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Energy Related Issues for MANETs: A Study

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***Abstract*—**Energy efficient Routing is one of the keyissues in MANETs due to their highly dynamic topology and limited battery power at the nodes. In particular identifying energy efficient routing is the most important parameters for mobile ad-hoc networks. Power failure of a mobile node not only affects the node itself but also reduces the overall network lifetime. The goal of this paper is to facilitate research efforts in combining existing solutions in order to offer a more energy efficient routing approach. Towards this goal, we analysed of the three routing protocols AODV, DSR and DSDV for mobile ad-hoc networks scenarios. Our study mainly the energy consumed by each protocol.

***Keywords*—** Routing Protocols, Energy Consumption, Ad-Hoc Network

INTRODUCTION

Ad-hoc networking [13] allows portable mobile devices to establish a communication path without having any central infrastructure. The lack of centralized infrastructure and the mobility of the devices, gives rise to various kinds of problems such as related to routing and security.

A key assumption is that not all nodes can directly communicate with each other. So nodes are required to relay packets on behalf of other nodes in order to deliver data across the network. Especially energy efficient routing is most important because all the nodes are battery powered. Failure of one node may affect the entire network. If a node runs out of energy the probability of network partitioning will be increased. Energy depletion has become one of the main threats to the lifetime of ad hoc network. So routing [1-5] in MANET should be in such a way that it will use the remaining battery power in an efficient way to increase the life time of the network.

Many protocols [12] have been proposed for mobile ad-hoc networks, with the goal of achieving efficient routing. These algorithms differ in the approach used for searching a new route and/or modifying a known route, when hosts move. The ad-hoc routing protocols may be generally categorized as table-driven and source-initiated on-demand driven. The simulation results reported in several papers show that normally on-demand routing protocols have higher packet delivery ratio and need less routing messages than table-driven routing protocols. Our goal is to carry out a systematic study of AODV, DSR, DSDV routing protocols for mobile ad-hoc networks.

The Random Waypoint Model

The Random Waypoint Model [15] was first proposed by Johnson and Maltz. Soon, it became a 'benchmark' mobility model to evaluate MANET routing protocols, because of its simplicity and wide availability. This mobility model can be described as follows: as the simulation starts, each mobile node randomly selects one location in the simulation field as the destination. It then travels towards this destination with constant velocity chosen uniformly and randomly from [0, V], where the parameter V is the maximum allowable velocity for every mobile node. The velocity and direction of a node are chosen independently of other nodes. Upon reaching the destination, the node stops for a duration defined by the ‘pause time’ parameter.

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Dynamic Source Routing Protocol

The key distinguishing feature of DSR [10] is the use of source-routing. That is, the sender knows the complete hop by-hop route to the destination. These routes are stored in a route cache. The data packets carry the source route in the packet header.When a node in the ad hoc network attempts to send a data packet to a destination for which it does not already know the route, it uses a route-discovery process to dynamically determine such a route. Route discovery works by flooding the network with route-request (RREQ) packets. Each node receiving a RREQ re -broadcasts it, unless it is the destination or it has a route to the destination in its route cache. Such a node replies to the RREQ with a route reply (RREP) packet that is routed back to the original source. The RREQ builds up the path traversed across the network. The RREP routes itself back to the source by traversing this path backward. The route carried back by the RREP packet is cached at the source for future use. If any link on a source route is broken, the source node is notified using a route error (RERR) packet. The source removes any route using this link from its cache. A new route discovery process must be initiated by the source if this route is still needed.

An obvious advantage in DSR is that source nodes are aware of existence of alternative paths, which implies that recovery from a link failure will be easy and quick. Another advantage is that there will not be a chance of a routing loop. Furthermore, nodes do not have to maintain routing tables, which is an advantage especially for a large network where nodes continue to move. The disadvantage in DSR is long route acquisition delay due to route discovery if short transmission delay is a significant factor. Long route acquisition delay may not be acceptable in certain situations, such as mobile communication at a battlefield. It is also quite possible that the path between a source and a

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destination may not be the shortest path, resulting in paths with suboptimal end-to-end delay.

Another disadvantage is that messaging overhead of the protocol will be high during busy time, when many connections must be established in a short time since broadcast is used in route discovery. Large packet header will also cause low payload utilization, since each packet has to contain a list of all the intermediate routers to reach a destination.

Ad-Hoc On- Demand Distance Vector Routing Protocol

AODV protocol [9] is a reactive routing protocol that has a motivation of providing a compromise between reactive source routing protocols and proactive protocols. The trade-off problem AODV addresses is the one between high messaging overhead due to periodic announcements of links states in proactive protocols and the large packet header to contain the entire route information to reach a destination in source routing protocols. Unlike pure distance vector protocols, routes are discovered and maintained on demand in AODV. Different from DSR, AODV uses a distributed approach, meaning that source nodes do not maintain a complete sequence of intermediate nodes to reach a destination. Different from Distance Vector and DSDV, each path is established as a pair of two streams of pointers chained between a source and a destination node, which eliminates the need for broadcasting error packets on a link failure.

Similar to DSR, AODV uses the route discovery and route reply mechanism to create and maintain a route on demand. When a source node wants to send information to a destination node, it first looks up its own routing table to see if a valid route exists. If a valid route does not exist, a source node broadcasts a route request message that contains the source address, source sequence number, destination address, destination sequence number, broadcast ID, and hop count. The combination of the source address and the broadcast-ID is used to uniquely identify each route request message while a route request message is globally broadcast. Any node that has a valid route to the destination or the destination node is supposed to respond to route request messages by sending a route reply message.

The route maintenance is performed using three different types of messages: route-error message, “hello” message and route time-out message. The purpose of the time-out message is obvious: if there is no activity on a route for a certain amount of time, the route pointers at the intermediate nodes will time out and the link will be deleted at the intermediate nodes. The periodic “hello” messages between immediate neighbours are required to prevent the forward and backward pointers from expiration. If one of the links in a route fails, a route-error message is generated by the node upstream on the link and the message is propagated to every source node upstream that uses the failed link. Thus, the error packets will not be globally broadcast in AODV. Then, the source nodes in the upstream will initiate the route discovery process.

Primary advantages of AODV protocol are as follows. Route caches are small in AODV, because of its on-demand routing. Routes are guaranteed to be loop-free and valid. Convergence time is short for propagating changes in link states because link failure information will be propagated only to the nodes that are using a failed link. Information of a link failure will be propagated following the back pointers to reach such nodes. This implies that messaging overhead to announce link failures will be less than that of DSR, where link failure information is broadcast. As another advantage, each data packet does not contain the complete list of all the nodes on a route in AODV, which reduces the size of message packet. Similar to DSR, a source node is aware of multiple alternative paths.

One of the disadvantages in AODV protocol is that nodes cannot perform routing (forwarding) packets as aggregate. This is because a set of pointers is used to maintain a route and each "flow" requires its own pair of back and forward pointers. For the nodes where a large number of connections exist, overhead for maintaining pairs of two pointers will be significant and may not be traffic-load scalable. Another disadvantage is longer route acquisition delay compared to that for proactive protocols since route discovery still must take place on demand. Different from DSR, AODV requires periodic “hello” messages to maintain pointers set up at every node on a path. Use of broadcast during route discovery, which contributes to high messaging overhead, is still the major overhead [11].

Destination Sequenced Distance Vector

The DSDV protocol [12] differs from the other protocols in several ways. DSDV requires each node to maintain routing tables. This can lead to substantial memory requirements, especially when the number of nodes in the network is large. Furthermore, the DSDV protocol requires the use of hello packets whenever there are no recent packet transmissions from a given node. The hello packets consume bandwidth and disallow a node to enter sleep mode. However, although it belongs to the class of path-finding algorithms, DSDV has an advantage over other path-finding algorithms because it avoids the problem of creating temporary routing loops that these algorithms have through the verification of predecessor information, as described in an earlier section.

ISSUES IN MANETS

Due to the fact that bandwidth is scarce in MANET nodes and that the population in aMANET is increasing the scalability issue for wireless multi-hop routing protocols is mostly concerned with excessive routing message overhead caused by the increase of network population and mobility. Routing table size is also a concern in MANETs because large routing tables imply large control packet size hence large link overhead. Routing protocols generally use either distance-vector or link-state routing algorithms and only in the last years also geographical routing protocols that make use of node location/position have been investigated [16].

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However, scalability issues in terms of overhead and, consequently number of nodes operating in the network are strongly related also to energy consumption because higher number of control packets overheadimplies more energy consumption spent in transmission, reception and overhearing. This means that trying to design a more scalable protocols can offer more benefits also to the energy saving of mobile nodes in a MANET. When we consider the design of an energy efficient routing protocols not always this means that the routing strategies are also scalable because the protocols can reduce the energy consumption under just some specific operative conditions such as lower mobility, light traffic load or low number of nodes. This means that the design of energy-efficient routing protocols should consider also scalability issue in order to apply it in wider scenarios and to be sure that the protocol performances do not degrade too much when some project parameters are changing. Moreover, another important issue should be considered in the routing strategies applied to MANETs.

It is the QoS in terms of many metrics definition such as minimum bandwidth availability, maximum end-to-end delay, minimum delay jitter, path stability and so on. Often, in literature, these QoS issues are not related to energy consumption but in the protocol design some connection between QoS support and energy consumption exist. In particular, the selection of the lowest energy path among a couple of nodes can lead to the selection of a longer route with higher end-to-end delay [17]. Moreover, the possibility to offer higher bandwidth to a connection and consequently higher data rate imply often to deplete the battery charge of a node more quickly. In this view, also QoS aware routing protocols should take into account also the energy issues related to the rationale of the forwarding scheme, route maintenance and path discovery. In the rest of the chapter, some of the most famous approaches related to the energy aware routing protocols are presented with particular reference to proactive, reactive, hybrid, cluster-based, hierarchical and position based routing protocols.

CONCLUSION

In this paper we study the energy consumption of three prominent on-demand routing protocols in ad hoc networks: DSR, AODV and DSDV. We note that in mobile ad hoc networks, the Dynamic Source Routing Protocol is quite effective as per energy consumption. The second protocol is that the DSDV routing protocol consumes more energy compared to AODV and DSR routing protocols. Another interesting review is that the DSDV protocol consumes highest energy and DSR consumes least energy and AODV follows between these two protocols. As a future work we plan to investigate for this paper and improve the protocols performance in order to reduce the energy consumption.

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