Chapter IX
Network Planning Algorithms for Optimizing Signalling Load in Mobile Networks

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ABSTRACT

In the next generation IP-based mobile networks, one of the most important QoS parameters are the delay and the delay variation. The cell handover causes incremental signaling traffic, which can be critical from the point of view of delay variation. It worsens the quality parameters of the real-time services, which are the backbone of next generation mobile commercial services. We have designed and implemented two algorithms: a location area forming algorithm (LAFA) and a cell regrouping algorithm (CEREAL), which can help us to guarantee QoS parameters in the next generation mobile networks. We used our realistic mobile environment simulator to generate input statistics on cell changes and incoming call for our algorithms and by comparing the values of the cost functions proposed by us, we recognized that significant reduction was achieved in the amount of the signaling traffic, the location update cost was decreased by 40-60% in average. To confirm the results obtained by the realistic mobile environment simulator, a vehicular mobility simulator was used for generating the input to the algorithms for realistic vehicle mobility behavior. The same was recognized, that by employing our LA forming schemes, a significant reduction was attained in the signalling traffic that causes delay and delay variation, helping us improving QoS parameters in general.

INTRODUCTION

Signalling delay and the delay variation are very important service quality parameters of the next generation, IP based mobile networks. The cell handovers in mobile networks causes an incremental signalling message overhead (Akyildiz, Mcnair, Ho, Uzunalioglu, and Wang, 1998), which affects the delay variation and it is critical in the case of timing-sensitive real-time media applications. The signalling overhead is caused because the location information of a mobile is maintained by registration (Wong & Leung, 2000), where the mobile terminals update their location area information to their home agents (Location Management). The determination of the location of the user is also important, because the demand of mobile Location Dependent Information Services (LDIS) has fueled in recent years. (Jayaputera & Taniar, 2005) proposed a new approach to generate a query result for Location-Dependent Information Services. Another scope is when the users location moves from one base station to another and the queries cross multi-cells, (Jayaputera & Taniar, 2005) gave an approach of mobile query processing in these situations.

The determination of the optimal number of cells in each location area (LA) is a very important task, but the optimal partition of cells into LAs is an NP-hard problem. There was an important contribution in the determination of the optimal number of cells in an LA (Saraydar, Kelly, and Rose, 2000), but they were not focusing on the selection of the optimal set of cells for each LA. Therefore we propose a solution to obtain the optimal partition of cells for every LA.

The location area structure means that we can join several cells into one administrative unit, so-called location area, and in this way the cell border crossings inside this domain will be hidden for the upper hierarchical levels. Signalling overhead will be produced only when we cross a domain border, but that is rarer than a cell handover, thus the traffic of signalling messages will be reduced (Cayirci & Akyildiz, 2003).

The question arises: What size the LA should be? Both, increasing and decreasing the size have their own benefit. On the one hand if we join more and more cells into one LA, then the number of LA handovers will be smaller, so the number of location update messages sent to the upper levels will decrease. However in the case of numerous cells belonging to a single LA, an incoming call will cause lots of paging messages (Zhang, Castellanos, and Campbell, 2002), since we must send one to every cell to find where is the mobile user inside that LA. That will increase the load of base stations.

On the other hand if we decrease the number of cells, then we do not need to send so many paging messages (hereby we will load less links and the processing time will decrease, too), but then the number of LA changes will increase.

Accordingly we must search for the optimal compromise between these two conflicting aspects (Kameda & Li, 2000).

The LA management is classified according to its use of time, distance, movement profile information in its paging and location update procedures. The location update can be performed due to the time elapsed since the last registration process (Jun & Ho) or the number of cell boundary crossings measured since the previous update (Tsai & Hsiao, 2001). (Wong & Leung, 2001) recommend a distance-based scheme, where the location update will be performed, when a mobile user moves a threshold number of cells away from the cell where the last registration process was carried out. The hybrid of distance-based and zone-based is studied by (Casares-Giner & Mataix-Oltra, 2002). (Bar-Noy, Kessler, and Sidi, 1995) have compared time-, distance-, and movement based schemes in terms of location management cost, and they have shown that the distance-based one performs best. However, its implementation is hard since the distance of the mobile terminal has to be computed dynamically as it moves from cell to cell.