

Protection for Geographic Routing in Mobile Ad hoc Networks

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Abstract – Geographic routing protocol is becoming an attractive choice in Mobile Ad Hoc Network. In this protocol the nodes need to maintain their up-to-date position for making effective forwarding decisions. Periodic broadcasting of beacon packets is used to maintain the position of their neighboring nodes. Adaptive Position Update (APU) strategy is used to update the position of nodes and using Greedy Perimeter Stateless Routing Protocol (GPSR) the path has been established between these nodes. APU is based on two simple principles: 1) nodes whose movements are harder to predict update their positions more frequently (and vice versa), and (ii) nodes closer to forwarding paths update their positions more frequently (and vice versa). Our theoretical analysis, which is validated by NS2 simulations of a well-known geographic routing protocol, Greedy Perimeter Stateless Routing Protocol (GPSR), shows that APU can significantly reduce the update cost and improve the routing performance in terms of packet delivery ratio and average end-to-end delay in comparison with periodic beaconing and other recently proposed updating schemes. The benefits of APU are further confirmed by undertaking evaluations in realistic network scenarios, which account for localization error, realistic radio propagation, and sparse network. Also for security purpose we are also encrypting the data packets during transmission. So that the intermediate nodes are not able to view the data during transmission. For Encryption process, we are using RC4 Algorithm.

Index Terms – Geographic routing, positions, Manets, Nodes.

1. INTRODUCTION

We propose here Geographic Random Forwarding (GeRaF, pronounced as “giraffe”), a novel transmission scheme based on geographical routing where packets are relayed on a best effort basis, i.e., the actual node which acts as a relay is not known a priori by the sender, but rather is decided after the transmission has taken place. This idea leverages on the fact that in the wireless environment broadcast is free (from the sender’s point of view) and that in the presence of randomly changing topologies a node may not be aware of which of its current neighbors is in the best position to act as a relay. In a sense, this is like doing contention at the receiver’s end, which is untraditional because in classic schemes it is the transmitter which contends for the channel. Here, since the intended recipient is not specified, multiple nodes may be able to receive the packet, and a receiver contention scheme is therefore needed to guarantee that a single relay is chosen, thereby avoiding packet duplication.

An ad hoc network is a set of wireless mobile nodes (MNs) that cooperatively form a network without specific user administration or configuration. Each node in an ad hoc network is in charge of routing information between its neighbors, thus contributing to and maintaining connectivity of the network. Since ad hoc networks have proven benefits, they are the subject of much current research. Many unicast routing protocols have been proposed for ad hoc networks; a performance comparison for a few of the protocols are in [1] and [2]. Some of the unicast routing protocols for an ad hoc network use location information in the routing protocol in an effort to improve the performance of unicast communication. A few of the proposed algorithms include the Location-Aided Routing (LAR) algorithm [3], the Distance Routing Effect Algorithm for Mobility (DREAM) [4], the Greedy Perimeter Stateless Routing (GPSR) algorithm [5], and the Geographical Routing Algorithm (GRA) [6]. Many location based routing protocols have been developed for ad hoc networks. This paper presents the results of a detailed performance evaluation on two of these protocols: Location-Aided Routing (LAR) and Distance Routing Effect Algorithm for Mobility (DREAM). We compare the performance of these two protocols with the Dynamic Source Routing (DSR) protocol and a minimum standard (i.e., a protocol that floods all data packets). We used NS-2 to simulate 50 nodes moving according to the random waypoint model.

Our main goal for the performance investigation was to stress the protocols evaluated with high data load during both low and high speeds. Our performance investigation produced the following conclusions. First, the added protocol complexity of DREAM does not appear to provide benefits over a flooding protocol. Second, promiscuous mode operation improves the performance of DSR significantly. Third, adding location information to DSR (i.e., similar to LAR) increases both the network load and the data packet delivery ratio; our results conclude that the increase in performance is worth the increase in cost. Lastly, our implementation of DREAM provides a simple location service that could be used with other ad hoc network routing protocols.

2. RELATED WORK

Dynamic Source Routing (DSR)

DSR is a source routing protocol which determines routes on demand [7, 17]. In a source routing protocol, each packet

carries the full route (a sequenced list of nodes) that the packet should be able to traverse in its header. In an on demand routing protocol (or reactive protocol), a route to a destination is requested only when there is data to send to that destination and a route to that destination is unknown or expired. In the evaluation of DSR, both [1] and [2] only locate routes that consist of bi-directional links. (Although DSR does not require bi-directional links in the protocol, IEEE 802.11 [18] requires bi-directional links in the delivery of all non-broadcast packets.) The version of DSR in our study also only locates bi-directional links. In other words, a route reply packet containing the complete route from S to D is sent along the reverse route to S. MNs using DSR may operate in promiscuous mode. In promiscuous mode, an MN can learn potentially useful routes by listening to packets not addressed to it. Simulation results on DSR presented in [1] use promiscuous mode operation, while simulation results on DSR presented in [2] do not use promiscuous mode operation. Contrary to comments in [2], we discovered that including promiscuous mode operation in DSR significantly reduced control overhead and significantly increased delivery ratio at higher speeds. However, as noted in [2], promiscuous mode operation is power consuming. Thus, we chose to present both promiscuous mode operation and non-promiscuous mode operation in our simulation results for DSR.

Location Aided Routing (LAR)

1) Protocol Overview: Like DSR, LAR [3] is an on-demand source routing protocol. The main difference between LAR and DSR is that LAR sends location information in all packets to (hopefully) decrease the overhead of a future route discovery. In DSR [7], if the neighbors of S do not have a route to D, S floods the entire ad hoc network with a route request packet for D. LAR uses location information for MNs to flood a route request packet for D in a forwarding zone instead of in the entire ad hoc network. (The term forwarding zone in this paper is defined the same as the term request zone in [3].) This forwarding zone is defined by location information on D. The authors of [3] propose two methods used by intermediate nodes between S and D to determine the forwarding zone of a route request packet. In method 1, which we call LAR Box, a neighbor of S determines if it is within the forwarding zone by using the location of S and the expected zone for D. The expected zone is a circular area determined by the most recent location information on D, (X_D, Y_D) , the time of this location information, (t_0) , the average velocity of D, (V_{avg}) , and the current time, (t_1) . This information creates a circle with radius $R = V_{avg} \times (t_1 - t_0)$ centered at (X_D, Y_D) . The forwarding zone is a rectangle with S in one corner, (X_S, Y_S) , and the circle containing D in the other corner.

A number of recent papers also propose specific energy efficient routing schemes for sensor networks. The authors of [17] [18] propose LEACH, which is a cluster-based routing

protocol in which the role of clusterhead is rotated among the sensor nodes to avoid stressing only some of them. An improvement of LEACH, called PEGASIS, which is chain-based and provides near optimum energy and delay performance is proposed in [19]. Similarly, energy aware routing [20] avoids using consistently the lowest-energy routing paths, as this may lead to energy depletion of nodes in key locations; instead, it allows the use of suboptimal paths. Routing is coupled with a thresholding mechanism in [21] [22], where transmissions are inhibited when the sensed attribute is not significant or not significantly different from what sensed/transmitted in the past, thereby reducing the transmission/relaying activity of nodes. A routing scheme which minimizes the control traffic in the network is proposed in [23]. Traffic shaping to make the network load more uniform, thereby improving the energy utilization of the nodes in the network, is proposed in [24]. An algorithm based on constrained shortest paths, which tries to minimize energy consumption while retaining good end to end performance, introduces the maximum flow-life curve as the routing objective and proposes a new routing scheme based on this concept. Techniques to improve packet forwarding in sensor networks are proposed. The authors of [20] propose to modify the sensor node layering architecture so that forwarding decisions can be made by the hardware, thereby greatly improving the energy (and latency) performance of the overall system.

Routing protocols based on geographic information have been considered in the past. GPSR is a scalable greedy algorithm with the ability to go around low-density network regions. GEAR also uses geographic information to deliver packets to a certain service region (rather than to a specific node). Other protocols which make use of geographic information to improve efficiency include LAR and DREAM.

3. OUR WORK

We propose a novel beaconing strategy for geographic routing protocols called Adaptive Position Updates strategy (APU). Our scheme eliminates the drawbacks of periodic beaconing by adapting to the system variations. APU incorporates two rules for triggering the beacon update process. The first rule, referred as Mobility Prediction (MP), uses a simple mobility prediction scheme to estimate when the location information broadcast in the previous beacon becomes inaccurate. The next beacon is broadcast only if the predicted error in the location estimate is greater than a certain threshold, thus tuning the update frequency to the dynamism inherent in the node's motion.

We model APU to quantify the beacon overhead and the local topology accuracy. The local topology accuracy is measured by two metrics, unknown neighbor ratio and false neighbor ratio. The former measures the percentage of new neighbors a forwarding node is unaware of but that are actually within the radio range of the forwarding node. On the contrary, the latter

represents the percentage of obsolete neighbors that are in the neighbor list of a node, but have already moved out of the node's radio range. Our analytical results are validated by extensive simulations.

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4. ALGORITHM

ADAPTIVE POSITION UPDATES STRATEGY

1. All nodes are aware of their own position and velocity,
2. All links are bidirectional,
3. The beacon updates include the current location and velocity of the nodes, and
4. Data packets can piggyback position and velocity updates and all one-hop neighbors operate in the promiscuous mode and hence can overhear the data packets.

Upon initialization, each node broadcasts a beacon informing its neighbors about its presence and its current location and velocity. Following this, in most geographic routing protocols such as GPSR, each node periodically broadcasts its current location information. The position information received from neighboring beacons is stored at each node. Based on the position updates received from its neighbors, each node continuously updates its local topology, which is represented as a neighbor list. Only those nodes from the neighbor list are considered as possible candidates for data forwarding. Thus, the beacons play an important part in maintaining an accurate representation of the local topology.

RC4 Algorithm

RC4 generates a pseudorandom stream of bits (a keystream). As with any stream cipher, these can be used for encryption by combining it with the plaintext using bit-wise exclusive-or; decryption is performed the same way (since exclusive-or with given data is an involution). (This is similar to the Vernam cipher except that generated *pseudorandom bits*, rather than a prepared stream, are used.) To generate the keystream, the cipher makes use of a secret internal state which consists of two parts:

1. A permutation of all 256 possible bytes (denoted "S" below).
2. Two 8-bit index-pointers (denoted "i" and "j").

5. CONCLUSION

Our results indicate that the APU strategy generates less or similar amount of beacon overhead as other beaconing schemes but achieve better packet delivery ratio, average end-to-end delay and energy consumption. We have identified the need to adapt the beacon update policy employed in geographic routing protocols to the node mobility dynamics and the traffic load. We proposed the Adaptive Position Update strategy to address these problems. The APU scheme employs two mutually exclusive rules. The MP rule uses mobility prediction to estimate the accuracy of the location estimate and adapts the beacon update interval accordingly, instead of using periodic beaconing. The ODL rule allows nodes along the data forwarding path to maintain an accurate view of the local topology by exchanging beacons in response to data packets that are overheard from new neighbors. We mathematically analyzed the beacon overhead and local topology accuracy of APU and validated the analytical model with the simulation results. We have embedded APU within GPSR and have compared it with other related beaconing strategies using extensive NS-2 simulations for varying node speeds and traffic load. Our results indicate that the APU strategy generates less or similar amount of beacon overhead as other beaconing schemes but achieve better packet delivery ratio, average end-to-end delay and energy consumption. In addition, we have simulated the performance of the proposed scheme under more realistic network scenarios, including the considerations of localization errors and a realistic physical layer radio propagation model. Future work includes utilizing the analytical model to find the optimal protocol parameters (e.g., the optimal radio range), studying how the proposed scheme can be used to achieve load balance and evaluating the performance of the proposed scheme on TCP connections in Mobile Ad hoc Networks.

6. FUTURE ENHANCEMENTS

Future work includes utilizing the analytical model to find the optimal protocol parameters (e.g., the optimal radio range), studying how the proposed scheme can be used to achieve load balance and evaluating the performance of the proposed scheme on TCP connections in Mobile Ad hoc Networks.

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