A Survey on De-registration Schemes in PCS Network

Rajeev R. Kumar Tripathi[1], G.S. Chandel[2], Ravindra Gupta[3]

Abstract— In Personal Communication Network (PCS), the Mobile Terminal (MT) frequently changes its location. Whenever an MT changes the Registration Area (RA) that results in change of Visitor Location Register (VLR), the Home Location Register is updated. The HLR provides the profile of MT that is cached in the current serving VLR. The HLR informs the previous old VLR to de-register the MT from its database as the MT is currently residing in the new RA being served by another VLR. In this way the current PCS network avoids the stale entry of the left MT. When a call is originated for an MT, the current location of the MT is determined from the HLR end even though called and calling MTs both are residing in the same VLR. Location management and call delivery cost both increase in the same proportion as the number of database access increases.Higher the database access higher will be the cost. In PCS network, the HLR has always the information about the current location of MT. The existing call delivery scheme encourages the idea that whether it is necessary that de-registrtaion of the left MT should be explicitely controlled by the HLR as in existing location management scheme. In past years various de-registration schemes were proposed to reduce the traffic signal incurred in the location management cost as: distance based, movememt based, polling, timeout and group de-registration schemes. This paper is shading light on the various de-registration shemes.

Index Terms— Personal Communication Network, Explicit De-registration, Distance based De-registration, Movement based De-registartion, Polling De-registration, Timeout De-registartion Scheme, and Group De-registration Scheme.

1 Introduction

THE PCS network uses two-tier database architecture: Home Location Register (HLR) and Visitor Location Register(VLR). In PCS network, cell is the smallest coverage area. Ecah cell has a dedicated Base Station (BS). On requirement, the PCS network may use Base System Controller (BSC) to manage a group of BSs. Collection of cells are known as Registration Area (RA). A BSC may serve more than one RAs. A group of BSCs are connected to Master Switching Center (MSC). In general VLRs are collectively located with the MSCs. The MSC is known as heart of PCS network as it performs: call routing; bandwidth management etc. In PCS network there is a single HLR. Many VLRs are connected with the HLR. In HLR MT's profile are stored on permanent basis. Profile subset of the MT is cached in the VLR where the MT resides. This cached subset profile is used to authenticate the MT and to determine the services that the MT is availing from the network.

Location management is needed when an MT performs the movement. Movement of an MT can be classified into two ways: Intra-VLR Movement and Inter-VLR Movement. In intra-VLR move, the MT performs the movement but does not leave the VLR. In this case the MT may change the RA such that both the RAs are being served by the same VLR. In this movement, the VLR is updated, the HLR remains unaffected.

In the inter-VLR move, the MT changes the VLR.

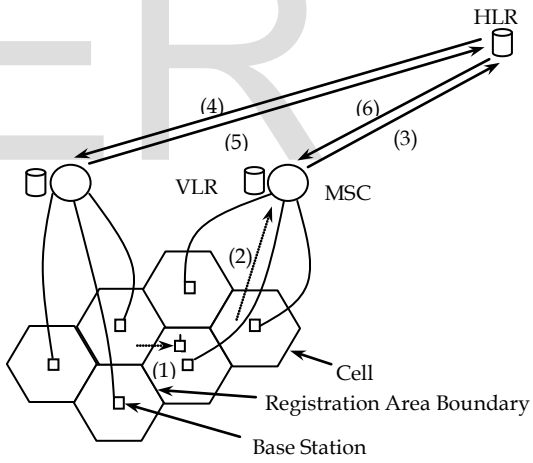

Fig1. Location Management in PCS Network

The MT comes to an RA which is being served by a new VLR. In this move, the new VLR informs the HLR, the HLR updates the location information of the MT. The HLR sends the location cancellation meassge to the VLR from where the MT is detached. The removal of the MT's entry from the previous VLR is required to make the network free from the inconsistent information about the location of an MT. The forcely removal of the MT's entry is termed as explicit de-registration scheme.

The location management procedure requires the following steps as:

For intra-VLR move:

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1. The MT changes the location; this change in location is updated at the VLR end. If the MT is performing the movement within the RA, there is no need to update the VLR. If the MT changes the RA, then and only then it is updated to the VLR. The HLR is not updated in this case.

For inter-VLR move: In this move, following steps are invloved.
1. The MT detects that it is in a new RA, it sends location registration message to the MSC/VLR through the nearest BS.
2. The VLR registers the MT at its end. The VLR sends this information to the HLR. The HLR updates this information and sends acknowledgemnt to the new VLR with the subset of the MT profile.
3. The HLR sends registrtation cancellation message to the old VLR to de-register the MT. The old VLR de-register the MT and sends acknowledgement to the HLR.

This process of removing stale entry from the VLR is called explicit de-registration. In PCS network, call delivery process has the following steps:
1. When a call is initiated by the MT, call initiation signal is sent to the MSC through the BS.
2. The MSC of calling MT sends location request to the HLR to get the current location of the called MT. The HLR determines the current location of MT and sends a route request to the serving MSC of called MT.
3. The MSC determines the current location of MT and assigns a Temporary Location Directory Number (TLDN) to the called MT and sends this TLDN to the HLR.
4. The HLR sends the TLDN to the MSC of calling MT. Now MSC can setup a connection to the called MSC through the PSTN.

The current call delivery scheme consults the HLR to get the current location of the MT even though calling and called both MTs are residing in the same VLR[1-4].

2. TROMBONING PROBLEM

In existing call delivery scheme, when a call is initiated, the current location of the called MT is determined by querying the HLR. In the PCS network, the HLR has always the location information of the MT. When calling and called both MTs are residing in the same VLR, then is it required to consult the HLR to get the current location of the called MT? If call routing is made via the serving MSC of both called and calling MT, we can significantly reduce the traffic and the time. This situation is termed as tromboning problem.
To avoid this problem when a call is initiated, location of the called MT should be first checked in the VLR database where the calling MT is residing. If called MT is found in the same VLR, it is termed as a *hit*. In case of a *hit* we have reduced the traffic that is required in querying the HLR and call setup time. If called MT is not in the VLR, it is termed as a *miss.* In case of *miss*, the HLR is consulted to get the current location of the called MT [4-5].

If an MT only performs location updates, without making any call, during busy hours HLR is updated again and again. Total cost increases in the same proportion as the number of database access increases. There is another aspect that we can explore that"Is it necessary to remove the entry of the MT from the old VLR? We are determing the current location of the called MT by querying HLR." The next section is shading light on some de-registartion scheme:

3. DE-REGISTRATION SCHEMES

As number of HLR access increases, the HLR tends to condition of bottleneck during peak load. The bottleneck may result into either HLR failure or call miss routing. This section is dedicated to the various de-registration schemes:

3.1 Implicit De-registartion Scheme

This scheme says that there is no any need to delete entry of MT from the VLR. Registration of MT is already taking place at new VLR and HLR has updated this information.In [1] this scheme was implemented and its performance was found better than the existing scheme. This scheme suffers from additional storage overhead.

3.2 Polling De-registartion Scheme

Polling de-registartion scheme is used to remove the entry of left MT from the VLR.After a fixed time the polling signal is transmitted periodically in the RAs. The MTs residing in the RAs received the signal and respond the MSC by sending the acknowledgement. Polling de-registration scheme is shown in the figure 2. On basis of received acknowledgements, the MSC determines that which one MT has left the RA. Entries of those MTs are removed from the VLR.

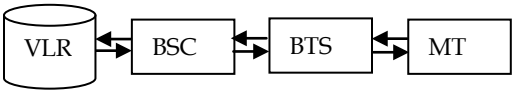

Fig 2. Polling de-registration

3.3 Timeout De-registartion Scheme

This scheme is a refinement of polling de-registration scheme. In this scheme, an MT periodically registers itself with the MSC. This fixed time is known as timeout period. After the timeout period, the MSC comes to know that how many MTs have left this RA. Those MTs who have left the RA are removed from the VLR database. The time out de-registartion is shown in the figure 3.

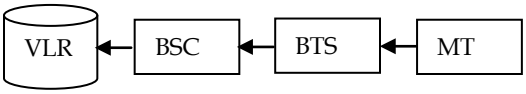

Fig 3. Timeout de-registration

The timeout de-registartion and polling de-registartion schemes are suitable enough to remove the stale entries from the VLR but these schemes are actually based on time. In polling and timeout de-registartion schemes, the stale entries are being removed after a time. If an MT left the RA before the timeout or polling de-registration starts, the stale entry of the MT will reside in the network. In [2-4] performance of timeout

and polling de-registration are compared and found that timeout de-registration is more efficient than the polling de-registration.

3.4 Movement Based De-registartion Scheme

In this de-registartion scheme a threshold on the basis of movement performed by the MT across the cell boundary is made. When the MT reaches this threshold by performing the movement this de-registration starts. This de-registration scheme is shown in the figure 4.

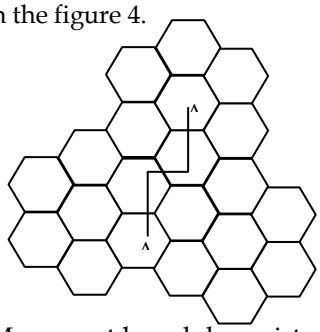

Fig4. Movement based de-registration

When an MT '*A*' reaches the movement threshold 3(the threshold value), de-registration takes place.

3.5 Distance Based De-registartion Scheme

In this de-registration scheme a threshold is defined on the basis of distance between two cells. This distance threshold is counted from the cell where last location update was made. When the MT reaches this threshold value de-registration takes place. This scheme is shown in the figure 5.

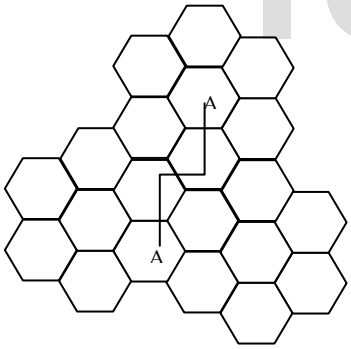

Fig5. Distance based de-registration

When the MT 'A' reaches the distance threshold 2(threshold value), the de-registration process takes place.
Actually in the above two schemes, the MT performs the location registration on reaching the threshold value. If change in location of MT (i.e. the MT has changed the VLR) is noticed by the HLR, de-registration process is started. Nov and Sidi [5] evaluated these schemes by using a simplified one-dimensional movement model. Result shows that distance based de-registartion scheme is better than movement based de-registration scheme. Due to overhead involved in the movement based and distance based de-registration schemes they were not implemented further. The first two schemes suffer from the problem of synchronization. Z. Mao proposed group de-registration scheme to solve this problem.

3.6 Group De-registration Scheme

In group de-registration scheme, the HLR maintains Old Mobile List (OML) for each VLR. In this OML, the HLR keeps the record of those MTs who have left a VLR. When HLR receives a location update for an MT, it does not send any location cancellation message to the old VLR from where this MT is detached. When the HLR receives any location update from the old VLR, then it sends the OML list to the VLR along with the acknowledgement that the location registration sent by the VLR is received and updated successfully in its database. When the VLR receives this acknowledgement with the OML then it comes to know that some of the MTs registered in its database in now registered into another VLR, and finalliy deletion process of these MT's entry starts. These steps can be summarized in the following steps:

1. When an MT comes into a new RA, the VLR associated with the new RA sends a registration request to the HLR to update the location information of the MT
2. The HLR receives the request and updates this location information in its database. The HLR does not immediately send a registration cancellation message to the old VLR; the HLR keeps the identification of the MT in the OML of the VLR from where it is detached
3. The HLR sends an acknowledgement to the new VLR of the MT along with a copy of the MT's service profile and all MT identifications kept in the OML of newVLR. Now the OML is empty.
4. The VLR receives the acknowledgement message and the OML. On reception of the OML, the VLR comes to know that following MTs have left its RAs. After determination of left MTs, the VLR starts the process of removal of stale entries.

Thus the invalid MT's identifications are removed from the VLR every time a new MT enters the RA. This de-registration scheme is more efficient than the polling and timeout de-registration scheme. In this scheme de-registration process is entirely based on the movement not on time.

Perfomance analysis of polling, timeout and group de-registration scheme is evaluated in the [2]. Result shows that cost wise timeout de-registration scheme is more efficient than the polling and group de-registration scheme. As polling and timeout de-reghistration schemes suffer from the problem of synchronization [2] concludes that group de-registration scheme is the most appropriate de-registration scheme. In [3-5] group de-registration scheme is implemented with the multi HLR architecture. Result shows that group de-registration scheme is more efficient

than the explicit de-registration scheme in multi HLR architecture [3-5].

4. CONCLUSION

De-registration schemes are important because it can significantly reduce the traffic generated due to location update. Bandwidth is a scarce resource in wireless communication. Less traffic means low requirement of bandwidth. Intelligent use of bandwidth provides better Quality of Service (QoS).It helps the HLR not to move towards bottleneck condition and call miss routing can not take place. If a call is initiated for an MT, before consulting the HLR to get the current location of the MT, the serving VLR of calling MT should be checked first to get the current location of the MT. If both calling and called MT is being served by the same VLR then we can significantly save the time required in establishing a connection. It is to be noted that it is a heuristic approach. If a hit occurs time requirement is less else the HLR is consulted to get the current location of the MT.

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