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ROUTING PROTOCOLS IN AD HOC WIRELESS NETWORKS

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Abstract: Routing is a process of determining a path and transferring packets from source to destination. There are several routing protocols were developed for ad hoc wireless network, but this chapter will give an overview on two most common reactive routing protocols, DSR and AODV. Here reactive routing protocols have chosen since they are well performing in ad hoc wireless network. Reactive routing protocol creates routes when they are needed by the source to send data packets to the destination.
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Introduction:

Dynamic source routing (DSR) protocol is one of the purest example of on-demand multicast routing protocol. It is specially designed for use in multi-hop ad hoc wireless networks of mobile nodes. Since DSR is used in ad hoc wireless network, the network is completely self-configuring and self-organizing without use any preexisting central administrator. It uses the concept of source routing. Because of source routing concept, DSR allows packet routing trivially loop free, avoids to store routing information in intermediate nodes and allows node forwarding and overhearing packets to cache the routing information for future use. It uses no periodic routing message, so in this way it can reduces battery power conservation, bandwidth overhead and avoid large routing update throughout the ad hoc wireless network. DSR composed of two mechanisms: Route Discovery and Route Maintenance which work together to allow nodes to discover and maintain source routes to arbitrary destinations in the ad hoc wireless network.

Route Discovery process

Route Discovery mechanism is used when a source node wants to send a packet to the destination node. Route Discovery mechanism is used only when source node attempt to send and no preexisting route in between source and destination. It uses two types of messages: Route Request (RREQ) message and Route Reply (RREP) message.

Route Discovery mechanism is initiated with Route Request (RREQ) message that is send by the source node when it has a packet to send to the destination node. Source node requests a route by broadcasting the RREQ message. All the nodes within thetransmission range of source node can receive the RREQ message. After receiving this message, every node searches the route to the required destination through its RouteCache. If no route found in the Route Cache, the RREQ is again forwarded and add its own address to the RREQ message. This request message is propagated until either to the destination or a node with a route to the destination is reached. Each RREQ message contains the IP address of source and destination node and unique request id determined by the source of the request. Each RREQ is also contains the address of each intermediate node through which particular copy of the RREQ message has been forwarded. This route record is initialized to an empty list by the source node of the Route Discovery.

When a node receives the RREQ message, if it is an intermediate node, it appends its own address to the route record of the RREQ message and again broadcast this messagewith its request id. Otherwise, if a node is receiving RREQ has recently seen another RREQ message from the same source node bearing the same request id or if it finds that itsown address is already listed in the route record in the RREQ message, it discard the request message. When a node receives a RREQ message, if it is a destination node of the Route Discovery, it sends the Route Reply (RREP) to the source node of the RouteDiscovery. It uses the copy of the accumulated route record from the RREQ. When the source node receives the RREP message, it caches this route in its Route Cache. Using this Route Cache, source node can send subsequent packets to the destination.

Within in a Route Discovery process, the source node saves a copy of the original packet in a local buffer which is called Send Buffer. The send buffer contains each packet which can't be transmitted since they don't yet have a route from source to destination. Each packet of Send Buffer can placed into buffer for a limited time period and discarded after residing in the send buffer for some timeout period.

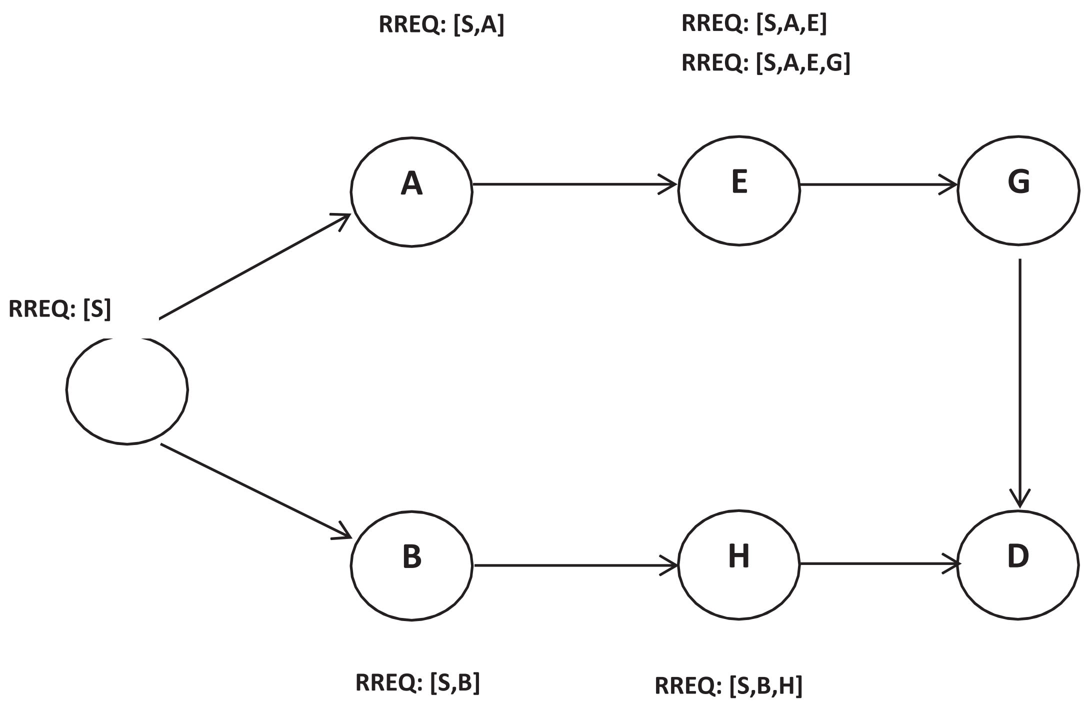

Figure 1.1: DSR Route Request

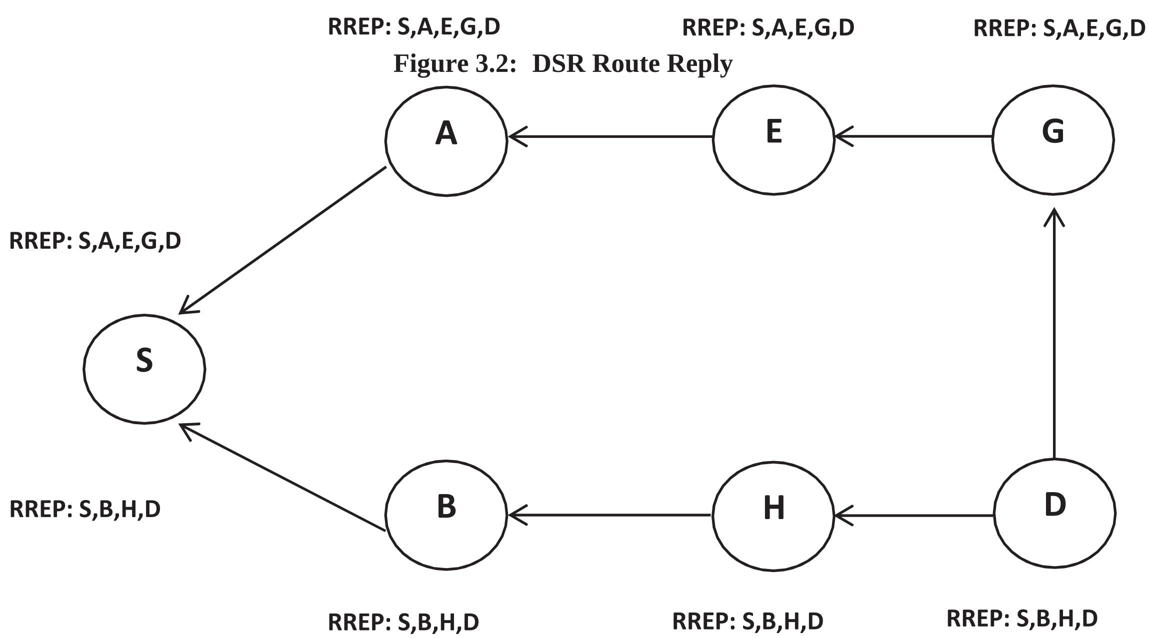

Figure 3.2: DSR Route Reply

If necessary, Send Buffer can prevent the packets to store while buffer is overflow and for that it can use FIFO or other replacement strategy before expiration of packets. While packet remains in the send buffer, the node should occasionally initiate new Route Discovery for the packet to the destination. There may possibilities of several routes to be initiated between source and destination by using Route Discovery mechanism while destination node is node reachable and the node should limit the rate at which such new route discoveries for the same addressare initiated. In ad hoc wireless network, due to the wireless transmission range and the movement of the nodes in the network, the routes between the nodes may changes and for that new Route Discovery process is needed. If a new Route Discovery process is initiated for each packet sent by the source node then in such situation large number of RREQ messages propagated throughout the network reachable from this node. To reduce this overhead we must use the exponential back-off to limit the rate at which the new Route Discovery process is initiated by any node for the same destination. If a node wants to sendadditional data packets to the same node more frequently than this limit, packets are stored in the send buffer until source receives the RREP message, but the node must not initiate a new Route Discovery until minimum route interval between Route Discoveries for the destination node has been reached.

When a node discovers that it cannot forward a data packet since the next-hop link is broken and then it generates Route Error (RERR) message and send to the upstream node. After that it searches its own cache to find an alternate route from itself to the destination node to forward the packet. If route is found, the node modifies the route as perthe route cache and forwards to the next hop node.

The following figure 1.1 shows the Route Request (RREQ) process and figure 3.2 shows the Route Reply (RREP) of Route Discovery mechanism.

In figure 1.1, S is the source node that wants to send data packet to the destination node D. So S broadcasts the request message by initiating the Route Request (RREQ) of Route Discovery process. This message received by node A and B and since none of them is a destination, so they again broadcast RREQ message. After receiving RREQ by E from A it sends the message to node G and then G again rebroadcast the request message. Node H receives the broadcasted message from B and it again propagates the RREQ message. D receives the RREQ message from both the node G and H. D does not forward request message since it is the intended destination of the Route Discovery process. Here eachnode caches a new route it learns by any means. [S, A, E, G] represents cached route at a node G. When node S finds route [S, A, E, G] to node G, node S also learns the route [S,A, E] to node E. Using of the route cache can speed up route discovery and reduce propagation of route requests.

Here in figure 1.2, D is the destination node and when it receives RREQ message from the source node S, it sends the Route Reply (RREP) message by using the route stored in its Route Cache. But if the route is not found in the Route Cache then D can againuse the Route Discovery process to search the route to the source.

In figure 1.2, if the link between node H and D is broken after reaching the RREQ message to D, it checks its route cache for an alternate route to the source node S and it finds an alternate route via node G, E and A, it choose that route and send RREP message to S. But if both links between node D and G, D and H are broken, then no other route between D and S exists. Node G and H send the RERR message to its upstream node which is received by the source node S.

Route Maintenance process

Route Maintenance is the mechanism that can handle link breaks between nodes. It can happen while network topology has changed.

Route Maintenance mechanism contains two different processes: hop-by-hop acknowledgement at the data link layer and end-to-end acknowledgement. Hop-by-hop is the process at the data link layer which allows an early detection and retransmission of lost packets. When a node encounter a fatal transmission error in the data link layer, it remove the route from its route cache and generate RERR message and RERR message is sent back to the sender of the packet. The RERR message includes the address of the hosts at both ends of the hop in error (host detecting error and the host's address which was trying to transmit the packet). When a node receives the RERR message, removes the hop from its route cache and all the routes containing this hop also removed.

Route Maintenance process also contains the end-to-end acknowledgement when wireless transmission between two hosts does not work equally in both directions. As long as route exists between two hosts they can communicate easily and Route Maintenance may be used. At this stage, acknowledgement or replies on the transport layer used to indicate the status of this host's route to the other host. With end-to-end acknowledgement,it is not possible to find the hop error.

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