Managing BTSs to Solve Handover Problem in Mobile Network

Wael Etaiwi, Haitham Almhairat, Mujahed Jarad and Laith Batarseh

Al-Balqa' Applied University, Al-Salt, Jordan

Abstract—**Handover is a key solution that improves the telecommunication services using GSM by assure the continual service delivery between two mobiles regardless of location's changes of the sender or receiver, and now GSM technology becomes applicable all over the world and the customers become more satisfied to the dealer's services delivery, But Handover suffers from a major problem refers to the limitation of hardware capacity of the BTS (Base Transfer Station).**

This approach consists of three schemes, the first one based on reserve an extra ports for handover purposes by implementing a software solution that control BTS ports. The second alternative scheme based on channel exchange between adjacent BTSs by shifting a chosen allocated signal to another adjacent free BTS and then allocating the new signal to the new free port. The third schema depends on carrying the Handover problem to another BTS to solve it if it didn't solved in the second schema.

Index Terms—**Handover, BTS, BSC, channel exchange, mobile network, ports allocation.**

I. INTRODUCTION

A. Handover

The process of changing cells during a call is called handover in GSM terminology (Global System for Mobile Communications). To choose the best target cell, measurements are performed by the MS (Mobile Station) and the RBS (Radio Base Station). Because the MS contributes to the handover decision, this type of handover is often called Mobile Assisted Handover (MAHO).

B. Locating

An MS continuously measures signal strength and quality on its own cell and signal strength on the BCCH (Broadcast Control Channel) carriers of the neighboring cells. The measurements are carried out on the downlink while MS is in active mode. The measurement results are sent to the RBS on SACCH (Slow Associated Control Channel) at regular intervals. The serving RBS measures signal strength and quality on the uplink. The measurements from the RBS and MS are sent to the BSC (Base Station Controller) in the form of measurements reports. Based on these reports, the BSC decides if a handover is necessary and to which cell. This is called locating. As soon as a neighboring cell is considered to be better than the serving cell, a handover is attempted.

Another reason for attempting a handover, apart from signal strength and quality, is when the Timing Advance (TA) used by MS exceeds a threshold value set by the operator. This usually happens when the MS is moving
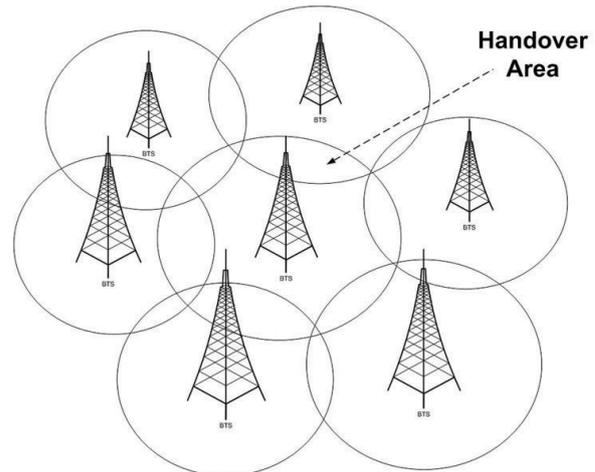

Figure 1. This figure represents the Handover Area

over the cell border to another cell. When the MS has changed cells, the new RBS informs the MS about the new neighboring BCCH carriers so measurements can be taken again. If the MS has also switched to a new LA (Location Area), a location updating type normal takes place after the call has finished. Handover can be used for load balancing between cells. During a call setup in a congested cell, the MS can be transferred to a cell with less traffic if an acceptable connection quality is likely to be obtained. Another area where forced handover is a useful tool is maintenance. Channels can be released from traffic if necessary, e.g. for RBS maintenance reasons.

There are several types of handover, including:

- Intra-cell handover.
- Handover between cells controlled by the same BSC.
- Handover between cells controlled by different BSCs, but the same MSC/VLR.
- Handover between cells controlled by different MSC/VLRs.

Each of these traffic cases is described in greater detail below. In each case, the decision to perform a handover has already been made and a target cell has been identified.

1) Intra-Cell Handover

A special type of handover is the intra-cell handover. It is performed when the BSC considers the quality of the connection too low, but receives no indication from the measurements that another cell would be better. In that case the BSC identifies another channel1 in the same cell, which may offer a better quality, and the MS is ordered to retune to it.

Note: the BSC will attempt to handover first to a channel on another frequency. If none are available, it will perform a handover.

2) Handover between Cells Controlled by the Same BSC

When performing a handover between two cells controlled by the same BSC, the MSC/VLR is not involved. However, the MSC/VLR will be informed when a handover has taken place. If the handover involves different LAs, location updating is performed once the call is finished.

As shown in figure 2, the Handover perform as:

1. The BSC orders the new RBS to activate a TCH.

2. The BSC sends a message to the MS, via the old RBS, containing information about the frequency and time slot to change to, and also the output power to use. This information is sent to the MS using FACCH.

3. The MS tunes to the new frequency, and transmits handover access bursts in the correct time slot. Since the MS has no information yet on TA, the handover bursts are very short (only 8 bits of information).

4. When the new RBS detects the handover bursts, it sends information about TA. This is also sent via FACCH.

5. The MS sends a Handover Complete message to the BSC via the new RBS.

6. The BSC tells the old RBS to release the old TCH.

3) Handover between Cells Controlled by Different BSCs but the Same MSC/VLR

When another BSC is involved in a handover, the MSC/VLR must also be involved to establish the connection between the two BSCs.

As shown in figure 3, Handover over different BSCs is performed as:

1. The serving (old) BSC sends a Handover required message to the MSC containing the identity of the target cell.

2. The MSC knows which BSC controls this cell and sends a Handover Request to this BSC.

3. The new BSC orders the target RBS to activate a TCH.

4. The new BSC sends a message to the MS via the MSC and the old RBS.

5. MS tunes to the new frequency and transmits handover access bursts in the correct time slot.

6. When the new RBS sends information about TA.

7. MS sends a Handover Complete message to MSC via the new BSC.

8. MSC sends the old BSC an order to release the old TCH.

9. The old BSC tells the old RBS to release the TCH.

4) Handover between Cells Controlled by Different MSC/VLRs

Handover between cells controlled by different MSC/VLRs can only be performed within one PLMN and not between two PLMNs. Cells controlled by different MSC/VLRs also means that they are controlled by different BSCs.

As Figure 4 shows Handover over different MSCs as:

1. The serving (old) BSC sends a Handover required message to the serving MSC (MSC-A), with the identity of the target cell.

2. MSC-A identifies that this cell belongs to another MSC, (MSC-B), and requests help.

3. MSC-B allocates a handover number to reroute the call. A Handover Request is then sent to the new BSC.

4. The new BSC orders the target RBS to activate a TCH.

5. MSC-B receives the information, and passes it on to MSC-A together with the handover number.

6. A link is set up to MSC-B, possibly via PSTN.

7. MSC-A sends a handover command to the MS, via the old BSC.

8. The MS tunes to the new frequency and transmits handover access bursts in the correct time slot.
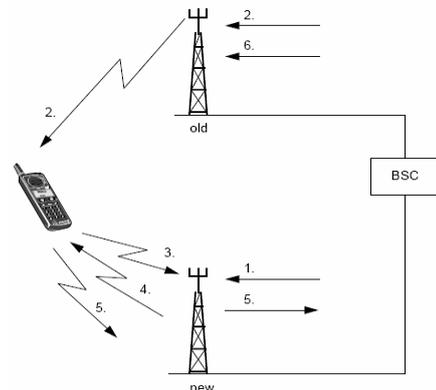

Figure 2. Handover between Cells Controlled by the Same BSC [1]
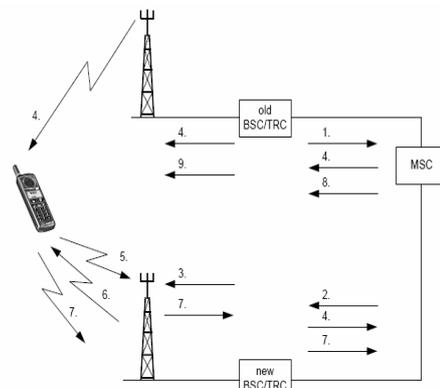

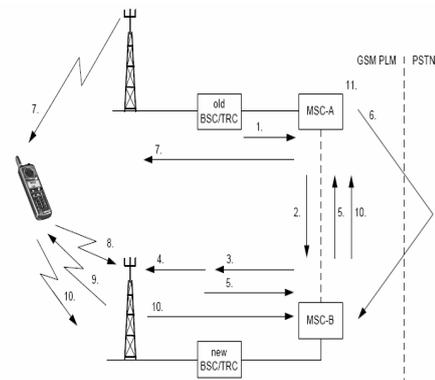Figure 3. Handover: different BSCs but the same MSC/VLR [1]

Figure 4. Handover: cells controlled by different MSCs [1]

After Clarifying all types of handover; these types are applied in all telecom networks that support GSM, GSM networks still face the problem of losing the call when the following scenario holds: When MS switches to a new LA that locates out of the current cell reach or coverage, and all ports in the other adjacent cells are full, the network will drop the call; this might reflect a bad image about the operator, so a solution must be found.

II. RELATED WORK

A new handover management scheme for capacity limited LEO (Low Earth Orbit) mobile satellite systems (MSS with dynamic channel assignment presented Vladimir Obradovic and Sascha Cigoj, there new scheme passed on two subschema: the first one depends on Queuing handover requests in FIFO term, and the second one that improve the first one up to 80% depends on reserve an amount of system resources exclusively for handover purposes. [11]

Dinesh K. Anvehar and S. Sandeep Pradhan[10] introduce a new scheme (HCE) that minimizes handover failure probability with no detrimental effect on call blocking probability by exchange of channels between two mobiles which are moving in opposite directions across the handover area of adjacent cells.

A new possible scenario for future mobile wireless access that allow users to switch to the provider and access technology that best fits their needs at any given moment dynamically is presented by Frank A. Zdarsky and Jens B. Schmitt[7].

Miska Sulander, and others [6] present a new method for faster handover in IPv6 which uses the features of IPv6 protocol and benefits from IPv6 traffic control called "Flow-Based Fast Handover Method for Mobile IPv6 Network - FFHMIPv6", they compare the new method with other handover methods focusing on handover delay, packet loss and requirement processing time.

Low-Latency Non-Predictive handover scheme in mobile IPv6 environment is proposed by Geunhyung Kim and Cheeha Kim [13], they analyze the impact of incorrect prediction in fast Mobile IPv6 on mobility management in term of signaling and packet delivery cost.

III. PROPOSED SOLUTION

A telecommunication company has limited handover equipment such as BTS, MSC and huge number of equipments such as the BTS's which is responsible of locating the company subscribers and traversing their calls, so to keep the company running without any additional cost and also without any decrease in the service quality it must find a new solution to go over the limitation of this equipments.

The most common problem facing telecommunication companies is handover subscriber's calls between

BTSs when a subscriber moving through mobile network cells, if a subscriber moves away from the allocated BTS, the BTS will calculate the distance of the subscriber from the related BTS and a specific algorithm is used to calculate ratio between the distance from the BTS and the frequency at BTS signal, if it reaches a specific value then the BSC needs to reallocate the moving subscriber to a new adjacent free BTS, this case called Handover.

The simple solution for like problem is to allocate the certain signal to another free BTS, but if the best or the nearest BTS was fully allocated and no other BTS's can take the new signal then the signal will be lost and this is the worst thing a telecom company face because it reduce profit and reflecting bad image of the company.

This approach represent a new solution that reduce the probability of failed Handover and assure that the

Handover may always success; the represented approach consists of three schemas that used sequentially and on demand. The first scheme depends on managing the physical ports of BTS by reserving some ports used for such cases. When the BSC calculates that the customer will go out the boundary of the covering BTS area and all other adjacent BTSs are full, then it will trigger the BSC to free a number of ports depends on a number of like customers- on each BTS, so the signal will be carried over an alternative port.

The first schema (Figure 5) reduces the probability of Handover problem occurrence but it still exists. Actually if the number of Handover occurrence equal to the number of available ports reserved for Handover cases, then any new Handover will fail, so the second alternative schema is used in case of the first schema is useless.

The second schema (Figure 6) used in case if the BTS's ports are fully allocated and the alternative ports are allocated too, then BSC determine all adjacent BTSs that contains a suitable number of free ports, then the BSC select the mutual IMSIs among the two BTSs (the fully allocated and the suitable) then calculate the distance between the selected IMSIs and the selected free BTS, after that the BSC carry the nearest IMSI to the selected free BTS, then the released port is now available to carry the IMSI caused Handover.

This approach reduce the ability of Handover occurrence in the selected BTS by selecting it with respect of available free ports, so the Handover problem will not carried to another location.
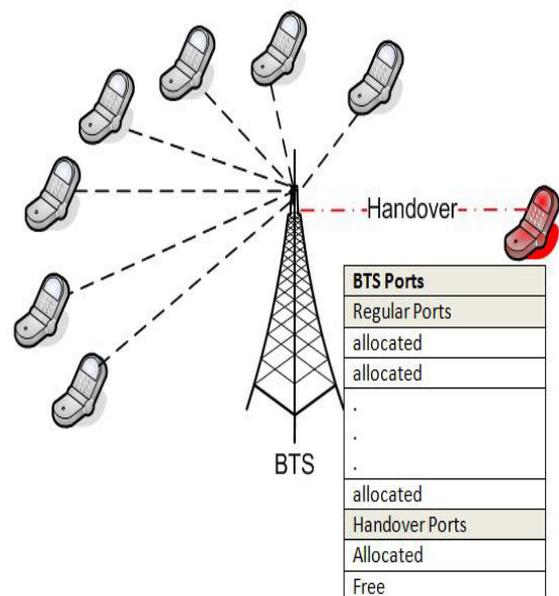
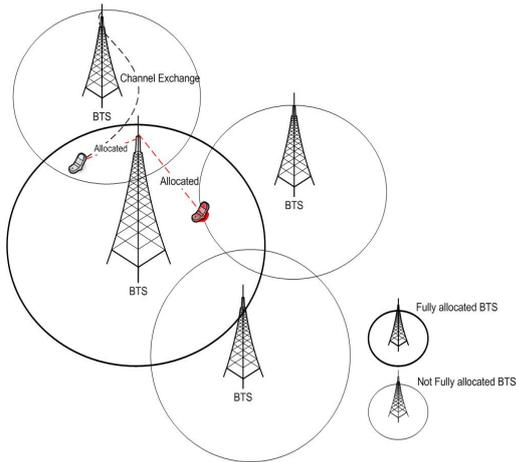

Figure 5. The first schema solution
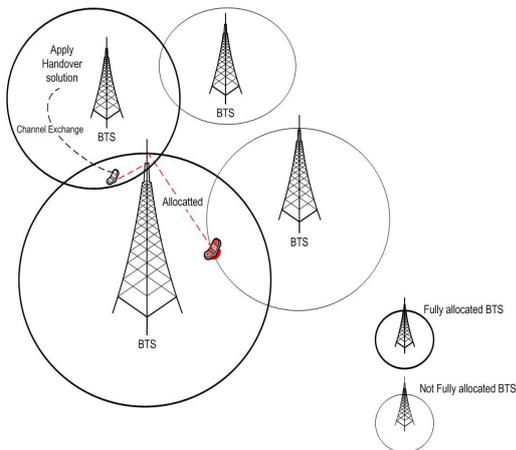
Figure 6.   The second schema solution

Figure 7.   The third schema solution

Now, if the BSC couldn't find any available free adjacent BTS, then it will select the nearest BTS and determine the nearest IMSI to it and carry the selected IMSI to the selected fully-allocated-BTS, in this case the Handover problem is shifted to the selected BTS that will repeat this approach (the three schemas) until the Handover problem is solved, and this step what is called the third schema (Figure 7).

IV.   SIMULATION AND EXPERIMENTAL RESULTS

This approach was developed with Arena v.12 simulator on Intel® Core 2 Due with speed 2.0 GHz Processor, 4 GB RAM with Windows Vista Home Premium environment.

In all experiments, the following information is fixed in order to calculate the success percentage of handover occur on BTS:

- Total number of calls equal to 500 calls.
- Total number of ports on the BTS equal to 50 ports.
- Total number of reserved ports for Handover cases equal to 10% of total number of ports.
- The interval time between each two handover requests is random exponential to 120 seconds.
- The interval time between each two calls requests is random exponential to 30 seconds.
- The call duration is between 0.5 second and 100 seconds.

TABLE I.
PURE HANDOVER RESULTS

Handover rate	50%	30%	10%
Total no. of calls	500	500	500
No. of new calls	250	350	450
No. of Handover	250	150	50
Handover Success percentage	90.4%	74.6%	72%
Handover Fail percentage	9.6%	25.4%	28%
New call Success percentage	60%	57.1%	63.3%
New call Fail percentage	40%	42.9%	36.7%

TABLE II.
1ST SCHEMA HANDOVER RESULT

Handover rate	50%	30%	10%
Total no. of calls	500	500	500
No. of new calls	250	350	450
No. of Handover	250	150	50
Handover Success percentage	93.6%	83.3%	86%
Handover Fail percentage	6.4%	16.7%	14%
New call Success percentage	56.4%	53.4%	60.6%
New call Fail percentage	43.6%	46.6%	39.4%

TABLE III.
2ND SCHEMA HANDOVER RESULT

Handover rate	50%	30%	10%
Total no. of calls	500	500	500
No. of new calls	250	350	450
No. of Handover	250	150	50
Handover Success percentage	94.8%	92.6%	90%
Handover Fail percentage	5.2%	7.3%	10%
New call Success percentage	58%	58%	62.4%
New call Fail percentage	42%	42%	37.6%

TABLE IV.
3RD SCHEMA HANDOVER RESULT

Handover rate	50%	30%	10%
Total no. of calls	500	500	500
No. of new calls	250	350	450
No. of Handover	250	150	50
Handover Success percentage	98.4%	99.3%	100%
Handover Fail percentage	1.6%	0.7%	0%
New call Success percentage	58.4%	54.6%	60.4%
New call Fail percentage	41.6%	45.4%	39.6%

As seen in the results below, the handover success percentage increasing in all cases, that may mention to the efficient solution for handover problem. Although the percentage of handover success is increased, the percentage of success new calls is decreased, but this still useful because the telecommunication companies are interesting to increasing the customer's satisfaction. The customer will be more satisfied if the company keeps his call a live rather than prevent him to make a new call.

V. CONCLUSION

This paper presents a new approach that solves a common problem in mobile telecommunication sector which is the handover, by applying three schemas; the first schema depends on reserving a specific amount of ports to carrying the handover calls. The second schema depends on channel exchange between two adjacent BTSs. The third schema depends on carrying handover problem to another BTS to solve it.

The experimental results show that this approach is useful in all cases regardless of the amount of the handover calls occurred onto the BTS.

REFERENCES

[1] Introduction to Mobile Telecommunications and GSM, Copyright °c 1998 by Ericsson Radio Systems .

[2] Johan Zuidweg, Next Generation Intelligent Networks, Artech House Inc.

[3] Syed S. Rizvi1, Aasia Riasat2, and Khaled M. Elleithy3, A QUANTITATIVE ANALYSIS OF HANDOVER TIME AT MAC LAYER FOR WIRELESS MOBILE NETWORKS, International Journal of Wireless & Mobile Networks (IJWMN), Vol.1, No 2, November 2009

[4] Zhiwei Yan, Huachun Zhou, Hongke Zhang, Jianfeng Guan, Sidong Zhang, An Adaptive Multi-criteria Vertical Handover Framework for Heterogeneous Networks,

[5] Jaeouk Ok, Pedro Morales and Hiroyuki Morikawa, AuthScan: Enabling Fast Hando® across Already Deployed IEEE 802.11 Wireless Networks, 978-1-4244-2644-7/08/$25.00 °c 2008 IEEE.

[6] Miska Sulander, Timo Hamalainen,, Ari Viinikainen and Jani Puttonen, Flow-Based Fast Handover Method for Mobile IPv6 Network, 0-7803-8256-0/04/$20.00 °c 2004 IEEE.

[7] Frank A. Zdarsky and Jens B. Schmitt, Handover in Mobile Communication Networks: Who is in Control Anyway?,

[8] Adisak Busaranun, Panita Pongpaibool And Pichaya Supanakoon, Handover Performance of Mobile IPv6 on Linux Testbed.

[9] Universal Radio Communication Tester R&S R°CMU 200, Handover scenarios in GSM systems, News from Rohde & Schwarz, Number 180 (2003 / IV).

[10] DINESH K. ANVEKAR* and S. SANDEEP PRADHAN, HCE: A New Channel Exchange Scheme for Handovers in Mobile Cellular Systems, ICPWC96, 0-7803-3177-x/%/$5.0001996 IEEE.

[11] Vladimir Obradovic, Improvement of the Performances of the Mobile Satellite Systems by Sophisticated Handover Management,

[12] Farouk Belghoul, Yan Moret, Christian Bonnet, IP-Based Handover Management over Heterogeneous Wireless Networks, Proceedings of the 28th Annual IEEE International Conference on Local Computer Networks (LCN03), 0742-1303/03 $ 17.00 °c 2003 IEEE

[13] Geunhyung Kim and Cheeha Kim, Low-Latency Non-predictive Handover Scheme in Mobile IPv6 Environments, I. Niemegeers and S. Heemstra de Groot (Eds.): PWC 2004, LNCS 3260, pp. 451465, 2004., °c IFIP International Federation for Information Processing 2004

[14] Sarra BEN OUBIRA, Mounir FRIKHA, Sami TABBANE, Hando® Management In 4G Networks,

[15] Manpreet Singh Dang, Amol Prakash, Rajeev Shorey, Natwar Modani and Dinesh K. Anvekar, Performance Modeling and Analysis of a Handover Channel Exchange Scheme in Mobile Cellular Communication Systems, 0-7803-6283-7/00/$10.00 °c 2000 IEEE

[16] Marco Ajmone Marsan, Fellow, IEEE, Carla-Fabiana Chiasserini, Member, IEEE, and Andrea Fumagalli, Performance Models of Handover Protocols and Bu®ering Policies in MobileWireless ATM Networks, IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, VOL. 50, NO. 4, JULY 2001, 00189545/01$10.00 °c 2001 IEEE

AUTHORS

Wael Etaiwi, Haitham Almhairat, Mujahed Jarad and **Laith Batarseh** are with Al-Balqa' Applied University, Al-Salt, Jordan.