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Efficient Handoff for Mobility and Security for GSM

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Abstract*: Handoff Management, which is one of the basic functions of Mobility Management, has become more important in the area of wireless networks which support multimedia services. This is a procedure which allows the structure to define a mobile device's existing position, the recent network link attachment point, anywhere the mobile device can collect traffic, from the arrangement. Mobile communications play a major role in the sector of voice/data network. Different wireless technologies and networks which exist currently, fulfil dissimilar requirements of mobile consumers. When a person transfers through numerous wireless networks, it should keep its' network attachment ideas or should transfer from single kind of wireless network to another network of another place. Blend of these networks will allow the mobile consumers to be always associated, to the finest accessible network, giving to their necessities. Efficient Handoff Management will curtail handoff failure degree, packet falling quantity and handoff latency. With the demands of fresh data and actual time facilities, wireless networks ought to care calls with diverse characteristics. For effective facilities to the mobile users, the wireless networks involves in different strategies of Mobility Management, where the place of every single user is actively resulted before the service is distributed. The paper will discuss basic issues involved in Handoff Management, in the view of General Mobility Management in wireless communication systems. The relevance of Mobility Management, Handoff Management and the protocols will be explained. Handoff mechanisms, Causes of delays in handoffs and security in handoff procedures will be examined. With the implementation of mass scale 3G around the world, new directions are already being explored. Design of efficient handoff management mechanisms will play an important role in providing a smooth service to the consumer.*

Keywords: *Handoff Management, Mobility Management, wireless networks, traffic, Mobile communications, wireless technologies, efficient delivery, new mechanisms, delays, Security*

1. Introduction

The growth of the capacity of mobile subscribers over the last years has led to a revolution of voice-oriented wireless telephone systems. Wireless networks satisfy the requirements for associating the speedily increasing mobile data and multimedia services, as they can bring a successful Internet servicing process to mobile providers and consumers. Wireless networks can integrate smoothly with the Internet to permit mobile consumers to contact the facts, applications and services available over the Internet. Mobile networks which are expected to be very complex systems, interconnecting various technologies and architectures, should be aware of location that can determine which types of devices are available and how communication should be conducted. Mobility management allows mobile wireless networks to discover roaming users for call delivery and to continue connections as the user is moving into a new fresh service area.

Mobility management contains two categories which is the Location Management and the Handoff Management. Location management empowers the system to track the attachment points of users between communications. Handoff management enables the network to sustain a user's connection as the user continues to swap and change its access point to the network. Handoff Management offers the finest connectivity to the user by linking the user to the best accessible network.

Handoff Management is the technique by which a mobile node possesses its linking activity when it travels from one single access point to another. Handoff process can split in to three main categories. First, the launching of handoff is start by

using a mobile device, or an another network. The second one is connecting a new connection generation and finally, data flow needs to maintain the distribution of the data from the previous connection path to the new path. During the measure of the mobile device, it may suffer few types of handoff. The strategy of handoff management approaches in all wireless networks need to talk about the issues such as, diminishing the signaling overhead, Network properties should be resourcefully used and the handoff mechanism should be ascendable and trustworthy.

Location management used to identify the locations of mobile station. Location management has two main sub tasks, which is, location registration, and call delivery. In the location registration practice, the mobile node sends unambiguous signals to advise the network of its existing accessible position, so that the position database is modernized. The call transport process is called once stopping the location registration.

Established on the facts that has been recorded in the network through the location registration, the call transfer procedure questions the network regarding the particular location of the mobile equipment subsequently a call is delivered effectively.

In the communication protocol, all the layers would get stuck if there is an interruption in a handoff. Link Layer Delay hangs on the access technology, which will go over numerous phases, earlier a fresh link is established. For intra subnet handovers, where network layer arrangements are required, link layer gives the highest to the delay. Network Layer Delay needs to start a network layer variation. A network layer conversion will do some steps such as, getting a new IP address, identifying an identical address, Address Resolution Protocol (ARP) update, and subnet-level confirmation. Application Layer Delay is paid to restoration and variation of the application layer features such as IP address however using Session Initiation Protocol (SIP).

Whenever a Mobile Node joins a point of network access, it starts a security context with the mobile network. During the handover process, there can be a possibility of changing in the security mechanism. The Mobile Node and the network have to guarantee that they are communicating with each other and agree upon the keys to defend their communication.

In this Introduction, a complete conversation has been completed on efficient handoff for mobility and security for GSM technologies. Issues in location, registration and handoff management are inspected and numerous prevailing devices have been presented. As global roaming will be the growing trend in coming, attention has been paid on devices which are valid in wide ranging networks. In spite of all the evolving technologies, the final success of new mobile generations will be inspected by the new services and contents made available to users. These new applications must meet user expectations, and give added value over existing offers.

Accordingly, Section II describes the Background and Related Works to the Research. Section III describes the Approach to the research. Handoff in Base Transceiver Station (BTS), Advantages and Disadvantages of Inter-MSC handover are clarified in Section III. Security in the Handoff procedure is explained in Section IV. Solutions for the prevailing problems in handoff such as, high velocity, is described in Section V. In the Section VI it will explain the Conclusion of the entire research paper, while Section VII clarifies the Future Works where the knowledge and the practice can be utilized in the upcoming events. Finally, Section VIII is to show the sincere gratitude and will explain the Acknowledgement.

2. Background and Related Works

Handover results in when a call shifts from one network to another or across the parallel networks. The primary requirement of this method is to make it stable by using genuine security machineries. Thus, it will not be certain due to some reasons. Accordingly, it will be very useful to continue balance between security and performance throughout handover. Different handover security strategies that can issue stable security plus performance to a conclusive level will be discussed in this research paper. The focus is how to sustain stability amid handover security and performance [1]. Moveable communication has achieved fabulous reputation due to its capability to afford global information access to consumers on the move.

This paper discusses about delivering network connectivity to an enormous amount of affecting clients in a well-organized and accessible way. The paper mainly concentrates on handoff management. Handoff is the practice through which a mobile terminal retains its linking activity when it transfers from the attention of one network access point to another. Dissimilar categories of handoffs can happen in wireless intersection networks. There are some other tasks discussed in this paper, for instance, Mobile IP which is a mobility management etiquette offered to explain the problem of node mobility by forwarding packets to the mobile node's existing

location and Context Handover protocol, which forward the matching information about every mobile node's data-movements when the mobile node travels from its earlier access router to a fresh access router [2]

3. Approach

The Global System for Mobile Communication (GSM) network architecture is shown in figure 1. The GSM system involves in a number of functional features comprising mobile switching centers (MSC), base stations (BSC) with associated Base Transceivers (BTS), an Operation and Maintenance Centre (OMC) and Gateway MSC. GSM mobile terminal or mobile stations communicate across the Um interface, identified as the air interface, with a base BTS in the minor cell in which the mobile unit is discovered. This communication with a BTS happens over the radio channels. The network coverage range is separated into minor sections called cells. Numerous cells are assembled together to form a Locations Area (LA) for the Mobility Management. Figure1. GSM Network Architecture BSC are linked to MSC over dedicated line or radio communication link. The BSC reserves radio frequencies, accomplishes the handover of the mobile station from one cell to another within the BSS (base station subsystem). MSC interface to the PSTN (public switched telephone network) is called the gateway MSC [3] [4]. MSC incorporate functions including Home Location Register (HLR), Visitor Location Register (VLR), Authentication Register (AuC) and tools to categorize register (EIR). The HLR and VLR together through MSC run the call routing and roaming skills of GSM. The HLR supplies information both permanent and temporary about every mobile station that fit in to it. The VLR register conserves information about mobile station that is presently substantially in the region protected by MSC. VLR converts to important when user leaves the range aided by his home MSC. The two registers are utilized for authentication and security purposes. The EIR is a list that holds a gradient of completely legal mobile tools on the network, where every mobile station is known by its International Mobile Equipment Identity (IMEI). It benefits in security and avoids habits of network by mobile station that have been supported. The AuC grasps the authentication and encryption keys that are stocked in every user SIM card for authentication and encryption through radio channel.

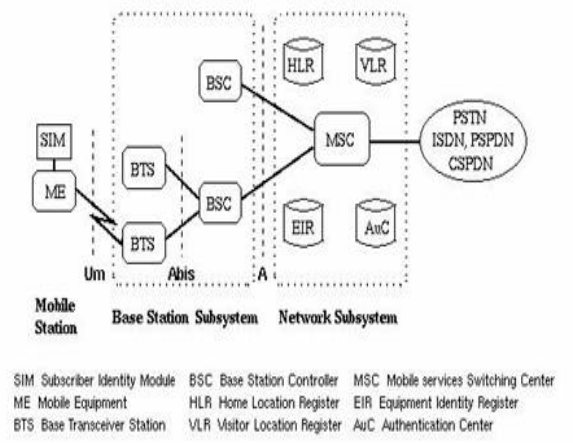

Figure1(Source:http://www.polarsat.com/en/index.php?option=com_content&view=category&layout=blog&id=7&Itemid=17&lang=en)

A. Handoff in Base Transceiver Station (BTS)

BTS is a segment of network equipment that simplifies wireless communication amid a device and network. It will have equipment for encrypting and decrypting communications. Antennas will be reflected as components of BTS in general sense as they simplify the functioning of BTS.

BTS holds the following fundamental components:

- **Antenna System:**

Antennas are practiced to communicate the mobile signal to air. There are few categories of antennas such as Single band (Transmits one frequency band), dual band (Transmits two frequency bands) and Tri band antenna (Transmits three frequency bands).

- **Base Band Unit (BBU):**

BBU is utilized to do several changes in the BTS. Every antennas and Micro Wave Link connectivity is pooled together through the BBU.

Antennas that relay radio messages – It is the arrangement that the BTS lies below, which can be connected as it is or disguised in some other method.

Multiplexer - For separating, directing and receiving packets to/from antenna.

Combiner - Combines packets from numerous Drive Receivers (DRX)s therefore they could be delivered through a particular antenna. Allow for a decrease in the number of antennas used.

Power amplifier (PA) - Amplifies the signal/packets from DRX for broadcast over antenna.

Alarm Extension System - Assembles working position alarms of many elements in the BTS and spreads them to Operations and Maintenance (O&M) monitoring stations.

Control function - Controls and accomplishes the different parts of BTS, comprising any software. Configurations, status alterations and software upgrades are done over the control utilities.

Baseband Receiver Unit - This method, identified as antenna diversity or space diversity, evades interruption caused by path loss. The antennas can be spread out horizontally or vertically. Horizontal spacing needs more complex connection, but brings superior performance.

A base transceiver station (BTS) has four major categories, which is, Radio Frequency (RF) block, Baseband block, Control and Clock block, and the Transport block. The Radio Frequency Block sends and receives signals to/from movable devices (via the air interface) and transforms between digital data and antenna signal. The Baseband Block operates the baseband signal. The functions are encoding/decoding, frequency hopping etc. The Transport Block assists to external network. The functions are security functions and synchronization. Control and Clock Block maintains the coordination between these three blocks.

The BTS links to the transceivers and antennas utilized in every cell of the network (Figure 2). A BTS is usually positioned in the middle of a cell. Its spreading power provides an explanation of the scope of a cell. Each BTS contains 1 to 16 transceivers, depending on the thickness of consumers in the cell. Every BTS assists as a single cell. The subscriber equipment can be mobile phone, wireless internet devices, and the operator network could be a GSM (Global System for Mobile Communication) platform.

When a Mobile Subscriber (MS) is trying to call to another person who is located in the different BTS area, it is called as Intra-BSC handover. This is another word for the MS handover from one single base station to another base station, or handover from one cell to another cell within the same BSC. Assume that the BSC finds the handover target cell is in another BTS. This is MS handover from BTS 1 to BTS 2 and the both BTS are in the same BSC. Now BSC will send a “Channel active” to the new target BTS, and then BTS will return one “channel active ACK”, thus a new Traffic Channel (TCH) is established via these two messages. BSC shall send the relevant message of the new TCH to the MS, and the message is called “handover command”. The sending of this message is completed in the previous TCH, because the previous TCH is still occupied by the MS.

Then the MS receives the handover command and it will get the relevant parameters of the target channel such as frequent point number, time slot number, etc. The MS will forward these to the new target channel. The first message sent by the MS in the target channel is called “handover access”. After BTS 2 receives this message, it will convert this in to “handover detect”, and notify BSC that the handover is detected.

Functions - Major functions are encoding, multiplexing, encrypting, modulating and feeding the Radio Frequency (RF) signals to the antenna. Transcoding and rate adaptation, decoding, time and frequency synchronizing, random access detection, decrypting and equalizing received signals, timing advances and uplink channel measurements can be mentioned as additional functions.

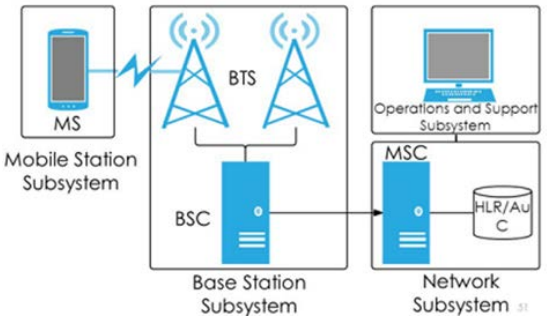

Figure 2 (Source: Google Images)

The BTS equipment are usually placed in a shelter which protects its’ equipment from dust, corrosion and theft etc. The external conditions, such as, humidity is another prime concern, as it is maintained below 60% to avoid condensation of fluid on the equipment.

B. Inter-MSC handover

Inter MSC handover occurs when changing between networks (Figure 3). GSM mobile phone can maintain a call even when moving from a cell control by using one MSC and to another cell controlled by another cell. The calls are maintained by handing over the call from the source MSC to the target MSC. And there is a protocol which is used to manage the interaction between the sources MSC and target MSC. It is called MAP (Mobile Application Part)

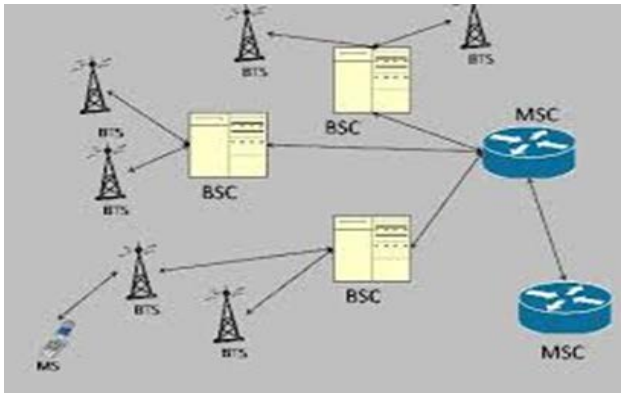

Figure3(Source:https://gnuradio.org/redmine/projects/gnuradio/wiki/OpenBTSNetwork_Architecture)

C. Advantages

a. Real-time switching

Services must be developed immediately to ensure rescue actions when a sudden incident happens. The MSC Pool disaster recovery scheme confirms that services on the smashed or overloaded MSC can be interchanged to other MSCs instantly.

b. Slight influence on traffic models

The regional traffic in disaster areas may change seriously during rescue operations. The network will be severely jammed with a sudden growth of roaming and handover traffic if people are relocated to safer areas and many relief workers and reporters enter the disaster area.

When the MSC Pool is deployed, there are no location update and handover difficulties if mobile users travel within the MSC Pool aided areas. The signaling connects between Network Elements (NEs) and the influence on the communication signaling network is decreased.

c. Efficient utility of network resources

When an incident occurs, traffic in the range soars and surpluses the switch, producing network traffic. The traditional adventure recovery scheme develops the active and standby modes, sensing that the standby device does not work unless the active one pauses down. A certain disadvantage is that when congestion go away from the extreme volume of the active device, the standby device cannot be utilized once congestion occurs.

D. Disadvantages

a. Non-unified planning

The main attention is that the wireless access network must be improved to keep up the conventional MSC Pool. The maintenance and skills of the equipment completed by diverse suppliers are different and the equipment dissimilarity moves the whole network planning and developing schedule.

The next feature is that the data arrangement is not synchronized. The data arrangement of the MSC Pool network desires that the access network and core network connect with each other to recognize unified procedure.

b. Poor user experience

In the outdated MSC Pool, the named service for subscribers cannot be suddenly recovered once one of the switches in the resource pool converts damaged. The called service can be stimulated passively few hours later. The shortage of an enhanced recovery arrangement for the called service can critically disturb subscribers and their pleasure with services.

Investment is additional when the outdated MSC Pool is arranged in the TDM network, and the Base Station Controller (BSC) must be linked around the clock with all of the switches in the pool. Consequently, huge bulks of TDM transmission properties are consumed. It is rigid for most operators to make large investments for network design and maintenance. Moreover, the improvement of wireless Units for the entire network is capital intensive, which also increases assignment charges.

4. Security

Capacity, strength of signal and maintainability are ensured by describing the planning constraints and propagation models. Security in the equal settings of the current standards is acceptable for standard applications. There is a situation that can effect problems even in GSM and is not yet well studied. Assume a Mobile Station moves with very high speed (>250 km/h) during a handover process, therefore, the planning limitations in this background lead to very small cells. As end result the MS stays in the cell only for such a short time which is not an enough size of data which can be collected. This problem will be demonstrated by investigating the handover procedure during Group Receive Mode (GRM) in GSM.

1. The high velocity problem

GRM is perfect that during a group call the listening station acts as in idle mode. Therefore, the data capacity needed for handover preparation takes more time, e.g. the MS attempts to translate parameters within 15s. The calculation of the average of five measurement samples spread over 3s to 5s and also it takes at least the 3s, the BS identity code (BSIC) is interpreted every 10s and the Broadcast channel (BCCH) at least every 30s. Which are the Networks with high reliability and requirements are available and with subscribers moving at high speed principal to small cells with a length of 2 to 3 km, depends on Network provider and field strength requirements. This is because high-speed situation often results in tunnels and forest aisle with high reduction to the signal. Thus a MS stays in the same cell for 28.8s, 21.8s and 14.4s if it is moving at speeds of 250, 330 and 500 km/h correspondingly. So in the worst case there is no measurement takes place, while the MS is visiting a certain cell. To avoid network failures, a stand-alone GSM adjustment is necessary. It should confirm high-speed handovers while slightly changing the measurement requirements. There are some side effects such as it leads to savings of time that can be used for other signaling traffic.

5. Solutions

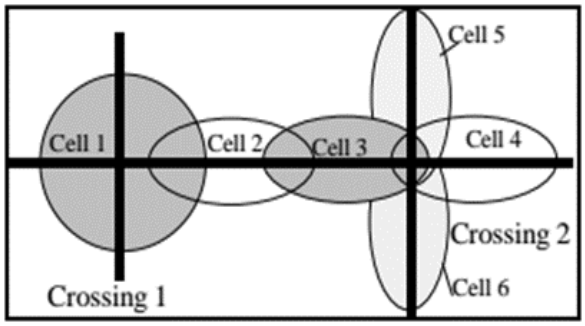

Figure 4 : Network topology with two cellular patterns for crossings. (Source: Dialog Telecom)

The handover procedure has to be accelerated to get around the problem described above. Forecasting the next cell can do this. One way to forecast the next cell uses knowledge of network topology, location and direction of the movement of the subscriber. Moving with high speed clues to a special pattern of movement. Subscribers move along lines, for example motorways and tracks. So the form of the planning area changes from area-wide to a line-shaped grid. This information can be used to accomplish handovers with nearly no measurement effort. If subscribers move in one direction the next cell can be resulting from knowledge of the network topology. In view of (Figure 4), a MS coming from cell 1 will leave cell 2 towards cell 3. It is justified to leave aside turnarounds due to high-speed drive. The next cell can easily be ensure from the knowledge of the previous locations of the MS. In this perfect case each cell has only two neighbors. At crossings there are two situations possible: A transmitter placed in the middle of the cell or two or more transmitters pointing from the center of the crossing along the tracks. In both situations the direction of movement has to be forecast. The distance between MS and BS can be gained from Timing Advance (TA) values. But for handover matters we also need information about the way of movement. Crossing 1 Crossing 2 Cell 1 Cell 6 Cell 5 Cell 4 Cell 2 Cell 3 (Figure 4). Network topology of a line shaped network with two cellular designs for crossings. In line-shaped networks this direction can be derived by information of the past allocation cell. This information can be forwarded to the new serving cell during the handover procedure and the new serving cell can control the cell for the next handover instantly. If there are more than one target cells for handover the incoming direction information about the last cell is not enough. The current cell can request the Mobile Station for more information. For measurement of the location of a MS there are several concepts discussed. It is planned to extract position data from TA measurement of three BSs with interaction to the MS (3TA). In this situation, incoming information can be used, because there is just one target cell, or the two cells TA declared above. If the MS reaches crossings the number of detected BSs increases and the 3TA measurement has to be used. If there are numerous crossings and changes of direction the speed will not be that high and the normal handover procedure can be useful. In train environment or following a route-planning program for cars, handover information can also be taken from the schedule. Just the careful point of time for the handover performance has to be verified by seeing TA data. The BS on its own can do this, so that the air interface can be used for other signaling proceedings at the same time.

6. Conclusion

Some important matters on handoff management in the general context of mobility management in next-generation mobile wireless networks are discussed in this research paper. It suggests user, supreme freedom of moment while utilizing cell phones (mobiles). Records of cells (or radio cells) are completed through a cellular network. Each cell is assigned a group of frequencies and assisted by base station to consisting of transmitter, receiver and control unit. Adjacent cells are assigned different frequencies to evade interference or cross talk. As more clients use the cellular network with one single base station traffic, it may be build up, there are not enough frequency bands assigned to a cell to handle its calls. This implementation in this field of cellular communication has controlled to increase intensive research towards and development towards cellular system. The main aim of this development is a fresh conception of mobile terminal and user mobility.

7. Future Work

Future wireless network will be created on all-IP framework and diverse access machineries. Design of efficient handoff management mechanisms will lead an important role in providing absolute services. Some open areas of research that will define a superior role include QoS (Quality of Service) concerns, user terminals, handoff management in wireless overlay networks, and cross-layer development. Mobility management is the fundamental technology to enable the uninterrupted admission to next generation wireless networks and mobile services. Upcoming IP-based wireless networks support all types of multimedia services including real-time services such as voice and video flooding as well as non-real-time services such as email, web- browsing, and FTP (File Transfer Protocol).

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