# An Efficient Technique for Inter/Intra Network Handover Process

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**Abstract**— In a telecommunication system, run of prepaid mobile balance and degraded signal strength are two important reasons for the disruption of mobile conversation besides other reasons. Presence of multiple Subscriber Identification Module (SIM) cards in the mobile handset can facilitate us to avoid disruption partially that improve the overall call quality. In our work, we proposed a novel handover technique that uses multiple SIM to avoid such disruptions. Our work shows a guideline of necessary network operations that should be performed at the telecommunication switching centers to establish an inter/intra network handover.

**Keywords** — Inter/Intra System Handover, Mobile Telecommunication, Call Quality, Signal Strength.



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## 1 Introduction

Now-a-days mobile phone becomes very popular. It is more popular than the fixed line telephone because of its mobility and access of network at fair rate without any cable. There are usually two kinds of billing system the telecommunication mobile companies offer - postpaid and prepaid system. Although postpaid mobile is more popular than the prepaid mobile in most of the countries, in some third world countries like Bangladesh, Prepaid system becomes popular among general people and telecommunication companies earn a large revenue from the postpaid packages. Although for a typical user in these countries prepaid system can be more comfortable, but a major disadvantage of it is the disruption of a conversation due to the run of the mobile balance. This is one of the specific problem our work is intended to solve.

In cellular communication system, the physical mobile devices are equipped with Subscriber Identity Modules *(SIM)* card. It holds the necessary information of the operator that enables the device to communicate to the cellular operator. A multi-SIM mobile phone is one which holds two or more SIM cards. Since dual-SIM handsets are major among them, we generally call a multi-SIM mobile phone a dual-SIM phone that is more intuitive for present days. Dual-SIM mobile phones are available since 2000 [18]. A mobile device that holds more than two SIM card are also available [16], [17]. In many countries, a lot of mobile users use dual-SIM mobile phone. Day by day, number of dual-SIM activated mobile users are increasing rapidly because of different levels of unique tariffs and facilities offered by the different mobile communication vendors [13] . It negates the need for having two or more separate devices with SIM cards of different operators. Dual-SIM phones are very popular in developing countries mostly in Southeast Asia and Indian subcontinent.

Multiple SIM cards are being used by 71 million subscribers across India according to a study by Nielsen in 2012. They also found that 75 percent of the Multi-SIM card users intended to buy a dual-SIM card handset and 4 out of every 5 Multi SIM card users own a single handset [13]. As of Q1 and Q2, 2013, around 44.9 and 50.8 million respectively dual-SIM handsets were sold in India [14]. Strategy Analytics forecasts on dual-SIM handset penetration to reach 20% worldwide by 2016 [15]. Samsung has dual SIM versions of many devices in their offering. Research shows that some devices enjoyed a great success in sales due to its dual SIM compatibility feature despite of being exceptionally poor in performance [14]. Dual-SIM phones also allow for easier roaming by being able to access a foreign network while keeping existing local card.

Dual-SIM phone devices are equipped with two transceivers. They are capable of receiving calls on both SIM cards unless one is being used for a conversation. In this paper, we will call a *SIM* active *SIM* on which a conversation is being taken place and the other *SIMs* passive SIMs which are ready for carrying a conversation. Although existence of multiple SIM cards naturalizes several advantages to the user, it cannot help switching between SIM cards when an active conversation is being interrupted due to the expiration or run out of mobile balance. Again, during a conversation, when network signal of the active operator is weakened enough to drop the call, despite of the presence of SIM of another (passive) operator there is no way to transfer the call from the active operator to the passive one. In this work, we will try to find a solution to continue an ongoing communication in that circumstances through an

alternative SIM card (i.e. alternative vendors).

This paper is embodied as follows. We will explain our motivation in Section II. Next, we will describe the related works in Section III and it will be followed by our proposed solution, Section IV demonstrates the handover process architecture. Limitation of the work is given in Section V. Finally the paper is concluded in Section VI.

## 2 Motivation

Avoidance of disruption of ongoing communication is very important to a telecommunication system. It can also be taken as a quality measuring criteria of communication system. In cellular telecommunication system, handover is one of the most important processes so that the conversation can be continued in difficult situation by transferring it from one channel connected to the core network to another channel. Although simple handover works fine in some situations, it cannot help in many other situations.

In a prepaid mobile system, a user needs to buy a finite amount of balance. For different facilities used by the user, the provider deducts certain amount of balance from the user's account. It is often happen that an ongoing call is disconnected only due to the run out of the balance of the caller. That is why the fluency and flow of the conversation may fall. To avoid such a disruption, the operator may provide loan of additional balance that can in turn be used up before the conversation is finished. Naturally a user needs to buy the balance again to continue the conversation that cannot be easily possible without being disconnected.

A single SIM mobile handset user may not have any easy way to avoid such a circumstances. But a multi-SIM handset user usually re-establishes the call by calling through the other SIM. Still, this process is manual and it needs to disconnect the active connection and it is followed by reconnection by the other (*passive*) communication channel.

Sometimes another situation can also arise. For a mobile caller, if the condition of the atmosphere affects and degrades its active communications, the call quality can be improved by handing it over to the passive SIM.

Usually a SIM card is associated to a user in a telecommunication network system. When a single user uses a multi-SIM handset and it holds more than one active SIM cards, it would be best to automate the transfer of the conversation from the active SIM to passive SIM.

The main motivation of the work is to take advantages of multi-SIM mobile handsets to improve call quality. It is done by automating handover process in network level as well as at the handsets level.

## 3 Related Works

As If there is no disruption, mobile communication is much more efficient than the fixed line communication to the mobile users. However, there are many unwanted disturbance occurs during a conversation which may not be avoided because of lack of technologies. Mobile telecommunication conversation can be dropped for the several reasons. When a calling mobile host *(MH)* is not be fixed, it may move from one cell to another cell of the network. In the moving time from one cell to another one, handover in same network is necessary to avoid call drop that is introduced by [7], [8].

In the *GSM* or cellular communication system handover is controlled by the *BSC*. Handover can be initiated by the network depending on the quality of the signaling strength of the Mobile Switching Center *MSC* and the new and old *BSC*. When a Mobile Station *(MS)* first establishes connection with the *BSC*, the *MS* may send a message to the base station to confirm its capabilities so as to allow the system to properly accommodate the *MS*. In *GSM* network, the message is sent to *MSC* when the information is needed. Billing System (BS) (referred as Billing Gateway or BGW in some literature) is responsible for calculation bill run-time.

Inter-system handover [4], [3] is a special technique that happens between different networks. It is needed when the handset is out of one network cell but inside a cell of different network. When a new network is being introduced it can take some time to install all the base stations and associated apparatus. For that, there is a delay before the new network provides the full geographical coverage. If the new network does not provide the full coverage, the customer will be dissatisfied by its coverage to the old network. The cost of the new network is high and no return can be gained from it until it is in use. A method has been proposed to tackle this problem by allowing mobile station using the new network to be handed over the calls to the old network when they move outside the coverage of the new network. This is known as Inter-system handover [4].

Along with the handover system management there are several kinds of technologies exist to solve the partial problems of the network as like Dynamic Buffering Control Scheme [12], Handover Management for Mobile Nodes in IPv6 Networks, Handover Process [10], Handover Management Architectures [11], Inter system handover [4] etc. But the cost of the technologies is little bit high. Because an operator used to charge high to another operator when a call of the second one uses resources of the first one.

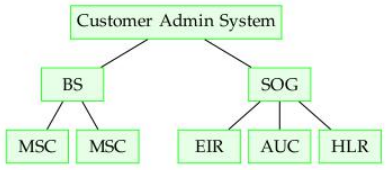


Figure 1: Relation of the BS (or BGW) with the SOG.

So, to reduce the cost, a method is proposed in this paper. When the first network does not have the full coverage, we propose to establish a second call using passive SIM of its own operator so that the operator can think it as its own call.

The proposed method in this study is needed when the

balance is finished during the conversation time. It is basically a different version of inter-system handover for completely different purposes.

Several procedures take place to setup a call. If anyone wants to setup a call, the network maintain such kind of system as the bill must be checked by Real-time charging

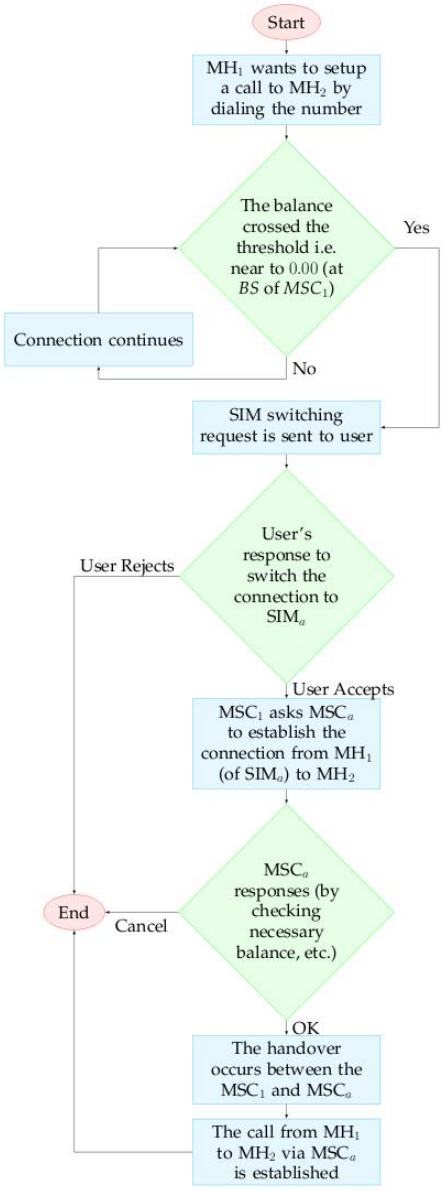


Figure 2: The flow chart of soft handover process when balance is near to be finished.

of Billing System *(BS)*, the Home Location Register *(HLR)*, the Authentication Center (*AUC)* and the Equipment Identity Register *(EIR)* must be checked by the Service Order Gate Way (*SOG)*. In figure **1** the billing system and the checker of the *HLR* are shown how they are connected [5]. In this study the presented proposal must reduce the cost of the re-setup call and also reduce the delay time.

## 4 Handover Process Architecture

If the balance is gone to run out, or the time of weaker signal strength, it is very important to handover with the alternative *SIM* to continue to keep the fluency of the conversation. According to the aspect of the presented process architecture, a method/rule is provided for performing inter-system handover when balance is being finished or when the network signal strength falls. The first protocol is about when the balance comes near to finish and the second protocol is regarding the falling of the networks signal strength.

The method may comprise the step of monitoring at least one condition indicative of a need for the said handover, and initiating the handover when the said condition is beyond a second threshold. The second threshold is being preferably beyond the first threshold. So that the further information may be transmitted in advance of the handover itself being initiated.

In figure **2** our proposed inter/intra system handover is shown by the flow chart view when the handover is needed in the time of the expiration of the balance. It explains the procedure of the handover in the network system when it is needed. Let $MH_1$ being the calling mobile host, $MH_2$ being the receiving mobile host, $MSC_1$ is being the master switching control of $MH_1$ in a mobile conversation. Also let $SIM_1$ being the *SIM* associated to the network operated by $MSC_1$, $SIM_a$ being the alternative *SIM* available and ready at $MH_1$ and $MSC_a$ being the *MSC* that controls the network of the $SIM_a$.

With a sufficient balance the conversation should be continued uninterrupted. During a conversation, the run-time charging is operated at the billing system and it informs the *MSC* about the current balance status.

Informally, when the balance is expired (or crosses a predefined threshold), the $MSC_1$ informs the $MH_1$ that the balance is about to be finished and requests an answer if it wants to continue the conversation. Software/apps may get activated upon arriving of such a request. The software may show a yes/no dialog asking the user to respond. If the user responds positively, it will indicate that he/she wants to handover the call to the alternative *SIM*. A negative answer will terminate the call naturally. The software may also have functionality to perform necessary tasks at the device end to support the handover. The software/apps may show additional information that helps the user to take decision, but it is out of the scope of this discussion. When the user responds positively the software sends back the reply along with the information of the alternative SIM i.e. the mobile numbers and name of its respective networks operator that is controlled by $MSC_a$. $MSC_1$ then requests $MSC_a$ to establish a call between $MH_1$ and $MH_2$ via $SIM_a$. $MSC_a$ accepts the connection if and only if the $SIM_a$ has sufficient balance. In absence of sufficient balance of $SIM_a$, the handover would not take place.

Two cases may arise - a) the *MSC* of $MH_1$ and $MSC_a$ are belongs to two different operators and b) they are belongs to the same operator. The first case is typical but the second one is special.

In the first case, the communication channel after the handover will be from $MH_1$ to $MH_2$ via $MSC_a$, $MSC_1$ and *MSC* of $MH_2$. It can be tuned by establishing a channel from $MSC_a$ to the *MSC* of $MH_2$ directly. It is an inter

network handover.

In second case, the handover can be tuned to establish a cost effective conversation channel. Here $MSC_1$ is supposed to handle the total communication alone. It is an intra network handover.

The two cases are discussed in detail below.

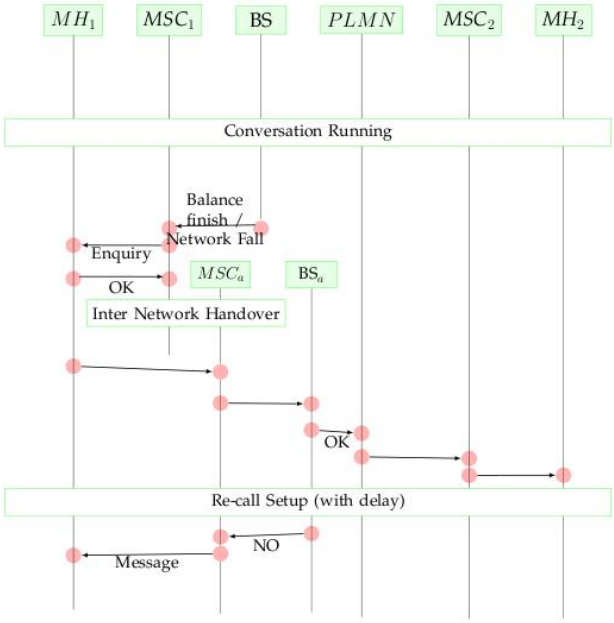


Figure 3: Inter network handover for different operators when balance crossed the threshold of either near to zero balance or significantly degraded signal strength.

### 4.1 Handover between Different Networks

The $MH_1$ and $MH_2$ are belongs to different operators. In the time of conversation, if the balance is being finished, the *BS* is being informed the $MH_1$ that the balance is already finished and also asks the $MH_1$ users if he/she wants to handover the call with the alternative *SIM* he/she must press 'OK'. If the user presses 'OK' then there an inter-system handover will take place and the $MSC_1$ will connect with $MSC_a$ and $MSC_a$ requests the $BS_a$ for checking the balance. If the $MSC_a$ is being said 'OK' by $BS_a$, then $MSC_a$ will be connected with *PLMN* and then *MSC* of the $MH_2$ and after that a re-connection will be setup between $MH_1$ and $MH_2$ via $BSC_a$. If the network signal strength is being fall, the call re-setup is as same as above description. It is shown in figure **3**. By using the arrow line the connection is shown in the particular figure.

### 4.2 Handover Process Inside the Same Networks

In figure **4** $MH_1$ and $MH_2$ is the same operator and they are placed in different *MSC* and different *BSC*, and the third one which help to intra-system handover to continue the conversation with the help of the same network is also the same operator. When a call or conversation is running between the same operator and in the running time the balance is being finished the $BS_1$ gives a message to the $MSC_1$ that the balance has to be finished and it also inquiries the caller that if $MH_1$ wants to handover the call to the alternative *SIM*, if the sender or $MH_1$ press OK, the $MSC_1$ then hand it over with the $MSC_a$ and $MSC_a$ asks the $BS_a$ to checks the bill, after checking the bill the $BS_a$ gives a message. If the balance is sufficient then the $BS_a$ connects with the *PLMN* of the $MSC_2$ and the *PLMN* makes a connection with the $MSC_2$ and after that the $MSC_2$ connect with $MH_2$ via the $BSC_2$ Then the call will be re-setup.

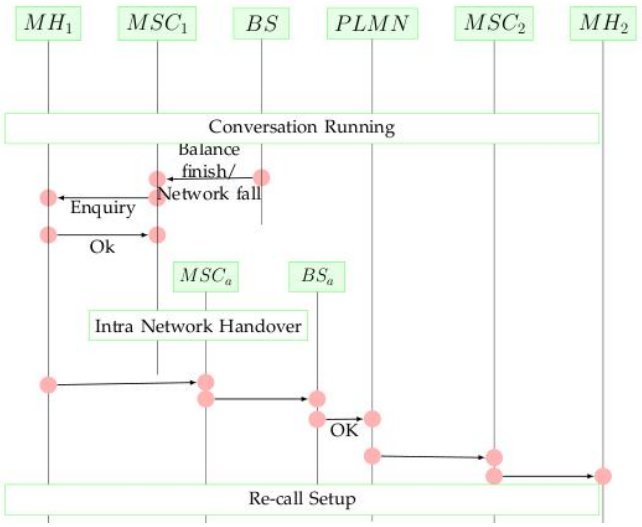


Figure 4: While conversation is running in the same operator an intra network handover is needed.

Other objects features of the presented method will become apparent from the following detailed description considered in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are intended solely for purposes of illustration and not as a definition of the method, for which reference should be made.

## 5 Limitation of Our Work

We have proposed a theoretical method to solve the problem. The available wireless telecommunication simulation software does not fit for simulating our proposed solution. The available simulation software provides features mainly to measure physical quality of the system. It is almost impossible to simulate *BS, PLMN*, and *MSC* etc. apparatus for different mobile operators with the currently available software. Therefore, we are planning to develop a simulator for our purpose. We also want to test it in real life if at least two mobile operators agree to carry out the research.

## 6 Conclusion

We have presented a new and efficient technique for the inter/intra system handover in the time of balance finishing and network signal strength falling that helps to reduce the delay time to re-establish the call that is subjected to the inter handover process. The proposed protocol is ethnic enough to do work along with the operator management protocol. In now-a-days there is no method available for that both particular cases. Though there exists many type of handover process in time of

network signal strength falling but they are more expensive than the method we have proposed in our paper. There is no method available for regarding the run out or expiration of the balance. The proposed method is not only for network falling but also for the expiration of the balance that helps to reduce the cost and time to establish a new call. For those reasons the proposed method should be preferable.

## REFERENCES


[1] Lee, K.C. and Karmi, G. and Mohanty, B. and Sutton, T.R. and Ziv, N.A. (1999, August 17). Inter-system calling supporting inter-system soft handoff. US Patent 5940762. Available Online: http://www.google.com/patents/US5940762 (accessed on 15 August 2014).

[2] Tekinay, S.; Jabbari, B. Handover and channel assignment inmobile cellular networks. Communications Magazine, IEEE, vol.29, no.11, pp.42, 46, Nov. 1991 doi: 10.1109/35.109664.

[3] Johnson, C.; Cuny, R.; Davies, G.; Wimolpitayarat, N. Inter-System Handover for Packet Switched Services. 3G and Be-yond, 2005.

[4] Back, J. and Hulkkonen, T. and Vainola, K. (2006, August 8). Inter- system handover. US Patent No 7089008 B1. Available Online: http://www.google.com/patents/US7089008 (accessed on 15 August 2014).

[5] Ericsson, GSM System Servey, student text EN/LZT 123

[6] , 2008.

[7] Bell, J.R. (2002, September 3). Call re-establishment for a dual mode telephone. US 6445921 B1. Available Online: http://www.google.com/patents/US6445921 (accessed on 15 August 2014).

[8] Pollini, G.P. Trends in handover design. Communications Magazine, IEEE , vol.34, no.3, pp.82,90, Mar 1996 doi: 10.1109/35.486807

[9] Viterbi, A.J., Viterbi, A.M., Gilhousen, K. and Zehavi, E. Soft handoff extends CDMA cell coverage and increases reverse link capacity. Mobile Communications Advanced Systems an Components, Lecture Notes in Computer Science, Springer Berlin Heidelberg, vol.783, pp.541-551, 1994.

[10] Li Ma; Yu, F.; Leung, V.C.M.; Randhawa, T. A new method to support UMTS/WLAN vertical handover using SCTP. Wireless Communications, IEEE , vol.11, no.4, pp.44,51, Aug. 2004 doi: 10.1109/MWC.2004.1325890

[11] Tripathi, N.D.; Reed, J.H.; VanLandinoham, H.F. Handoff in cellular systems. Personal Communications, IEEE , vol.5, no.6, pp.26,37, Dec 1998.

[12] Lampropoulos, G., Passas, N. I., Merakos, L. F., and Kaloxylos, A. (2005). Handover management architectures in integrated WLAN/cellular networks. IEEE Communications Surveys and Tutorials, 7(1-4), 30-44.

[13] Dutta, A., van den Berg, E., Famolari, D., Fajardo, V., Ohba, Y., Taniuchi, K. and Schulzrinne, H. (2006, September). Dynamic buffering control scheme for mobile handoff. In Personal, Indoor and Mobile Radio Communications, 2006 IEEE 17th International Symposium on (pp. 1- 11). IEEE.

[14] Farshad Family, The Rise of Multi-SIM users: Customers shifting to dual SIM phones to have effective control over costs, The Nielsen Company. Press Release, 2012.

[15] Asif Shaik (2013, 24 September). Dual-SIM mobiles phones are wildly popular in India. Available Online: http://www.gomonews.com/dual-sim-mobiles-phones-are-wildly-popular-in-india/ (accessed on 15 August 2014).

[16] Linda Sui (2011, 16 November). India Leads Emerging Markets in Driving Dual-SIM Handset Sales. Available Online:

[17] http://www.strategyanalytics.com/default.aspx?mod=reportabstractviewer&a0=6860 (accessed on 15 August 2014).

[18] LG A290. Available Online: http://www.lg.com/in/mobile phones/lg-A290 (accessed on 15 August 2014).

[19] Cherry Mobile Q70 Quad. Available Online: http://www.cherrymobile.com.ph/products/lifestyle/q70-quad (accessed on 15 August 2014).

[20] Benefon and VLP Introduce a World Innovation: Benefon Twin Dual SIM Utilizes Two SIM Cards, PR Newswire. Available Online: http://www.prnewswire.co.uk/ (accessed on 15 August 2014).



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