Enhanced Position Updation In Manet Using Self Adaption

Reshma P.R , S.Bharathi

Abstract - Geographic routing has been widely hailed as the most promising approach to generally scalable wireless routing. It has been a big challenge to develop a routing protocol that can meet different application needs and optimize routing paths according to the topology changes in mobile ad hoc networks. However, there is a lack of holistic design for geographic routing to be more efficient and robust in a dynamic environment. Inaccurate local and destination position information can lead to inefficient geographic forwarding and even routing failure. The use of proactive fixed-interval beaconing to distribute local positions introduces high overhead when there is no traffic and cannot capture the topology changes under high mobility. In this work, two self-adaptive on-demand geographic routing schemes are proposed which build efficient paths based on the need of user applications and adapt to various scenarios to provide efficient and reliable routing. On-demand routing mechanism in both protocols reduces control overhead compared to the proactive schemes which are normally adopted in current geographic routing protocols. The route optimization scheme adapts the routing path according to both topology changes and actual data traffic requirements. The simulation studies demonstrate that the proposed routing protocols are more robust and outperform the existing geographic routing protocol and conventional on-demand routing protocols under various conditions including different mobilities, node densities and traffic loads. Specifically, the proposed protocols could reduce the packet delivery latency up to 80 percent as compared to GPSR at high mobility. Both routing protocols could achieve about 98 percent delivery ratios, avoid incurring unnecessary control overhead, have very low forwarding overhead and transmission delay in all test scenarios.

Index Terms - Back Off Period, Beacons,Control Overhead, Geographic Routing, Local Topology, On-Demand Routing, Optimization, Recovery Schemes, Route Adaptation, Self-Adaptive Schemes

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1. INTRODUCTION

In a mobile ad hoc network (MANET), wireless devices could self configure and form a network with an arbitrary topology. The network's topology may change rapidly and unpredictably. Such a network may operate in a stand-alone fashion, or may be connected to the larger Internet. The topology of a Mobile Ad Hoc Network is very dynamic, which makes the design of routing protocols much more challenging than that for a wired network. The conventional MANET routing protocols can be categorized as proactive [19], [11], reactive [12], [13], [14], and hybrid [8], [9], [10]. The proactive protocol maintain the routing information actively, while the reactive ones only create and maintain the routes on demand. The hybrid protocols combine the reactive and proactive approaches. The proactive protocols incur high control overhead when there is no traffic, while for on-demand protocols, the network-range or restricted-range flooding for route discovery and maintenance limits their scalability, and the need of search for an end-to-end path prior to the packet transmission also incurs a large transmission delay.

In recent years, geographic unicast [19], [20], [15], [5] and multicast [12], [13], [14] routing have drawn a lot of attentions. They assume mobile nodes are aware of their own positions through GPS or other localization schemes [12], [13] and a source can obtain the destination's position through some kind of location service [17], [4]. In geographic unicast protocols, an intermediate node makes packet forwarding decisions based on its knowledge of the neighbors' positions and the destination's position inserted in the packet header by the source. By default, the packets are transmitted greedily to the neighbor that allows the packet forwarding to make the greatest geographic progress toward the destination. When no such a neighbor exists, perimeter forwarding [19], [20] is used to recover from the local void. In this paper two self-adaptive on-demand geographic routing protocols are introduced which can provide transmission paths based on the need of applications. The two protocols share the following features. First, to reduce control overhead, the routing path is built and the position information is distributed on the traffic demand. Second, through a more flexible position distribution mechanism, the forwarding nodes are notified of the topology change in a timely manner and thus more efficient routing is achieved. Third, optimization schemes are designed to make routing paths adaptive to the change of topology and traffic, and robust to the position inaccuracy. Fourth, the routing schemes in the two naturally handle the destination position inaccuracy. Lastly, each node can set and adapt the protocol parameters independently based on the environment change and its own condition. The two protocols adopt different schemes

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- *Reshma P.R is currently pursuing masters degree program in Communication Systems in M.Kumarasamy College Of Engineering, India, E-mail: reshmapr4@gmail.com*
- *S.Bharathi is currently working as lecturer in electronics and communication engineering in M.Kumarasamy College Of Engineering, E-mail: sbharathiece@gmail.com*

to obtain topology information. One protocol purely relies on one- hop topology information as other geographic routing schemes, and the other one assumes a hybrid scheme which combines geographic and topology-based mechanisms for more efficient routing. The use of hybrid scheme avoids the performance degradation of conventional geographic routing by not constraining to local view of topology, and takes advantage of geographic information to find each next-hop thus significantly reducing the overhead and delay incurred by network in range search of end-to-end path conventional topology-based on-demand routing.

To summarize ,the contributions in this work include:
- Analyzing the effect of outdated topology information on the performance of geographic routing;
- Proposing two novel geographic routing protocols with different schemes to obtain and maintain topology information based on the need of traffic transmissions;
- Introducing route optimization schemes, and to our best knowledge, this is the first geographic routing scheme that adapts the path to the underlying topology change and traffic demand;
- Designing an efficient position distribution mechanism that can adapt its behavior under different dynamics and routing requirements to provide more accurate and updated geographic topology information for efficient routing while reducing unnecessary control overhead;
- Adapting parameter settings in both protocols according to different criteria, such as network environment, traffic demand, and node's own condition;
- Handling the inaccuracy of destination position and efficiently avoiding delivery failure.
- Analysing the performance of Qos parameters with moving speed and node density

2. SELF-ADAPTIVE ON-DEMAND GEOGRAPHIC ROUTING PROTOCOLS

In this section, we present two Self-adaptive On-demand Geographic Routing (SOGR) schemes. In both schemes, we assume every mobile node is aware of its own position (e.g., through GPS or some in-door localization technique), and a source can obtain the destination's position through some kind of location service. We also make use of the broadcast feature of wireless network to improve routing performance and assume mobile nodes enable the promiscuous mode on their network interfaces. For the convenience of presentation, in the remainder of the paper, except when explicitly indicated, F represents the current forwarding node, D is the destination, N denotes one of F's neighbors, posA is the position coordinates of A, and dis(A;B) is the geographical distance between node A and B.

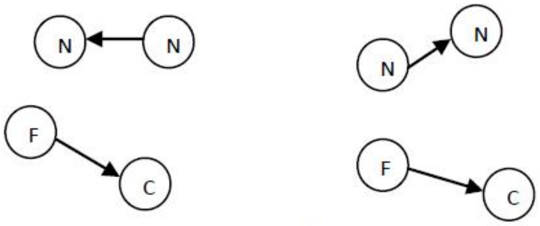
3. SCHEME 1: SOGR WITH HYBRID REACTIVE MECHANISM (SOGR-HR)

Without proactive beaconing to distribute local topology, a scheme needs to be designed for a forwarding node to find the path to the destination. In SOGR-HR, the next-hop of a forwarding node is determined reactively with the combination of geographic-based and topology-based mechanisms. By incorporating topology-based path searching, an important benefit of the proposed scheme is to obtain the topology information at a larger range when necessary to build more efficient routing path, while general geographic routing protocols are usually constrained by their local topology view. Furthermore, the planar-graph-based geographic routing strategy becomes unpractical under the real physical channel conditions . The use of topology-based routing recovery scheme in SOGR helps overcome such shortcomings of geographic routing.

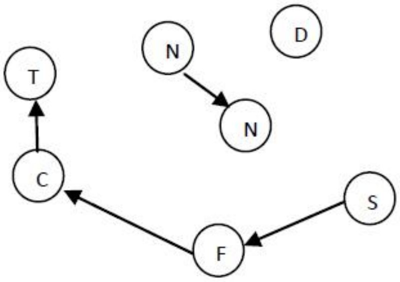
3.1 Geography-Based Greedy Forwarding

Normally a forwarding node F will attempt to forward a packet greedily to a neighbor closest to the destination D and closer to D than itself. When there is no next-hop information cached, F buffers the packet first and broadcasts a request message REQ(D; posD; posF; h) with the hop number h = 1 to restrict the searching range to its one-hop neighbors. If a neighbor node N closer to D than F sends shortcomings of geographic routing. back a REPLY, F will record N as the next-hop to D with the transmission mode set as greedy and unicast the data packet to N. If another REPLY from a node N' arrives later, F updates its next-hop to N' if N' is closer to D than N, and ignore the reply otherwise. REQ has a small size and a higher probability of being transmitted successfully. To avoid transmission failure of data packets on bad channel, a node will reply only if the received signal to noise plus interference ratio of it received REQ is above a conservative threshold set higher than the target decoding need. Further, to avoid collisions, a neighbor N waits for a back off period before sending back the REPLY and the pending REPLY will be canceled if it overhears either a REPLY from another neighbor closer to D than itself or the packet sending by F with the next-hop closer to D than N, indicating that F has already received a REPLY without being overheard by N. To make sure the neighbor closer to D responds sooner and suppresses others' REPLYs, the back off period TNbf should be proportional to dis(N;D) and bounded by the WWmax value h x Ibf , where Ibf is a protocol parameter, and the hops h is set to 1 in greedy forwarding. The back off period for a node N is calculated as

$$\mathrm{TbfN} = \propto \times\, h \times \mathrm{Ibf} \times \left(\frac{\mathrm{dis}(F, D) - \mathrm{dis}(N, D)}{h \times R} \right)$$



Greedy mode



Recovery mode

Where R is the reference transmission range of mobile nodes. If multiple neighbors have very similar distances to D, their reply messages may collide. To address this issue, we introduce a parameter α which is set to 1 when F sends out the first search message to ensure that the nodes closer to D reply earlier, and set to a random number between 0 and 1 during recovery forwarding (presented next) to avoid reply collisions from neighbors that are of equal distance to D. After F broadcasts the first REQ message, if multiple neighbors have similar closest distance to D and collide in their replying while F gets a reply from a node that has a larger distance to the destination, the protocol will still function properly although the next-hop found is not the one closest to the destination. A node closer to D than the current next hop can send a CORRECT message later to F through the optimization process If all the reply messages are lost, a neighboring node is given a further opportunity of sending back its REPLY during the recovery forwarding.
If F does not receive any reply within 1:5 x h x Ibf , F will initiate a recovery process. There may be two reasons for F to fail in getting any reply message:

1) The reply messages from all its neighbors are lost;
2) F may not have neighbors closer to D, resulting in a local "void."

Without knowing the local topology, the recovery schemes [20], [19], [10], [11] based on planar structure cannot be used to address the local void problem. Also, the planar-graph-based geographic routing strategy becomes unpractical under the real physical channel conditions. Instead, SOGR-HR uses a recovery strategy with expanded ring search (which is normally used in path finding in topology based routing protocols [13], [12]) to address both issues, and build a more efficient path to recover from the local void by taking advantage of larger range topology information.

In a recovery process, F increases its searching range to two hops. Since the absence of a REPLY on the first try may be caused by the loss of REQ or REPLY message due to collisions, whenever a REQ reaches a one-hop neighbor that is closer to D than F, the neighbor sends back a REPLY after a back off period according to (4) with $h = 1$. Otherwise, the one-hop neighbor of F continues broadcasting the REQ to its own one-hop neighbors. When a second-hop neighbor of F gets this REQ and is closer to D, it sends a REPLY following the reverse path of the REQ message, with the back off period calculated from (4) at $h = 2$. Different from that in greedy forwarding, the α here is set to a random number between 0 and 1 for both one-hop neighbors and two-hop neighbors to avoid potential reply collisions from neighbors that have similar distance to the destination. When a REPLY is sent by a two-hop neighbor, the intermediate nodes record the previous hop of the REPLY as the next-hop toward D with the transmission mode set as recovery. On the other hand, when the REPLY is originated from a one-hop neighbor of F, F set the transmission mode to be greedy. To avoid overhead, an intermediate node drops a REPLY if it already forwarded or overheard a REPLY from a node closer to D than the current replier. F then unicast the data packet to the detected next hop with the corresponding transmission mode. If the route searching fails with $h = 2$, F may expand the searching range again by increasing the value of h until it reaches Maxhops. Instead of searching for an end-to-end path as in the conventional topology-based routing, the position information is used to guide the searching and selection of relay node(s) toward the destination. As the recovery forwarding is only triggered when needed and the relay nodes can generally be found within a small range (i.e., two hops from our performance studies), the path searching overhead and delay are much smaller than that in conventional topology-based routing.

TABLE 2
Values Used in SOGR-HR and
SOGR-GR's Adaptive Parameter Settings

	values	**protocol**
Ref_{bf}	10ms	SOGR-HR
Δ_{bf}	2ms	SOGR-HR
Dis_t	300m	SOGR-HR
$[I_{t,min}, I_{t,max}]$	[10s,30s]	SOGR-HR
Dis_{bc}	150m	SOGR-GR
$[I_{bc,min}, I_{bc,max}]$	[5s,15s]	SOGR-GR

4. SCHEME 2: SOGR WITH GEOGRAPHIC-BASED

REACTIVE MECHANISM (SOGR-GR)

SOGR-GR depends only on one-hop neighbors' positions to make greedy and perimeter forwarding like other geographic routing protocols [20]. However, it adopts a reactive beaconing mechanism which is adaptive to the traffic need. The periodic beaconing is triggered only when a node overhears data traffic from its neighbors the first time. The beaconing is stopped if no traffic is heard for a predefined period. A forwarding node may broadcast a request (REQ) message to trigger its neighbors' beaconing when necessary, and the neighbors will have random back off before broadcasting a beacon to avoid collision. With the neighbor topology information, SOGR-GR takes the same local void recovery method as existing geometric routing protocols to avoid the need of extra searching as in SOGRHR. In addition, similar to SOGR-HR, the important protocol parameters of SOGR-GR are also set adaptively for optimal performance. To make the beacon sending on demand, every node keeps three time values treq, treqHeard, and tbc, in which treq records the time when the latest REQ or data packet was sent out, treqHeard is the time when the latest REQ or data transmission was heard, and tbc saves the last beaconing time.

4.1 Route Adaptation and Optimization with Both Schemes

With the movement of nodes, the cached topology information gets outdated and the routing path may become inefficient. Our route optimization schemes adapt the path according to topology change and traffic conditions. Specifically, motivated by the analysis , the validity of the cached topology information is evaluated before packet forwarding to avoid forwarding failure due to outdated neighbor information, and the routing path is optimized with the cooperation of the forwarding node and its neighbors to avoid non optimal routing due to the inaccuracy in topology knowledge. The optimization mechanisms are applicable to both protocols.

5. OPTIMIZATION FOR THE FORWARDING PATH

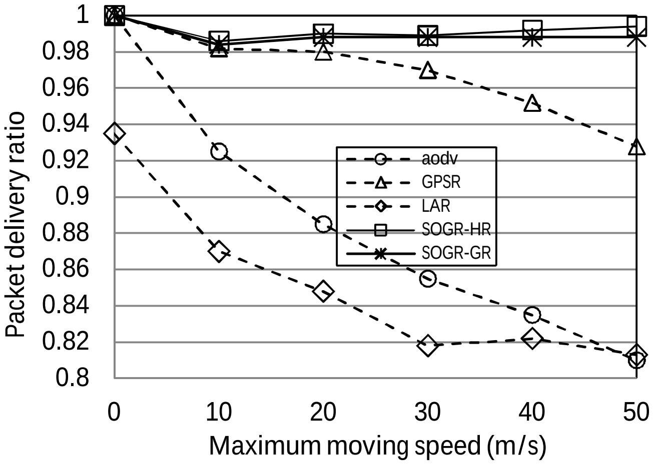
Both these algorithms forms a step by step procedure so that loop free networks can be obtained. In SOGR-HR, due to the local topology change, the cached next hop C may no longer be the best one toward D. To achieve more optimal routing, F's neighbors monitor whether F makes correct forwarding decisions and help to improve transmission path opportunistically. After F forwards a packet to C which continues the forwarding toward D, a neighbor N overhears both transmissions and gets posF , posC, and posD. A packet forwarded using the recovery mode will also carry the position of the node (say node S) where the recovery forwarding is originated, posS. If N determines that it is a more optimal next hop than C, it sends to F a message CORRECT(posN;D) asking it to change its next hop to N. We consider three route optimization cases, using examples in Fig. With mode(A;B;D) representing the forwarding mode from A to B toward a destination D, the criterion for N to send a CORRECT message in each case is as follows:

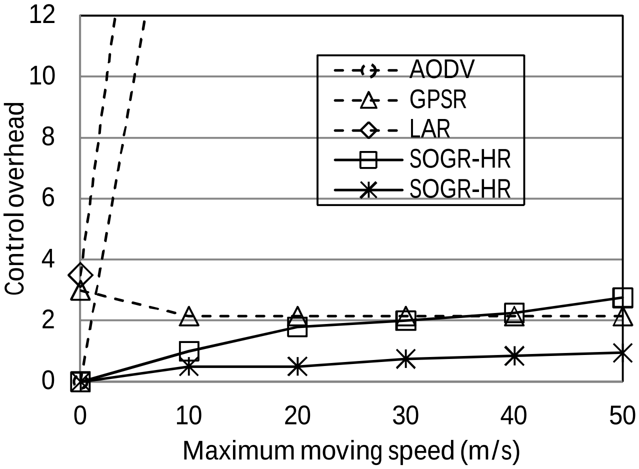
Case 1: N is the destination of the packet. When N moves into F's transmission range, F should forward the packet directly to N.
Case 2: mode(F;C;D) = greedy. When another node N is currently closer to D than C is, i.e., dis(N;D) < dis(C;D), node N will inform F which will set its new next hop to N.
Case 3: mode(F;C;D) = recovery. There are two cases: a) F is the last hop of the recovery mode, so dis(C;D) < dis(S;D). If dis(N;D) < dis(C;D), F should forward its future packets to N for a more optimal route. b) F is not the last hop of the recovery forwarding, so dis(S;D)xdis(C;D). If dis(N;D) < dis(S;D), it means F should forward the packet to N and N can resume the greedy forwarding. Overall, if dis(N;D) < dis(S;D) and dis(N;D) < dis(C;D), N needs to send a CORRECT to F.

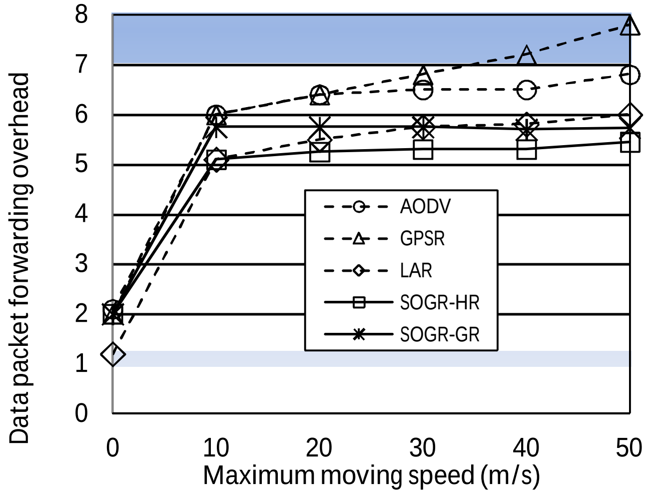
Through this process, more optimal routing can be achieved. In cases 2 and 3, to avoid that multiple neighbors detect nonoptimal forwarding simultaneously and send CORRECT messages to F at the same time, the CORRECT message will also be sent with back off and suppressed as that done for REPLY message with h = 1. Without a recovery forwarding phase as for next-hop finding, the parameter α is set as a random number between 0 and 1 to further reduce message collision from nodes with similar distance to D. There is also another possibility for the recovery forwarding. Suppose recovery forwarding starts at F, F sets its next hop to C in order to reach node T which is closer to D than F. Since F is not aware of the positions of non neighboring nodes on the recovery path to T, a node on the recovery path should notify F with an ERROR message whenever it detects that its next hop is unreachable. T should also notify F if it is no longer closer to D than F is, and F will start a new route searching process. SOGR-GR assumes similar route optimization schemes.

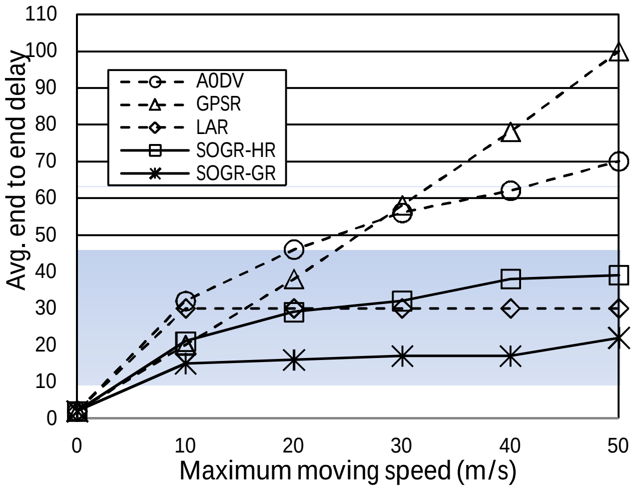
6. SIMULATION OVERVIEW

We implemented SOGR-HR and SOGR-GR with ns2. As our protocols are on-demand and geography-based, for performance evaluations, we compare our protocols with the classic topology-based on-demand routing protocol AODV [12], LAR [15], an on-demand routing protocol utilizing position information to restrict the flooding range of route searching, and the geographic routing protocol

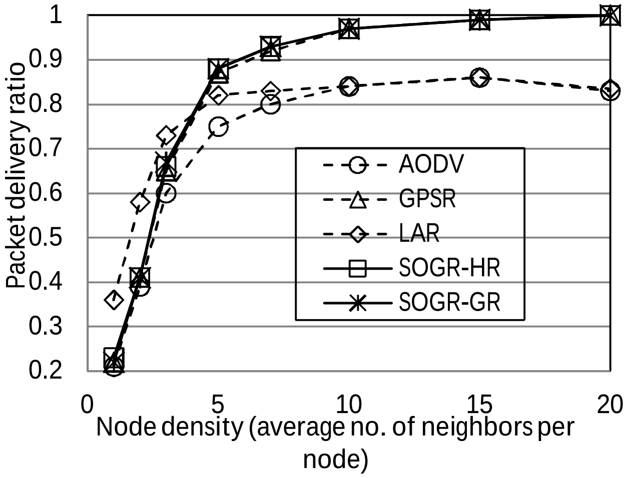


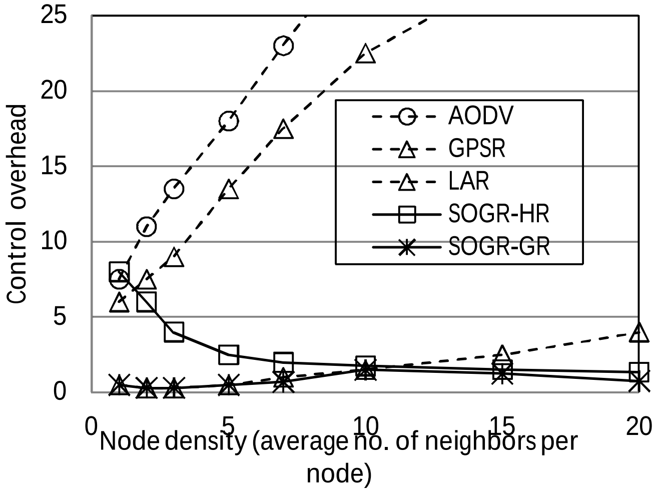


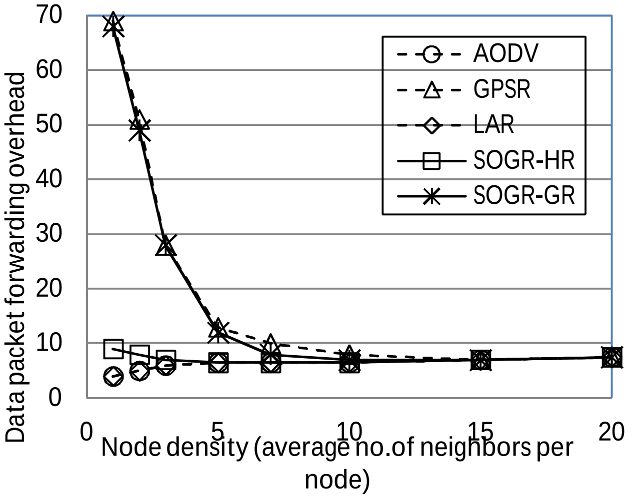


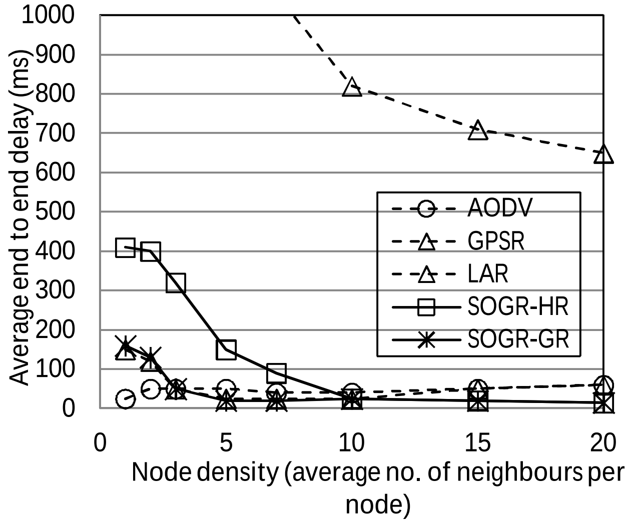


GPSR [20]. Besides demonstrating the efficiency and robustness of our protocols in dynamic scenarios, we further confirm the benefit of using geographic routing. We run simulations using the AODV and LAR1 codes carried with the simulator We set GPSR's beacon interval as 1.5 s with neighbor table time-out interval set as 4:5 x 1:5 s = 6:75 s according to [20]. Table 2 lists the initial values or constraints we used in SOGR-HR and SOGR-GR for parameter setting. As all the parameters are adaptive and adjusted at each forwarding, the initial values are not critical. The parameter Ijitter in SOGR-GR is set to 10ms. The reference distance threshold Disbc for a beacon update in SOGR-GR is set to be smaller than the transmission range. The time-out reference distance Dist for SOGR-HR is set to be double Disbc so that the time-out periods for SOGR-HR and SOGR-GR are comparable. The initial back off interval Refbf and the minimum and maximum back off potential collision. We restrict the searching range of SOGR-HR to two hops by setting Maxhops as two because in most cases nodes closer to the destination can be found within this range and a larger searching range will result in a bigger control overhead. The simulations were run with 300 nodes randomly distributed in an area of 3000 m x 1500 m. We chose a rectangular network area to obtain a longer path. The moving pause time was set as 0 second, the minimum speed was 0 m/s, and the default maximum speed was 20 m/s except in the performance evaluation of the impact of mobility. We set the MAC protocol and radio parameters as [9] according to the Lucent Wave LAN card, which operates follows the Rayleigh model, and a packet is considered to be a threshold. IEEE 802.11b was used as the MAC layer protocol to coordinate medium access and resolve collisions. Each simulation lasted 900 simulation seconds. A traffic flow was sent at 8 Kbps using CBR between a randomly chosen source and destination pair with packet length 512 bytes. By default, 30 CBR flows are used in the simulations, except when evaluating the impact of traffic load. Each CBR flow starts at a random time between 10 and 15 s so that the reference proactive protocol GPSR has enough time to accumulate topology information, and ends at 890 s to allow the emitted packets to reach destinations. A simulation result was gained by averaging over 20 runs with different seeds to increase the confidence of the results. The receiver power is set to 0.01 and transmitter power is set to 0.02. The initial energy is set to 100.









7. SIMULATION RESULTS

7.1 EFFECT OF MOVING SPEED

We study the impact of mobility on the performance of various protocols by moving speed from 0 to 50 m/s. The two SOGR protocols are robust to the quick topology change under high mobility, and can distribute the position information more timely and adaptively in response to different mobility levels. With more updated position information, better path finding strategy and various optimization schemes, both SOGR-HR and SOGR-GR have much fewer redundant transmissions and lower end-to-end delay as compared to GPSR. The delivery ratio of GPSR reduces quickly at high mobility due to the lack of updated positions of neighbors and its inefficient routing. As expected, the two conventional on-demand protocols could not react fast to the topology change, and incur higher control overhead and end-to-end delay.

7.2 EFFECT OF NODE DENSITY

In Fig. all the routing protocols have higher delivery ratios under a higher density, and the three geographic routing protocols perform better at a higher node density. The topology-based routing protocols generally have a lower delivery ratio as a result of larger number of control messages and hence collisions as observed in Fig. all the three geographic routing protocols have low control overheads when the node density is larger than average two neighbors per node with SOGR-GR having the lowest overhead, while the overheads of the two topology based protocols rise sharply due to their use of network range flooding of path search messages and the flooding overhead is larger in a higher density network. At high density, however, the control overhead of GPSR is more than double those of SOGR-HR and SOGR-GR. GPSR uses fixed-interval beaconing and the total number of beacon messages will increase as the number of network nodes increases, while both SOGR protocols assume reactive routing mechanism and adaptive parameter setting to reduce control overhead. Due to the hybrid mechanism adopted, SOGR-HR makes a better balance between control overhead and packet forwarding overhead. Only when the forwarding node finds a node closer to the destination within its Maxhops neighbor range, it will forward data packets. Hence, in a sparse network, SOGR-HR has up to 86 percent lower packet forwarding overhead than GPSR and SOGRGR, with more path searches. .For all three geographic routing protocols, packets often traverse a longer path to reach the destination in a sparse network as a recovery forwarding has to be used more frequently. In summary, all geometric protocols could achieve higher delivery ratio and much lower control overhead under a higher network density compared to topology base on-demand routing protocols. By making a better tradeoff between path searching overhead and forwarding efficiency, SOGR-HR achieves a significant lower packet forwarding overhead compared to GPSR and SOGR-GR in a sparse network.

8. CONCLUSIONS

In this work, we propose two self-adaptive on-demand geographic routing protocols SOGR-HR and SOGR-GR. The two protocols adopt different schemes to obtain and maintain local topology information. SOGR-GR purely relies on one-hop topology information for forwarding as other geographic routing.The simulation results demonstrate that our protocols are very robust in a dynamic mobile ad hoc network, and can efficiently adapt to different scenarios and perform better than existing geographic routing protocols and conventional on-demand protocols under various environments, including different mobility and node densities Both proposed routing protocols could achieve about 98 percent delivery ratios, avoid incurring unnecessary control overhead, have very low-forwarding overhead and transmission delay in all test scenarios. Moreover this paper concentrates on reducing the redundancy to establish path.

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