Mobility Adaptive Location Based Update for Geographical Routing in Highly Dynamic Mobility Environment

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Abstract

In geographical routing, each node takes the data forwarding decision based on the location information of its one-hop neighbors. Dissemination of location information is the key function of the geographic routing. The location error due to the node mobility models has direct impact on the geographical routing. Node mobility is a great challenge to the beacon based location broadcasting schemes. The general mechanism to optimize the local topology information according to the node mobility is Proactive beaconing schemes support specific mobility model, but it does not perform well under various mobility models. However, it is difficult to capture the changes in the network topology and fit the beaconing approach correctly to the various mobility models.

Keywords: *Geographical Routing Protocols, Node Mobility, Mobility Models, location broadcasting, Proactive beaconing scheme and network topology.*

I. INTRODUCTION

A self-organized MANET [1] is comprised of several wireless portable devices forming an arbitrary network topology. It allows interconnection of mobile nodes within communication range without the aid of permanent infrastructure. A mobility model dictates the movement of mobile nodes in terms of node position, speed, and direction over a certain period [2]. The mobility model describes the characteristics of mobile nodes in the dynamic network topology. The geographical routing protocol delivers a data packet to the intended destination using the location information of its one hop neighbors using greedy forwarding [3]. Thus, each node in the geographical routing needs to disseminate the location information to its one hop neighbors using beacon packets. The local topology information changes dynamically, which makes the design of the scalable beaconing scheme more challenging for location dissemination.

Geographical routing makes use of the positioning devices such as Global Positioning System (GPS) and other localization schemes [4]. Proactive beaconing is a common beaconing approach for maintaining the accurate local topology information. Each node frequently broadcast the beacon packets including the updated location information to the neighboring nodes. Such a proactive mechanism induces high overhead and outdated position knowledge in a highly dynamic network [5]. Various mobility models make it difficult for the proactive beaconing approach. If a mobile node changing its position frequently, it needs to send the beacon packets frequently including its current location information to the neighboring nodes. However, the slow mobile nodes need not broadcast the beacon packets frequently. Though, the proactive beaconing approach assures the accuracy of local topology information; it is not adapted for various mobility models. Thus, a concrete beaconing approach is mandatory to fit correctly to various mobility models and reduce the beaconing overhead.

II. RELATED WORKS

A general approach to update the location information on neighbor list is beaconing. A node in motion updates its mobility to the neighboring nodes through beacon broadcasting [5], [6], [7]. The node considers the neighbor node is moved out of the direct communication range, when it does not receive the update packet until the timer has terminated. Moreover, the node removes the expired neighbor's information from its neighbor list. In [8], shows that the periodic beacon broadcasting for the location update can induce the location inaccuracy due to the highly dynamic network topology. It induces frequent packet loss and longer data delay. Hence, the geographic routing performance is degraded. In geographical routing, a lot of simple optimizations have been proposed and it includes three kinds of beaconing such as distance-based beaconing, speed based beaconing, time based beaconing, reactive beaconing, and mobility based beaconing [9] [10]

A. Distance Based Beaconing

The beacon interval considers the metric of distance to update the location information that is named as the distance based beaconing [11]. In that, the node broadcasts the beacon when it is moved more than the specified distance value. This approach is adaptive to the unpredictable node mobility for instance a highly mobile node broadcasts the beacon packets more frequently, and vice versa [9]. A slow node may increase the outdated information in the neighbors list as it broadcast the beacons in- frequently. Second, highly mobile node cannot detect the slow nodes while it is moved from one location to another location that reduces the network connectivity. The position update schemes commonly employ the hexagonal cell configurations in the cellular networks [12]. However, the highly dynamic network topology incurs the beacon collision and degrades the performance due to the various beaconing intervals.

B. Speed Based Beaconing

The dynamic changes in the node motion and velocity affects the node ability to predict its accurate neighbors' location information for packet routing [13]. The node movement in a constant velocity is easy to predict, but the dynamic node speed makes difficulties in the accurate neighbors' prediction under MANET environment. The beacon time out interval that supports to identify the expired location information is the multiple factor of its beacon interval. The interval values are piggybacked onto the beacon packets. Every node compares the time out interval with its own when the beacon packet is received and it selects the small time out interval value to provide the accurate location information. However, in the speed based beaconing a fast moving node may not detect the slow nodes under a widely varying network topology.

C. Reactive Beaconing

In on demand beaconing, the source node broadcasts the beacon packets to its neighboring nodes on demand. A node in the communication range can overhears the request packet that is sent from the source node and the receiving node replies the source node with beacon packets to begin the data packet transmission [14]. In addition, the beaconing is commenced when the difference between current time and last beacon receiving time exceeds the beacon time out interval. Then, the source node forwards the request packets to the radio neighbors to commence the beaconing. This technique is used to reduce the communication cost as it limits the rate of beaconing. In contrast, [13] a node commences the beaconing when it is moved beyond the particular region.

D. Time Based Beaconing

In time based beaconing, every node updates its neighbor's information per T time unit. The unit time is the network parameter and it is easy to determine under the dynamic network topology. According to the on demand data transmission the beacon interval time T is determined [15] [16]. There is need for a node that maintains the local clocks to commence the beaconing. The main benefit of this scheme is the minimum computational cost. The main disadvantage in the time based beaconing is that it incurs unnecessary beaconing per T time interval under low mobility network. This kind of beaconing does not consider the data communication delay so; it is not suitable for delay sensitive applications. In addition, it is easy to implement under various MANET environments, but it results in unnecessary signaling traffic degrades the routing performance.

E. Mobility Based Beaconing

In contrast to other location update schemes it considers the mobility dynamics to update the location information [13] [17] [18] as the infrastructure less and the random node mobility in the network make issues to the location accuracy [19]. In that, every node changes the beacon broadcast intervals based on the node mobility dynamics. For instance the Adaptive Position Update (APU) scheme [13] includes the components of mobility prediction and on demand learning. The requirement of beacon packets is significantly increased with the rate of node mobility and it induces the high routing overhead [20] as well as the communication cost [7] in the network. Based on the node mobility patterns, various experiments are conducted to simulate the effects of location errors on the GPSR performance under MANET environment [21]. The primary issues resulting from the unpredictable node mobility are loop formation and lost links.

Though the existing schemes enhance the geographical routing performance owing to the most precise location update under a highly dynamic network topology, an explicit technique is in the need to reduce the routing overhead. Thus, there is a need to propose the novel beaconing approach to reduce the beaconing overhead under a highly dynamic network topology.

III. PROBLEM STATEMENT

The design of common beaconing approach for location dissemination that require to meet various mobility model scenarios and optimize the beaconing overhead is more challenging, since each node has its own mobility model. The proactive beaconing is a general approach for distributing the beacon packets which carry the location information induces high overhead, even when there is no high traffic in the network. The decrease in the beaconing interval increases the routing overhead and it is a reasonable cost for high mobility scenario, but is a waste for the slow nodes. It is not possible to decide the common beaconing interval for all nodes, as each node employs different mobility models. Similarly, frequent beaconing is a reasonable cost for the nodes which are closer to the destination, but it is inefficient for the nodes which are far away from the destination. To avoid the location inaccuracy, the existing systems introduce the mobility prediction schemes along with the beaconing approach. However, the mobility prediction is not possible for the mobility models which excludes the uniform pause time. This not only incurs a large delay and packet collision, but it leads to the frequent link failure. In addition, each mobility model provides different mobile scenario for nodes, making the beaconing approach complex to maintain the accurate topology information. Thus, the performance of the proactive approach on the geographical routing is not well, and the performance level is different for various mobility models. It is important to propose the novel beaconing approach to fit correctly to the various mobility models under MANET environment.

IV. PROPOSED CONTEXT AWARE APPROACH

Upon initialization, each node in the network broadcast the beacon packets to the neighboring nodes to inform about its location, pause time, and speed. Following this, each node frequently broadcasts the beacon packets to inform its current location information. Each node retains the location information of neighboring nodes, when it receives the neighboring beacons. Based on the received beacon packets from its neighboring nodes, each node updates the local topology, which is named as a neighbor list. Only the nodes in the neighbor list are selected for the data transmission. Each node needs to maintain the accurate local topology information, thus the beacon packets play an important role in the geographic based routing. Instead of frequent beaconing, the Proposed Context Aware Approach controls the beaconing interval based on the node distance.

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