Comparative Study of Two Existing Location Management Schemes in PCS Network

Nilesh Patel[1], Er. Varinder Kaur Attri[2]

[1] Student,CSE, Guru Nanak Dev University RC, Jalandhar, Punjab

[2]Assistant Professor, Guru Nanak Dev University RC, Jalandhar, Punjab

ABSTRACT

Main aim of this paper is comparing the two schemes of location management in PCS network. One scheme is Database-Driven scheme and another scheme is HLR/VLR scheme. Database driven approach does not handle efficiently the mobility while HLR/VLR approach handles this situation efficiently. The comparison is based on the cost of both location update and location search. In PCS network, we emphasis on the mobility of the user and hence location management is more important to deliver the call efficiently. As mobility is very high hence we require frequent updation of the location information by reducing its cost.

Keywords: Location Management, Mobility Management, PCS, Database-Driven scheme HLR/VLR approach.

I.INTRODUCTION:

Cellular communication has been experiencing a rapid growth in recent years. Since its introduction in the early 1980s, cellular communication has been evolving from a costly service with limited availability toward an affordable alternative to wired telephone service. This wide acceptance of cellular communication has led to the development of a new generation of mobile communication network called personal communications services (PCS), which can support a larger mobile subscriber population while providing various types of services unavailable to traditional cellular systems. The introduction of different types of services and the establishment of new service providers will result in an unprecedented predicted growth in the number of mobile subscribers from 15 million currently to around 60 million by the year 2005. Both the research and business communities are equally excited by this predicted growth in the number of subscribers. The recent government auction of frequency bandwidth for the emerging PCS has resulted in fierce competition between both established and startup communication companies. In the research arena, a large number of studies are being performed. These research efforts range from the development of location management schemes, to the design of multiple access and channel allocation schemes, to the design of PCS network architectures. In this article, we focus on surveying the location management mechanisms in PCS systems. In ordinary wire line networks, such as the telephone network, there is a fixed relationship between a terminal and its location. Changing the location of a terminal generally involves network administration, and it cannot easily be performed by a user. Incoming calls for a particular terminal are always routed to its associated location because there is no distinction between a terminal and its location. In contrast, PCS networks support mobile terminals (MTs) that are free to travel, and the network access point of an MT changes as it moves around the network coverage area. As a result, the ID of an MT does not implicitly provide the location information of that MT. A location-tracking mechanism is needed for effective delivery of incoming calls. The current methods (IS-41, GSM MAP) for location management require each MT to report its location to the network periodically. The network stores the location information of each MT in location databases, and this information is retrieved during call delivery. Current methods for location management employ centralized database architecture, while tracking and searching of MTs involve the transmission of signaling messages among various components of a signaling network. As the number of mobile subscriber increases, this scheme will become inefficient, and new and improved schemes that can effectively support a continuously increasing subscriber population are needed[1,2].

II. NEED OF LOCATION MANAGEMENT

In PCS, location management enables the network to determine the MU's current LA for call delivery. It is a two-phase process implying location update and location search. Location update occurs when the MU enters a new LA and notifies the network of its new location. Location search occurs when an MU is called; in which case the network database is queried in order to determine the MU's current LA. Currently, there are two commonly used standards for location management: Interim Standard 41 (IS-41) [2,3] and the Global System for Mobile (GSM) Mobile

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Application Part (MAP) . Both standards employ a two-level database architecture consisting of one Home Location Register (HLR) and many Visitor Location Registers (VLRs), referred to as HLR/VLR(s) architecture in this study and shown in Fig. 1. In this architecture, the HLR serves the entire network and is considered the centralized database of the network. It permanently stores the location profile and subscriber parameters of its assigned MUs. The VLR serves one LA or more and stores all the relevant parameters of the MUs that roam within the LA(s) that it controls. It is usually collocated with an MSC. In order to deliver the calls correctly we need to maintain the location management. Two standards currently exist for PCS location management: IS 41 (Commonly used in North America) and GSM MAP (It is popular in Europe and Asia). Both strategies share the same characteristic, they both use of two tier system of HLR-VLR databases. Next section is shedding light on HLR-VLR approach[1,3].

III.HLR-VLR APPROACH

In the HLR/VLRs architecture, the network database HLR is consulted during the processing of an incoming call. Conversely, the HLR is updated as the MU moves to a new LA and is serviced by different VLR within the network. Querying the HLR every time a location search or a location update is performed results in tremendous strain on the use of the network resources due to the signaling traffic and database access load. This may significantly degrade the performance of the network with today's high number of subscribers. Reduction of signaling and database access traffic constitutes a growing research issue. Several strategies have been recently proposed.

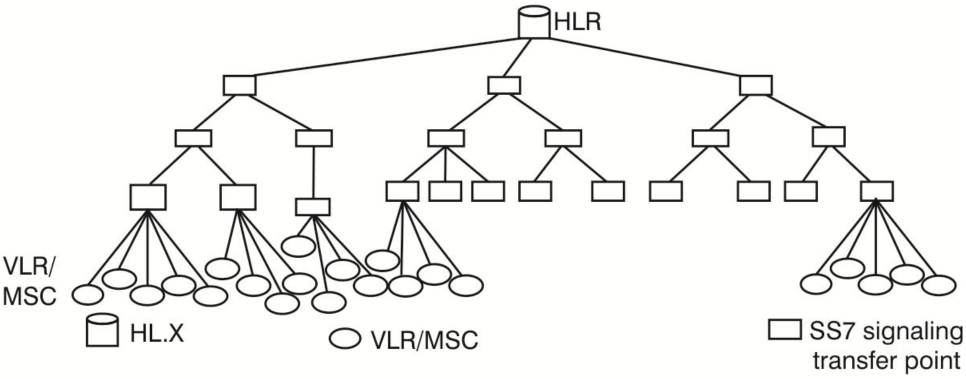

Fig1: HLR-VLR Architecture

To calculate location update cost we are using the formula given below:

$$M_{HLR-VLR} = [P(m_{a,n}= 1) \times C_m(1)] + \sum_{i=2}^{R} P(m_{a,n}= i) \times \{2 \times C_m(1) + C_m(R) + 4T(1,R)\} \ldots\ldots..(\mathbf{1})$$

The first part of Eq. (1) is the cost of location update in intra-VLR move. The second part illustrates the scenario after an inter-VLR move. T (1, L) =T (1, 2) +T (2, 3) +……..+T (L-1, L) is equal to the cost of traversing links between a node of layer 1(i.e., VLR) and the node of layer R (i.e., where an HLR is located). This cost is multiplied by 4 because new VLR sends registration request to the HLR, the latter sends cancellation request to the old VLR, old VLR sends an acknowledgement in response to the HLR and finally HLR confirms the registration of new MT at the new VLR. Transmission cost of the message is described as follows: T(1,L)=T(1,2)+T(2,3)+……..+T(L-1,L)T (1, 2) will give the result 2; T (2, 3) will give the result 3 and so on[4].

IV. DATABASE DRIVEN APPROACH

Distributed database driven architectures are proposed by Anantharm *et al* and Wang. In these architectures, the HLR/VLRs architecture is replaced by a large number of location databases that are organized as a tree with the root at the top and the leaves at the bottom. The MUs are associated with the leaf databases. Each database contains the location data of the MUs that are residing in its sub tree. When an MU moves to a new LA belonging to a different leaf database, all the databases along the path from its old LA to its new LA are updated to indicate the correct location of the MU. When a call is initiated the databases are queried sequentially, starting from the database of the calling MU and going up till

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reaching a database that contains an entry for the called MU, then following this entry down till the MU is located. This architecture reduces the distance traveled by signaling messages but increases significantly the database access, which results in large processing delays for location update and location search procedures. A similar architecture is proposed by Mao and Douligeris but it uses a three-level tree to represent the covered region. There is a common drawback with the architectures; the crash of the root database (or master database) may paralyze the entire system. In this context, the study proposes a new architecture to improve the performance of the location management in the PCS networks[4,5,6].

V. LOCATION UPDATE AND SEARCH

In the database driven architecture, the location update occurs at all the databases on the path between the old LA and the new LA. Therefore, the estimated cost of a location update operation in this scheme can be written as following:

$$M_{database} = \sum_{i-1}^{R} P\,(Ma,n=i)*[\sum_{j-1}^{i-1} [4T(j,j+1) + 2Cm\,(j)] + Cm\,(i)] \;\ldots\ldots\ldots\; (2)$$

For, R=5 we have

$M_{database}$ = P (Ma,n = 1) * Cm (1) + P (Ma,n = 2) * [4T(1,2)+2 Cm (1)+ Cm (2)]+ P (Ma,n = 3) * [4T(1,2)+2 Cm (1)+ 4T(2,3)+2 Cm (2)+ Cm (3)]+ P (Ma,n = 4) * [4T(1,2)+2 Cm (1)+ 4T(2,3)+2 Cm (2)+ 4T(3,4)+2 Cm (3)+ Cm (4)] + P (Ma,n = 5) * [4T(1,2)+2 Cm (1)+ 4T(2,3)+2 Cm (2)+ 4T(3,4)+2 Cm (3)+ 4T(4,5)+2 Cm (4)+ Cm (5)]

Hence, $M_{database}$ at various values of p

p	0.0	0.2	0.4	0.6	0.8	1.0
$M_{database}$	81	44.3344	22.4464	10.3344	4.1104	1

The estimated cost of a location search in the database driven scheme is given by:

$$M_{database} = \sum_{i-1}^{R} P\,(Ma,n=i)*[\sum_{j-1}^{i-1} [4T(j,j+1) + 2Cm\,(j)] + Cm\,(i)] \ldots\ldots\ldots\ldots(3)$$

For, R=5 we have

Rdatabase = P (Ma,n = 1) * Cm (1) + P (Ma,n = 2) * [4T(1,2)+2 Cm (1)+ Cm (2)]+ P (Ma,n = 3) * [4T(1,2)+2 Cm (1)+ 4T(2,3)+2 Cm (2)+ Cm (3)]+ P (Ma,n = 4) * [4T(1,2)+2 Cm (1)+ 4T(2,3)+2 Cm (2)+ 4T(3,4)+2 Cm (3)+ Cm (4)] + P (Ma,n = 5) * [4T(1,2)+2 Cm (1)+ 4T(2,3)+2 Cm (2)+ 4T(3,4)+2 Cm (3)+ 4T(4,5)+2 Cm (4)+ Cm (5)]

Hence, $M_{database}$ at various values of p[5,6]

P	**0.0**	**0.2**	**0.4**	**0.6**	**0.8**	**1.0**
$M_{database}$	81	44.3344	22.4464	10.3344	4.1104	1

VI. RESULT

We present the numerical results of the comparison between the HLR/VLRs and database driven models. We consider various values of R and L. In this analysis, we assume that the database access cost in layer i is equal to i, the cost of crossing a link between layer i-1 and layer i is equal to i and 13.We denote M (database driven/MHLR/VLR) the relative cost of the location update procedure for the database driven model to that of the HLR/VLRs model. These costs are obtained from Eq. 1-6. A relative cost of 1 means that the costs under both models are the same. Tables above shows the performance of the analyzed schemes with R = 5 and various values of L (i.e., L = 2, 3, 4). Users are classified with respect to their moves. When p is very small (i.e., The MU moves are not local), the HLR/VLR scheme outperforms the database driven scheme because a great number of signaling messages is exchanged between the various databases in the database driven scheme. The latter scheme is the most costly. When p = 1.0, the performance of both the schemes is equal. We observe that the performance of the database driven scheme improves when p increases significantly (p>0.7) due to the decrease in the number of signaling messages during the location update when the MU's moves become local.

Probability (p)	**HLR/VLR**	**Database driven**
0.0	63	81.000
0.2	50.600	44.334
0.4	38.2	22.446
0.6	25.8	10.334
0.8	13.4	4.1104
1.0	1.0	1.000

Table 2: HLR-VLR V/S Database Driven Approach (For Updation Only)

Probability (p)	HLR/VLR	Database driven
0.0	62	81.000
0.2	49.8	44.3344
0.4	37.6	22.446
0.6	25.4	10.334
0.8	13.2	4.1104
1.0	1.0	1.0

Table 3: HLR-VLR V/S Database Driven Approach (For Search Only)

VII. CONCLUSION

In Personal Communication System, a subscriber is free to change its location. Location update must be done in efficient manner so that the next call to the appropriate subscriber must be routed. Table 2 and 3 are summarizing the results of database driven approach and existing HLR-VLR approach. From the above tables 2&3 it is clear that when mobility is very high (i.e. p=0.0) HLR/VLR architecture is efficient than Database Driven approach. When MUs are static means not changing its location both the approaches are showing the same behavior.

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