Improved Location Scheme Using Circle Location Register in Mobile Networks

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Abstract. We propose Circle Location Register (CLR) scheme to solve Home Location Register (HLR) bottleneck problem and terminal's Ping-pong effect in Mobile Networks (MN). Each Visiting Location Register (VLR) has a given fixed circle Registration Area (RA) around itself and has IDs of other VLRs in this circle area. Whenever a terminal moves to another RA, system computes whether the terminal is located in the current CLR area, and sends the recent location information of terminal to the old or new CLR according to computing results. The proposed scheme reduces to location traffic cost compared with IS-41scheme.

1 Introduction

The Interim Standard-41(IS-41) and Global System for Mobile Communication(GSM) [1-3] based mobility management scheme which records all the movements of terminals in a centralized DB, HLR, is questionable considering that keeping track of lots of users in real time is not a simple task. This scheme has been the bottleneck problem on HLR which occurred in due lots of signal transfer between one HLR and many VLRs and Ping-pong effect which arise frequently in the boundary of RA because of the terminal's Ping-pong movement. For this case, frequent DB queries and call updates will degrade the system performance.

2 Proposed Structure

In this scheme, each VLR acts as a CLR and has a given fixed circle area (k-circle) around itself and IDs of VLRs which are included in its circle area. When a terminal powered on, the VLR which includes terminal becomes the CLR of terminal and the terminal's latest location information is sent to the CLR when terminal changes its RA. This state is maintained as long as the terminal is located in the current k-circle area. When the terminal moves to new VLR from the current CLR's k-circle, the new

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VLR becomes the CLR of the terminal. By this manner, the k-circle of the terminal can be changed dynamically. This mechanism can be performed easily by comparing VLR_id which current CLR has with VLR_id where terminal moved. For the example in Fig. 1, suppose the 1-circle which consists of seven VLRs where current CLR is VLR_1 and the others are VLRs which are included in 1-circle area. The terminal is located in VLR_5 now. If the terminal moves to the new RA, VLR_6, the CLR isn't changed, and VLR_6 sends the terminal's new location information to VLR_1, current CLR. If the terminal moves to VLR_10, the current CLR of VLR_1, has no id of VLR_10. Thus the CLR is changed, and VLR_10 belongs to the new CLR of terminal.

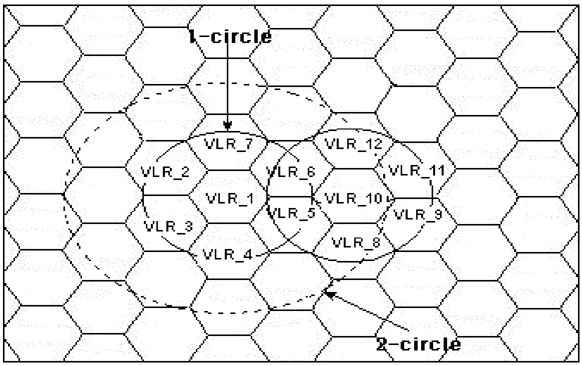

Fig. 1. CLR Structure

In mobility management algorithm, this following shows the Pseudo-code for location registration and call tracking algorithm.

Algorithm Location Registration
{
Terminal's current CLR id, VLR_xxx, received from old VLR;
Compare VLR_xxx with My_CLR_entry;
If VLR_xxx exist in My_CLR_entry, then Send terminal_CURR_LOC to CLR;
else { Write TID to MY_CLR_Area; //*belongs to a new CLR of the terminal
Send terminal_CURR_LOC to HLR;
Send REGCANC to VLR_xxx; //*REGCANC is registration cancel message
}
If call location update, then the terminal which moved to a new RA requests registration to the VLR of the new RA;.
The new VLR inquires the id of the terminal's current CLR to the old VLR and the old VLR replies to the new VLR with ACK message including this information;
The new VLR calculate and determines whether the id of current CLR exist in its VLR list of not;
end if hit, then After sending the location information of the terminal,
the new VLR send a registration cancel message to the old VLR;

else miss, then after transmitting location information of the terminal to HLR,
the new VLR transmits registration cancel message to old VLR and old CLR;
}

Algorithm Call tracking
CLR FIND( )
{
Call to MN user is detected at local switch;
If called party is in the same RA, then return;
else {
Switch queries called party's HLR;
Called party's HLR queries called party's current CLR, VLR_xxx;
VLR_xxx returns called party's location to the calling switch;
} }

3 Performance Analysis

To estimate the call cost, we assume a mobility model for MN users. The direction of movement is uniformly distributed over [0, 2π]. The MN users are uniformly populated with a density of ρ. The rate of RA crossing, R is (1/π)ρvL where the average velocity of users is v and RA boundary is of length L. In order to simply performance analysis, call cost parameter and cost set are defined using formulas [4].

In Fig. 2, we can see that proposed method has lower cost than IS-41 scheme, even though it is a worst case of proposed method provides mostly same cost as IS-41 scheme. The worst case takes places when ratios of six cases are same. In other word, it occurs when LSTP connected with very few RAs (i.e., less then three VLR/MSC). But we know that a LSTP's coverage is more than that of three RAs generally. The worst case of proposed scheme seldom occurs in actual networks. We know that the next generation wireless system will adopt smaller RA. It means that a LSTP will cover more wide registration area. We can see that the proposed scheme is more efficient than IS-41scheme.

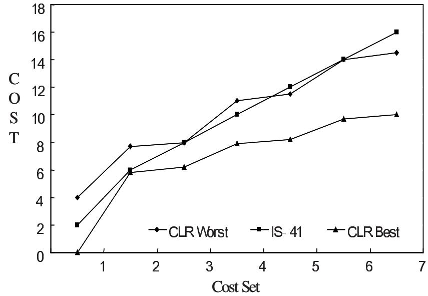

Fig. 2. Location registration cost

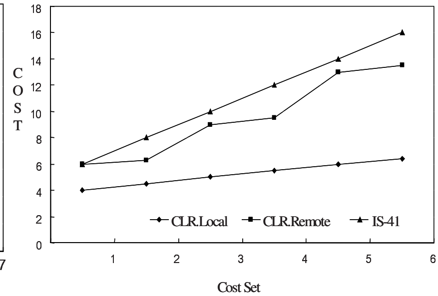

Fig. 3. Call tracking cost

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4 Conclusions

In this paper we proposed CLR method, which is effective for smaller cell and more frequent terminal moving pattern. Each VLR has a given fixed circle registration area around itself and has IDs of other VLRs which belong to the circle in proposed method. VLR only computes whether the terminal is located in the current CLR area or not by comparing the old VLR id with its ids. Then it sends recent location information of the terminal to the old or new CLR according to computing results

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