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A Centralized Approaches for Location Management in Personal Communication Services Networks

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ABSTRACT: A location management plays an important role in guaranteeing the effective operation of Personal Communication Services (PCS). With the increasing use of mobile devices, the need of Location Management in PCS Networks has emerged as a challenge to call delivery in an efficient manner. In order to facilitate all suitable parameters for the efficient functions of Location registration and call delivery, various approaches are being explored and modified in these days by research community to optimize the existing location management techniques. This paper makes an attempt to shed light on comparative analysis of such location management strategies.

KEYWORDS: PCS, GSN Network, Location Management, Call Delivery.

I. INTRODUCTION

Personal Communications Services (PCS) support mobile devices which are free to travel within the service coverage area. The network is composed of several functional entities: The *Mobile Station (MS)* which is carried by the subscriber; the *BSS (Base Station Subsystem)* that controls the radio link with the mobile stations; and the *MSC (Mobile Switching Centre)* that performs the switching of calls between the mobile users and between mobile and fixed network users. MSC is also responsible for *registration*, *authentication*, *location updating*, *handovers*, *call routing to a roaming subscriber* etc. In order to effectively locate an MS when a call is initiated, Location Management Schemes are used to keep track of the locations of the MTs. The current approach for location management requires each MT to report its location to the network periodically [13]. The location of the called MT is then stored in the databases. When a call is initiated, a database lookup and paging procedure determines the current location of the called MT. The cellular system has registered a rapid growth in world communication scenario now-a-days. The standard like GSM has captured around 78% of the world communication market through its widespread use in European countries, India etc. In GSM, a mobile unit (MU) is free to move around within the entire area of coverage. The movement is random and therefore the geographical location of mobile unit is unpredictable. In order to deliver a call to MU, it is necessary to have information about its current location. Location management are based on a two-level data hierarchy; Home location register (HLR) and Visitor Location Register (VLR) that involved the call tracking of MTs. HLR contains all the administrative information of each subscriber registered in the corresponding GSM networks along with the current location of the mobile. There is logically one HLR per GSM network, although it may be implemented as a distributed database. VLR contains selected administrative information from the HLR necessary for all control and provision of the subscribed services, for each mobile currently located in the geographical area is controlled by the VLR. Personal Communication Service (PCS) networks provide wireless communication services that enable Mobile Terminals (MTs) to transfer any form of information between any location at any time [1, 2, 3].

II. RELATED WORK

The network is composed of several functional entities: The *Mobile Station (MS)* which is carried by the subscriber; the *BSS (Base Station Subsystem)* that controls the radio link with the mobile stations; and the *MSC (Mobile Switching Centre)* that performs the switching of calls between the mobile users and between mobile and fixed network users. MSC is also responsible for *registration*, *authentication*, *location updating*, *handovers*, *call routing to a roaming subscriber* etc. In order to effectively locate an MS when a call is initiated, Location Management Schemes are used to keep track of the locations of the MTs. The current approach for location management requires each MT to report its location to the network periodically [13]. The provision of unrestricted mobility of mobile units creates a complex dynamic environment, and the location management component must be able to identify the correct location of a unit without any noticeable delay. The location management performs three fundamental tasks: (a) location update, (b)

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location lookup, and (c) paging. In location update, which is initiated by the mobile unit, the current location of the unit is recorded in HLR and VLR databases. Location lookup is a database search to obtain the current location of the mobile unit and through paging, the system informs the caller the location of the called unit in terms of its current base station. It is always necessary to have efficient location management to provide communication facilities for the users in mobility. New approaches and various strategies have appeared in research publications that reduce the handshaking overheads, improve the bandwidth usage and facilitate the call to subscriber with better response time. The location management approaches can broadly be classified as (1) Centralized approaches (2) Distributed approaches. Centralized approaches are based on a database located and maintained at one location. Hence these approaches keep information only at one node in the mobile network. IS-41 and GSM are centralized approaches in existing location standards. In this scenario, location updating and location lookup are simple and easy to implement but this approach faces severe problems like congestion, single point failure, and heavy load on the single point. High signaling cost, delays during high network utilization are some other drawbacks of centralized approach.

To improve the performance of network in respect with the location management and call delivery, various schemes have been proposed. The problems faced in centralized approach is not only every location request but service registration is also operated by a single node called HLR that becomes overloaded and gives rise to more problems like congestion, delay in call delivery etc. In order to overcome such type of problems, various approaches have been proposed. The *Local Anchor (LA) Scheme [4]* has been proposed to reduce the signaling traffic by using a local anchor (a VLR, a mobile user is currently visiting when a user receives a call).

In Distributed approach, the information about user location is distributed among various nodes in the network. Therefore, it provides better stability as compared to centralized approach. However, the operations like location lookup and location updating are performed in a complex way and hence needs high computation cost.

Various schemes and algorithms have been proposed to optimize the centralized as well as distributed approaches. This paper attempts to present a comprehensive overview of only centralized approaches/techniques.

III. PROPOSED SOLUTION

A. Centralized Approach

The HLR contains the permanent data of the MSs whose primary subscription is within the area. To assist routing incoming calls MS contains a pointer to VLR. A VLR is associated with a Mobile Switching Center (MSC) in the networks and contains temporary record for all MSs currently active within the service area of the MSC. The VLR retrieves information for handling calls to or from a visiting MS. To facilitate the tracking of a moving MS, a PCS network is partitioned into many Registration Areas (RAs). In a PCS network, there are several HLRs as shown in fig. 1.

The service area served by an HLR is referred to as Service Area (SA). The SA that is associated with the master HLR is called the master SA for the MS. When an MS moves to another new SA, the new SA that the MS resides is called the current SA.

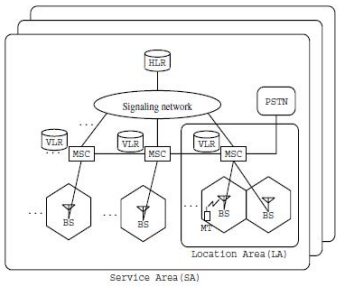

Fig. 1 A PCS network

The associated HLR is called the current HLR for the MS. The two basic operations in location management are location registration and call delivery. Location registration is the process through which system tracks the locations of MSs that move in the networks. When an incoming call arrives, the system searches the called MS (the"callee") by

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sending a location request message to the HLR of the callee. The HLR determines the VLR of callee and sends a location message to the associated MSC. Then the MSC sends the polling signals to all the cells in the RA to determine the cell location of the callee. This searching process is referred to as call delivery. In the existing location management schemes, only the master HLR is used for an MS even though it may move to another SA associated with another HLR.

When an MS moves far away from its master HLR, the communication costs for accessing the master HLR for both location registration and call delivery will be increased dramatically. This problem leads us to consider why current HLR of MS cannot be used for the location management to improve the system performance. To improve the performance of network in respect with the location management and call delivery, various schemes have been proposed. The problems faced in centralized approach is not only every location request but service registration is also operated by a single node called HLR that becomes overloaded and gives rise to more problems like congestion, delay in call delivery etc. In order to overcome such type of problems, various approaches have been proposed. The *Local Anchor (LA) Scheme [4]* has been proposed to reduce the signaling traffic by using a local anchor (a VLR, a mobile user is currently visiting when a user receives a call). In this scheme, a VLR close to the user is selected as the local anchor (LA) for the user. Whenever a user moves from one RA to another, it will perform location update to the LA. A LA for a mobile will change only when a call request to the mobile arrives; at the same time, the HLR is also updated via the registration process. When a call request terminating at this user is received by the HLR, the user can be traced to the LA. The LA scheme avoids update to HLR completely at the expense of the increase in local signaling traffic. The drawback of this scheme is that when the user keeps moving constantly without receiving any call, the updates to LA may become costly, a similar bottleneck as the HLR. Another scheme, *Per-user Pointer Forwarding Scheme* [5] has been proposed. In this scheme, some updates to the HLR can be avoided by setting up a forwarding pointer from the previous VLR to the new VLR. When a call request to a mobile user arrives, the PCS network first queries the user's HLR to determine the VLR, which the user was visiting at the previous location update, then follows a chain of forwarding pointers to the user's current VLR to find the mobile user. The traffic to the HLR is decreased by using the pointer chain; however, the penalty is the time delay for tracking the user when a call to the user arrives. The longer the pointer chain, the less the signaling traffic, the longer the setup delay for finding the user. To avoid long setup delay, a threshold of the length of the pointer chain is used. The user needs to perform registration to the HLR after the chain threshold is reached. In order to overcome the drawbacks these two schemes, *Two-level pointer forwarding strategy* was proposed [6]. Two kinds of pointers are used in this scheme. Some VLRs are selected as the Mobility Agents (MA), which will be responsible for location management in a larger area comparing to the RAs and can be geographically distributed. But the result concluded is that this strategy can significantly reduce the network signaling traffic for users with low Call to Mobility Ratio (CMR)[5]-[6] without increasing much of the call setup delay. Another scheme*[7]* proposed has suggested *caching technique* for current standards. In existing HLR/VLR scheme, call is routed through MSC to LR in which callee is located. When a particular MSC receives a large number of calls to a particular mobile that belongs to a different home system, the signaling and database cost involved in setting up the call can be significantly reduced by caching the location information at the calling MSC. Each time when a call is attempted, the cached information is checked first. Since the access time in looking up an entry in the cached memory is very short (in microseconds), checking the cached information for every call doesn't affect the performance of the MSC. In case of cache hit, call is directly routed to serving LR of callee. But in case of cache miss, HLR is needed to be contacted and call-establishing time will be longer than normal HLR/VLR scheme. Location information of MH is cached at an MSC if local call to mobility ratio (LCMR) maintained for the MH at the MSC is larger than a threshold derived from the link and database access cost of the network. LCMR is the ratio between the numbers of calls originating from an MSC to the number of times the MH changes its service area as seen by that MSC. However, this caching scheme may have cached invalid location information as MS moves into a new registration area. So a new location management strategy based on the centralized database architecture with HLR/VLR concept has been proposed. The basic idea is to reduce the cost of call delivery using location information cached at MSC/VLR. This scheme can't cache invalid location information. There is another scheme, *new caching technique [8]* proposed as announcing the location of MS to MSC/VLR or invalidating the location information by MSC/VLR. That is, cached location information, a miss can't occur. Therefore, the call setup delay for this proposed scheme is always shorter than, or equal to that of the current method. This scheme minimizes the total signaling cost on location management by reducing cost of call delivery more than increased the cost of the location update. An MS has two memory sets, a candidate and an update set. The candidate set includes the ID of the MSC/VLR that initiates a call for the MS and time at which call is delivered to compute the call frequency. The candidate set has a limited memory size. If the candidate set is full, an old entry is replaced by a new entry on LRU (Least Recently used) policy. However, if CMR (Call

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mobility Ratio) is low i.e. if the mobility is high compared to call request, the scheme may not be sufficient for the better performance.

Therefore, another scheme [9], fVLR has come forward to somehow resolve the issue. A mobile user moves anywhere in mobile networks and the location registration for call tracking is always needed. These registration operations cause high network traffics. In this scheme, a new simple mobility management is done by registering frequently dialed mobile phone numbers in a database, called fVLR. Using the fVLR scheme, cost of maintaining location of mobile users is being reduced. As per this scheme, when set up the call path between mobile users, first of all the VLR of the caller queries the callee's fVLR database for searching the location of the callee instead of requesting to HLR of the callee. The proposed fVLR database is stored or updated whenever mobile phone numbers are dialed by mobile users, that is, fVLR can be inserted by frequent dialing or deleted by no dialing during a certain period. Nevertheless, this scheme is feasible for only those users whose mobility is frequent.

B. Centralized Approach for Personal Communication Services Networks

As the number of PCS subscribers increase, the system overheads involved with the location management will increase beyond the capacity of the current network design. Methods for reducing the overheads are critically important for the design and implementation of PCS networks. A novel dynamic HLR location management scheme, *DHLR* (dynamic home location register)[10]for PCS networks has been introduced in which a dynamic copy of location information of an MS is made in the current (nearest) HLR which can be accessed for location management. In the proposed dynamic HLR management scheme, when an MS moves from its master SA (Service area) to a new SA, the new current HLR obtains a copy of the data about the MS from the old current HLR and sends an acknowledgment message to the old current HLR. An MS can always use the location data in its nearest (current) HLR for performing location registration and call delivery. This scheme concludes that the proposed method can reduce the total costs of location registration and call delivery comparing to the existing location management scheme significantly from about 20% to even 70%. Another scheme to reduce the cost of maintaining the location of users has also been proposed [11]. In this scheme, a VLR among group of several VLRs is chosen simply for location management. The chosen VLR so called *rVLR-B* (that is representative VLR for broadcasting) is registered as the representative VLR and performs broadcasting for searching mobile users. This scheme reduces the network traffic and involves less registration operations to some extent. This scheme proposes to manage the representative VLR of several VLRs and registers mobile users' location. When set up the call path between mobile users, the VLR of the caller queries callee's rVLR for searching the location of callee instead of requesting to VLR of callee. And then, rVLR broadcasts the callee's location to all VLR of the region concurrently. Location registration is only performed when a mobile user visits a new rVLR network area from current area. The selection of rVLR is quite challenging in this scheme for a huge network.

The centralized approaches discussed above are purely devoted to yield better methods to reduce location management cost and to improve call delivery in all possible circumstances.

IV. CONCLUSION AND FUTURE WORK

As per the above discussion about the centralized location management approaches, it is clear that location management and call delivery is performed on the basis of HLR and VLR

The approaches reviewed in the above section try to optimize the location management by making variations/modifications in the existing HLR/VLR architecture. However, a well-optimized, practically deployable solution for change in existing GSM architecture is still awaited. This keeps the area of mobile location management as a fertile research field and we hope to witness more optimized solutions related to this field in near future.

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