Effect of Pause Time on DSR, AODV and DYMO Routing Protocols in MANET

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Abstract— **A Mobile ad hoc network is a collection of wireless mobile nodes that are capable of communicating with each other without the use of a network infrastructure or any centralized administration. The mobile nodes perform both as a host and a router forwarding packets to other nodes. Routing in these networks is highly complex. Due to moving nodes, many protocols have been developed. Performance of each protocol is depending on their working in different conditions. This paper describes some special characteristics of ad hoc routing protocols DSR, AODV and DYMO. It also presents their performance and comparative study. Evaluation based on comparative study of above protocols was done with some realistic parameters like Total Packet Received, Packet Drop Ratio, Throughput, Average Jitter and End to End Delay with variations in Pause Time of network. Simulations of protocols to analyze their performance in different conditions were performed in QualNet 4.0 simulator.**

Keywords: Ad Hoc Networks, routing protocol, DYMO, DSR, AODV.

I. INCUCTION

An ad-hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any stand-alone infrastructure or centralized administration. Mobile Ad-hoc networks [1] [13] are self-organizing and self-configuring multihop wireless networks where, the structure of the network changes dynamically. This is mainly due to the mobility of the nodes. Nodes in these networks utilize the same random access wireless channel, cooperating in a friendly manner to engaging themselves in multihop forwarding. The nodes in the network not only act as hosts but also as routers that route data to/from other nodes in network. The applications of the adhoc network are vast. It is used in areas of Sensor networks for environmental monitoring, Rescue operations in remote areas, Remote construction sites, and Personal area Networking, Emergency operations, Military environments, Civilian environments.

A key issue in MANETs [13] is the necessity that the routing protocols must be able to respond rapidly to topological changes in the network. At the same time, due to the limited bandwidth available through mobile radio interfaces, it is imperative that the amount of control traffic, generated by the routing protocols is kept at a minimum.

Ad hoc routing protocols can be classified in two groups [1] [9] pro-active (reactive) and on-demand. Pro-active protocols (like DSDV [5], WRP [9] and STAR) try to have a correct view of network topology at all times. Any changes in topology are propagated through the network, so that all nodes know of the change in the topology as it happens. This type of protocol operation is considered pro-active, since it tries to determine routes before they are needed.

On-demand routing protocols (like AODV [5], DSR [4], DYMO [3], TORA [5]), as the name suggests, only try to keep valid routing information to the destinations that they need. In other words, network topology is detected as needed (on-demand). These protocols usually initiate topology discovery at a time when traffic requires it.

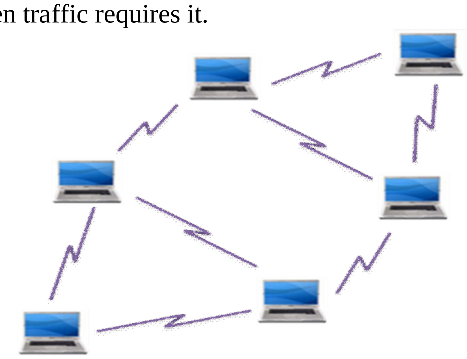

Figure 1: Ad-hoc Network

Several studies have been published comparing the performance of the above routing protocols using different simulators, mobility models and performance metrics. One of the comprehensive studies was done by the Monarch project of CMU, the results of which are presented in [2]. This study compared DSDV, AODV, DSR and TORA. This paper presents a comparative study of some on-demand routing protocol like DSR, DYMO and AODV.

The rest of this paper is organized as follows. Section II briefly describes the ad-hoc routing protocols. Section III discusses the most important on-demand routing protocols. Section IV presents a comparative study of various protocols. Section V presents simulation and analysis of protocols. Section VI concludes this paper.

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II. AD-HOC ROUTING PROTOCOLS

Several routing protocols have been developed for ad hoc mobile networks [1] [13]. Such protocols must deal with typical limitations of these networks which include high power consumption, low bandwidth and high error rates. As figure 1 shows the categorization of these routing protocols.

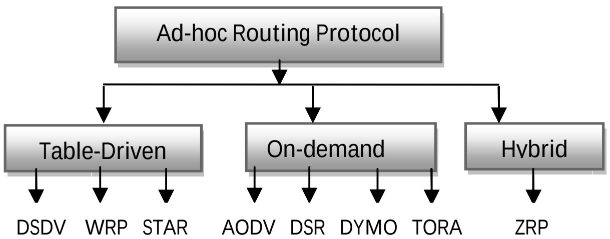


Figure 2: Categorization of ad-hoc routing protocol

A) Table-Driven Routing Protocols

Table-driven routing protocol [1] [8] attempt to maintain consistent, up-to-date routing information from each node to every other node in the network. These protocols require each node to maintain one or more tables to store routing information, and they respond to changes in network topology by propagating updates routes through out the network in order to maintain a consistent network view. The Destination-Sequenced Distance-Vector Routing (DSDV) protocol shown in figure 2 is a table driven algorithm that modifies the Bellman-Ford routing algorithm to include timestamps that prevent loop-formation. The Wireless Routing Protocol (WRP) is a distance vector routing protocol which belongs to the class of path-finding algorithms that exchange second-to-last hop to destinations in addition to distances to destinations. This extra information helps remove the “counting-to-infinity” problem that most distance vector routing algorithms suffer from. It also speeds up route convergence when a link failure occurs.

B) On Demand-Driven Routing Protocols

A different approach from table-driven routing is on-demand routing [5] [6] [4]. This type of routing creates routes only when desired by source node. When a node requires a route to a destination, it initiates a route discovery process within the network. This process is completed once a route is found or all possible routes permutations have been examined. Once a route has been established, it is maintained by a route maintenance procedure until either the destination becomes inaccessible along every path from the source or until the route is no longer desired.

On-demand routing protocols were designed with the aim of reducing control overhead, thus increasing bandwidth and conserving power at the mobile stations. These protocols limit the amount of bandwidth consumed by maintaining routes to only those destinations for which a source has data traffic. Therefore, the routing is source-initiated as opposed to table-driven routing protocols that are destination initiated. There are several recent examples of this approach (e.g., AODV [5], DSR [4], TORA [5], ZRP [12]) and the routing protocols differ on the specific mechanisms used to disseminate flood search packets and their responses, cache the information heard from other nodes’ searches, determine the cost of a link, and determine the existence of a neighbor. However, all the on-demand routing proposals use flood search messages that either: (a) give sources the entire paths to destinations, which are then used in source-routed data packets (e.g., DSR); or (b) provide only the distances and next hops to destinations, validating them with sequence numbers (e.g., AODV) or time stamps (e.g., TORA).

C) Hybrid Routing Protocols

Based on combination of both table and demand driven routing protocols, some hybrid routing protocols are proposed to combine advantage of both proactive and reactive protocols. The most typical hybrid one is zone routing protocol [12].
As to the major division of routing protocols, Table 1 gives a comparison of table-driven, demand-driven and hybrid Routing Protocol.

Parameters	**Table-Driven**	**Demand-Driven**	**Hybrid**
Network Organization	Flat Hierarchical	Flat	Hierarchical
Topology Dissemination	Periodical	On-Demand	Both
Route Latency	Always Available	Available when needed	Both
Mobility Handling	Periodical Updates	Route Maintenance	Both
Communication Overhead	High	Low	Medium

Table 1: Comparison of Routing

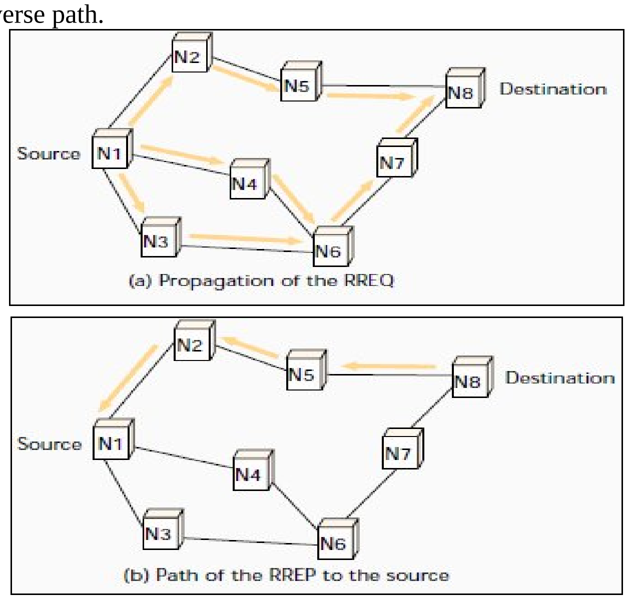
III. ON-DEMAND ROUTING PROTOCOLS

A) Ad hoc On-demand Distance Vector (AODV)

Ad hoc On-demand distance vector (AODV) [5] [10] is another variant of classic distance vector routing algorithm, based on DSDV and DSR. It shares DSR on-demand characteristics, discovers routes on an as needed basis via a similar route discovery process. However, AODV adopts traditional routing tables; one entry per destination which is in contrast to DSR that preserves multiple route cache entries for each destination. The early design of AODV is undertaken after the experience with DSDV routing algorithm. Like DSDV, AODV provides loop free routes in case of link breakage but unlike DSDV, it doesn’t need global periodic routing advertisement. AODV uses a broadcast route discovery algorithm and then the unicast route reply massage. The following sections explain these mechanisms in more details.

1) *Route Discovery:*

When a node wants to send a packet to some destination and does not have a valid route in its routing table for that destination, initiates a route discovery. Source node broadcasts a route request (RREQ) packet to its neighbors, which then forwards the request to their neighbors and so on shown in figure 3. To control network-wide broadcasts of RREQ packets, the source node use an expanding ring search technique. In this technique, source node starts searching the destination using some initial time to live (TTL) value. If no reply is received within the discovery period, TTL value incremented by an increment value. This process will continue until the threshold value is reached. When an intermediate node forwards the RREQ, it records the address of the neighbor from which first packet of the broadcast is received, thereby establishing a reverse path.



(a) Propagation of the RREQ

(b) Path of the RREP to the source

Figure 3: AODV Path Discovery Process

When the RREQ reaches a node that is either the destination node or an intermediate node with a fresh enough route to the destination, replies by unicasting the route reply (RREP) towards the source node. As the RREP is routed back along the reverse path shown figure 3, intermediate nodes along this path set up forward path entries to the destination in its route table and when the RREP reaches the source node, a route from source to the destination establish.

2) *Route Maintenance:*

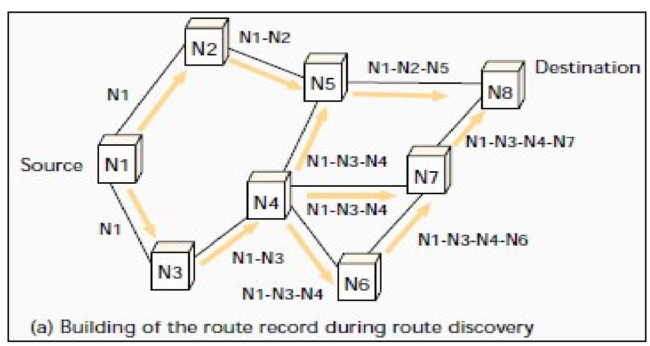
A route established between source and destination pair is maintained as long as needed by the source. If the source node moves during an active session, it can reinitiate route discovery to find out a new route to destination. However, if the destination or some intermediate node moves, the node upstream of the break remove the routing entry and send route error (RERR) message to the affected active upstream neighbors. These nodes in turn propagate the RERR to their precursor nodes, and so on until the source node is reached. The affected source node may then choose to either stop sending data or reinitiate route discovery for that destination by sending out a new RREQ message.

B) Dynamic Source Routing (DSR)

The Dynamic Source Routing (DSR) [4] [13] is one of the purest examples of an on-demand routing protocol that is based on the idea of source routing. It is designed specially for use in multihop ad hoc networks for mobile nodes. It allows the network to be completely self-organizing and self-configuring and does not need any existing network infrastructure or administration. DSR uses no periodic routing messages like AODV, thereby reduces network bandwidth overhead, conserves battery power and avoids large routing updates. Instead DSR needs support from the MAC layer to identify link failure. DSR is composed of the two mechanisms of Route Discovery and Route Maintenance, which work together to allow nodes to discover and maintain source routes to arbitrary destinations in the network show in figure 4. The following sections explain these mechanisms in more details.

1) Route Discovery:

When a mobile node has a packet to send to some destination shown figure 4, it first checks its route cache to decide whether it already has a route to the destination. If it has an unexpired route, it will use this route to send the packet to the destination. On the other hand, if the cache does not have such a route, it initiates route discovery by broadcasting a route request packet shown in figure 4. Each node receiving the route request packet searches throughout its route cache for a route to the intended destination. If no route is found in the cache, it adds its own address to the route record of the packet and then forwards the packet to its neighbors.



(a) Building of the route record during route discovery

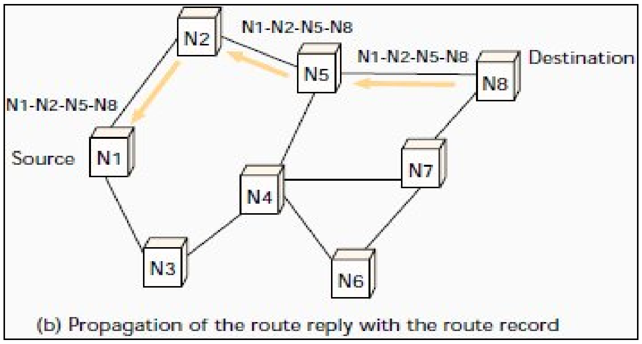


Figure 4: DSR Route Discovery Process

This request propagates through the network until either the destination or an intermediate node with a route to destination is reached. Whenever route request reaches either to the destination itself or to an intermediate node which has a route to the destination, a route reply is unicasted back to its originator.

2) Route Maintenance:

In DSR, route is maintained by using route error packets and acknowledgments. When a packet with source route is originated or forwarded, each node sending the packet is responsible for confirming that the packet has been received by the next hop. The packet is retransmitted until the conformation of receipt is received. If the packet is transmitted by a node the maximum number of times and yet no receipt information is received, this node returns a route error message to the source of the packet. When this route error packet is received, the hop in error is removed from the host's route cache and all routes containing the hop are truncated at that point.

C) The Dynamic MANET On-demand (DYMO):

The Dynamic MANET On-demand (DYMO) [6] [13] routing protocol is a simple and fast routing protocol for multihop networks. It discovers unicast routes among DYMO routers within the network in an on-demand fashion, offering improved convergence in dynamic topologies. To ensure the correctness of this protocol, digital signatures and hash chains are used [6]. The basic operations of the DYMO protocol are route discovery and route management. The following sections explain these mechanisms in more details.

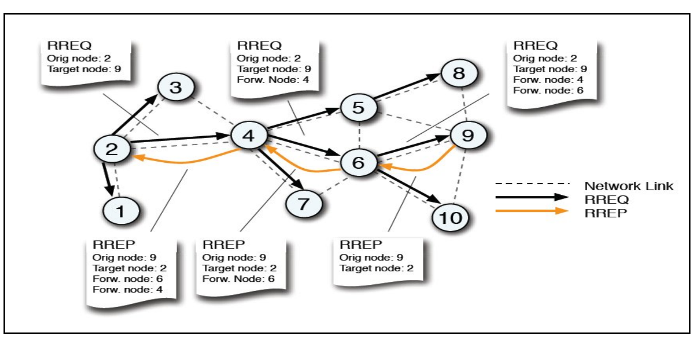


Figure 5(a): DYMO Route discovery

1) Route Discovery:

When a source needs to send a data packet, it sends an RREQ to discover a route to that particular destination shown in figure 5(a). After issuing an RREQ, the origin DYMO router waits for a route to be discovered. If a route is not obtained within RREQ waiting time, it may again try to discover a route by issuing another RREQ. To reduce congestion in a network, repeated attempts at route discovery for a particular target node should utilize an exponential backoff. Data packets awaiting a route should be buffered by the source's DYMO router. This buffer should have a fixed limited size and older data packets should be discarded first. Buffering of data packets can have both positive and negative effects, and therefore buffer settings should be administratively configurable or intelligently controlled. If a route discovery has been attempted maximum times without receiving a route to the target node, all data packets intended for the corresponding target node are dropped from the buffer and a Destination Unreachable ICMP message is delivered to the source.

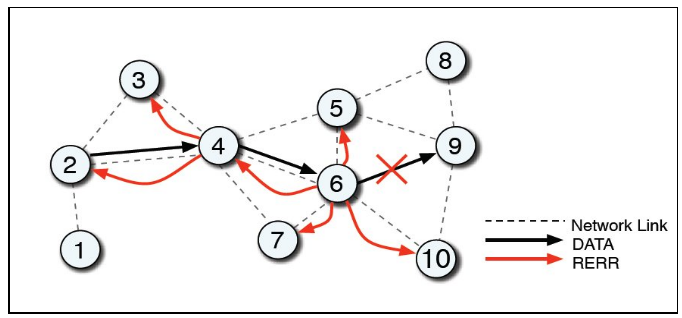


Figure 5(b): Generation and dissemination of RERR messages

2) Route Maintenance:

When a data packet is to be forwarded and it can not be delivered to the next-hop because no forwarding route for the IP Destination Address exists; an RERR is issued shown in figure 5(b). Based on this condition, an ICMP Destination Unreachable message must not be generated unless this router is responsible for the IP Destination Address and that IP Destination Address is known to be unreachable. Moreover, an RERR should be issued after detecting a broken link of a forwarding route and quickly notify DYMO routers that a link break occurred and that certain routes are no longer available. If the route with the broken link has not been used recently, the RERR should not be generated.

IV. Experiment Configuration

All the simulation work is perform in QualNet wireless network simulator version 4.0 [11]. Initially number of nodes are 30, Simulation time was taken 100 seconds and seed as 1. All the scenarios have been designed in 1500m x 1500m area. Mobility model used is Random Way Point [7] (RWP). In RWP a mobile node is initially placed in a random location in the simulation area. For simulation, environmental surrounding selected is Pause time. Pause time is varying between the ranges of 30-110 sec. “Pause time is a time in which all nodes in network are motionless but transmission in continued”. All the simulation works were carried out using on-demand routing protocol (DSR, AODV, DYMO) with varying pause time. Network traffic load is provided by constant bit rate (CBR) application. A CBR traffic source provides a constant stream of packets throughout the whole simulation, thus further stressing the routing task.

There are five measurements in our experiments were defined as follows:

1) Throughput (bits/s):- Throughput [9] is the measure of the number of packets successfully transmitted to their final destination per unit time.

2) Total Packets Received:- Packet delivery ratio [2] is calculated by dividing the number of packets received by the destination through the number of packets originated by the application layer of the source (i.e. CBR source).

3) Drop Packet Ratio:- Packet drop ratio [6] is calculated by subtract to the number of data packets sent to source and number of data packets received destination through the number of packets originated by the application layer of the source (i.e. CBR source).

4) End-To-End Delay:- Average End to End Delay[10] signifies the average time taken by packets to reach one end to another end (Source to Destination)**.**

5) Average Jitter Effect [2]:- Signifies the Packets from the source will reach the destination with different delays. A packet's delay varies with its position in the queues of the routers along the path between source and destination and this position can vary unpredictably.

V. SIMULATION RESULTS & ANALYSIS

The simulation for on-demand routing protocols is based on simulation time, number of node, area of network, pause time, routing protocols, and speed of node. In experimental methodologies performance matrix can be measured with variation in pause time while rest of all other parameters like simulation time, area of network, and speed of node kept constant. Effects of different parameter on performance of on-demand protocols are publicized below.

From simulation results in figure 6(a)-6(d), it is observed that the performance of DSR protocol is better than other on-demand routing protocols (AODV, DYMO), because of the proper receiving of packets and less packet drop. But due to simulation results of End to End Delay with variation in pause time in figure 6(e) it is observed that the performance of DYMO protocol is superior then DSR and AODV.

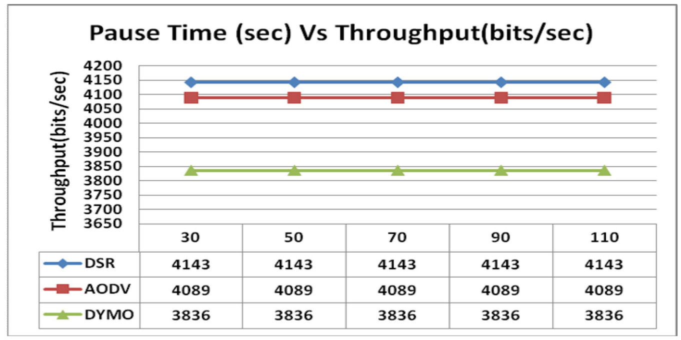


Figure 6(a): Pause Time Vs Throughput (bits/s)

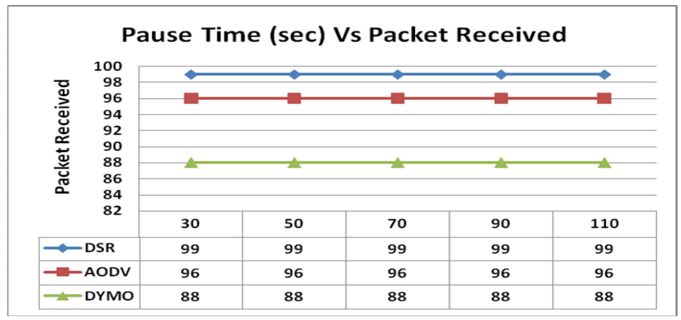


Figure 6(b): Pause Time Vs Total Packet Received

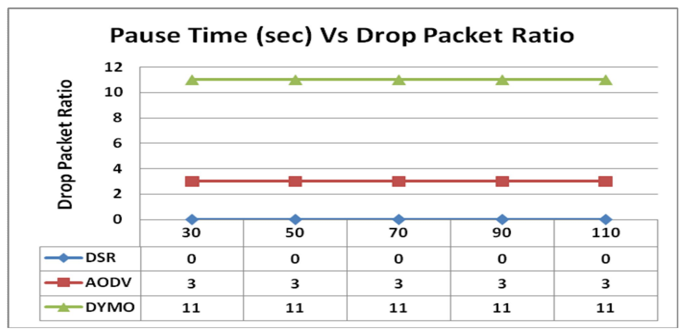


Figure 6(c): Pause Time Vs Drop Packet Ratio

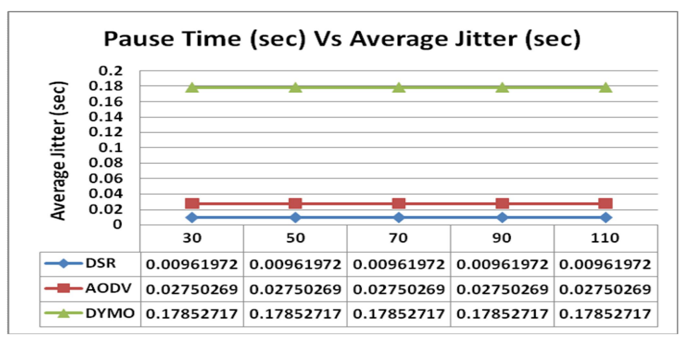


Figure 6(d): Pause Time Vs Average Jitter

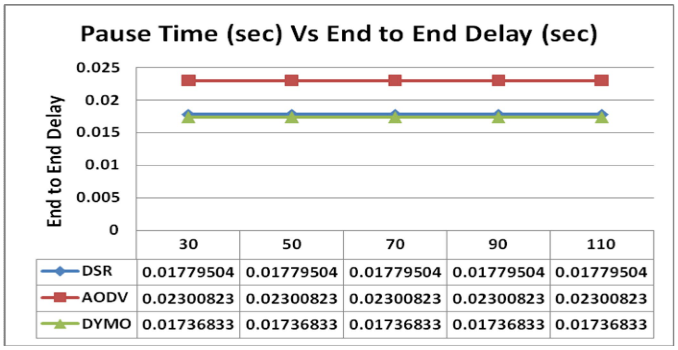


Figure 6(e): Pause Time Vs End to End Delay

VI. Conclusion

This paper provides explanation and simulation analysis of on-demand routing protocols like DSR, AODV and DYMO for ad-hoc mobile networks and also provides a classification of these protocols according to the routing strategy (i.e. table driven, on-demand and hybrid routing protocol). It has also presented a comparison of these on-demands routing protocol under variation of Pause Time, simultaneously measured performances under various performance metrics including throughput, data packet received, packet drop ratio and average jitter, end to end delay.

From different analysis of graphs and simulations it can be concluded that DSR performs well than AODV and DYMO under different situations with variation in pause time. Although DYMO is enhanced version of AODV, so performance of DYMO is better than AODV, DSR in some situations.

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