Handover Management in GSM Cellular System

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Abstract - Handoff is an essential element of cellular communications. The integration of existing cellular systems with new wireless access technologies, such as wireless LANs, has attracted considerable attention during the past few years. The challenges to be addressed include authentication, security, QoS support and mobility management. This idea is based on the neighbouring cells have an ovelapping (the area served by more than one cell) coverage area. A large number of solutions have been proposed in an attempt to tackle all relevant technical issues concerning handover management.

Keywords - GSM, QOS, Handover management, soft handoff

I. INTRODUCTION

Handoff is a process of transferring a mobile station (MS) from one base station (BS) or channel to another ,Be through a time slot, frequency band, code word, or combination of these for time-division multiple access (TDMA), frequency- division multiple access (FDMA), code-division multiple access (CDMA), or a hybrid scheme, respectively [1]. We Due to rapid change in technology the demand for better and faster cellular communication also increases. This growth in field of cellular communication has led to increase intensive research toward and development toward cellular system. The main reason of this growth is newly concept of mobile terminal and user mobility. The main characteristics of cellular communication system offer user maximum freedom of moment while using cell phones (mobiles). A cellular network is made up of numbers of cells (or radio cells). Each cell is allocated a band of frequencies and served by base station consisting of transmitter, receiver and control unit. Adjacent cells are assigned different frequencies to avoid interference or cross talk. As more customers use the cellular network with single base station traffic may be build up so there are not enough frequency bands assigned to a cell to handle its calls. The degree of reuse determined by how apart cells must be reuse the same frequency is depending upon the actual implementation of the radio link. The reuse of frequencies in different cells is a from of space division multiple access and it requires that location of each mobile agent to be known this is provided through a service known location management or mobility management. The obstruction in cellular network involves the problem when a mobile user travels from one cell to another during a call. As adjacent cell do not use the same radio channels, a call must be transferred from one radio channel to another when a user crosses the line between the adjacent cells. The process of handover takes place that transfer an ongoing call from one cell to another cell as the user moves through the coverage area of a cellular network. In handover process cellular network automatically transfer a call from one radio channel to another radio channel while maintaining quality of services (QoS) of a call. Each handover require network resources to route the call to next base station. If handover does not occur at right time the QoS may be drop below an adequate level and connection will be dropped. The mobile monitors the strength of the base stations, but only the cellular network knows the status of channel availability and the network make the decision about the handover [3]. The final outcomes of the research will theoretical results to convince the users as possible. To introduce new concepts and handover schemes for enhancing and optimizing GSM wireless network performance. To provide effective methods for evaluating GSM handover mechanisms as well as cellular
network performance..

Frequency Reuse Distance and Cluster Size

A GSM cellular network is made of number of radio cells or cells served by fixed base station. These cells are used to cover different areas to provide radio coverage over wider area. These radio cells are combined into clusters and each frequency is used once per cluster. The capacity in cellular network can be increased comes from the fact that the same radio frequency can be reused in different area for completely different transmission in a regular way. The ruse of frequencies enables a cellular system to handle huge number of calls with limited numbers of channels. GSM cellular layout typically involves the frequency Reuse factor which is inversely proportional to K (where K is number of cell per cluster). The value of K is 7 for TDMA system. The co- channel interference is a serious problem in this scheme while adjacent co-channel interference is not a big problem. Where R is the radius of the cell and D is the distance from the center of the cell to its neighbor using the same frequency. The minimum separation between two cells using the same frequency so that the two cells don't not interference with each other can be calculated by D/R=3K [3].

Macrocell

Macrocell radii are in several kilometers. Due to the low cellcrossing rate, centralized handoff is possible despite the large number of MSs the MSC has to manage. The signal quality in the uplink and downlink is approximately the same. The transition region between the BSs is large; handoff schemes should allow some delay to avoid flip-flopping. However, the delay should be short enough to preserve the signal quality because the interference increases as the MS penetrates the new cell. This cell penetration is called *cell dragging*. Macrocells have relatively gentle path loss characteristics [2]. The averaging interval (i.e., the time period used to average the signal strength variations) should be long enough to get rid of fading fluctuations. First- and second-generation cellular systems provide wide-area coverage even in cities using macrocells [3].

Microcells

Some capacity improvement techniques (e.g., larger bandwidths, improved methods for speech coding, channel coding, and modulation) will not be sufficient to satisfy the required service demand. The use of microcells is considered the single most effective means of increasing the capacity of cellular systems. Microcells increase capacity, but radio resource management becomes more difficult. Microcells can be classified as hot spots (service areas with a higher traffic density or areas that are covered poorly), downtown clustered microcells (contiguous areas serving pedestrians and mobiles), and in-building 3-D cells (serving office buildings and pedestrians). BS antennas have lower heights compared to the surrounding buildings; RF signals propagate mostly along the streets. This propagation environment has low time dispersion, which allows high data rates. Microcells encounter a propagation phenomenon called the *corner effect*. The corner effect is characterized by a sudden large drop (e.g., 20–30 dB) in signal strength (e.g., at 10–20 m distance) when mobile turns around a corner. The corner effect is due to the loss of the line of sight (LOS) component from the serving BS to the MS. The corner effect demands a faster handoff and can change the signal quality very fast. The corner effect is hard to predict. A long measurement averaging interval is not desirable due to the corner effect. Moving obstacles can temporarily hinder the path between a BS and an MS, which resembles the corner effect.

In a microcellular system there are two types of handoff : an LOS handoff and a non-LOS (NLOS) handoff. An LOS handoff is a handoff from one LOS BS to another LOS BS. An NLOS handoff is a handoff from an NLOS BS to an LOS BS. In an LOS handoff, premature handoff requests should be prevented. In an NLOS handoff, the handoff must be done as fast as possible as the user turns the corner. Some of the solutions are different requirements for LOS and NLOS handoffs in microcells are umbrella cells, macro diversity, and switching to mobile controlled handoff[2].

***Half-Square Cell Plan* —** This cell plan places BSs with omnidirectional antennas at each intersection, and each BS covers half a block in all four directions. This cell plan avoids the street corner effect and provides the highest capacity. This cell plan has only LOS handoffs[1].

***Full-Square Cell Plan* —** There is a BS with an omnidirectional antenna at every other intersection, and each BS covers a block in all four directions. It is possible for an MS to experience the street corner effect for this cell plan. The FS cell plan can have LOS or NLOS handoffs[1].

***Rectangular Cell Plan* —** Each BS covers a fraction of either a horizontal or vertical
street with the BS in the middle of the cell. This cell plan can easily be adapted to market penetration. Fewer BSs with high transmit power can be used initially. As user density increases, new BSs can be added with reduced transmit power from appropriate BSs. The street corner effect is possible for this cell plan. The R cell plan can have LOS or NLOS handoffs. Figure 4 shows an example of a rectangular cell plan in a microcellular system[1].

II.GSM HANDOVER PROCEDURE

Handover is the procedure that transfers an ongoing call from one cell to another as the user's moves through the coverage area of cellular system. The purpose of the handover procedure it to preserve ongoing calls when the mobile station moving from one cell to another. In GSM measurements reports to perform handover, which is made by serving BSC which has no direct knowledge of the radio quality. These measurements reports contain the radio signal quality of the downlink from the BTS to MSC of the call and up to five neighboring cells. The serving BTS measures the uplink from the MSC to BTS radio signal quality of the call and forward in the measurements reports. The information in the measurements reports the BSC is able to decide whether a handover to another cell is needed. These measurements reports are periodically transmitted from the MSC to BSC on the SACCH channel assigned to each communication for every connection. The repetition duration of the SACCH produces a fixed time grid of 480 ms in the measurements reports. The measured RXLEVs from the BTS and from a neighbor to the measurements reports submitted during a call In many cases these measurements reports takes place to take handover procedure in a way to avoid shortcomings. A connection is continuously measured and evaluated by respective base station and MSC. Handover is based upon that evaluation. As the mobile users leaves the coverage area of the one base station must obtain coverage from the neighboring station in order to keep the connection keep on. Cut off connection or drop call are not acceptable at any level during the call. Handover take places when the traffic level of cell reaches to high level or when neighboring are being underutilized [3].

III. GSM HANDOVER INITIATION

Handover initiation is the process of deciding when a request to a handover. Handover is based on received signal strength (RSS) from the current base station and the neighboring base station. Mobile station is moving from one BTS (named BTS1) to another BTS (named BTS2). The RSS of BTS1 decreases as the mobile station moves away and increases as the mobile station get closer to the BTS2 as a result of the signal propagation. We examine various approaches to handover initiation as in the forms BTS1 for Potential Handover, Relative Signal Strength, Relative Signal, Strength with Threshold, Relative Signal Strength with Hysteresis, Relative Signal Strength with Hysteresis and Threshold, Prediction Approaches [3].

GSM Handover Type

There are different categories of GSM handover which involves different parts of the GSM network. Changing cells within the same BTS is not complicated as the changing of the cell belonging to different MSC. There are mainly two reasons for this kind of handover. The mobile station moves out of the range station or the antenna of BTS respectively. Secondly the wire infrastructure the MSC or the BSC may decide that the traffic in one cell is too high and move some to other cells with lower load. These are the main reasons that initiate different kinds of handover. Following are the kinds of handover and their details [3].

Intra-cell BTS Handover: The terms intra-cell and intra BTS handover are used both for frequency change. There is a slight between them but usually they are considered the same. The term intra-cell handover in not real as it deals with the frequency change of a going call. The frequency change occur when the quality of the communication link degrading and the measurements of the neighboring cells better than the current cell. In this situation the BSC which controls the BTS serving the MSC order the MSC and BTS to switch to another frequency which offers better communication link for the call. The communication link degradation is caused by the interference as the neighboring cell using the same frequencies and it’s better to try another channel. In the intra BTS handover cell involved are synchronized. In the synchronization the MSC sends four HND_ACC messages to the serving BTS. The HND_ACC message is only one byte long and contains the handover reference. The BSC send the HND_CMD to initiate the intra BTS handover. The BSC HND_CMD time slot and new channel. The connection is established between BSC and MSC by exchanging these messages. After these messages exchanged MSC receives HND_PREF message that the handover is performed by the BSC and then BSC requests BTS to release the resources that is no longer used. This synchronized handover saves resources and faster than non synchronized handovers [2].

Intra-BSC Handover: The intra-BSC handover is performed when the MSC changes the BTS but not the BSC. The intra- BSC handover is entirely carried out by the BSC, but the MSC is notified when the handover has taken place. If the targeted cell is in different location area then the MSC needs to perform the location updates procedure after the call. In the intra-BSC handover both synchronized and non synchronized handover are possible. The figure X shows the intra-BSC situation. In the intra-BSC handover the BSC send HND_CMD message which contain the time slot, the frequency of the new channel and how MSC shall identify itself on the new channel. And at the same time BTS send PHYS_INFO message and wait for the SABM (Set Asynchronous Balance Mode) from the MSC. When the MSC receives PHYS_INFO message then send SABM in order to establish LAPD for mobile. When the BTS receives the SABM it sends an empty as an acknowledgement to the BSC. Now the MSC only receive the information that the handover was performed by the BSC and BTS releases the used radio resources [2].

Intra-MSC Handover: In the intra-MSC handover when the BSC decides that handover is required but the targeted cell is controlled by different BSC then it needs assistance from the connected MSC. Comparison to the pervious handover discussed the MSC mandatory for this kind of handover. Responsibilities of the MSC do not include processing the measurements of the BTS or MSC but to conclude the handover. This kind of handover can be other intra-MSC or Inter-MSC. In the intra-MSC handover the targeted cell is allocate in different BSC connected by the same MSC. The MSC contacts the targeted BSC for allocation of the resources and inform the BSC when they are ready. After the successful resources allocation the MSC instructed to access the new channel and the call is transferred to the new [2].

Inter-MSC Handover: The inter-MSC handover is performed when the two cells belonging to different MSC in the same system. In the inter-MSC handover the targeted cell is connected is connected to different MSC (named as MSC-B) than the one currently serving the call MSC (named as MSC-A). When BSC-A determines that a handover is into another area its sends HND_RQD to its connected MSC-A. HND_RQD contain information the CI (cell identify) and the LAC (location area code) belonging to another MSC area. After identifying the correct neighbors MSC sends prepare handover to MSC-B. The VLR of the MSC-B assign the temporary handover number and passes the HND_REQ to the target BSC-B. In the response of HND_REQ message BSC-B sends HND_REQ_ACK if the resources are available to MSC-B. The MSC-B forward to prepare for handover by sending BSSAP message back to MSCA. In the response MSC-A sends IAM which contains the handover number between MSC-A and MSC-B and after getting the correspondent ACM from MSC-B, MSC-A sends HND_CMD message to MSC-B to perform the handover to the target BTS. The BSC-B sends HND_DET that HND_ACC was received from the MSC. The HND_DET message is forwarded in a MAP to MSC-A. Now the traffic channel is established between MSC-A and MSC B, and the transport of the payload is carried to MSC-B, and the handover number is released by VLR in MSC-B. By receiving HND_CMP at MSC-B is signaled to MSC-A in a MAP message in Send End Signal. This triggers MSC-A to send CLR_CMD message to BSC-A to release the radio resources

IV. GSM HANDOVER MEASUREMENTS

The mobile station makes measurements which are used in triggering of the handover and in the evaluation of the handover candidate cell. This makes the measurements as essential part of the handover process. In order to make efficient handover these measurements should be refreshed very fast as possible. The mobile station measures the system parameter continuously and the level of the neighboring cells and sends this information to the network so that the decision for the handover is available to network all the times. These measurements reports from the mobile station is carried on the SACCH signaling channel after every 0.48 sec but a minimum once per second. In capacity the SACCH channel is error free which means that the measurements reporting is perfect almost.

In GSM one measurements message send from a mobile station to the BTS every 0.48 sec contains the signal level up to 6 neighboring cells. However a mobile station may pre-synchronize with more than 6 neighboring cells. In this case the measurements corresponding to the 6 cells but it receive best are reported to the BTS. The measurements of the neighboring cells is more difficult because a mobile station mush establish which neighboring cell it can receive and divided the measurements times among those cells capable of receiving. The possible measurements times are between the transmission and reception of a burst of the traffic channel. When there is discontinuous between the transmissions then the GSM measurements become inaccurate. To overcome these problems the power control and handover settings should be set more accurate.

V. Conclusion

Handover has been a critical process in both WLANs and cellular systems. This functionality is more difficult to be performed in an efficient manner when user's connections are handed over from one technology to another. Handover management architectures in WLAN/Cellular networks have been surveyed in this paper. Handoff is an integral component of cellular communications. Efficient handoff algorithms can enhance system capacity and service quality cost effectively. Extensive survey and analysis of the handover prioritization schemes that is guard channels, call admission control and handover queuing has been provided. It has been analyzed theoretically and mathematically that capacity depends on the size of the overlapping area between adjacent cells, the numbers of channels per cells and distribution of traffic. The higher the overlapping area, the higher the trucking efficiency gains. The overlapping area can be used to reduce the call blocking and dropping probabilities. The attractive feature of this scheme is that it organizes traffic in distributed manner and doesn't increase the system complexity.

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