Work Done on Avoidance of Bottleneck in PCS Network

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ABSTRACT

This paper contains work done on avoiding the bottleneck from network using some formulas and techniques that we have surveyed and studied. This is done by replicating the primary copy of HLR at same level which provide all services of primary HLR when it is not in serving mode. Also we have analyzed its performance and drawn results on this basis.

KEYWORDS*: PCS, Location Management, HLR-VLR, Replicated databases, mobile computing.*

I. INTRODUCTION

We studied the various replication techniques to replicate HLR in PCS network. Replication is the key strategy for improving reliability, fault tolerance and availability in Distributed System. Personal Communication Service (PCS) network is the integration of cellular Network and conventional wired network. To support user mobility, the locations of the mobile stations (MSs) should be constantly tracked using a database. The widespread deployment of PCS will lead to a tremendous increase in the number of updates and queries to the location database. The centralized, stand-alone Home Location Register (HLR) in GSM can be a potential bottleneck. In case of the location database failure, incoming calls may be lost. According to the analysis of the load in HLR, we suggest replicating the HLR in order to increase its capacity and reliability. We compare all the replication strategies in order to maintain availability, consistency and fault-tolerance in PCS Network to avoid bottleneck.

1.1. Multi HLR Architecture Scheme in PCS Network:

In conventional HLR-VLR scheme, De-registration of a Mobile Terminal from a Visitor Location Register is always explicit. Explicit in the sense that stale entries of Visitor Location Register s are removed with the help of Home Location Register. Actually Home Location Register sends De-registration message to the Visitor Location Register to remove the stale entries when a Mobile Terminal changes its Visitor Location Register. This explicit De-registration increases the total cost by increasing the traffic load. To reduce the traffic load following De-registration strategies were proposed [2].

(A) Distance Based De-registration Scheme.
(B) Time-Based De-registration Scheme.
(C) Polling-Based De-registration Scheme.
(D) Group De-registration Scheme.
(E) Movement-Based De-registration Scheme.

In the proposed architecture, we have several HLRs zone wise or circle wise instead of a single Home Location Register. It reduces the storage overhead of the Home Location Register. Each Home Location Register can serve more than one Visitor Location Register and each Visitor Location Register can serve more than one RAs. Simply we can say that this architecture contains several conventional HLR-VLR architectures.

II. PERFORMANCE ANALYSIS OF MULTI HLR ARCHITECTURE:

An analytical model to evaluate the performance of multi HLR architecture has been presented here along with the group de-registration strategy implemented in same architecture. Here all HLRs are located at the same layer and they are communicating each other in point-to-point basis. In this analysis, hierarchal trees of R layers are being used. The layer R contains the roots of all trees and leaves of all trees are at the level 1. It means both roots and leaves reside on the same layer.

Following terms are being used in the performance analysis:-

$m_{x,y}$ Layer of the closest common node to RA x and RA y.
p Probability that the MT move is intra-VLR.

n New RA of the MT.
a Old RA of the MT.
P ($m_{x,y}$=i) is defined as the probability that the closest common node to LA x (RA x) and LA y(RA y) is in layer i. This probability can be given by the following equation.

$$P_{m(a,n)} = p(1-p)^{i-1}) \; for \; i = 1, 2, \ldots \ldots R-1$$
$$(1-p)^{i-1} \; for \; i = R \ldots \ldots \ldots . . (1)$$

We furthermore denote the costs of various operations used in this analysis as follows:
T (i, j): Cost of transmitting a message over a link between two adjacent layers i and j.
Cm (i): Cost of accessing or updating a database in layer i.
$M_{multi\ HLR\text{-}VLR(explicit)}$: Estimated cost of a location update in the explicit multi HLR-VLR scheme.

$M_{mutiHLR\text{-}VLR\ (group)}$: Estimated cost of a location update using group de-registration scheme in multi HLR-VLR architecture.

Estimated cost of location update in explicit stand alone HLR-VLR scheme is given as:

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

The first part of Eq. (2) 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.

Estimated cost of location update with group de-registration scheme is given as follows:

$$M_{HLR-VLR(explicit)} = [P(m_{a,n} = 1) \times C_m(1) + 1] + \sum_{i=2}^{R} P(m_{a,i} = i) \times \{2 \times C_m(1) + 3 \times C_m(R) + 2T(1, R)\} \ldots . (3)$$

The first part of this Equation number (3) is the cost of location update in intra-VLR move. The second part illustrates the scenario after an intra-VLR move. When an MT leaves its RA and enters into new RA the new VLR sends a registration request to the HLR. HLR keeps the identification of the MT into the OML of the old VLR. After performing the MT's profile update by accessing its database HLR sends the acknowledgement message along with the OML of new VLR. We see that HLR database is being consulted three times. The first access is done for putting the MT's identification into the old VLR's OML, second time for updating the MT's current location information and third time for emptying the OML of new VLR, further the entries of this OML is sent back with the acknowledgement. At the VLR side database is being consulted twice, first for the registration of new MT and second for de-registration of the entries sent by the HLR.

In part 3 of this equation, we are generalizing the movement of an MT when MT leaves its resident-HLR and enters into new serving-HLR and then after it again changes its serving-HLR to another serving-HLR. A cost of 4 is being added to it because of the following reasons: Let an MT leaves its resident-HLR and enters into a serving-HLR say serving-HLR1. Again the same MT leaves this serving-HLR1 and enters into another serving-HLR say serving-HLR2. In registration process of MT in serving-HLR2, it sends location update to resident-HLR (cost incurred is 1), on reception of this message, resident-HLR updates the location information of MT and sends a location cancellation message to serving-HLR1 (cost incurred is 1). On reception of this message, the serving-HLR1 deletes the location information of this MT. The serving-HLR1 acknowledges the resident-HLR about the location cancellation message (cost incurred is 1). Finally the resident-HLR acknowledges the serving-HLR2 (cost incurred is 1) and location registration takes place at the serving-HLR2. As all HLRs are the same level hence message exchange cost between the two HLRs is T (1, 1) =1.

III. RESULTS

In this section the numerical values of explicit de-registration scheme and group de-registration scheme implemented in the multi HLR-VLR architecture are evaluated and compared. Fig (6) and (7) show the performance of location update schemes with R=5 and R=3 respectively.

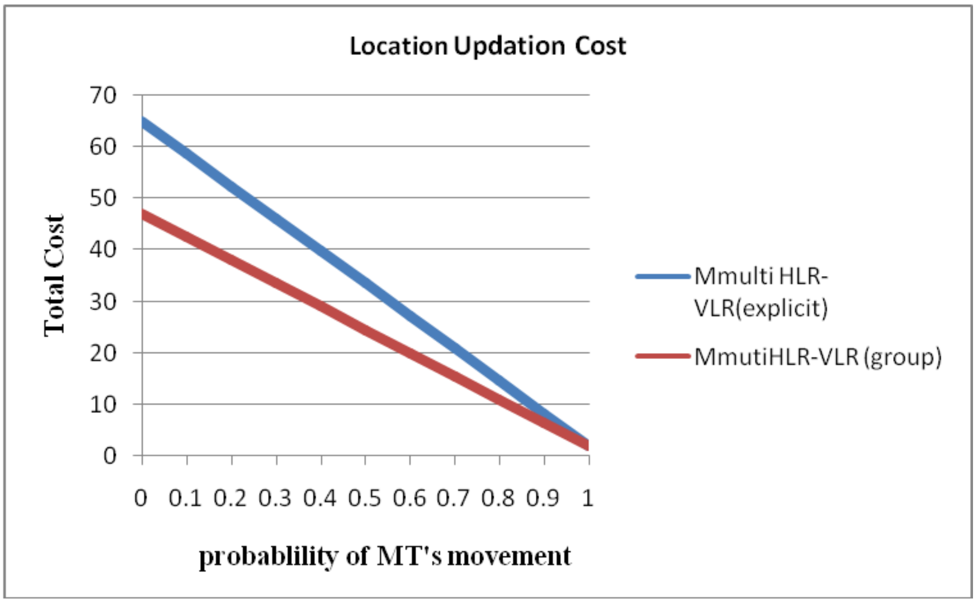

Figure 1: Location update cost for R=5

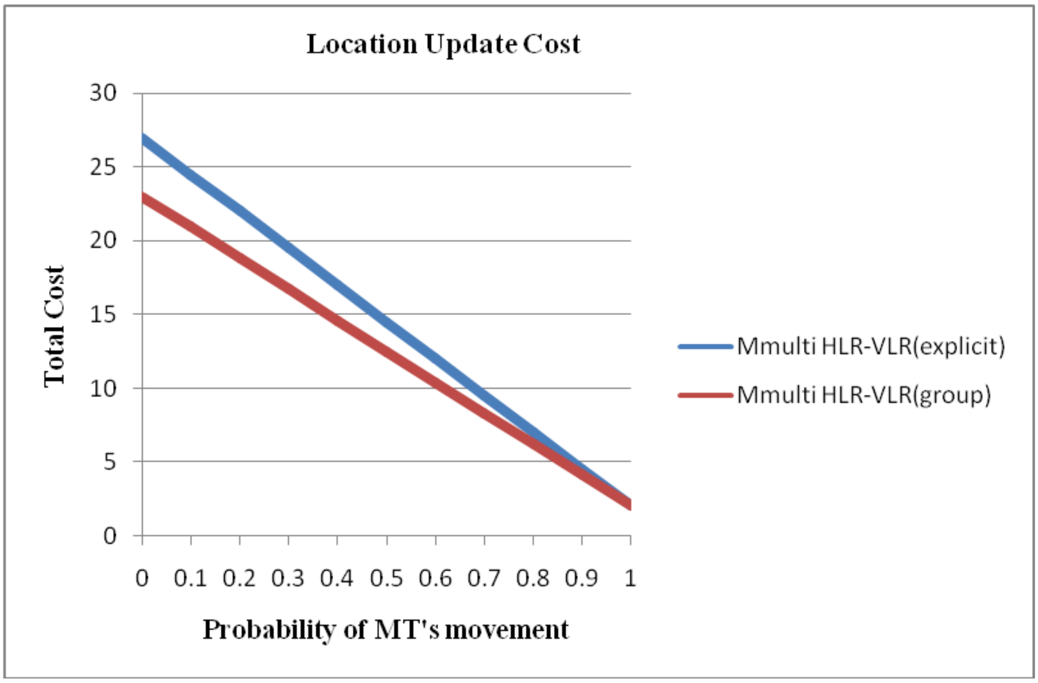

Figure 2: Location update cost when R=3

Probability shows that the MT will reside in its resident-HLR. Probability and indicate that MT will be in serving-HLRs. When has value 1 then MT is not changing its resident-HLR. Probability p defines the MT's intra VLR move. If p equals to 1 then MT is not changing its location. When p tends to 0, it means MT's move is not local. When and p are equal to 1, MT is in its resident-HLR and not changing its location and hence location update cost is 1. When and p equals to 0, it means MT is not in its resident-HLR and its move is not local with respect to serving-HLR. When and p equal to 0, it shows the maximum degree of movement.

IV. CONCLUSION

Conventional architecture has a single HLR and that's why it suffers from call misrouting and bottleneck during peak load. To remove this, several conventional architectures are group together to form multi HLR architecture. In this scheme we store the user profile in HLRs zone wise. This approach reduces the storage load on HLR and hence minimizes the possibility of bottleneck. Now in this architecture even in high load appropriate information is fetched from HLRs and we significantly minimize the possibility of call misrouting.

Analysis done in the last section shows that total cost incurred into the location management in the proposed multi HLR-VLR architecture using group de-registration scheme is efficient than the explicit de-registration scheme. The proposed architecture is free from the problem of bottleneck as we are not entirely relying on one HLR. We have not any stale entry of MT in any VLR as we have associated the de-registration process of the MT with its movement and saved sufficient cost by implementing group de-registration scheme instead of conventional explicit de-registration.

REFERENCES

[1] W.F. Ames. Numerical Methods for Partial Differential Equations. Academic Press, 1977.

[2] R. Aris. Discrete Dynamic Programming. Blaisdel, 1964.

[3] D.R. Bailes and C.J. Taylor. The Use of Symmetry Chords for Expressing Grey Level Constraints. In Proc. British Machine Vision Conference, pages296-305. Springer, 1992.

[4] D.H. Ballard. Generalizing the Hough Transform to Detect Arbitrary Shapes. Pattern Recognition, 13:111-122, 1981.

[5] R. Bellman. Dynamic Programming. Princeton University Press, 1957.

[6] A. Blake and M. Isard. Active Contours. Springer, 1998.

[7] G.J. Borse. Numerical Methods with Matlab. PWS, 1997.

[8] J.P Boyd. Chebyshev and Fouirer Spectral Methods. Springer, 1985.

[9] W. Cheney and D. Kincaid. Numerical Mathematics and Computing. Brook-s/Cole, 1985.

[10] J.H. Chuang. Potential-Based Approach for Shape Matching and Recognition. Pattern Recognition, 29:463-470, 1996.

[11] P.G. Ciarlet and J.L. Lions. Handbook of Numerical Analysis, Volume 5. El-sevier, 1997.

[12] L.D. Cohen. NOTE On Active Contour Models and Balloons. Computer Vision and Image Processing: Image Understanding, 53:211-218, March 1991.