FINAL YEAR PROJECT REPORT

COMSATS INSTITUTE OF INFORMATION TECHNOLOGY

Progress Report

Fixed-Mobile Convergence

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Date, 12.06.2008

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This document contains the details of the methodology applied for the handoff between GSM and WiFi networks or the aim of the convergence of Fixed $not\ mobile$ and the Mobile Networks. This document contains the introduction of both the networks i.e. GSM and WiFi. This document covers the market survey for the launching of the service. Also, this document explains the method of convergence or handover of user continued voice sessions in between the two networks. Our goal is to provide the user roaming in both the networks provided the user is using a dual mode handset. In this document the possibility of such handover is discussed, the algorithm which we have proposed for mentioned handoff is also explained in detail and then the prototype simulation of the algorithm is discussed.

1 Introdution

The project is based on the user roaming in both the networks or handover between fixed and mobile networks i.e. between GSM and WiFi. GSM is a well organized setup in Pakistan with good coverage but low data rates as the TDMA scheme allow only one slot per frame to a user and WiFi is newly going to be adopted by the users with small range but high data rates due to D-SSS technique used during the modulation and good qualities interms of voice.

These are the two different technologies, so the user will have the choice of selecting one of the technologies provided the user have dual mode handset. It is not neccessarily be a manual swtching from one network to the other because of the power matters will come in the way when user move in the specific cell and the decisins should be taken accoring to the condition. So the network can automatically be cahnged to one another on the basis of recieved power and other parameters. The conditions can be of different types like if both the networks are accessible mean to say that the user is in a specific area where there is good covrage of GSM as well as WiFi then the user may manualy switch between the networks provided the user is not in a continued session. If the user is in an area where one of the operating networkś recieved power is low to a specific level then the user may select the best one again if the usert is not in a continued session.

One other condition to discussed is that when a user is in a continued session of voice now it may not be able to switch the network manualy. Now there is an algorithm designed for this purpose will be explained later in the document. The implimentation of the algorithm provides the user to automatically handoff when there is some weak power from the transmitter of the network which the user is using at that moment. If both the networks are providing enough power to be utilized then the algorithm selects WiFi as it is low cost and has good quality. WiFi network is always preferred by the user because of its good features on a fixed location. But if the user moves, the ongoing session should be swithed to the other network to avoid the power lowering and data loss during an audio session which requires the convergence between the GSM and WiFi networks, called Fixed Mobile Convergence.

2 Business Analysis

2.1 Introduction

This chapter outlines a business case, a key document, used by management, to define, assess and evaluate the best approach to either proceed or not proceed with a product delivery project or initiative. This business case examines the potential business opportunity related to Fixed Mobile Convergence.

2.2 Executive Summary

2.2.1 Product Overview

WATEEN Fixed Mobile Convergence FMC is aimed at providing a better and affordable convergence of fixed and mobile networks. It is based on the handover between fixed and mobile networks i.e. handover between GSM and WiFi cells. **WATEEN** Fixed Mobile Convergence makes this handover possible an enriches the Handover experience of its users.

2.2.2 Unique Selling Point

Unique Selling Point USP is the uniqueness of the product going to be launched as compare to the other existing products in the market. This product provides convergence of GSM and WiFi, like no other product do in the market. So, the audio, video and data handover between the two technologies is the Unique Selling Point of the product because it merges the two technologies, that is obviously in favor of the users as well as the network brands. So, hopefully it will be having a good position to do well in the market.

2.2.3 Key Performance Indicator

Key Performance Indicator KPI or Key Success Indicator KSI depends on all the points which indicates the business performance or success of the product in the market. For this product, the maximum number of satisfied customers using the product is the KPI of the product. Having a good place in the market with better marketing strategy will be helpful in this regard.

2.3 Market Problem and Opportunity

2.3.1 Market Problem

Today there is no such technology in the market that converges the fixed and mobile networks. So the users fail to handover their data/ video/call when they enter from a mobile cell to a fixed network due signal power and data rates.

2.3.2 Market Opportunity

Analyzing the market problem, it is the best opportunity to launch such a technology that should be better for the convergence to satisfy the dual technology users.

2.4 Product and Service Description

2.4.1 Product Description

The product, Fixed Mobile Convergence, basically support both the GSM and WiFi networks. GSM is the well-organized national wide setup in Pakistan and WiFi is newly going to be adopted by the users. As, they are the two different technologies, so the consumers will be divided in selecting any one of the technologies or both according to their requirements, because of the distortion/ dropping of audio/ video /call session during handover between the two networks. If both the networks are accessible then WiFi network is always preferred by

the user because of its good features on a fixed location. But if the consumer moves, the ongoing session should be handedover to the other network, to avoid the drop of call, audio or video session which requires the convergence between the GSM and WiFi networks, called Fixed Mobile Convergence. So, the convergence of these two technologies gives a common platform for the dual technology users, and will act as $shakehand$ between the two different technologies, which will be in favor of both the network brands as well as the users.

2.4.2 Problem Solution

The seamless handover problem between GSM and WiFi can be solved by making the convergence algorithms that can handover ongoing session of call/video/data from one network to the other. For implimentation of this approach, network simulation of GSM and WiFi can be done using simulation softwares like $NS2$. Based on the convergence algorithm and the network simulation, **WATEEN** TELECOM can implement this approach which can be experienced by moving a mobile station from one network cell to the other.

2.4.3 Product Objectives

The objective of the project is to make convergence possible by having fast seamless handover between fixed and mobile networks along with the following key points. ¢ A single device for users to make and receive calls on mobile networks or via fixed networks, with the ability to make voice calls and share audio, video contents on either network. ¢ Reduced voice call and other service charges by using the fixed network in place of the mobile network for calls made inside the home or office. ¢ Higher data rates for multimedia services using WLAN or mobile cells. ¢ The opportunity for fixed-network operators to slow and perhaps reverse the trend of falling voice-call revenues. ¢ The opportunity for mobile network operators to improve in-building coverage and to offer hotspot services.

2.5 Strategic Fit

2.5.1 Corporate Strategy

WATEENś corporate strategy is to be equipped with modern technology in order to have a good place and position in the modern world. To keep an eye on the upcoming technologies is the great vision of the company. The basic theme of its successful products is the timely evaluation of its products by their $KPI's$ $(keyperformanceindicator)$. The products are selected on the bases of their $(USPs)$ $uniquesellingpoints$, which ensures the successful launch of the product. The companyś first periority is the fully satisfaction of its customers.

2.5.2 Marketing Strategy

In order to play a distinct role in the market, **WATEEN** pays a good attention to its market strategy because it plays an important role to make a product successful. Target customer is the main point of its strategy. To market a new product in a different style is the key of its strategy.

2.5.3 Existing Portfolio

The existing portfolios are the intranet handover i.e. within the same networks like WiFi to WiFi and GSM to GSM networks. There may exist the handover between GSM and WiFi but they are not seamless and thus audio, video and data sessions are not continued during the handover session.

2.5.4 User Interaction Strategy

Interaction with the users can be made possible by providing a toll free helpline number for solving their queries and their response towards the product.

2.6 Market Analysis and Segmentation

2.6.1 Residential Sector Analysis

FMC is useful for residential sector. When a residential user travels or moves from one network to the other, then there should be a fast seamless handover between the two networks, so that they can enjoy both the network services with respect to their need.

2.6.2 Corporate Sector Anaysis

This sector requires the FMC services much more than that of the former one because corporate sector requires very high data rate for their business purposes which is provided by the WiFi network and also a good range of network services which is provided by the GSM infrastructure. So they need both the services according to their runtime requirement. Thus convergence service is more impotant for this sector to have good flavors of GSM as well as the WiFi network.

2.6.3 Residential Consumer Segmentation

There are two segments of the residential sector. One segment is of the consumers who make a bulk use of WiFi technology near the available WiFi access points for the high data rate requirement and the other segment make a little use of WiFi. As the range of WiFi is very low as compare to that of GSM. So, the selection of the network depends on the user requirement and the available network service. This product is useful for the residential sector.

2.6.4 Corporate Consumer Segmentation

FMC product is attractive to this sector also. There is a great need of high data rate in the corporate sector to send and receive data at a very high data rate. Like the former segment, this sector also assumes two categories of the consumers depending upon the use of high data rate and the available network. If both the networks are accessible, then WiFi network is always preferred by the user because of its good features. If the consumer is mobile then convergence

is required to handover the ongoing session because of low range of WiFi services. Thus to avoid this problem, fast seamless handover between these two networks will be highly appreciable by the corporate sector also.

2.7 Competitive Advantage

This time mostly cellular companies are providing GPRS and EDGE technologies based on GSM system having low data rate as compare to WiFi but by this product the user can also have a good data rate when it handovers from GSM to WiFi cell. So the product can attract the users and win the market.

2.8 Barriers to Entry

2.8.1 Costly Dual Mode Sets

The handsets compatible for both GSM and WiFi are some how expensive as compare to that of the GSM series. Although this is a small barrier for this product marketplace but it can't suppress the great features of the product.

2.8.2 Product line inimitable by a single incumbent

Currently Pakistan Telecommunication Authority PTA doesn't allow the handover of calls between GSM and WiFi networks because of some basic issues. These problems are relating to the billing and bandwidth issues etc. **WATEEN** is trying to solve these issues with PTA. So whenever in the coming future this restriction is waived off, **WATEEN** can easily offer this product in the market at that golden time, as the product will be ready to launch.

2.9 Monopolized Industry

No other specific company is doing the same job for this convergence like criteria, so this is almost monopolized.

2.10 Marketing Strategy and Positioning

2.10.1 Target Customers

This product is for the dual technology users who uses both the GSM and WiFi technologies. So, the product is just to facilitate the customers of both the networks. As, the first periority is always the customer's satisfaction.

2.10.2 Seamless Handover Feature

There are no such handover criteria, or one must say "Seamless Handover" that can converge the two networks just for the benefit of the customers as well as the cellular companies. So, the product is itself unique for the purpose of convergence.

2.10.3 Future Enhancement

First this product is launched successfully then there are further edges to give more enhancements to the product in the coming future, like handover at a very high speed traveling etc.

2.11 Customer Experience

2.11.1 Service Delivery

Convergence service can be ensured just by the launch of the product depending as per policy of **WATEEN** Telecom.

2.11.2 Hardware Required

No extra hardware required to have the facility of the product i.e. just the dual mode handset.

2.11.3 Package

Package will be decided before the launching of the product.

2.11.4 Installation Activation

To get the facility, just the settings are needed to be installed in the dual mode handset from any nearest customer service center, and the a user can have a good taste of seamless handover, never experienced before.

2.11.5 Billing

The costing models may be as: 1) Flat rate tariff. 2) Volume based (traffic in terms of transacted bits/bytes) + fixed charge. 3) Volume based (traffic in terms of transacted bits/bytes) + fixed charge + local value additions (managed services). 4) Volume based (traffic in terms of transacted bits/bytes) + fixed charge + content based differentiated tariff. 5) Subscribers would pay separately for connectivity and services.

2.11.6 Business center/ Franchise

Franchise and business centers gives add to the customer services, so more and more business centers/ franchise should be established to have better customer services just for the convenience of customers.

2.12 Impact Assessment

2.12.1 Business Impacts

The product, Fixed Mobile Convergence, basically support both the GSM and WiFi networks, so obviously it will have a good impact in the market, because it is not going to harm any technology. GSM is the well-organized setup and WiFi is going to be adopted by the market. Thus both the setups will be promoted because of the positive effect of the product. As, these both are the two different technologies. So, the customers will be divided in selecting any one of the technologies, or both, according to their requirement. So, the convergence of these two technologies will prevent users from using different technologies and will act as ”shake hand” between them.

2.12.2 Operational Impacts

GSM is the well-organized national wide setup in Pakistan, having costly equipment, good coverage with low data rate. In contrast, WiFi setup is going to be adopted having low coverage with high data rate. So, both the setups have their own importance and one can’t deny it. Thus, this product makes the users possible to have the fruits of both the technologies, according to their need.

2.13 Conclusions and Recommendations

2.13.1 Conclusions

In the last, it is concluded that the product is very much in need by the dual mode technology users and should be completed as early as possible to facilitate the users. The product is in favor of both the users and network brands.

2.13.2 Recommendations

It is the matter of great vision to have such an idea of convergence by keeping an eye on the coming future. The theme of the product is highly appreciable. The product should be recommended as a project, as it is the need of the hour to have a convergence platform between Fixed amd Mobile networks, because in the near future, its all coming up together.

3 Global System for Mobile

3.1 Introduction to GSM

The roots of the development of the global system for mobile communications GSM began with a group formed by the European Conference of Postal and Telecommunications Administrations CEPT to investigate the development of a standard mobile telephone system to be used throughout Europe. This group was known as the Group Special Mobile, from here the acronym GSM came. GSM was eventually adopted as a European standard by the European Telecommunications Standards Institute ETSI. It has been standardized to operate on three principal frequency regions, being 900MHz, 1800MHz and 1900MHz. GSM is by far the most successful of the second generation cellular systems, and has seen widespread adoption across the world. Also in Pakistan GSM is an established standard that has quit large market volume. Now GSM has some low data rates as compared with WiFi

3.2 Architecture

3.2.1 Mobile Station

The MS consists of the mobile equipment ME and a smart card called the Subscriber Identity Module (SIM). The SIM offers personal mobility since the user can remove the SIM card from one mobile device and place it in another device without informing the network operator. The SIM contains a globally unique identifier, the international mobile subscriber identity $(IMSI)$, as well as a secret key used for authentication and other security procedures. A mobile device not equipped with a SIM must also be able to make emergency calls. In the fig**??** the connection of the MS to the Network has been shown.

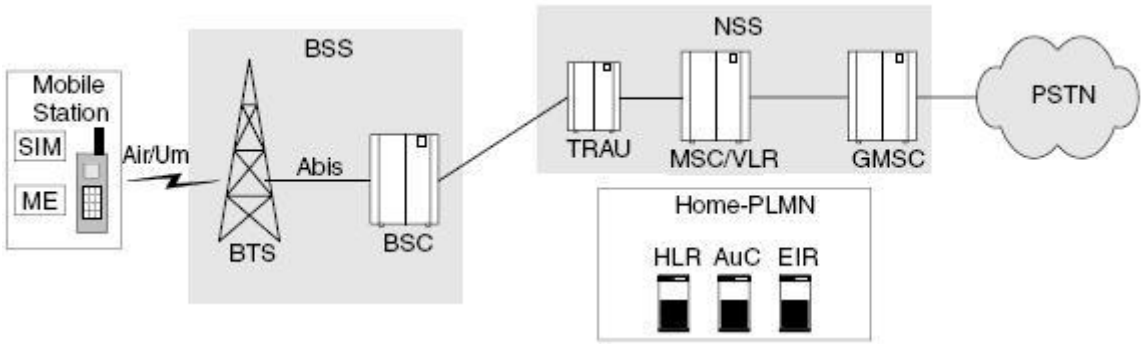

Figure 3.1: Mobile station communication with the network

3.2.2 Base Station Subsystem

The base station subsystem (BSS) is composed of three parts.

- Base Transceiver Station (BTS)
- Base Station Controller (BSC)
- Transcoding and Rate Adaption Unit (TRAU)

Base Transceiver Station

The BTS houses the radio transceivers (TRXs) that define a cell and handle the radio link with the mobile station. Each TRX can handle up to eight full rate users simultaneously. If more than eight full rate users request resources within the TRX then they will receive a busy tone. When a mobile device moves from one cell to another, the BTS may change. Within the GSM system a mobile device is connected to only one BTS at a given time. The BTS is also responsible for encrypting the radio link to the mobile device based on security information it receives from the core network.

Base Station Controller

The BSC manages the radio resources for one or more BTSs. It handles the radio channel setup and handover procedures when a user moves from one cell to another. When a handover occurs, the BSC may change. It is a design consideration that this will not change with the

same regularity as a BTS change. A BSC communicates with the BTS through time division multiplex (TDM).

Transcoding and Rate Adaption Unit

The central role of the second generation systems is to transfer speech calls and the system has been designed and optimized for voice traffic. The human voice is converted to binary in a rather complex process. GSM is now quite an old system and as such the original encoding method used, is not as efficient as some of the more recently developed coding systems such as those used in other cellular systems. There have been many developments in digital signal processing (DSP) which have enabled good voice quality to be transmitted at lower data rates. Although the TRAU is actually seen as being logically part of the BSS, it usually resides close to the MSC since this has significant impact on reducing the transmission costs. The voice data is sent in a 16 kbps channel through to the TRAU from the mobile device via the BTS and BSC. The TRAU will convert this speech to the standard 64 kbps for transfer over the PSTN or ISDN network.

3.2.3 Network Switching Subsystem

The (NSS) comprises the circuit switched core network, a part of the GSM system. The main element is the mobile switching centre (MSC) switch and a number of databases referred to as the visitor location register (VLR) and home location register (HLR). The HLR is always in the home network for roaming subscribers and thus any data exchange may have to cross international boundaries. The MSC and VLR are usually combined and are located in the visited network.

3.2.4 Mobile Switching Centre

It has the dual role of both switching and management. When a mobile device is switched on, and requests a connection to a mobile network, it is principally the (MSC) that processes this request, with the (BSS) merely providing the access to facilitate this request. If the request is successful then the (MSC) registers the mobile device within its associated (VLR). The VLR will update the HLR with the location of this mobile device, and the HLR may be either in

the same network, or a different network in the case of a roaming user. The MSC deals with registration, authentication, mobile device location updating, and routing of calls to and from a mobile user. An MSC which provides the connectivity from the mobile network to the fixed network, e.g. ISDN or PSTN, is known as a gateway MSC (GMSC).

3.2.5 Home Location Register

When a subscriber registers with an operator, they enter into a service level agreement. This operator mobile network is known as the home network. The HLR is a huge database located within this home network which stores administrative information about the mobile subscriber. The information stored for a user in the HLR will include their IMSI, service subscription information, service restrictions and supplementary services. The HLR also knows the location of its mobile users. It actually knows their location only to the VLR with which the mobile device is registered. The HLR also only knows the location of a mobile device which is switched on and has registered with some mobile operator network.

3.2.6 Visitor Location Register

The VLR is another database of users and is commonly integrated with an MSC. Unlike the HLR, where most information is of a permanent nature, the VLR only holds temporary information on subscribers currently registered within its vicinity. This vicinity covers the subscribers in the serving area of its associated MSC. When a mobile device enters a new area, the mobile device may wish to connect to this network and if so informs the MSC of its arrival. Once the MSC checks are complete, the MSC will update the VLR. A message is sent to the HLR informing it of the VLR which contains the location of the mobile. If the mobile device is making or has recently made a call, then the VLR will know the location of the mobile device down to a single cell.

3.2.7 Equipment Identity Register

The EIR is a list of all valid mobiles on the network. If a terminal has been reported stolen or the equipment is not type approved then it may not be allowed to operate in the network. The

terminals are identified by their unique (IMEI) identifier.

3.3 Mobility of Mobile Station

To make and receive calls, the location of the mobile device has to be known by the network. Each cell broadcasts its globally unique identity on its broadcast channel, which is used by the mobile device for location purposes. Mobility management is the mechanism that the network uses for keeping a dynamic record of the location of all of the mobile devices currently active in the network. The major benefit of the cellular telephone over a fixed landline is the mobility that it presents to the subscriber. Mobility extends to cover the concept of roaming. The provision of mobility makes the network much more complex to design and operate. As a subscriber moves from one location to another, the strength of the signal it receives from the base station will fluctuate and the signal received by the base station from the mobile device will also vary. Both the network and the mobile device must constantly monitor the strength of the signal, with the mobile device periodically reporting the information it has measured to the network. The mobile device also monitors the strength of other cells in the vicinity. When the signal strength gets too weak from a particular base station, a handover to a base station in another cell may take place. The network must try to guarantee that in the event of a handover, the user call is not dropped and there is a seamless handover from cell to cell, even if the user is moving quite rapidly.

3.4 The GSM Handover

In order to illustrate the approach as clearly as possible, we concentrate on the following nodes of the GSM network.

3.4.1 Intra BSC Handover

When a subscriber geographical location changes, there may be rather frequent movements from one cell to another. The change of a cell from one base station to another is relatively simple if the BTSs are controlled by the same (BSC). When a user changes from one cell to

another, a cell update is required. This does not require much in the way of signalling like User1 in the figure.

3.4.2 Inter BSC Handover

The handover process concerns two BTS but of two different BSC controlled by the same MSC.The change of a BSC is more complex,so a cell update and a BSC update are required. Hence it will require more signalling because the MSC is controlling the change in BSC but will occur less frequently since each BSC controls a number of BTSs. User2 in the figure describes the inter BSC handover.

3.4.3 Inter MSC Handover

The handover process in this case is between two BTS belonging to different BSC controlled by different MSC. A change of the MSC is also possible but again this should be rather infrequent for most users. A cell update, BSC update and an MSC update are required. This is a much more complex task, which will require a greater amount of signalling.If a user is in a vehicle and moving at high speed, then a number of (MSC) handovers may take place during a prolonged voice call. This system of handover enables a subscriber to continue with a call in progress while moving from one geographical area to another. User3 in the fig3.2 describes the MSC handover.

3.5 Goal Behind GSM

WATEEN actually does not aim at providing any thing or any service related to GSM but only want the user to move from GSM to VoIP i.e. the WiFi. Because the iternet is best provided in WiFI not GSM. GSP provide GPRS in which the user is provided the complete frame for communication but that is still not enough to support VoIP so user must handoff. The handover scenarios discussed in the fig3.2 are to be analysed before we go into the handoff algorithm. Also the behavior of the user is analysed during the peak timings. Like in the busiest hour of the day the load on the system that support this handoff will be greater enough to congest it. Other analysis include the operators exciting service offers that can come at any time in

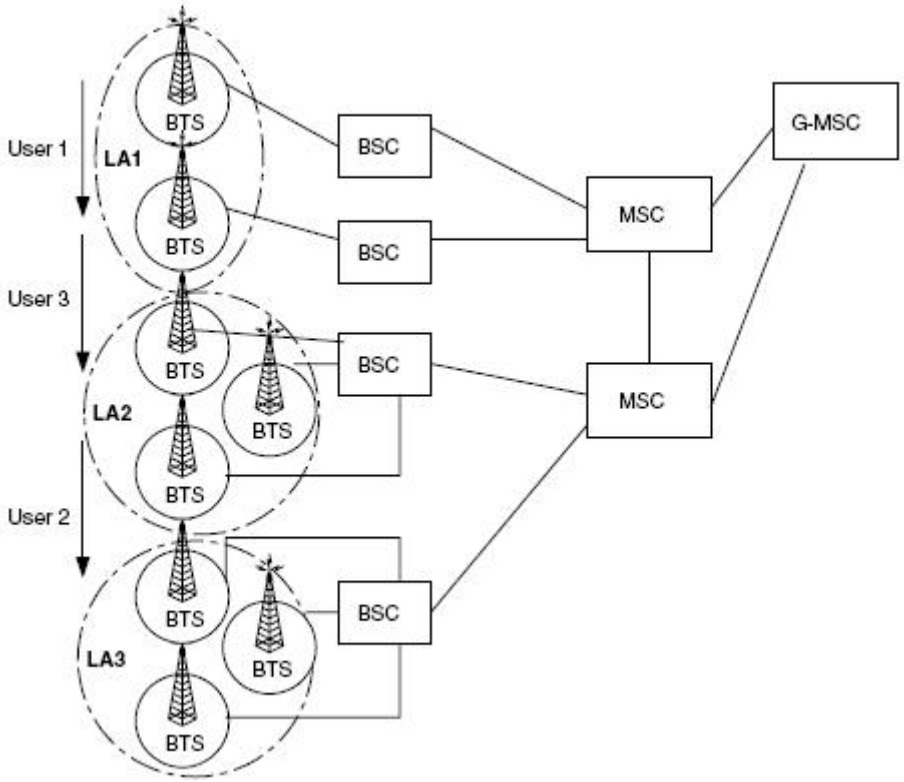

Figure 3.2: Different types of handovers

the market and which direcly effect the customer behavior. So we must be prepared for these kinds of changes in the future that make a network congested and hence more users rapidly want to handoff and leave particular networks or join some networks.

4 IEEE 802.11 Family

A way to get Internet access, the term Wi Fi is a play upon the decades old term HiFi that describes the type of output generated by quality musical hardware. WiFi stands for Wireless Fidelity and is used to define any of the wireless technology in the IEEE 802.11 specification including (but not necessarily limited to) the wireless protocols 802.11a, 802.11b, and 802.11g. The WiFi Alliance is the body responsible for promoting the term and its association with various wireless technology standards. What is a Wi Fi Hotspot? A Wi Fi hotspot is defined as any location in which 802.11 wireless technology both exists and is available for use to consumers. Generally, the most common usage of Wi Fi technology is for laptop users to gain Internet access in locations such as airports, coffee shops, and so on, where Wi Fi technology can be used to help consumers in their pursuit of work-based or recreational Internet usage.
Originally, WiFi certification was applicable only to products using the 802.11b standard. Today, WiFi can apply to products that use any 802.11 standard. The 802.11 specifications are part of an evolving set of wireless network standards known as the 802.11 family. The particular specification under which a WiFi network operates is called the (flavour) of the network. WiFi has gained acceptance in many businesses, agencies, schools, and homes as an alternative to a wired LAN. Many airports, hotels, and fast food facilities offer public access to WiFi networks. These locations are known as hot spots. Many charge a daily or hourly rate for access, but some are free. An interconnected area of hot spots and network access points is known as a hot zone.

4.1 WiFi Standards

Home and business networkers looking to buy wireless local area network $(WLAN)$ can select from an array of choices. Many products conform to the 802.11a, 802.11b, 802.11g, or

802.11n wireless standards collectively known as WiFi technologies. Additionally, Bluetooth and various other non WiFi technologies also exist, each also designed for specific networking applications. This article describes the WiFi and related technologies, comparing and contrasting them to help you make educated network building decisions.

4.1.1 802.11

In 1997, the Institute of Electrical and Electronics Engineers (IEEE) created the first WLAN standard. They called it 802.11 after the name of the group formed to see its development. Unfortunately, 802.11 only supported a maximum network bandwidth of 2 Mbps - too slow for most applications. For this reason, ordinary 802.11 wireless products are no longer manufactured.

4.1.2 802.11a

While 802.11b was under development process and IEEE created a second extension to the original 802.11 standard called 802.11a. Because 802.11b gained in popularity much faster than did 802.11a, some folks believe that 802.11a was created after 802.11b. In fact, 802.11a was created at the same time. Due to its higher cost, 802.11a is usually found on business networks whereas 802.11b better serves the home market. 802.11a supports bandwidth up to 54 Mbps and signals in a regulated frequency spectrum around 5GHz. This higher frequency compared to 802.11b shortens the range of 802.11a networks. The higher frequency also means 802.11a signals have more difficulty in penetrating walls and other obstructions. Because 802.11a and 802.11b utilize different frequencies, the two technologies are incompatible with each other. Some vendors offer hybrid 802.11a/b network gear, but these products merely implement the two standards side by side (each connected devices must use one or the other). The speedṡ are always important in any standard. The max speed of 802.11a is 54 megabits per second. However it is quite fast at its standard rate which is about 25 mbps. This makes it more than twice as fast as 802.11g and almost 4 times as fast as 802.11b when using it in day to day operations. Also the range has similar importance as the speed has in a wireless standard. 802.11a delivers a range of about 33 meters or about 100 feet. This is about a 1/3 less than its cousin 802.11b which delivers a range of about 150 feet. It should be noted that because 802.11a uses much higher frequencies, there is less interference from cordless tele-

phones and microwave ovens. However, higher frequencies have their limitations. They do not penetrate walls and obstacles as good as lower frequencies and they require more energy to power these devices. 802.11a operates on the frequency 5.15-5.35/5.47-5.725/5.725-5.875 GHz, for the most part, the clarity of the signal is generally good, and you are less likely to experience interference than other types of 802.11 standards. The Price for 802.11a is more expensive than both 802.11b and 802.11g. While it does offer great speeds, many individuals might not view the speed worthy for its extra cost. However, for businessś that need fast, interference free networks, these costs can be rationalized and accepted. Unfortunately, 802.11a is not compatible with other types of standards. If you are running a network on 802.11a or have a Wifi card that receives 802.11a signals, do not expect this standard to work with others. There are dual band Wifi router and cards that offer both 802.11a and 802.11b, but they are usually very costly.

4.1.3 802.11b

IEEE expanded on the original 802.11 standard in July 1999, creating the 802.11b specification. 802.11b supports bandwidth up to 11 Mbps, comparable to traditional Ethernet. 802.11b uses the same unregulated radio signaling frequency (2.4 GHz) as the original 802.11 standard. Vendors often prefer using these frequencies to lower their production costs. Being unregulated, 802.11b gear can incur interference from microwave ovens, cordless phones, and other appliances using the same 2.4 GHz range. However, by installing 802.11b gear a reasonable distance from other appliances, interference can easily be avoided. 802.11b can delivers speeds of up to 11 megabits per second; however expect a typical rate of transfer near 6.5 megabits per second. This standard usually delivers a clear enough signal to make it effective for about 50 meters (150 feet). Range can vary, depending on many variables including structure such as being in an apartment building or office building, having your router on another floor than your computer, being outside or in an open area and having interference from other devices operating close to the frequencies being used such as a microwave oven or cordless phone. Since 802.11b operates on a frequency that is 2.4-2.5 GHZ, the clarity of the signal is generally good and because it is lower than other frequencies, it has the ability to move through walls and other obstacles usually unaffected. The price points for both the router and wifi cards are both usually under $100 dollars$ making this technology easily affordable for large corporations, small and home based businesses and private home use.

4.1.4 802.11g

In 2002 and 2003, WLAN products supporting a newer standard called 802.11g emerged on the market. 802.11g attempts to combine the best of both 802.11a and 802.11b. 802.11g supports bandwidth up to 54 Mbps, and it uses the 2.4 Ghz frequency for greater range. 802.11g is backwards compatible with 802.11b, meaning that 802.11g access points will work with 802.11b wireless network adapters and vice versa.
The max speed of 802.11g is 54 megabits per second; however expect around 11 megabits per second in normal day to day use. 802.11g delivers a range of about 33 meters or about 100 feet. While this is less than its cousin 802.11b which delivers a range of about 150 feet, most people's networks are well within this range's limits. It is important to note that range can vary depending on many factors including whether a network is set up in an apartment, office environment, if a router is on another floor than computers tied into the network or if there is interference from signals operating close to 802.11g's. 802.11g operates on the frequency 2.4-2.5 GHZ, for the most part, the clarity of the signal is generally clear and interference free. In addition, this frequency works well penetrating walls or other types of building obstructions due to the fact it operates at low frequencies.
The Price for 802.11g is relatively affordable for both corporations, home based businesses and private home networks. Expect price points around the $100dollars$ mark for both the router and Wifi cards. A great reason to choose 802.11g is due to its downward compatibility with 802.11b. The 802.11b standard is widely used and 802.11g can work seamlessly with this standard

4.1.5 802.11n

The newest IEEE standard in the WiFi category is 802.11n. It was designed to improve on 802.11g in the amount of bandwidth supported by utilizing multiple wireless signals and antennas instead of one. When this standard is finalized, 802.11n connections should support data rates of over 100 Mbps. 802.11n also offers somewhat better range over earlier WiFi standards due to its increased signal intensity. 802.11n equipment will be backward compatible with 802.11g gear.

4.2 Modulation in 802.11

Orthogonal frequency division multiplexing $OFDM$ essentially identical to Coded $COFDM$ and Discrete multi-tone modulation DMT is a frequency division multiplexing FDM scheme utilized as a digital multi carrier modulation method. A large number of closely spaced orthogonal subcarriers are used to carry data. The data are divided into several parallel data streams or channels, one for each subcarrier. Each subcarrier is modulated with a conventional modulation scheme such as quadrature amplitude modulation or phase shift keying at a low symbol rate, maintaining total data rates similar to conventional single-carrier modulation schemes in the same bandwidth.

OFDM has developed into a popular scheme for wideband digital communication, whether wireless or over copper wires, used in applications such as digital television and audio broadcasting, wireless networking and broadband internet access. The primary advantage of OFDM over single carrier schemes is its ability to cope with severe channel conditions for example, attenuation of high frequencies in a long copper wire, narrowband interference and frequency selective fading due to multipath without complex equalization filters. Channel equalization is simplified because OFDM may be viewed as using many slowly modulated narrowband signals rather than one rapidly modulated wideband signal. The low symbol rate makes the use of a guard interval between symbols affordable, making it possible to handle time-spreading and eliminate intersymbol interference ISI. This mechanism also facilitates the design of single frequency networks, where several adjacent transmitters send the same signal simultaneously at the same frequency, as the signals from multiple distant transmitters may be combined constructively, rather than interfering as would typically occur in a traditional single carrier system.

In telecommunications, direct sequence spread spectrum $DSSS$ is a modulation technique. As with other spread spectrum technologies, the transmitted signal takes up more bandwidth than the information signal that is being modulated. The name $spreadspectrum$ comes from the fact that the carrier signals occur over the full bandwidth $spectrum$ of a deviceś transmitting frequency.

It phase-modulates a sine wave pseudo-randomly with a continuous string of pseu-randomdonoise (PN) code symbols called c̈hips,̈ each of which has a much shorter duration than an information bit. That is, each information bit is modulated by a sequence of much faster chips. Therefore, the chip rate is much higher than the information signal bit rate. It uses a

signal structure in which the sequence of chips produced by the transmitter is known a priori by the receiver. The receiver can then use the same PN sequence to counteract the effect of the PN sequence on the received signal in order to reconstruct the information signal.

4.3 Mobility in WiFi APs

Modeling movements of users is important for simulating wireless networks, but current models often do not reflect real movements. Using real mobility traces, we can build a mobility model that reflects reality. In buildinga mobility model, it is important to note that while the number of hand held wireless devices is constantly increasing, laptops are still the majority in most cases. As a laptop is often disconnected from the network while a user is moving, it is not feasible to extract the exact path of the user from network messages. Thus, instead of modeling individual user movements, we model movements in terms of the influx and outflux of users between access points (APs). We first counted the hourly visits to APs in the syslog messages recorded at APs. We found that the number of hourly visits has a periodic repetition of 24 hours. Based on this observation, we aggregated multiple days into a single day by adding the number of visits of the same hour in different days. We then clustered APs based on the different peak hour of visits. We found that this approach of clustering is effective; we ended up with four distinct clusters and a cluster of stable APs. We then computed the average arrival rate and the distribution of the daily arrivals for each cluster. Using a standard method such as thinning for generating nonhomogeneous Poisson processes, synthetic traces can be generated from our model. Modeling the movements of mobile users between access points (APs) is important for simulating wireless networks. It is often not feasible to test new technologies in real wireless networks, especially not on a large scale. Simulations allow developers and researchers to try these new technologies before real-world deployment.
To simulate wireless networks at the AP level, we need a model that describes movements between APs. For example, we can estimate AP load or test resource allocation mechanisms with such a movement model. In developing a mobility model, we have three goals.

1. The model should reflect real user movements. Currently available mobility models are not based on real traces and may not reflect real mobility patterns.

2. The model should be general enough to describe the movements of every device. When a user is moving, handheld devices often stay turned on, while laptops are disconnected

from the network. Thus, it is not feasible to extract the physical path of laptop users by looking at network messages.

3. The model should consider the hourly variations over a day. A mobile user movements are highly affected by the time of day, and as a result the load of APs changes over time during a day.

For example, APs located at a cafeteria are visited most during lunch time. Thus, it is important to consider the hourly variations. Similarly APs at the Airports are very busy any time in the 24 hour period. So the chances of usersś utilization of the channel for voice communication is more less and the handover from WiFi to GSM is more likely to be appreciated.

4.4 Goal Behind WiFi

WATEEN is aiming at providing the user VoIP in the future so by converging GSM with a technology that best supports the internet in the future is an ultimat advantage. User if wants to talk through VoIP may handoff from costly GSM to low price VoIP. **WATEEN** has finished with the VoIP design by selecting MOTOROLA as their vendors for all this purpose. WiFi can provide greater data rates to the user and **WATEEN** can benefit from that and provide exciting offers in the VoIP services and can excel the market.

5 Fixed Mobile Convergence

5.1 INTRODUCTION

The word fixed means that the technology which is not wireless and also the technology which is wireless but not mobile. And the word Mobile is simply the technology that offer the user mobility in a covered area. We can not neglect the contribution of fixed networks to the communication networks. Like the PSTN has served for so many years as a network for human communication but now adayas being replaced by different latest networks, still we can see that PSTN is serving as signaling media for the GSM as different MSCs are interconnected through PSTN. Now here we can see that GSM is mobile and the PSTN is fixed so it is their convergence to provide user this whole current communication. Similarly if we consider that internet is fixed (not mobile) then if we converge a network with a mobile network and by this we can make internet mobile then we can say that we have converged fixed and mobile networks and this is all behind the title Fixed Mobile Convergence.

5.2 IP Multimedia Subsystem

IP multimeia subsystem provides the mechnism for convergence between differen networks. As it is IP based itself that is why it is the best subsystem for convergence between networks that provide internet and the others like wireless. **WATEENś** IMS has been designed by MOTOROLA and **WATEEN** will practically estalish a part of this subsystem for the convergence of 802.11 and the GSM.

The IP Multimedia Subsystem consists of the three Layers as shown in the fig5.1. Application software will be installed on the **Dual Mode Handsets** and the application layer protocol will be running on to that. The request messages will be onslaughted from application layer to

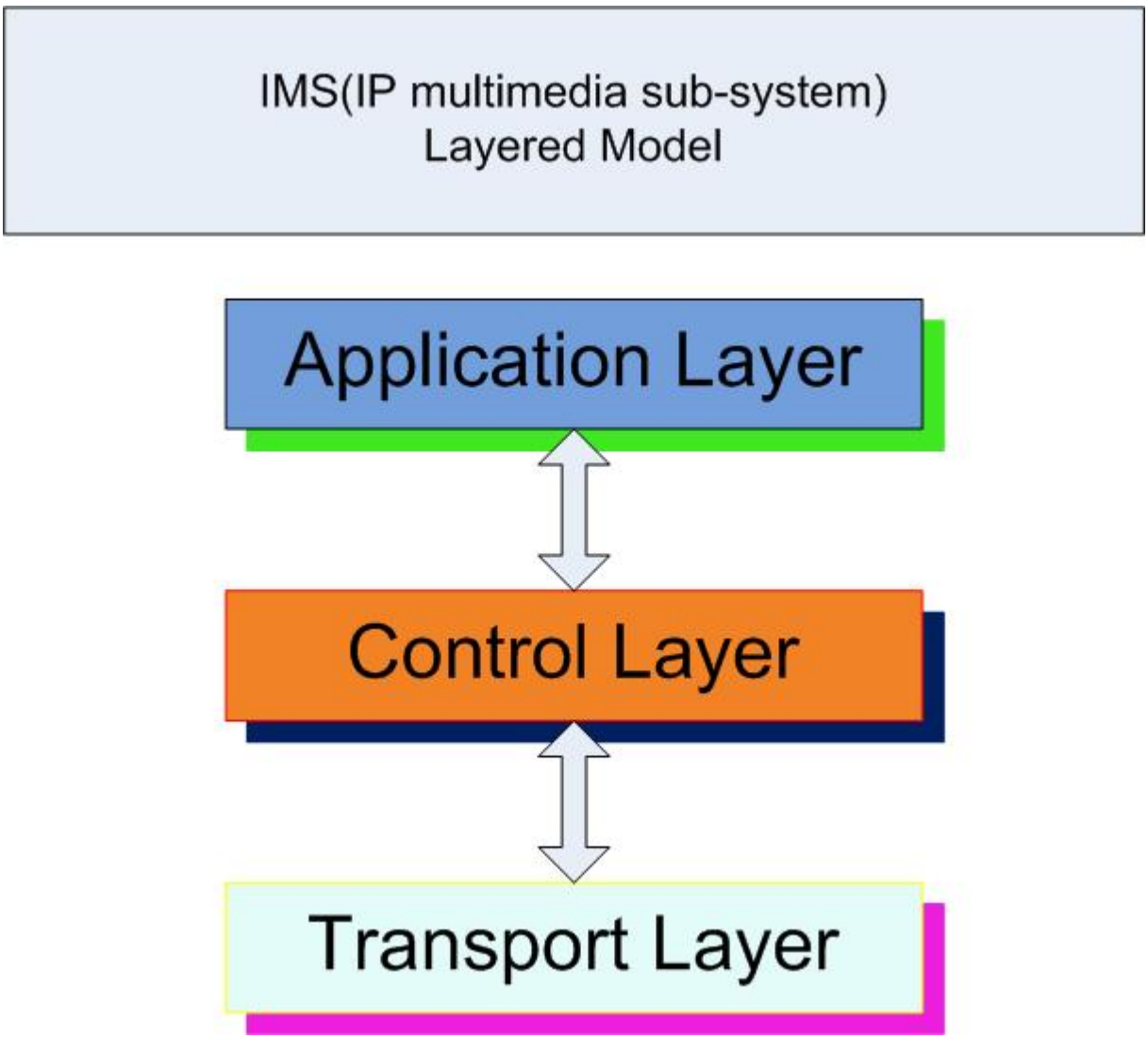

Figure 5.1: IMS Layered Model

control layer. Control layer is called the brain of IMS. The control layer recieve the request, authenticate it and forwards it to the transport layer and then the order is followed for further delivery. Th media request is analysed by the control layer and it requests to the application server about the media requested by the user. During the handoff the handoff request will first go to the control layer for analysis and then if acknowledged, will be transfered to the transport layer from where the IMS is conneted to gateways of different networks. And the PTA liscense would mean that the network will allow the handoff when IMS has requested it. During the signaling process the gate way function will recieve an acknowledgement of handoff and the other parameters will be sent like the signal strength at that moment, the IP asighned

by the DHCP server. After all this signaling process the voice session would be started in RTP packets. The IMS provides services to mobile users such as:

- real-time communication using voice, video or multimedia messaging i.e voice and video telephony;
- audio and video conferencing;
- content delivery services such as video, audio or multimedia download;
- content streaming services such as video, audio or multimedia streaming e.g. using video on demand server ;
- multimedia messaging service.

Each operatorś IMS can be connected to other operator IMS, allowing multimedia services between users on different networks. Connections to the public Internet allow MMS messaging as well as voice over IP and video telephony between mobile and fixed-line users. Finally, the interface to the ISDN or other circuit switched networks allows VoIP calls to be connected through to conventional fixed-line and mobile users, e.g. global system for mobile communications. And this is what we are aiming at connections between the IMS and other IP networks are controlled by firewalls to protect against hacking. Within the operator network the IMS is connected to the home subscriber server HSS to allow for subscriber authentication, authorization and mobility management.

5.3 Call session control function

Data transfer between users of IMS is organized into sessions. The CSCF is Call session control function which is responsible for session control. It control the following functions:

- User authentication
- Call routing
- Establishing QoS over the IP network
- Controlling the generation of call detail records for accounting purposes.

All call/session control signalling in the IMS is performed using the session initiation protocol SIP. Three types of CSCF are defined: P-CSCF, S-CSCF and I-CSCF. The connection of the CSCF has been shown in the fig5.2 that how it makes the connection to the application layer Signaling Processor being a transport layer component itself. The user requests are transfered in a well defined manner to the Sidnaling Processor and the processor then defines the operation on it according to the application plan. The processor forwards the request to the Resource Manager to decide which media has been requested. The Resource Manager then forwards the request to the Media Processor to select the requested Media from the Media Server. Relating to our goal the Media Server should have links to internet as well as the GSM then the request for internet will be forwrded to the internet assigned port and the request for GSM call can be forwarded to the GSM network for a voice call. The two links can be connected to the external media port in the Media Server. Media Server is processed by the Media Processor and logically the Media has been selecte and assigned to the user then the user utilize that media for further communication. Each network will typically provide multiple CSCFs of each type. This allows for load sharing and supports increased reliability through the use of backup servers.

5.3.1 Proxy CSCF

P-CSCF acts as the first point of contact for call signalling coming. The P-CSCF forwards the call signalling to the serving CSCF (S-CSCF), which is the home network point of control for the call. For a roaming subscriber, the P-CSCF will be located in the visited network just as the VLR work in the GSM. The P-CSCF is also responsible for controlling the generation of CDRs for mobile originated calls.

5.3.2 Serving CSCF

S-CSCF carries out the call and accounting control for a given subscriber. The S-CSCF is always located within the subscribe home network. This means that all mobile originated call signalling is routed via the user home network. For example, a Pakistani subscriber roaming in Malaysia who then phones America, would have their call routed via the UK. The reason for this is that it allows a network operator to reconcile its call charging records with its overseas roaming partners for each subscriber. This non optimal routing covers only signalling traffic.

5.3.3 Interrogating CSCF

I-CSCF is located at the boundary of the IMS and acts as a point of entry for SIP signalling coming from outside the operator network. This signalling include:

- A SIP call setup request destined to a subscriber of the operator network.
- A SIP call setup request destined to a roaming subscriber within the operator network.
- A registration request.

For incoming registration requests the I-CSCF is responsible for assigning an S-CSCF to the subscriber. The choice of S-CSCF can be made dependent on the identity of the subscriber SIP address or international mobile subscriber identify IMSI, handled on aload sharing basis or using a main server/backup server arrangement.

5.4 Application Server

This provides value-added services to a subscriber. This could be anything from receiving streaming video service (video on demand) to providing voice and video mail services. The application logic toolkit has been shown in the fig5.2 The main thing to be uner stood in th fig5.2 is the eternal media option in it. Having this option we can connect the two networks like WiFi and GSM to these ports and can converge them by sending a request to the Signaling Processor and so on to the Port of WiFi or GSM.

5.4.1 Breakout gateway control function

Any network can escaped through only one route and that is the Gateway(main router). BGCF is used to select the appropriate gateway to forward calls destined for the CS domain (the CS breakout point). Then to the External Media for convergence. An S-CSCF will forward all call requests with CS destinations, which will then forward them to the appropriate MGCF. MGCF then controls the requests for appropriate media.

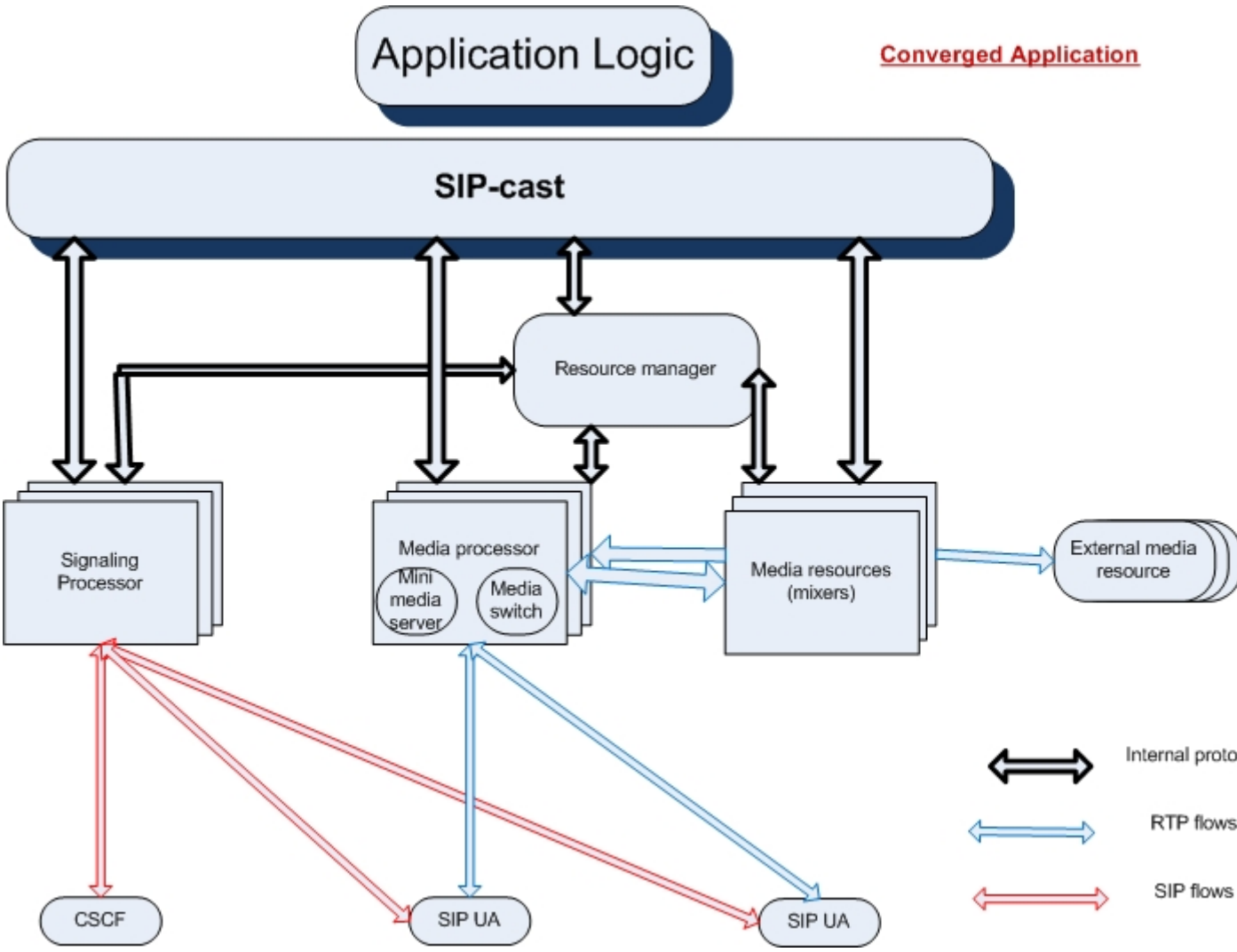

Figure 5.2: Application layer connection with Control layer

5.4.2 Multimedia resource function

The MRF control and MRF processor are the two components of MRF and is responsible for providing functions like:

- Mixing media for video/voice conferencing (conferencing bridge)
- Providing multimedia announcements
- Processing media streams

The MRF functionality is split into a control (MRFC) and a media processing (MRFP) part, in much the same way as functionality is split between media gateway controller (mobile switching centre MSC Server) and media gateway. The MRFC receives call control signalling via the SIP protocol e.g. to establish a Video-conference between a number of parties.

5.4.3 Media gateway control function and media gateway

The MGCF functionality and MGW provide a connection between the IMS and external CS networks such as WiFi and GSM. The MGCF controls the MGW and interfaces to the S-SCSF using the SIP protocol. Call signalling (SS7/ISUP) is forwarded from the CS network signalling gateway to the MGCF. The MGCF must translate messages between SIP and ISUP to provide interworking between the two protocols.

5.4.4 Sylantro Application Server

Sylantro provides is a VoIP feature server delivering advance telephone features that can be offered to multiple enterprises (tenants) in a hosted environment. Sylantro defines a node as a set of elements providing the following functionality:

- Control Server CS the Control Server software resides on a couple of Sun Servers as active-standby pair. Control Server is responsible of the call control communication with the IMS (ISC interface).
- Administration Server (AS) the Administration Server software resides on couple of Sun Servers working as active-standby. Adminitation Server is responsible of hosting the subscribers database, the system configuration database and call logs database $CDRs$.
- Web Application Servers WAS Typically deployed on a couple of Sun Servers working in active-active configuration. The Web Application Server is responsible of hosting the portal server and receives the requests from external web servers and forwards these request over the signaling interface to the virtual address of the Admin Server. Additionally two other systems are part of solution:
- Media servers MS, a number of media servers are assigned to a Sylantro node based of the traffic requirements, the media servers will support Sylantro when any media

traffic is required to be sent from the application to the subscribers $ring\ back\ tones$, $announcements$, etc.

- Sylantro CommManager EMS The EMS resides on a separate server and provides a web-based interface for remote management of the elements comprising the Sylantro node.

5.5 Home Subscriber Server HSS

The HSS is comprised of the following functional elements:

- The HSS Back End (BE) holds all subscriber, application and network configuration data in a single X.500 directory, and provide open interfaces such as LDAP and DAP to allow the HSS Front Ends as well as other network elements such as O and M systems, SCPs, IP services, and Feature Servers to easily access HSS data. The HSS Back End data is partitioned, allowing it to be scaled almost indefinitely in size and to be extended readily for new subscriber/application data. This partitioning, however, is completely transparent to the rest of the network allowing the HSS to be implemented as a single logical HSS. A single logical HSS implementation benefits from the removal of SLF functionality traditionally required in other network elements $MSCs$ to direct subscriber operations to the correct physical HSS platform.

- The HSS Front End FE handles all HSS subscriber transactions and signalling traffic from network elements such as SIP application servers and CSCFs that access or update HSS data. As the volume of HSS transactions grow, additional HSS Front End systems can be added to the configuration to provide additional signalling or transaction handling capacity.

For initial network deployments, it is also possible to combine both elements into a single hardware platform. The current implementation of **WATEEN** VoIP core network includes the installation of two HSS systems in the cities of Lahore and Karachi, each HSS system will be comprised of a couple of combined FE/BE and a HSS EMS. Two important issues must be highlighted:

- Redundancy: though geographical is an option, it has been decided to provide redundancy only locally, meaning that the CSCF located in a particular city (Lahore or Karachi) will have to configure a primary HSS being one of the local FE/BE platform and a secondary HSS as the other local FE/BE platform.
- Database: the HSS will have a distributed database across all the BE elements of the network ensuring that each BE has a same database replica.

5.6 Session Initiation Protocol (SIP)

SIP is designed to allow multimedia sessions to be established between users on an IP network. IP network becuse the when the user handoff from GSM to WiFi it may need a protocol that is compatible with real time interaction. TCP is the other protocol in comparison with SIP but that is not designed for realtime communication like RTP and SIP. SIP is the signaling protocol for IMS as well as call control and functions such as user mobility and call redirection as suggested by IEEE and IETF. Currently the following types of services are supported:

- multimedia call establishment
- user mobility
- conference call
- supplementary services (call hold, call redirect, etc.)
- authentication and accounting
- unified messaging
- instant messaging and user presence detection.

As our aim is to move user from GSM to WiFi the full benefits of SIP comes then infront at an all IP network like WLAN(WiFi) and here are the benefits of SIP then:

- end-to-end SIP signalling between mobile and fixed-line IP users;
- Internet SIP servers can provide value-added services to mobile users;

- SIP is designed as an IP protocol, therefore it integrates well with other IP protocols and services;
- SIP is lightweight and (relatively) easy to implement.

The first point is of particular interest. As a subscribers of the GSM network start to use services based on an IP infrastructure they may wish to communicate to fixed-line Internet lines. The mobile UE is participating in the voice portion of a video call with a user using a voice or video application on a desktop. The first point is of greater importance as the SIP will provide the signaling between the fixed line and the mobile. The 3rd point is imporatant as we want the user to an all IP enviroment and the SIP best supports it. The SIP application server shown in the fig5.3 can be accessed by users on the Internet or connected via the mobile network.

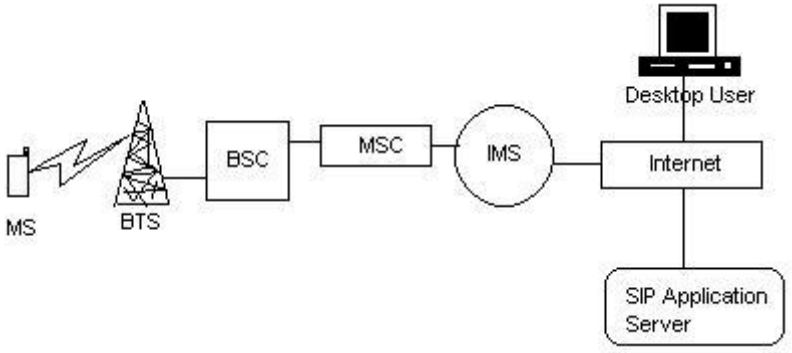

Figure 5.3: SIP connectivity

5.6.1 SIP Addressing

SIP users are located via a SIP uniform resource indicator (URIs). Here are some examples of SIP URIs: **Example:**Suppose we have two users want to communicate to each other one is Bob and the other is Alice.

```
Bob’s Sip Address is (sip:bob@193.64.210.89)

Alice’s Sip Address is (sip:alice@167.180.112.24)
```

5.6.2 SIP Messages

To have a brief look at the SIP INVITE message along with a few common header lines we again suppose an example. **Example:** Suppose Alice wants to communicate to Bob through an IP phone call and Alice only know Bob's SIP address,(bob@domain.com), and does not know the IP address of the device that Bob is currently using. Then the message may look like this.

```
Invite: sip:bob@domain.com

Via: SIP/2.0/UDP 167.180.112.24

From: sip:alice@hereway.com

To: sip:bob@domain.com
```

5.6.3 SIP Components

Location Service

A location service is used by a redirect or proxy server to obtain information about a user whereabouts. The location service can be co-located with other SIP servers. The interface between the location service and other servers is not defined by SIP. This option in the SIP is important for the mobile user to be located in WiFi networks through DHCP and in GSM through mobile IP.

Redirect Server

The redirect server responds to a UA request with a redirection response indicating the current location of the called party. In this case the UA must establish a new call to the indicated location.

Registrar Server

The registrar server allows SIP agents to register their current location. The registrar is responsible for keeping up-to-date information within the location service by sending updates.

6 Handover Algorithm

In this chapter the discussion is all about the suggested algorith for handover between WiFi and GSM. The **Dual Mode Handsets** contains the algorithm in the software form installed on it and the user can perform some settings at the start and then the user is ready to use it in the practical enviroment. The pseudo-code of the algorithm has been divided into four modules, module (1),(2),(3),(4). Each module will have to pass a succesful flag for the user to successfully handoff. If any of the module fails in its process the whole process will have to be restarted from module(1). Each module is a prerequisite to the next module so it has been taken care that if there is a failure in any of the module then restart the process. The restart(re-scan) time is given in the settings of the software and can be manualy set to possible user choice. The scenario has been shown in the fig6.1.

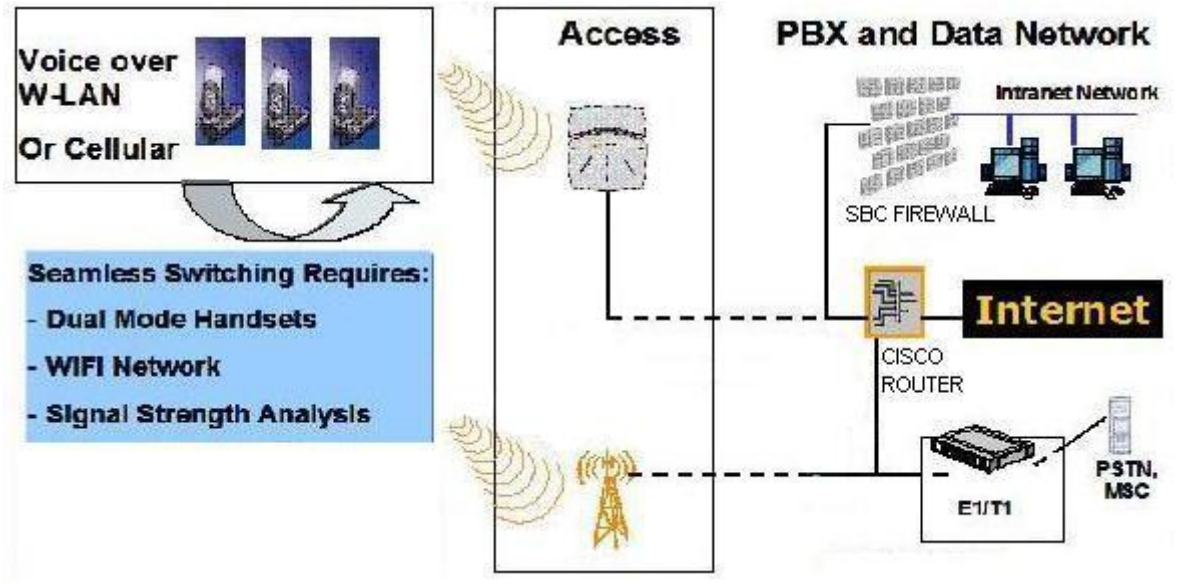

Figure 6.1: Mobile Station in the Handoff scenario

6.1 Module (1)

In this module the important scan process is being completed for both the transmitters so that one of the transmitters can selected on the best serving regards. The **Dual Mode Handset** scans the BTS of GSM network and AP of the WiFi network and does their comparison in module(1). When the process starts the MAIN Scan of the code scans the available transmitters and register them for primary and secondary scanning, then the parts of the MAIN_SCAN Primary Access Point are executed. As shown in the line(A) of the pseudo-code. When this line executes the **Dual Mode Handset** receives the information about the current AP it is using. And similarly in the line (B) the **Dual Mode Handset** has the ID of the AP in use and now it measure the intensity level of the received signal from the primary AP. There are 1-6 levels in which a MS store the level which it detects. These levels reflect the values of received power in dBm. In line (C) the received power is stored in the receiver log of the MS.In line(D) the extra information like data rates and the grade fo service is checked and stored to the profile of the primary AP. In line (E) the frequency of the AP is stored which will be discussed later that for which purpose does the frequency is stored. In the last line of the process every thing which has been gathered so far is saved in the SCAN LOG for further use. Every thing which we have noted in the primary access point profile will now be used for comparing it with the notes in the secondary access point profile, but we need to have the secondary access point profile reading before doing that.

```
MAIN\_SCAN:
Primary Acess Point Profile
  (A) Information of the network that is currently in use;

  (B) Signal Intensity;   (1-6)levels;

  (C) Reciever Information;  Power recieved etc;

  (D) Extra Information;     data rate, GoS etc;

  (E) Frequency in Use;   frequency of the current AP in use

  (F) SCAN LOG;    make the profile and save the parameters
```

```
Secondary Access Point Profile

  (A) Information of the network that is currently in use;

  (B) Signal Intensity;   (1-6)levels;

  (C) Reciever Information;  Power recieved etc;

  (D) Extra Information;  data rate, GoS etc;

  (E) Frequency in Use;  frequency of the current AP in use

  (F) SCAN LOG;    make the profile and save the parameters
```

We see that we have made profile for the primary AP and similarly we make the profile for the secondary AP, following the steps mentioned above. The frequency in use option is used to syncronize the MS with AP quickly because when we leave one AP and connect to the other we syncronize to the other AP and we aquire a channel for this purpose which is a time consuming process so we have the frequency saved in the receiver log and get the MS syncronized with it. When we are done with the profile making, we head to the next module i.e. module(2). In the previous module we only have the lists in which the APs are scaned for their signal quality and other parameters. Now their comparison is done in module(2).

6.2 Module (2)

Now as we are in the module (2) the comparison process will have to be carried out. In this module the MS Automatically does the comparison of the two profiles resulted from module (2). In the profiles different parameters were resulted from the process so this module check all of those parameters. Parameters like the received power and the dat-rates of the network atre very important. These parameters are analysed and the flag for voting any AP is passed based on the profile for that AP. All the above mentioned process is an automatic process and

if it fails then their is an alternative way of comparing the APs. This comparison is the manual comparison and the user does it manuaky by graphically viewing the results of the module one in the SCAN LOG. Anything set manualy by the user has been saved on the setting LOG. In this module the comparison of the scanned APs has been completed and now the results are flagged to module (3) for the selection of any one of the APs.

```
COMPARISON:

  (A) AUTO COMPARISON;  comparison by built-in configration

  (B) If Auto comparison fails;  set manual priority settings

  (C) MANUAL PRIORITY SETTINGS;  Options for the User
      (i)  Default settings;  Do as it is in Default
     (ii)  Uer defined;        Let user select it now

  (C) SETTING LOG;    Save the results to the Comparison LOG
```