A Comparative Study of Mobility Prediction Schemes for GLS Location Service

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Performance of geographic routing suffers from mobility-induced location errors. Location errors can also occur at location servers due to infrequent and/or lost updates, especially when the nodes are highly mobile. We performed an extensive study of the reasons for query failure in GLS [1] for different mobility models, namely the Random Way-Point (RWP), Reference Point Group Mobility (RPGM), Freeway (FW), and Manhattan (MH) using ns-2. We classified query failure reasons as in [2] namely, RLOOP, NRTE, NOSRVF and TTL. Specifically, we studied the impact of node velocity on query failure rates and reasons. In the case of RWP mobility model we observed that although only 8% of the total queries failed at 10m/s, the query failure rate increases to a high of 40% at 50m/s. Primary reason for this increase is mobility induced location errors such as RLOOP and TTL. In a more realistic mobility model such as Manhattan, this trend is more pronounced. 85% of the query failures are due to RLOOP at speeds higher than 20 m/s. The number of query failures also increased from a low of 3% at 10m/s to a high of 25% at 50m/s. We also observe that other query failure reasons such as inability to find a location server (NOSRVF) and voids (NRTE) do not show an increase with increasing mobility of nodes. In the case of freeway mobility model (in which geographic restriction is stricter compared to MH) the query failure rate is around 15-20% and the impact of failures due to location errors is less. Inability to find a location server was the major reason for query failures in FW. In RPGM model, we observed query failure rates of about 60%. At speeds of 30m/s and higher, TTL expiry is the major reason for query failures. We also observe that the communication pattern (inter group or intra group) has a major impact on the query failure rate since a query to find a target node in the same group is more likely to be successful than, that for a node in a different group.

We believe that mobility prediction by the location servers themselves can improve the query success rate in the Grid/GLS framework. Earlier work, such as Node Location Prediction (NLP) and Destination Location Prediction (DLP) [3], advocates location prediction by the forwarding node, and is more useful when routing packets hop-by-hop. Problems may arise if the location information maintained in the location server itself is in error, due to low location update frequency or high node mobility. We address this issue at the query point (location server) even before a destination location is given to start the routing.

Schemes proposed to predict node location can be broadly classified into ones that use movement history and frequency of visits, movement patterns, or constant velocity/direction. We implemented three prediction schemes in GLS: linear velocity based (LVP), weighted average based (WVP) and O (1) Markov recency-based (OMP) [4]. LVP uses the two most recent locations of a node to calculate the speed of the node and predict the current location. In WVP, we take running weighted average of node velocity. The history-based scheme (OMP) makes use of patterns in node movement to predict future locations. The evaluation metrics are control packet overhead, storage requirement, query success rate and prediction accuracy. These prediction schemes involve no communication overhead and require minimal increase in storage requirements (12 bytes per node) at location servers. In ns simulation runs, LVP scheme predicted a more accurate location than original GLS 58-70% of the prediction attempts. We observed that the effectiveness and accuracy of a particular prediction scheme in turn depends on the node mobility model. Geographic restrictions (such as in Manhattan and Freeway models) and node speed also impact the prediction accuracy.

We expect greater improvements in prediction accuracy by incorporating mechanisms that take into account changes in node speed and direction of movement. Validating predicted locations using maps (geographic restriction knowledge) is expected to further improve the accuracy of these prediction schemes, especially in mobility models such as Manhattan and Freeway models. We are currently investigating the performance of such schemes.

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