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Location Update Schemes in Mobile Ad Hoc Networks

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Abstract - Routing of packets in mobile ad hoc networks with a large number of nodes or with high mobility is a very difficult task. In geographic routing, nodes need to maintain up-to-date positions of their immediate neighbors for making effective forwarding decisions. To achieve the requirement of up-to-date location information, many location update schemes have been proposed. Periodic broadcasting of beacon packets that contain the geographic location co-ordinates of the nodes is a popular method used by most geographic routing protocols to maintain neighbor positions. Some routing protocols do not require the proactive transmission of control messages which saves network resources and some dynamically adjusts the frequency of position updates based on the mobility dynamics of the nodes and the forwarding patterns in the network. Optimizations are needed to improve the neighbor table accuracy.

***Keywords* - Quorum, home agent, GPSR, reactive beaconing, adaptive position update (APU).**

1. Introduction

Mobile Ad Hoc NETworks (MANET) are a set of wireless mobile nodes that do not require a pre-established infra-structure. Due to frequent change in topologies, routing in MANET becomes a challenging task to deal with. Position information available at each node is the key enabler for position-based routing protocols to enhance routing. Forwarding decisions are based on absolute or relative position of the current node, the positions of neighboring nodes and the destination.

In position-based routing protocols, nodes periodically broadcast beacons to announce their presence and location to their neighbors. Each node stores all neighbors and their current positions in a neighbor table. This table contains all nodes within the transmission range from which it receives beacons. If a node does not receive any beacon from one of its neighbors within a certain time interval, called neighbor time-out interval, the corresponding node is considered to have left the transmission range or is unreachable and is deleted from the neighbor table. Routing of packets is done based on the positions of nodes in the neighbor table. Inaccurate or outdated neighborhood information may severely affect position-based routing protocols because the data packets may not be delivered to the next hop or may be delivered to sub-optimally located neighbors. So mechanisms that improve the accuracy of neighborhood information is very essential.

2. Literature Survey

Several location update schemes are there for mobile ad hoc networks. Some of the approaches are described here.

2.1 Quorum Based Systems

Quorum-based approaches for information dissemination are based on replicating location information at multiple nodes acting as location servers along north and south directions of a node updating its location server ie, column of current location of updating node. In quorum systems [1], information updates are sent to a group (quorum) of available nodes and information queries to another quorum. Updated information is found only at nodes available at the intersection of these quorums. Location update is triggered whenever a link or edge is broken or created.

2.2 Home Agent Based System

Another method is home agent based location update scheme [2], where each node selects a circular area as its home agent and informs other nodes about it. When a node moves away to a new location update messages are sent only to nodes located within its home agent. The update may fail if home agent is disconnected from the current node location. Such failure may be reported back to the node, which will then choose a new home.

2.3 Periodic Beaconing

Periodic broadcasting of beacon packets, that contain the geographic location coordinates of the nodes, is a popular method used by most geographic routing protocols (GPSR) [4]. This helps to maintain up to date positions of neighbor nodes. Periodic beaconing is done regardless of the node mobility and traffic patterns in the network.

2.4 Beaconless Routing

Beacon-less Routing protocol (BLR) does not require nodes to periodically broadcast hello messages and thus avoids drawbacks such as extensive use of scarce battery-power, interferences with regular data transmission, and outdated position information in case of high mobility[5].

2.5 Distance Based Beaconing

M.Heissenbuttel, T.Braun and T.Bernoulli[7] have discussed the limitations, alternatives in beaconing and proposed some optimizations. In distance based beaconing, a node transmits a beacon when it has moved a certain distance ‘d’. The node removes an outdated neighbor if the node does not hear any beacons from the neighbor while the node has moved more than k-times the distance ‘d’, or after a maximum timeout.

2.6 Speed Based Beaconing

The beacon interval is dependent on the node speed in speed based beaconing. A node determines its beacon interval from a predefined range with value chosen being inversely proportional to its speed. The neighbor time-out interval of a node is a multiple k of its beacon interval. Nodes piggyback their neighbor time-out interval in the beacons. A receiving node compares the piggybacked time-out interval with its own time-out interval, and selects the smaller one as the time-out interval for this neighbor.

2.7 Reactive Beaconing

In reactive beaconing, the beacon generation is triggered by data packet transmissions. When a node has a packet to transmit, the node first broadcasts a beacon request packet. The neighbors overhearing the request packet respond with beacons. Thus, the node can build an accurate local topology before the data transmission.

2.8 Adaptive Position Update

This survey also contains an Adaptive Position Update (APU) strategy suggested by Q.Chen, S. Kanhere and M.Hassan[8], which dynamically adjusts the frequency of position updates based on the mobility dynamics of the nodes and the forwarding patterns in the network. This method employs two rules - Mobility Prediction (MP) rule and On-Demand Learning (ODL) rule. With MP rule the neighbors can track the nodes motion using simple linear motion equations by utilizing the motion characteristics included in beacon broadcast. Nodes that frequently change their motion 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.

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. It can reduce the update cost and improve the routing performance significantly.

3. Performance Analysis

Various location update methods are discussed here. In home agent based location update, new homes need to be created frequently, if movement is intensive. Dense connectivity and less undiscovered neighbors can be achieved by periodic broadcasting of location information to neighboring nodes. But it causes increase in energy consumption, update cost end-to-end delay. Distance based and speed based beaconing improves periodic beacon sending mechanism but a fast node may not be able to detect slow node. Reactive beaconing method overcomes this drawback whereas excessive beacon broadcast is required when there is high traffic.

Table 1: Performance Analysis

Schemes	***Packet delivery ratio***	***Avg end to end delay***	***Energy consumptio n***
Quorum	Very low	High	High
Home agent	High	Low	Low

Beaconless	High	High	Very low
Periodic	High	Very high	Very high
Distance based	Low	High	High
Speed based	High	Low	Low
Reactive	High	Low	Low
APU	Very high	Very low	Very low

In adaptive position update, beacons generated are more concentrated along routing paths. The frequency of sending of location information is adaptive to the traffic condition and node mobility. It reduces number of beacons significantly, at the same time maintaining more accurate local topology. A comparison of above methods based on packet delivery ratio, average end to end delay and energy consumption is given in the table (Table 1).

4. Conclusions

Routing of packets in mobile ad hoc networks is done based on the positions of nodes in the neighbor table. Inaccurate or outdated neighborhood information severely affects the routing performance of position based routing protocols. Various location update schemes are there, but they have many drawbacks. Adaptive position update (APU) strategy is comparatively better among the existing methods. Research on location update mechanisms for efficient routing in wireless network is necessary. Effective mechanisms have to be explored that can adapt with highly dynamic networks.

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