MANET Routing Protocols with VoIP Application (DSR vs OLSR)

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Different routing protocols try to solve the problem of routing in mobile ad hoc networks in one way or the other. in reactive routing approach, a routing protocol does the initiative for finding a route to a destination, until it is required. The protocol attempts to discover routes only "on-demand" by flooding its query in the network. This type of protocol reduces control traffic overhead at the cost of increased latency in finding the route to a destination. DSR is an example of such a protocol.On the other hand, proactive protocols are based on periodic exchange of control messages. Some are sent locally to enable a node to know its local neighbourhood, and some are sent in entire network which permit to exchange the knowledge of topology among all the nodes of the network. OLSR is an example.

Fig 1: Classification of Ad hoc Routing Protocols.

KEYWORDS: Wireless networking|Routing| Routing algorithms|Ad hoc routing protocols| Routing protocols| OLSR protocol | DSR Protocol.

INTRODUCTION:

A mobile ad hoc network (MANET), also known as wireless ad hoc network or ad hoc wireless network, is a continuously self-configuring, infrastructure-less network of mobile devices connected wirelessly.

Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Each must forward traffic unrelated to its own use, and therefore be a router. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. Such networks may operate by themselves or may be connected to the larger Internet. They may contain one or multiple and different transceivers between nodes. This results in a highly dynamic, autonomous topology.

A wireless ad hoc network (WANET) or MANET (Mobile ad hoc network) is a decentralised type of wireless network. The network is ad hoc because it does not rely on a pre-existing infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks. Instead, each node participates in routing by forwarding data for other nodes, so the determination of which nodes forward data is made dynamically on the basis of network connectivity and the routing algorithm in use.

In the Windows operating system, ad-hoc is a communication mode (setting) that allows computers to directly communicate with each other without a router.
Wireless mobile ad hoc networks are self-configuring, dynamic networks in which nodes are free to move. Wireless networks lack the complexities of infrastructure setup and administration, enabling devices to create and join networks "on the fly" - anywhere, anytime

Optimized Link State Routing Protocol

The Optimized Link State Routing Protocol (OLSR) is an IP routing protocol optimized for mobile ad hoc networks, which can also be used on other wireless ad hoc networks. OLSR is a proactive link-state routing protocol, which uses hello and topology control (TC) messages to discover and then disseminate link state information throughout the mobile ad hoc network. Individual nodes use this topology information to compute next hop destinations for all nodes in the network using shortest hop forwarding paths.

Fig 2: OLSR Working

Features specific to OLSR:

Link-state routing protocols such as Open Shortest Path First (OSPF) and Intermediate System to Intermediate System (IS-IS) elect a designated router on every link to perform flooding of topology information. In wireless ad hoc networks, there is different notion of a link, packets can and do go out the same interface; hence, a different approach is needed in order to optimize the flooding process. Using Hello messages the OLSR protocol at each node discovers 2-hop neighbour information and performs a distributed election of a set of multipoint relays (MPRs). Nodes select MPRs such that there exists a path to each of its 2-hop neighbours via a node selected as an MPR. These MPR nodes then source and forward TC messages that contain the MPR selectors. This functioning of MPRs makes OLSR unique from other link state routing protocols in a few different ways: The forwarding path for TC messages is not shared among all nodes but

varies depending on the source, only a subset of nodes source link state information, not all links of a node are advertised but only those that represent MPR selections.

Since link-state routing requires the topology database to be synchronized across the network, OSPF and IS-IS perform topology flooding using a reliable algorithm. Such an algorithm is very difficult to design for ad hoc wireless networks, so OLSR doesn't bother with reliability; it simply floods topology data often enough to make sure that the database does not remain unsynchronized for extended periods of time.

Multipoint relays

Multipoint relays (MPRs) relay messages between nodes. They also have the main role in routing and selecting the proper route from any source to any desired destination node.

MPRs advertise link-state information for their MPR selectors (a node selected as a MPR) periodically in their control messages. MPRs are also used to form a route from a given node to any destination in route calculation. Each node periodically broadcasts a Hello message for the link sensing, neighbor detection and MPR selection processes.

Benefits

Being a proactive protocol, routes to all destinations within the network are known and maintained before use. Having the routes available within the standard routing table can be useful for some systems and network applications as there is no route discovery delay associated with finding a new route.

The routing overhead generated, while generally greater than that of a reactive protocol, does not increase with the number of routes being created.

Default and network routes can be injected into the system by HNA messages allowing for connection to the internet or other networks within the OLSR MANET cloud. Network routes are something reactive protocols do not currently execute well.

Timeout values and validity information is contained within the messages conveying information allowing for differing timer values to be used at differing nodes.

Messages

OLSR makes use of "Hello" messages to find its one hop neighbors and its two hop neighbors through their responses. The sender can then select its multipoint relays (MPR) based on the one hop node that offers the best routes to the two hop nodes. Each node has also an MPR selector set, which enumerates nodes that have selected it as an MPR node. OLSR uses topology control (TC) messages along with MPR forwarding to disseminate neighbor information throughout the network. Host and network association (HNA) messages are used by OLSR to disseminate network route advertisements in the same way TC messages advertise host routes.

Hello:

Fig 3: Hello Packet Format

Topology control (TC):

Fig 4: TC Packet Format

Dynamic Source Routing

Dynamic Source Routing (DSR) is a routing protocol for wireless mesh networks. It is similar to AODV in that it forms a route on-demand when a transmitting node requests one. However, it uses source routing instead of relying on the routing table at each intermediate device.

Background

Determining source route requires accumulating the address of each device between the source and destination during route discovery. The accumulated path information is cached by nodes processing the route discovery packets. The learned paths are used to route packets. To accomplish source routing, the routed packets contain the address of each device the packet will traverse. This may result in high overhead for long paths or large addresses, like IPv6. To avoid using source routing, DSR optionally defines a flow id option that allows packets to be forwarded on a hop-by-hop basis.

This protocol is truly based on source routing whereby all the routing information is maintained (continually updated) at mobile nodes. It has only two major phases, which are Route Discovery and Route Maintenance. Route Reply would only be generated if the message has reached the intended destination node (route record which is initially contained in Route Request would be inserted into the Route Reply).

To return the Route Reply, the destination node must have a route to the source node. If the route is in the Destination Node's route cache, the route would be used. Otherwise, the node will reverse the route based on the route record in the Route Request message header (this requires that all links are symmetric). In the event of fatal transmission, the Route Maintenance Phase is initiated whereby the Route Error packets are generated at a node. The erroneous hop will be removed from the node's route cache; all routes containing the hop are truncated at that point. Again, the Route Discovery Phase is initiated to determine the most viable route.

Restricting bandwidth

Dynamic source routing protocol (DSR) is an on-demand protocol designed to restrict the bandwidth consumed by control packets in ad hoc wireless networks by eliminating the periodic table-update messages required in the table-driven approach. The major difference between this and the other on-demand routing protocols is that it is beacon-less and hence does not require periodic hello packet (beacon) transmissions, which are used by a node to inform its neighbours of its presence. The basic approach of this protocol (and all other on-demand routing protocols) during the route construction phase is to establish a route by flooding RouteRequest packets in the network. The destination node, on receiving a RouteRequest packet, responds by sending a RouteReply packet back to the source, which carries the route traversed by the RouteRequest packet received.

Consider a source node that does not have a route to the destination. When it has data packets to be sent to that destination, it initiates a RouteRequest packet. This RouteRequest is flooded throughout the network. Each node, upon receiving a RouteRequest packet, rebroadcasts the packet to its neighbors if it has not forwarded it already, provided that the node is not the destination node and that the packet's time to live (TTL) counter has not been exceeded. Each RouteRequest carries a sequence number generated by the source node and the path it has traversed. A node, upon receiving a RouteRequest packet, checks the sequence number on the packet before forwarding it. The packet is forwarded only if it is not a duplicate RouteRequest. The sequence number on the packet is used to prevent loop formations and to avoid multiple transmissions of the same RouteRequest by an intermediate node that receives it through multiple paths. Thus, all nodes except the destination forward a RouteRequest packet during the route construction phase. A destination node, after receiving the first RouteRequest packet, replies to the source node through the reverse path the RouteRequest packet had traversed. Nodes can also learn about the neighboring routes traversed by data packets if operated in the promiscuous mode (the mode of operation in which a node can receive the packets that are neither broadcast nor addressed to itself). This route cache is also used during the route construction phase.

Advantages and disadvantages

This protocol 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. In a reactive (on-demand) approach such as this, a route is established only when it is required and hence the need to find routes to all other nodes in the network as required by the table-driven approach is eliminated. The intermediate nodes also utilize the route cache information efficiently to reduce the control overhead. The disadvantage of this protocol is that the route maintenance mechanism does not locally repair a broken link. Stale route cache information could also result in inconsistencies during the route reconstruction phase. The connection setup delay is higher than in table-driven protocols. Even though the protocol performs well in static and low-mobility environments, the performance degrades rapidly with increasing mobility. Also, considerable routing overhead is involved due to the source-routing mechanism employed in DSR. This routing overhead is directly proportional to the path length.

SETUP OF PROJECT:

In this project, 2 scenarios are created. both the scenarios use VoIP application. While Scenario 1 uses DSR protocol, Scenario 2 uses OLSR protocol. The aim is to observe how the different routing protocols affect the network in terms of throughput, MOS value, Network Delay etc.

SOFTWARE USED FOR SIMULATION:

Riverbed Modeler.

Components and Simulation Methodology:

Application Config (one): Used to Describe the VoIP application service used over the network.

Fig 4.1: Application Config Attributes

Profile Config (one) : Used to apply the VoIP application profile on the network.

Fig 4.2: Profile Config Attributes

RX Group Config (one) : Used to compute the set of possible receivers a node can communicate with.

wlan_wkstn_adv (ten): Used to emulate the VoIP Clients.

wlan_server_adv (one): Used to emulate functionality of the VoIP Server on the network.

Fig 4.3: Network Setup containing various components.

After placing various components in the workspace and configuring the wireless nodes to work as VoIP Clients, right click anywhere in the workspace and select "Choose Individual DES Statistics" and select *"Wireless LAN > Throughput"*, *"Wireless LAN > "Network Delay"* , *"Voice"*, *"DSR"* and *"OLSR Performance"* under *"Global Statistics"*.

Results and Analysis

1: Throughput

The throughput is higher for OLSR as it has pre-calculated the routes from every node to every other node. Once a packet transmission request is generated it simply uses the path from the routing table. DSR , on the other hand has to flood the network with destination node request first and once a path is found it can send the packet. It is seen that OLSR performs better than DSR because it avoids the extra overhead of communicating with each node since only MPR nodes take part in communication.

Fig 5.1: Throughput Comparison of OLSR and DSR for 10 nodes.

Fig 5.2: Throughput Comparison(Time Average) of OLSR and DSR for 10 nodes.

Fig 6.1: WLAN Delay Comparison of OLSR and DSR for 10 nodes.

Fig 6.2: WLAN Delay Comparison(Time Average) of OLSR and DSR for 10 nodes.

2: Network Delay

DSR calculates route "on demand" by a node by flooding the network and thus has a lesser delay than OLSR where all nodes flood the network with HELLO message to create routing table for entire network.

3: MOS value

Fig 7: MOS Comparison OLSR and DSR

MOS stands for Mean opinion score, is a standard numerical value, defined by the International Telecommunication Union (ITU).
It lies between 1 to 5. Higher the value of MOS , better the protocol.

4: Effect of neighbourhood changes on OLSR

As the Neighbourhood changes in OLSR, the routing table needs to be updated which is denoted by the above graph comparison.

Fig 8: OLSR effect of neighbourhood changes on Routing and Topology

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