Improving Geographical AODV Protocol by Dynamically Adjusting the Request Zone

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***Abstract*— Geographical AODV Rotate is a variation of a regular Geographical AODV (GeoAODV) scheme that aims to reduce the control message overhead introduced by ad-hoc on-demand distance vector (AODV) routing protocol. GeoAODV reduces the route discovery overhead by searching only a portion of the network that is likely to contain the desired node. The search area is computed based on the nodes' location coordinates obtained via the Global Positioning System (GPS). GeoAODV Rotate improves the performance of regular GeoAODV by dynamically adjusting the search area during the route discovery process.**

Keywords - Ad-hoc ondemand distance vector routing; Geographical AODV; Mobile Ad-hoc networks;

I. Introduction

Ad-hoc on-demand distance vector (AODV) routing protocol is a reactive routing protocol for mobile ad-hoc networks (MANETS) [1-3]. When an upper layer protocol needs to transmit data, AODV finds a route to the destination if such route exists. The AODV route discovery process starts at the source node which broadcasts a route request (RREQ) packet to its immediate neighbors, i.e., the nodes located one hop away from the source. The neighboring nodes retransmit RREQ packet and the process continues until the destination or a node that has a path to the destination is reached. At this point, a route reply packet (RREP) is generated and unicast back to the source node. Arrival of the RREP at the source completes route discovery phase of AODV protocol, at which point the data can be transmitted to destination.

Geographical AODV (GeoAODV) [4, 5] improves the route discovery phase of AODV by only searching the area that is likely to contain the path to destination. Such a search area, called request zone, is computed based on the source and destination nodes' Global Position System (GPS) coordinates. Only the nodes within the request zone re-broadcast the RREQ packets. The nodes outside the request zone simply discard the RREQ packets. Such an approach significantly reduces the control packet overhead associated with the route discovery phase of AODV protocol.

The idea of GeoAODV is inspired by Location Aided Routing Protocol (LAR) [6, 7]. However, unlike LAR, GeoAODV does not assume that the nodes know the location and the traveling velocity of all the other nodes in the network. GeoAODV assumes that the nodes only know their own location precisely, while the GPS coordinates of the other nodes in the network are dynamically distributed during the route discovery phase. If the source node does not know the location of the destination node then GeoAODV's route discovery is performed the same way as in AODV. However, when the destination's coordinates are known then, the route discovery is limited to the cone shaped request zone shown in Figure 1.

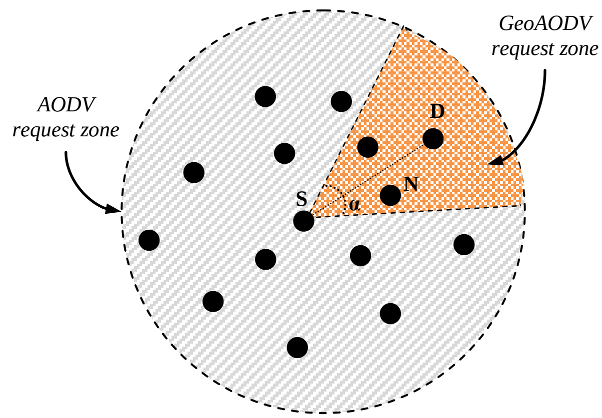

Figure 1. Example of Geographical AODV

GeoAODV Rotate is a variation on GeoAODV that dynamically adjusts the search area during the route discovery process, which effectively eliminates from the search area the nodes that are less likely to be part of the path to the destination.

This paper introduces the GeoAODV Rotate protocol and examines its performance through simulation in comparison to AODV and GeoAODV. The network simulation software package OPNET Modeler version 16.0 [8] was used to conduct an experimental study.

II. Overview of GeoAODV and GeoAODV Rotate

A. *Geographical AODV*

GeoAODV defines its request zone as a cone-shaped area of the network controlled via a flooding angle: a wider flooding angle corresponds to a larger request zone area. Whenever the value of the flooding angle is equal to 360 degrees the request zone area is equivalent to the whole network and GeoAODV operates identically to AODV.

The cone-shaped request zone is defined as an area where the source node is the apex of the cone, while the flooding angle is evenly divided by a line that connects the source and destination nodes. As shown in Figure 1, α is the flooding angle that defines the request zone for the route discovery process initiated from node ***S***.

GeoAODV determines if an intermediate node, let us call it ***N***, belongs to the request zone using the algorithm described below. Each RREQ packet carries the last known GPS coordinates of the source and destination nodes, which we will call ***S*** and ***D***, respectively. When an RREQ arrives at ***N***, it computes an angle θ formed between nodes ***D***, ***S***, and ***N***.

$$\theta = \cos^{-1} ((SD \bullet SN) / (|SD|\times|SN|)) \quad (1)$$

If θ is less than half of α, then node ***N*** is located within the request zone and should rebroadcast the route request. Otherwise, ***N*** discards RREQ.

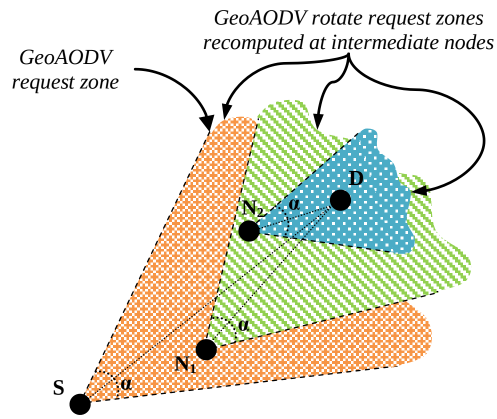

Figure 2. Example of Geographical AODV Rotate

B. Gegraphical AODV Rotate

GeoAODV Rotate operates similarly to GeoAODV, except that it computes the request zone based on the location of the previous hop, instead of the source node. This modification re-orients the cone-shape search area towards the destination node, excluding nodes that are less likely to be part of the path towards the destination. Figure 2 illustrates such a situation: node N_1 computes the request zone based on the location information of ***S*** and ***D***, while node N_2, uses coordinates of nodes N_1 and ***D*** to determine if it belongs to a new, dynamically adjusted request zone.

III. Simulation Study

We compared the performance of AODV, GeoAODV, and GeoAODV Rotate protocols using OPNET Modeler version 16.0 [8]. The network topology used in the simulation consisted of 50 nodes randomly placed within a 1500 meters x 1500 meters area. Each node was moving in the network with the random velocity. The node speed was computed using uniform distribution with the outcome in the range [0, 20] meters/second. We examined scenarios with the following number of communicating nodes: 2, 5, 10, 20, and 30. Each node started data transmission at time 100 seconds. Wireless LAN configuration parameters of each node were set to the default OPNET Modeler configuration values. The duration of each experiment was 300 seconds. We executed each scenario five times and averaged the results.

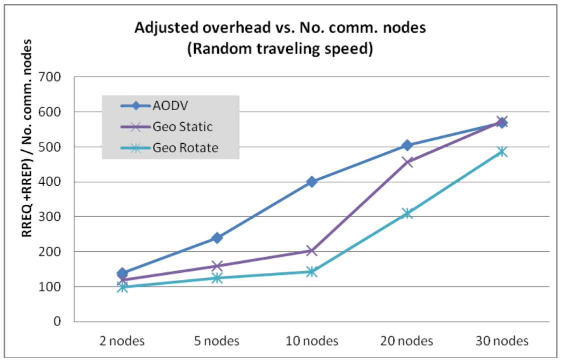

Figure 3. Summary of Simulation Results

Figure 3 shows a summary of the simulation results. This graph represents normalized control message overhead computed as the total number of generated RREQ and RREP packets divided by the number of communicating nodes. As expected, GeoAODV Rotate outperforms both GeoAODV and AODV protocols.

IV. Conclusions

This paper introduced a GeoAODV protocol modification called GeoAODV Rotate and examines its performance. The results of preliminary simulation study indicate that GeoAODV Rotate outperforms both GeoAODV and AODV. We plan to continue our study of GeoAODV Rotate protocol. We would like to examine the protocol under different sets of conditions and compare its performance with that of other location-aided routing protocols such as LAR.

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