Location Management Technique to Reduce Complexity in Cellular Networks

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Abstract

An important issue in the design of mobile computing is how to manage the location information of mobile nodes in wireless cellular networks. The existing system has two approaches. First approach is spatial quantization technique in which location update takes place only when the mobile terminal move from one location area to other and second approach is temporal quantization in which location update takes place only after a specific time threshold. In this paper, we introduce Intelligent Agent Quantization(IAQ) which is based on prediction of movements and distance between node and Base Station Controller(BSC) to locate the mobile nodes. The main idea of using IAQ is reduce the update cost considerably with slight increase in paging cost.

Keywords: *Location Management, Location Update and Paging, Spatial Quantization, Temporal Quantization, Intelligent Agent Quantization.*

1. Introduction

The ability to manage information about the current location of mobile nodes based on their last update is a significant issue. That enables the network to discover the current attachment point of the mobile user for call delivery. Location management has the two main functions as follows location-registration(LR) and call-delivery(CD).

Suppose a mobile node starts at the corner of 2nd street Saibaba colony in Coimbatore in TamilNadu, India at 7:00 AM. Here the following questions are raised, how do we start the update? How frequently update may be performed? During the night hours whether the update is reduced automatically? The first stage is location registration. In this stage, the mobile terminal periodically notifies the network of its new Access point(AP), allowing the network to authenticate the user and revise the user's location record. The second stage is Call delivery(CD). Here the network is queried for the user location record and the current position of the mobile node is found. Current techniques for location management involve database architecture design and the transmission of signalling messages between various components of a signalling network. As the number of mobile subscriber increases, new or improved schemes are needed to support increasing subscriber population continuously. The following are the other issues of dynamic database updates, querying delays, terminal paging methods, and paging delays.

2. Location Management

The objective of this work is to design the common adaptive location management technique to reduce the updating cost of the individual mobile terminal (MT) below the entropy bound. The Existing Location management [1] basically involves two processes namely, Location Update, Where the mobile terminal proactively reports its current location to the network. Paging, Where the network search for mobile terminal within a certain set of cells to confine its location uncertainty.

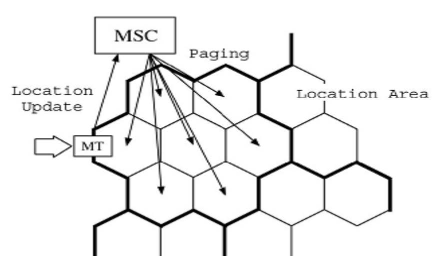

Figure 1 Location Management of Mobile Terminals

There exists trade-off between paging and update because a decrease in one results in increase in the other. In general, the precise degree of trade-off depends on the application requirements and characteristics of individual

MTs. For example, a car may choose a higher update rate to obtain smaller call setup latency. On the other hand, a wearable device might aim for very low update costs to conserve its battery.

In this work user-specific location update takes place where the update policy adapts to the movement and calling patterns of individual devices. As telecommunications technologies evolve, per-user schemes are expected to become more attractive, especially if they can significantly reduce the signaling load across billions of heterogeneous MTs. Although per-user schemes are known to result in lower signaling overheads than conventional registration-area-based static schemes, their practical adoption in large networks has been stymied by concerns on both computational and storage complexities. This work takes a step in this direction, theoretically establishing the performance benefits of MT-specific trade-off between paging and location update costs and quantifying the resultant computational and storage complexities.

3. Four dynamic update schemes

The following first three location update schemes are examined in [2, 3] and last scheme is the proposed scheme.

3.1 Time Based:

An MT performs location updates periodically at a constant time interval .If a location update occurred at location at time 0, subsequent location updates will occur at locations and if the MT moves to these locations at times and respectively.

3.2 Movement Based:

An MT performs a location update whenever it completes a predefined number of movements across cell boundaries (this number is referred to as the movement threshold).

3.3 Distance Based:

MT performs a location update when its distance from the cell where it performed the last location update exceeds a predefined value (this distance value is referred to as the distance threshold).

3.4 Time and Movement based:

Based on Intelligent Agent, unnecessary updates restricted to store in the mobile's movement record by using movement history of mobile node and based on time too. For example the during the night hours updates will be reduced due to mobile node is static in the most cases.

3.5 Time, Distance and Direction based:

Here the distance between nodes and BSC are computed by using Time, Distance and Direction which describe the angle between nodes and base station.

4. Related Work

In general update schemes can be classified into local (where update pattern is different for each and every individual Mobile Terminal (MT)) and global (update pattern is same for all the nodes). Again two classes of updates can be further classified into static and dynamic approaches. The current Personal Communication Systems (PCS) uses static global scheme in which network is divided into zones called Regional Areas (RA) and location update takes place only when the MT crosses the current RA . Blanket Paging is then used to find the exact location of the MT [1]. The larger the size of the RA lesser the update rate and higher the paging cost.

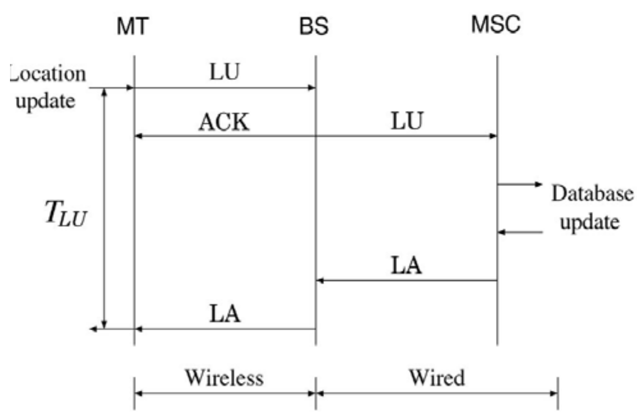

Figure 2 Location Update

To reduce the MT's update rate below the entropy bound, the proposed system exploits the Intelligent Agent Quantization by introducing new agent in the update process, that is, by transmitting only a quantized version of its necessary movement pattern. The three related but distinct forms of quantization:

4.1 Spatial: The MT groups contiguous cells into a spatial cluster and reports its movement pattern only at cluster-level granularity.

4.2 Temporal: The MT adaptively groups the movement sequences, where each sequence consists of a set of consecutive cells visited by the MT. It then reports to the network the movement pattern at the granularity of these “pattern-groups.”

Table 1 Comparison of Quantization

	Spatial Quantization	Temporal Quantization	Intelligent Quantization
Update Packets	6205	7284	6180
Energy Consumed (joules)	94.92	95.97	92.68
Delay (ms)	0.59	1.64	0.44

4.3 Intelligent Agent:

In all of these schemes, the MT observes its own changing cellular coordinates, stores this movement history locally, and intermittently updates the network with a coordinate sequence. Under spatial quantization, each coordinate represents a spatial cluster similar to conventional registration areas (RAs), whereas, under temporal quantization (TQ), each coordinate represents a group of cell sequences.

To reduce the location update cost below the entropy, instead of reporting the real pattern as such the compressed distorted pattern is sent. In the proposed schemes, the MT is thus responsible for four functions: tracking its own movement, storing its entire movement history efficiently (in compressed form) on its local disk, adaptively updating its quantizer, and transmitting the LZW-encoded updates to the network. The network controller receives the encoded updates, as well as modifications, and thus reconstructs and stores the MT’s movement history.

5. Simulation Study

The Spatial Quantization and Temporal Quantization algorithms are designed to illustrate the fundamental trade-offs in any abstract cellular environment. The simulated movement models is used to quantify the performance benefits of the proposed system and compared with the existing location management schemes. In particular, proposed system explores the potential reduction in the update cost versus the corresponding increase in the paging cost, as well as the energy and latency overhead on the MT. To study the performance, system is implemented using a network simulator, which takes as input a network topology and movement/calling trace and computes the resulting update loads.

Figure 3. Comparison of Number of Update Packets

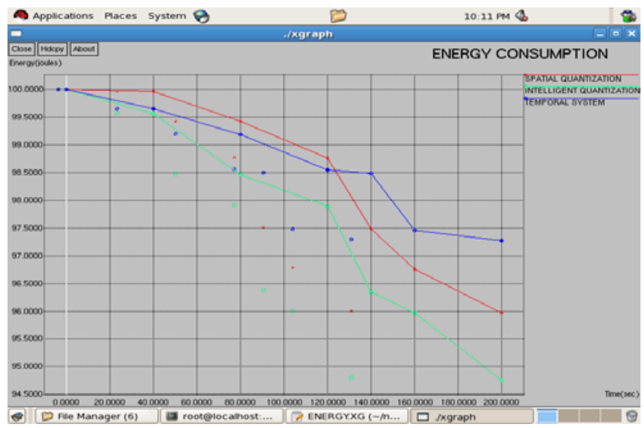

Figure 4. Comparison of Energy Consumption

Figure 5. Comparison of Delay

6. Conclusions

In this paper, we introduced a new an intelligent agent to reduce the updating cost. This agent has ability to handle the distance, direction and time, in which handling of direction is needed for further improvement.

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