped due to stale routing table entry. DSDV keeps track of only one route per destination. Due to lack of alternate routes, MAC layer drops packets that it is unable to deliver through stale routes. DSR on the contrary, is more adaptive to the frequently changing scenario due to its on-demand routing nature. In case of DSR, multiple routes exist in the cache. Thus, even if a link is broken due to high mobility, alternative routes can be found from the cache. This prevents packet dropping and results in better packet delivery performance of DSR. In both the graphs we see that as the mobility and number of sources increase, the packet delivery performance of both these protocols decreases. This happens due to the fact that with increasing mobility and greater number of sources, finding the route requires more and more routing traffic thus leaving a lesser portion of the channel available for network data traffic. Moreover, with reduced pause time as the network topology changes frequently, more number of routes becomes stale quickly. But the source node having no mechanism to determine a stale route uses the same stale route to forward the packet. This causes more and more number of packets to be dropped.

B. Average End-to-End Delay

It is a metric which is very significant with multimedia and real-time traffic. It is very important for any application where data is processed online.

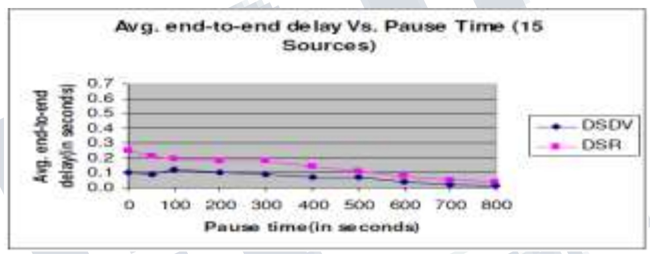

Figure 5. Average End to End Delay vs. Pause time for 15 Sources

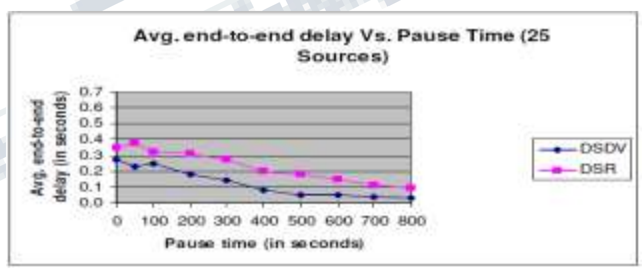

Figure 6. Average End to End Delay vs. Pause time for 25 Sources

From studying Figure 5 and Figure 6 for average end-to-end delay we see that DSDV has less delay in comparison to DSR. DSDV is a proactive routing protocol. In DSDV nodes periodically exchange routing tables between them in order to maintain up-to-date routing information to all destinations. Hence, whenever a source node wants to send a packet to a destination node, with the already available routing information it can do so without wasting any time for path setup. This reduces the average end-to-end delay of DSDV. DSR on the other hand is a reactive source routing protocol. If a node in DSR wants to send a packet to a destination node, it has to find the route to the destination first. This route discovery latency is a part of the total delay. DSR being a source routing protocol, the initial path set up time is significantly higher. During the route discovery process every intermediate node needs to extract the before forwarding the data packet. Moreover in DSR, the source has to wait for all the replies sent against every request reaching the destination. This increases the delay. While delivering a packet to a destination node, if DSR finds a link broken between two nodes on the path, it would make an attempt to find an alternate path from its cache entries, resulting in additional delay in packet delivery. From the graphs we also see that the delay increases with increasing mobility and traffic as we increase the number of sources and reduce the pause time. As the mobility and traffic increase there will be more link breaks. The link breaks will necessitate new route discovery and thus increase the delay. Congestion will also be more with increasing mobility and traffic which also adds to the increasing delay. Although DSR maintains multiple routes to the same destination in the cache, but it lacks any mechanism to determine the freshness of a route. It also does not have any mechanism to expire the stale routes. With high mobility link breaks become more frequent and there is the chance of the cached routes becoming stale quickly. DSR, being unable to determine a fresh route, may pick up a stale route for packet delivery. This unnecessarily consumes extra channel bandwidth and additional interface queue slots as the packet will ultimately be dropped. Moreover, every intermediate node can extract the information before forwarding the data packet and use this information to update its own cache entries. Therefore, selecting a stale route from a particular node's cache may pollute the cache entries of other nodes as well. This requires DSR to initiate more route discoveries which further ads to the increasing delay.

C. Normalized Routing Load

The total number of routing packets transmitted during the simulation. For packets sent over multiple hops, each transmission of the packet (each hop) counts as one transmission. Since End-to-end Network Throughput (data routing performance) is defined as the external measure of effectiveness, efficiency is considered to be the internal measure. To achieve a given level of data routing performance, two different protocols can use differing amounts of overhead, depending on their internal efficiency, and thus protocol efficiency may or may not directly affect data routing performance. If control and data traffic share the same channel, and the channels capacity is limited, then excessive control traffic often impacts data routing performance.

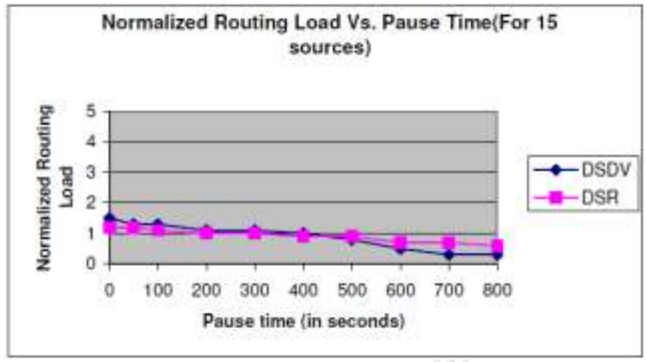

Figure 7. Normalized Routing Load vs. Pause Time for 15 Sources

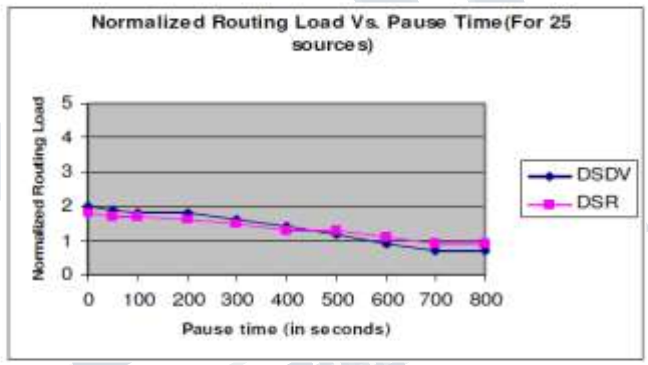

Figure 8. Normalized Routing Load vs. Pause Time for 25 Sources

From Figure7 and Figure8 we note that initially when the mobility is low, DSR has greater normalized routing load. This is attributed to the fact that DSR being a source routing protocol, with every packet the entire routing information is embedded. In addition to that, in response to a route discovery, replies come from many intermediate nodes. This increases the total control traffic. In case of DSDV, initially, when the mobility is low, the network topology remains relatively stable. Hence, nodes need to exchange only incremental dumps rather than full dumps. This results in lesser overhead of DSDV. With higher mobility the network topology changes frequently. DSDV being proactive in nature is less adaptive to this quickly changing scenario. Therefore, nodes need to exchange full dumps in order to maintain up-to-date routing information. This causes greater routing overhead for DSDV. In comparison, DSR uses aggressive caching strategy and the hit ratio is quite high. As a consequence, in high mobility scenario even if a link breaks, DSR can resort to an alternate link already available in the cache.

VI CONCLUSION

In this paper we have carried out a detailed ns2 based comparative simulation study of the performance characteristics of DSDV and DSR under hybrid scenario. Our work is the first in an attempt to compare these protocols in hybrid networking environment. The simulation results show that at higher mobility DSR outperforms DSDV in terms of packet delivery performance. This is attributed to the DSR's ability to maintain multiple routes per destination and its use of aggressive caching strategy. At lower mobility, however, DSDV performs better than DSR. The network being relatively stable, at the time of packet delivery, all the routes are already available in DSDV due to its proactive nature. This results in greater packet delivery fraction. Our experiment results also indicate that DSR exhibits more average end-to-end delay in comparison to DSDV. This is due to the fact that DSR being a source routing protocol, the initial path set up time is significantly higher as during the route discovery process every intermediate node needs to extract the information before forwarding the data packet. Although DSR maintains multiple routes to the same destination in the cache, but it lacks any mechanism to determine the freshness of the routes or to expire the stale routes. With high mobility and frequent link breaks there are chances of more routes becoming stale quickly. This requires the DSR to initiate the route discovery process which further adds to the increasing delay. At higher mobility we note that DSR has lower routing load than DSDV. DSR uses aggressive caching technique and maintains multiple routes to the same destination. Hence, in high mobility scenario even if a link breaks, DSR can resort to an alternate link already available in the cache. This reduces the frequency of route discovery, which ultimately results in lower routing overhead of DSR. On the other hand, at lower mobility, the network topology remains relatively stable. Hence, in DSDV, nodes need to exchange only incremental dumps rather than full dumps. This results in lesser overhead of DSDV. Thus we can conclude that if routing delay is of little concern, then DSR shows better performance at higher mobility in terms of packet delivery fraction and normalized routing load in hybrid networking scenario. Under less stressful scenario, however, DSDV outperforms DSR in terms of all three metrics. While in this work we focus on the three prime metrics to analyse the performance of these protocols, there are many other issues that need to be considered to have an in-depth idea of these protocols' behaviour in hybrid networking environment.

Future Scope

In our future work, we plan to study the performance of these protocols under other network scenarios by varying the network size, the number of connections, the mobility models and the speed of the mobile nodes etc.

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