Energy Efficiency Routing Based Adaptive Location Update for Wireless Sensor Networks

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Abstract

A Big challenges to develop routing protocol that can meet different application needs and optimize routing paths according to the topology change in Wireless networks. The continuous transmission of small packet is called beacon packet, that advertises the presence of a base station and the sensor units sense the beacons and attempt to establish a wireless connections. Basing their forwarding decisions only on the local topology, geographic routing protocols have drawn a lot of attentions in recent years. However, inaccurate local topology knowledge and the outdated destination position information can lead to inefficient geographic forwarding and even routing failure. Proactive local position distribution can hardly adapt to the traffic demand. It is also difficult to pre-set protocol parameters correctly to fit in different environments. We have developed two self-adaptive on-demand geographic routing schemes. The local topology is updated in a timely manner according to network dynamics and traffic demands. Our route optimization scheme adapts the routing path according to both topology changes and actual data traffic requirements. Each node can determine and adjust the protocol parameter values independently according to different network environments, data traffic conditions and node's own requirements. Our simulation studies have shown that the proposed routing protocols are more robust and outperform the existing geographic routing protocol. Specifically, the packet delivery latency is reduced almost four times as compared to GPSR at high mobility.

Keywords - *WSN, Geographic routing, GPSR, Local topology, Beacon packets.*

1. INTRODUCTION

Wireless networks are very fashionable in the compute production. Wireless network are adapted to enable mobility. MANETs are a kind of Wireless ad hoc network that usually has a routable networking environment on top of a Link Layer ad hoc network. In a mobile ad hoc network (MANET), a collection of mobile devices with in wireless network interfaces figure a momentary network without the help of any fixed infrastructure therefore, all nodes are free to travel arbitrarily. One of the merits of wireless networks is its capability to permit data communication between different parties and still maintain their own mobility. However, this communication is restricted to the range of transmitters. This means that two nodes do not communicate with all other when the space between those two nodes is outside the communication range of their own. MANET solve this difficulty by allow the intermediate parties to communicate data transmissions. This is achieved by separating MANET into two different types of networks, that is, single-hop and multihop. Here the single-hop network, all nodes inside the communication range talks directly with each other. And another one is a multihop network; nodes exchange information to intermediary nodes to transmit if the target is not in their communication range. In contrary to the conventional wireless system, MANET has decentralized network transportation.

1.1 ADVANTAGES OF WIRELESS NETWORKS

Low cost of deployment:

As the name suggests, ad-hoc networks can be deployed on the fly, thus requiring no expensive infrastructure such as copper wires, data cables, etc.

Fast deployment:

When compared to WLANs, mobile ad-hoc networks are very convenient and easy to deploy requiring less manual intervention since there are no cables involved.

Dynamic Configuration:

Mobile ad-hoc network configuration can change dynamically with time. For the many scenarios such as data sharing in classrooms, etc., this is a useful feature. When compared to configurability of LANs, it is very easy to change the network topology.

Minimal configuration and quick deployment make MANET ready to be used in emergency circumstances where an infrastructure is unavailable or unfeasible to install in scenarios like natural or human-induced disasters, military conflicts and medical emergency situations.

2. RELATED WORK

Geographic routing (also called georouting or position-based routing) is a routing principle that relies on geographic position information. It is mainly proposed for wireless networks and based on the idea that the source sends a message to the geographic location of the destination instead of using the network address. Geographic routing requires that each node can determine its own location and that the source is aware of the location of the destination. With this information a message can be routed to the destination without knowledge of the network topology or a prior route discovery. MANET used different types of routing protocols such as topology based routing protocols, Position based routing protocols. GPSR routing protocols offer significant performance improvements over topology-based routing protocols such as DSR and AODV.

2.1 TOPOLOGY BASED ROUTING PROTOCOLS

Topology Based Routing Protocols further divided into Proactive approach, e.g., DSDV, Reactive approach, e.g., DSR, AODV, TORA and Hybrid approach, e.g., Cluster, ZRP. A reactive routing protocol tries to find a route from S to D only on-demand, i.e., when the route is required, for example, DSR and AODV are such protocols. The main advantage of a reactive protocol is the low overhead of control messages. However, reactive protocols have higher latency in discovering routes. A proactive protocol maintains extensive routing tables for the entire network. As a result, a route is found as soon as it is requested. The main advantage of a proactive protocol is its low latency in discovering new routes.
However, proactive protocols generate a high volume of control messages required for updating local routing tables. The topology based routing protocols provides a certain demerits over the Position based routing protocols.

2.2 POSITION BASED ROUTING PROTOCOLS

In Geographic Routing, nodes need to maintain up-to-date positions of their immediate neighbors for making effective forwarding decisions. The forwarding strategy employed in the aforementioned geographic routing protocols requires the following information: (A) the position of the final destination of the packet and (B) the position of a node's neighbors. The former can be obtained by querying a location service such as the Grid Location System (GLS) or Quorum. To obtain the latter, each node exchanges its own location information (obtained using GPS or the localization schemes) with its neighboring nodes. This allows each node to build a local map of the nodes within its vicinity, often referred to as the local topology. However, in situations where nodes are mobile or when nodes often switch off and on, the local topology rarely remains static. Hence, it is necessary that each node broadcasts its updated location information to all of its neighbors. These location update packets are usually referred to as *beacons*. Beacons are performing important role in geographic routing. In most geographic routing protocols (e.g. GPSR), beacons are broadcast periodically for maintaining an accurate neighbor list at each node. Position updates are costly in many ways. Each update consumes node energy, wireless bandwidth, and increases the risk of packet collision at the medium access control (MAC) layer. Packet collisions cause packet loss which in turn affects the routing performance due to decreased accuracy in determining the correct local topology (a lost beacon broadcast is not retransmitted). A lost data packet does get retransmitted, but at the expense of increased end-to-end delay. Clearly, given the cost associated with transmitting beacons, it makes sense to adapt the frequency of beacon updates to the node mobility and the traffic conditions within the network, rather than employing a static periodic update policy.

For example, if certain nodes are frequently changing their mobility characteristics (speed and/or heading), it makes sense to frequently broadcast their updated position. However, for nodes that do not exhibit significant dynamism, periodic broadcasting of beacons is wasteful. Further, if only a small percentage of the nodes are involved in forwarding packets, it is unnecessary for nodes which are located far away from the forwarding path to employ periodic beaconing because these updates are not useful for forwarding the current traffic. Heissenbuttel et al. have shown that Periodic beaconing can cause the inaccurate local topologies in highly mobile ad-hoc networks, which leads to performances degradation, e.g., frequent packet loss and longer delay. They proposed several simple optimizations that adapt beacon interval to node mobility or traffic load, including distance-based beaconing, speed-based beaconing and reactive beaconing. Periodic beaconing regardless of the node mobility and traffic patterns in the network is not attractive from both update cost and routing performance points of view.

3. PROPOSED SYSTEM

3.1 ADAPTIVE POSITION UPDATES

Initially, 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. Instead of periodic beaconing, ALU adapts the beacon update intervals to the mobility dynamics of the nodes and the amount of data being forwarded in the neighborhood of the nodes. Adaptive Location Updates [ALU] strategy eliminates the drawbacks of periodic beaconing. ALU employs two mutually exclusive beacon triggering rules such as Mobility Prediction rule and On-Demand Learning rule.Adaptive Location Updates uses two principles 1) nodes that are frequently changing its position are updated frequently 2) nodes which are in forwarding path are updated. 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. (ODL), aims at improving the accuracy of the topology along the routing paths between the communicating nodes. ODL uses an on-demand learning strategy, whereby a node broadcasts beacons when it overhears the transmission of a data packet from a new neighbor in its vicinity. This ensures that nodes involved in forwarding data packets maintain a more up-to date view of the local topology. On the contrary, nodes that are not in the vicinity of the forwarding path are unaffected by this rule and do not broadcast beacons very frequently.

3.1 MOBILITY PREDICTION RULE

This rule adapts the beacon generation rate to the mobility of the nodes. Nodes that are highly mobile need to frequently update their neighbors since their locations are changing dynamically. On the contrary, nodes which move slowly do not need to send frequent updates. A periodic beacon update policy cannot satisfy both these requirements simultaneously, since a small update interval will be wasteful for slow nodes, whereas a larger update interval will lead to inaccurate position information for the highly mobile nodes. In our scheme, upon receiving a beacon update from a node *i*, each of its neighbors, denoted by the set *N(i)*, records its current position and velocity and continues to track node *i's* location using a simple prediction scheme (discussed below). Based on this position estimate the neighbors *N(i)*, check whether node *i* is still within their transmission range and update their neighbor list accordingly. The goal of the MP rule is to send the next beacon update from *i* when the error between the predicted location in *N(i)* and *i's* actual location is greater than an acceptable value. To achieve this, node *i*, must track its own predicted location in its neighbors, *N(i)*.

$$X^i_p = X_l^i + (T_c - T_l) * V_x^i$$
$$Y^i_p = Y_l^i + (T_c - T_l) * V_y^i$$

We use a simple location prediction scheme based on the physics of motion to track a nodes current location. Note that, in our discussion we assume that the nodes are located in a two-dimensional coordinate system with the location indicated by the x and y coordinates. However, this scheme can be easily extended to a three dimensional system. Let (Xa, Ya), denote the actual location of node i, obtained via GPS or other localization techniques. (Xp, Yp) denotes the predicated position of the node I at current time. Node i then computes the deviation Di devi as follows:

$$D^i_{devi} = \sqrt{(X^i_a - X^i p)^2 + (Y^i_a - Y^i p)^2}$$

If the deviation (Obtained in (1)) is greater than a certain threshold, known as the *Acceptable Error Range (AER)*, it acts as a trigger for node i to broadcast its current location and velocity as a new beacon. The AER threshold is an important parameter that can affect the performance of the APU scheme. The MP rule, tries to maximize the effective duration of each beacon, by broadcasting a beacon only when the position information in the previous beacon becomes inaccurate. This extends the duration of the beacon for nodes by the following way: For low mobility node, reduces the number of beacons, for highly mobile node frequent beacons for the support of the rapidly changing topology.

3.2 ON-DEMAND LEARNING RULE

The MP rule solely may not be sufficient for maintaining an accurate local topology. Consider the example illustrated in Fig. 3.2.1, where node P moves from L1 to L2 at a constant velocity.

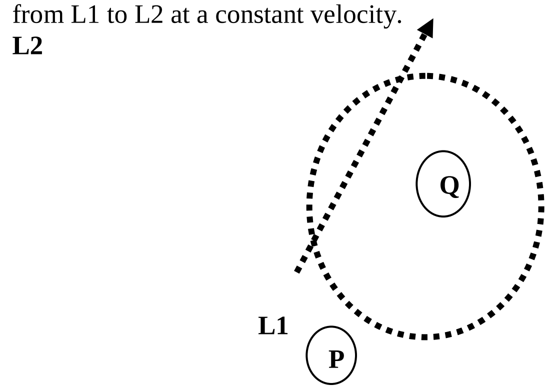


Fig.3.2.1. an example illustrating a drawback of the MP rule

Consider the example illustrated in Fig. 3.2.2, now assume that node P has just sent a beacon while at L1. Since node Q did not receive this packet, it is unaware of the existence of node P. Further, assume that the AER is sufficiently large such that the MP rule is never triggered. Node P is within the communication range of Q for a significant portion of its motion. If either P or Q was transmitting data packets, then their local topology will not be updated and they will exclude each other while selecting the next hop node.

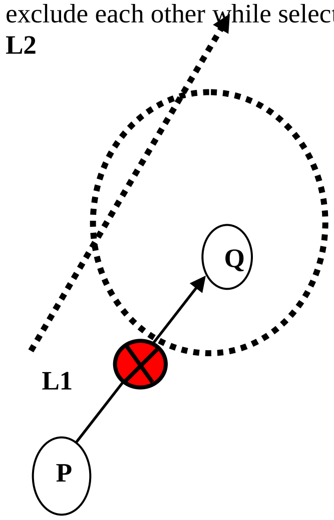
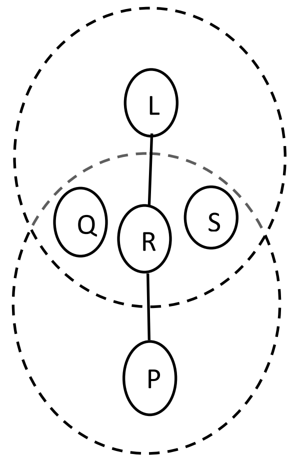


Fig.3.2.2 Loss of Beacon packet in MP Rule

Hence, it is necessary to devise a mechanism which will maintain a more accurate local topology in those regions of the network where significant data forwarding activities are ongoing. This is precisely what the *On-Demand Learning (ODL)* rule aims to achieve.

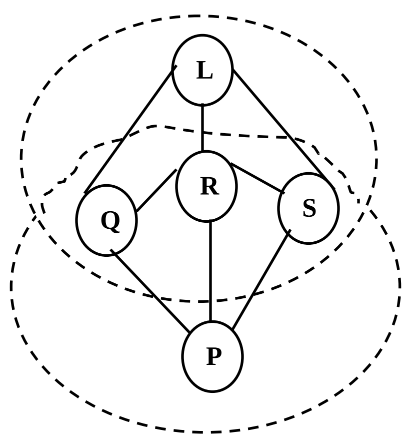
As the name suggests, a node broadcasts beacons *on-demand*, i.e. in response to data forwarding activities of that node. According to this rule, whenever a node overhears a data transmission from a *new* neighbor, it broadcasts a beacon as a response. The ODL rule allows active nodes that are involved in data forwarding to enrich their local topology beyond this basic set. Thus the rich list is maintained only at the active nodes and is built reactively in response to the network traffic.

All inactive nodes simply maintain the basic neighbor list. By maintaining a rich neighbor list along the forwarding path, ODL ensures that in situations where the nodes involved in data forwarding are highly mobile, alternate routes can be easily established without incurring additional delays. Figure. 3.2.3(a) illustrates the network topology before node P starts sending data to node L. The solid lines in the figure denote that both ends of the link are aware of each other. The initial possible routing path from P to L is P-R-L.



(a)

Now, when source P sends a data packet to node R, node Q and S receive the data packet from P. Since node Q and S are in communication range of node P. As P is a new neighbor of Q and S, according to the ODL rule, both Q and S will send back beacons to P. As a result, the links PQ and PS will be discovered. Further, based on the location of the destination and their current locations, Q and S discover that the destination L is within their one-hop neighborhood. Similarly when R forwards the data packet to L, the links RQ and RS will be discovered. Fig. 3.2.3(b) reflects the enriched topology along the routing path from P to L.



(b)

Fig.3.2.3 An example illustrating the ODL rule

4. CONCLUSION AND FUTURE WORK

Introduce two self-adaptive on-demand geographic routing schemes, the two schemes adopt to obtain and maintain local topology information. One scheme purely relies on one-hop topology information for forwarding as other geographic routing schemes; the other one combines both geographic and topology based mechanisms for more efficient path building. To alleviate the negative effects of outdated local topology information on geographic routing and design more efficient position distribution mechanisms to update the local topology knowledge in time and adaptively based on demand. The simulation results show that our proposed scheme can efficiently adapt to different scenarios and perform better than the existing geographic routing protocols. Nearly four times delay reduction has been observed in high mobility case. Future work includes find optimal protocol parameters such as the optimal radio range and load balancing.

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