Comparative study of AODV and AOMDV Routing Protocols in Mobile Ad Hoc Networks

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ABSTRACT: A mobile ad hoc network (MANET) is a collection of wireless mobile nodes that dynamically establishes the network in the absence of fixed infrastructure. One of the distinctive features of MANET is each node must be able to act as a router to find out the optimal path to forward a packet. As nodes may be mobile, entering and leaving the network, the topology of the network will change continuously. In this paper we compare AODV and AOMDV routing protocols for MANETs. The AODV is a unipath routing protocol and AOMDV is a multipath version of AODV. The key concept in AOMDV is computing multiple loop-free paths per route discovery. With multiple redundant paths available, the protocol switches routes to a different path when an earlier path fails. Thus a new route discovery is avoided.

Keywords: **AODV, AOMDV, MANET, Routing.**

1. INTRODUCTION

A mobile ad hoc network (MANET) is a collection of wireless mobile nodes that dynamically establishes the network in the absence of fixed infrastructure. One of the distinctive features of MANET is each node must be able to act as a router to find out the optimal path to forward a packet. As nodes may be mobile, entering and leaving the network, the topology of the network will change continuously. MANETs provide an emerging technology for civilian and military applications. One of the important research areas in MANETs is establishing and maintaining the ad hoc network through the use of routing protocols.

Ad hoc routing protocols can be divided into two categories : (1) proactive routing protocols and (2) reactive routing protocols.

Proactive (table-driven) routing protocol is an approach where each router can build its own routing table based on the information that each router or node can learn by exchanging information among the network's routers. This is achieved by exchanging update messages between routers on a regular basis to keep the routing table at each router up-to-date. Then, each router consults its own routing table to route a packet from its source to its destination. When a source node or an intermediate node consults the routing table, the path information, which is up-to-date, is immediately available and can be used by the node. This is because each router or node in the network periodically updates routes to all reachable nodes via broadcasting messages that the node received from the other nodes in the network.In a Proactive routing protocol, although getting the path information is fast, the maintenance of the up-to-date network information requires high overhead traffic and needs some significant amount of bandwidth. In addition, the process of maintaining the routes to the reachable nodes is continuous even if there is no data traffic flowing on these routes.

Reactive (on-demand) routing protocol is an approach where the routing process needs to discover a route whenever a packet arrives from a source and needs to be delivered to a destination. Here, each node has no pre-built routing table or global information to be consulted. Due to the node's mobility in a wireless network, maintaining the existing route is an important process. In a Reactive routing protocol, the route discovery process happens more often, but this process requires low control overhead traffic compared to the Proactive routing protocol. Therefore, the Reactive is considered to be more scalable than the Proactive routing protocol.

2. WORKING & COMPARISION OF AODV & AOMDV PROTOCOL

On demand routing protocols work on the principle of creating routes when required between a source and destination node pair in a network topology. Our discussion is limited to two on-demand ad-hoc routing protocols, AODV and AOMDV, as follows.

Ad hoc On-demand Distance Vector Routing (AODV)

AODV combines the use of destination sequence numbers as in DSDV with the on-demand route discovery technique in DSR to formulate a loop-free, on-demand, single path, distance vector protocol. In contrast to DSR, AODV uses hop-by-hop routing instead of source routing. Below we review some of the key features of AODV to provide sufficient background for AOMDV described in the next section.

Route Discovery

When a traffic source needs a route to a destination, it initiates a route discovery process. Route discovery typically involves a network-wide flood of a route request (RREQ) for the destination and waiting for a route reply (RREP). Duplicate copies of a RREQ at every intermediate node are discarded. Source attaches a strictly increasing broadcast id with each RREQ it generates. Source id along with the broadcast id of the RREQ is used to detect duplicates. An intermediate node receiving a non-duplicate RREQ first sets up a reverse path to the source using the previous hop of the RREQ as the next hop on the reverse path. If a valid route is available, then the intermediate node generates a RREP, else the RREQ is rebroadcast. When the destination receives a non-duplicate RREQ for itself, it generates a RREP. The RREP is routed back to the source via the reverse path. As the RREP proceeds towards the source, a forward path to the destination is established.

Note that the route discovery procedure just described requires that a bidirectional path exists between the source and the destination. Latest AODV specification describes a technique to find at least one such bidirectional path in the presence of unidirectional links. In the rest of our discussions, we will assume that there are no unidirectional links and that bidirectional paths exist between every pair of nodes. Also, several optimizations have been proposed in the literature to contain the scope of the flood and to reduce the redundancy of the broadcasts during the flood. However, these are somewhat orthogonal to our interest, and we will limit our discussion to pure flooding in this paper.

Sequence Numbers and Loop Freedom

Sequence numbers in AODV play a key role in ensuring loop freedom. Every node maintains a monotonically increasing sequence number for itself. It also maintains the highest known sequence numbers for each destination in the routing table (called "destination sequence numbers"). Destination sequence numbers are tagged on all routing messages, thus providing a mechanism to determine the relative freshness of two pieces of routing information generated by two different nodes for the same destination. The AODV protocol maintains an invariant that destination sequence numbers monotonically increase along a valid route, thus preventing routing loops. This is explained below further as it will play a crucial role in the understanding of the multipath protocol. In AODV, a node can receive a routing update via a RREQ or RREP packet either forming or updating a reverse or forward path.

AODV uses a timer-based technique to remove stale routes promptly. Each routing entry is associated with a soft state timer called route expiration timeout. This timer is refreshed whenever a route is used.

Periodically, newly expired routes are invalidated. Route maintenance is done using route error (RERR) packets. When a link failure is detected (by a link layer feedback, for example), routes to destinations that become unreachable are invalidated. A RERR is broadcast that includes the list of unreachable destinations and their sequence numbers. The RERR propagation mechanism ensures that all sources using the failed link receive the RERR. RERR is also generated when a node is unable to forward a data packet for lack of a route. A node upon receiving a RERR from a downstream neighbor for some destination invalidates the corresponding route and updates the sequence number from the RERR. RERR is rebroadcasts if at least one destination becomes unreachable.

Ad hoc On-demand Multipath Distance Vector Routing (AOMDV)

The key concept in AOMDV is computing multiple loop-free paths per route discovery. With multiple redundant paths available, the protocol switches routes to a different path when an earlier path fails. Thus a new route discovery is avoided. Route discovery is initiated only when all paths to a specific destination fail. For efficiency, only link disjoint paths are computed so that the paths fail independently of each other.

Note that link disjoint paths are sufficient for our purpose, as we use multipath routing for reducing routing overheads rather than for load balancing. For the latter, node disjoint paths are more useful, as switching to an alternate route is guaranteed to avoid any congested node. Link disjoint paths, on the other hand, may have common nodes. Since node disjointness is stricter than link disjointness, we use link disjointness in the hope to find more alternate routes in the network.

AOMDV Route Discovery

Several changes are necessary in the basic AODV route discovery mechanism to enable computation of multiple link disjoint routes between source destination pairs. Note that any intermediate node I on the route between a source S and a destination D can also form such multiple routes to D, thus making available a large number of routes between S and D.

Recall that in the route discovery procedure a reverse path is set up backwards to the source via the same path the route request (RREQ) has traversed. If duplicates of the RREQ coming via different paths are ignored as before, only one reverse path can be formed. To form multiple routes, all duplicates of the RREQ arriving at a node are examined (but not propagated), as each duplicate defines an alternate route.

Where their trajectories to meet again at a node, the copy arriving later in that node will not be propagated further. Thus, all trajectories of a RREQ between any pair of nodes with unique first hops are guaranteed to be disjoint. To determine this, however, the first hop information needs to be included in the RREQ packet as an additional field. Each node remembers the first hop of each RREQ (in a first hop list) it has seen with the same source id and broadcast id. A reverse path is always formed when the first hop is unique. However, as in regular AODV, only the first copy of the RREQ is forwarded. Thus there is no additional routing overhead. All these reverse paths can be used to propagate multiple RREPs towards the source so that multiple forward paths can be formed. Note that all such paths are node disjoint.

In the hope of getting link disjoint paths (which would be more numerous than node disjoint paths) the destination node adopts a "looser" reply policy. It replies up to k copies of RREQ arriving via unique neighbors, disregarding the first hops of these RREQs. Unique neighbors guarantee link disjointness in the first hop of the RREP. Beyond the first hop, the RREP follows the reverse route that have been set up already which are node disjoint (and hence link disjoint). Each RREP arriving at an intermediate node takes a different reverse route when multiple routes are already available. Note that because of the "looser" reply policy it is possible for the trajectories of RREPs to cross at an intermediate node.

Sequence Numbers and Loop Freedom Revisited

If only the destination replies to a RREQ as in the preceding treatment, loops are not possible. This is because RREQs cannot loop as only the first arriving copy is propagated further. This prevents any loop in the reverse or forward paths either. But are we still free from loops when intermediate nodes choose to reply to a RREP? Recall that AODV uses a sequence number-based invariant to guarantee loop freedom. A similar invariant is maintained in the multipath technique is as well. However, its design is trickier and needs a somewhat elaborate description.

Unlike the single path case, different routes for the same destination will now have different hop counts. Nodes must be consistent regarding which of these multiple routes it advertises to others. The basic structure of a routing table entry in the AOMDV in comparison with AODV is shown in Figure 1. There are two main differences: (i) the hopcount is replaced by advertised hopcount in the AOMDV and (ii) the nexthop is replaced by the route list. . The route list is simply the list of nexthops and hopcounts corresponding to different paths to the destination. The advertised hopcount represents the maximum of the hopcounts of each of those multiple paths so long as a strict route update rule is followed.
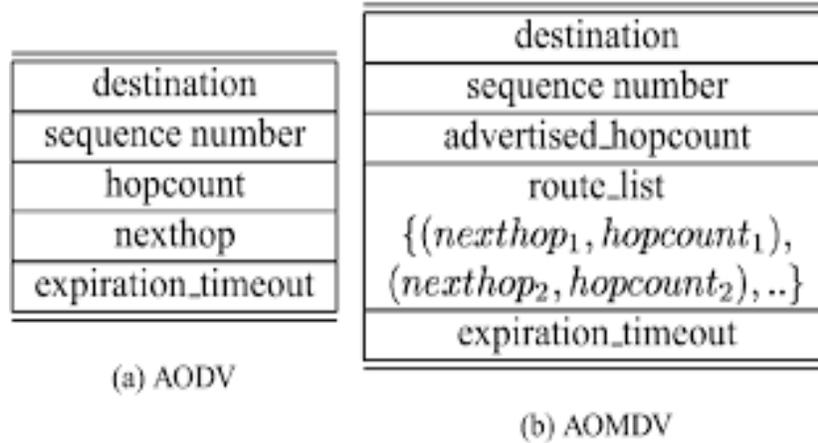
Figure 1: AODV & AOMDV RREQ Packet Formate

3. CONCLUSION

The AODV is a unipath routing protocol and AOMDV is a multipath version of AODV. The key concept in AOMDV is computing multiple loop-free paths per route discovery. With multiple redundant paths available, the protocol switches routes to a different path when an earlier path fails. Thus a new route discovery is avoided

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