

# White Paper ON Dual Mode Phone (GSM & Wi-Fi)

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## 1.0 Abstract

Dual Mode Handset is in demand for converged Network, Access, Billing, and Operation environment. Dual mode handsets provide cost effective mobile telephony. It has an advantage of rapidly deployed WiFi networks in public and private access locations which help in providing higher bandwidth for data access and seamless mobility for VoIP enabled cellular handsets subscribers between different locations. As per research reports, annual sale of Dual- mode mobile phone are likely to exceed 100 million in 2009 with Voiced call continuity operation, in WiFi-VoIP environment, cellular operation have option for better spectrum utilization where as fixed line operation have option for Value addition to the services.

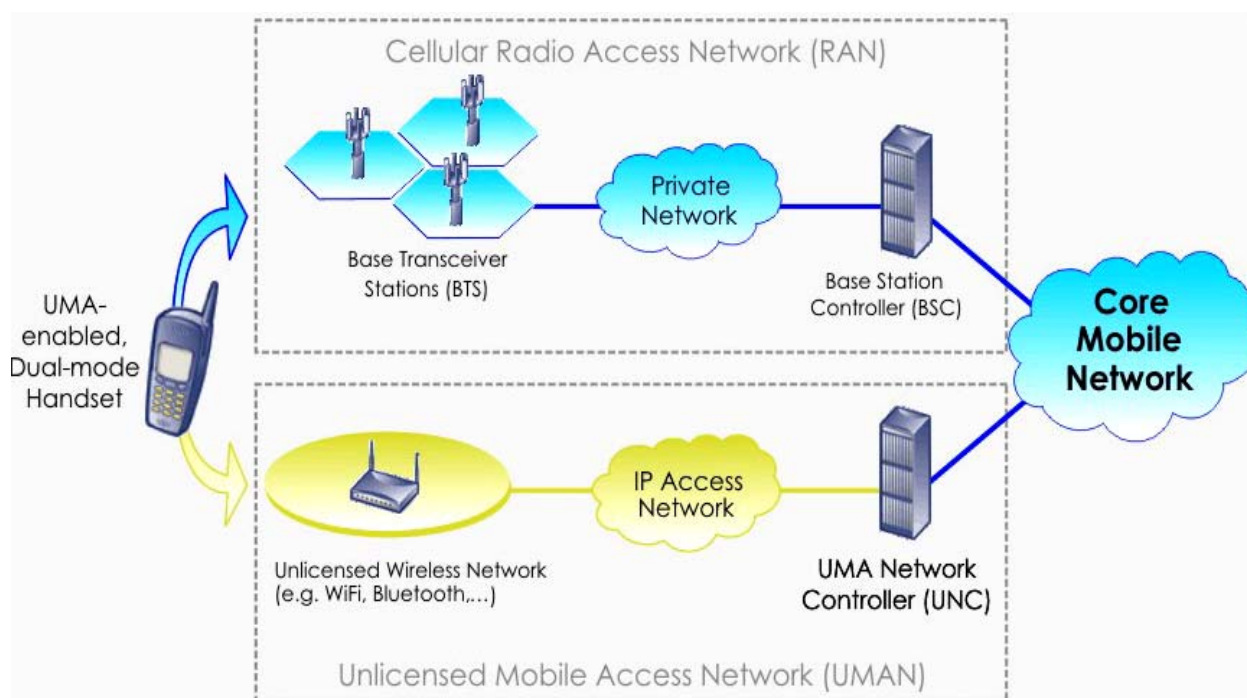
## 2.0 Introduction

A dual-mode phone is a phone that uses more than one technique for sending and receiving voice and data. This could be for wireless mobile phones or for wired phones.

Since the Dual Mode Phone will work both in GSM as well as VoIP call modes. This phone will offer cost saving over GSM calls, when WiFi connectivity is available. The call cost of VoIP is less as compared to GSM and the availability of WiFi connectivity is growing all over, the user will be able to keep on VoIP calls most of the time when he is in the vicinity of a WiFi Hot Spot. Network congestion seen in peak hours is also well avoided. it is not only VoIP Phone, the GSM coverage keeps him connected all the time when he is away from urban areas of WiFi Hot Spots. Other than that, since he is already on Internet over WiFi or GPRS, he can enjoy other features like email, browsing, etc. A picture of a dual mode handset (GSM+WiFi) is given below.



Fig 1: Dual Mode Handset GSM & Wi-Fi



**Fig 2: Basic Overview of Cellular/WiFi network**

This document discusses development and issues of Dual Mode Phone working on GSM and Wi-Fi.

## 2.1 VoIP/Wi-Fi/GSM

When connected to the Internet over WiFi, the Dual Mode Phone device will be able to make a VoIP call over Internet. The advantage of a VoIP call is its low cost as compared to GSM call.

Also when over VoIP over WiFi, the user will get VCC (Voice Call Continuity). The user is over a WiFi call and is going out of WiFi range, the device & the operative network will automatically detect it and transfer the call end on device side from VoIP call to GSM call. This action will be seamless so the user will not feel the switch over GSM from VoIP. Similarly when the user is on GSM call and comes in the vicinity of a WiFi network and connects to a WiFi Hotspot, the device and network will again make a seamless switch from GSM to VoIP without the user actually knowing that the switching is done.

The VoIP call control will have similar features of call connection, call waiting, call forward, call barring, caller ID, Prefix dialing, etc. Besides it will have addition features of VCC settings such as WiFi Range Band, Preferred Call Connection (GSM or VoIP), etc.

Concept has added value by getting roaming between WiFi and mobile network. WiFi reforms Wireless LAN based on IEEE 802.11 WLAN standards with theoretical data rates from 11M to 54Mbit/sec.

Hot spot i.e. Wireless LAN node provides internet connection and virtual private access from a given Location. Combining VoIP to WiFi results into reduction

of cost of Voice services in particular for roaming and for access to broadband services in addition to add convenience to users whereas cellular operators have option for better spectrum utilization.

### **3.0 Development of Dual mode handset**

Due to convergence of various technologies it results into integration of WiFi (wireless fidelity) and mobile networks (GSM network).

The Voice over WiFi (VoWiFi) is also known as voice over wireless LAN (VoWLAN) has been expanding significantly with development of supporting network equipment and handsets enables smooth roaming between WiFi and GSM networks.

#### **Issues for migration to Dual mode working**

- a) Technical & Operational issues
  - i) QoS
  - ii) Bandwidth
  - iii) Security
  - iv) Interoperability
  - v) Seamless roaming
  - vi) Value added application
  - vii) Billing for VoWiFi/mobile roaming
  - viii) Power back-up
- b) Policy issues
  - i) Fixed mobile convergence
  - ii) Spectrum
  - iii) QoS
  - iv) Security, emergency calling, roaming

### **4.0 Types of Dual mode Phone**

Generally there are three types of dual mode phones:

#### **4.1 GSM/CDMA:**

Mobile phone containing two types of cellular radios for voice and data. These phones include combination of GSM and CDMA technology. They can be used as a GSM or CDMA phone according to your preference. These handsets are also called global phones.

#### **4.2 GSM& WiFi / VoIP:**

Mobile phones containing both cellular and non-cellular radios used for voice and data communication. There are also 2 types of dual mode phones which use cellular radio which will contain GSM/CDMA/W-CDMA as well as other technologies

like IEEE 802.11 (Wi-Fi) radio or DECT (Digital Enhanced Cordless Telecommunications) radio.

### **4.3 CDMA& WiFi / VoIP:**

Wired phones with VoIP and POTS technology. These phones can be used for making VoIP calls and also used for phones on the circuit switch network. These phones require compatible routers and modem to make VoIP calls.

## **5.0 Features of Dual mode Phone**

### **5.1 GSM**

The dual mode phone will support standard GSM call control functions. It will also support other GSM features like SMS, GPRS and MMS, etc. The call control features include call connection, call transfer, call forward, call hold, call conference, multi party calling, etc. GPRS browsing and email access can be made available using the device.

The device will have one SIM slot in the phone for holding the SIM. The device will support both 900 & 1800 MHz bands in India.

- GSM 2.5G
- Dual band 900 & 1800 MHz
- One SIM Slot
- SMS: Text and PDU Mode
- MMS over GPRS
- GPRS: Class A capability, Class 10 Multi-Slot

### **5.2 WiFi**

The dual mode phone will connect to a WiFi Hot Spot in the vicinity to communicate over internet for VoIP calls, internet browsing, email access etc.

The WiFi will be equipped with authentication & security. It can use Radius Based Authentication or SIM Based Authentication etc.

- 802.11b/g/n
- Authentications: 802.1x
- Security
- WiFi Hot Spot Roaming for seamless VoIP call

### **5.3 Support of Algorithms**

For proper voice quality, adaptive de-jitter buffering algorithms will be implemented. Also there will be support of various codec including GSM, aLaw, uLaw, G726, G729, G723.1, etc.

- Adaptive De-Jitter buffer

- Multiple SIM registrations
- Codec: GSM, aLaw, uLaw, G726, G729a/b, G723.1
- VCC Specific:
- The device can be registered in either CS (Circuit Switched) or IMS (IP Multimedia Sub System) domains or both domains.
- The selection on device of access systems between CS Domain and IP Connectivity Access Networks dynamically according to network conditions or other aspects based on operators` policies
- The device may be capable of transmitting and receiving simultaneously in the CS (Circuit Switched) domain and on the IP Connectivity Access Network.
- It shall be possible for devices connected to the IMS to initiate or receive IMS session requests while a CS voice call is ongoing to a device with the related MSISDN (Mobile Station International ISDN Number).
- It shall be possible for a device to initiate/ receive CS voice calls while a UE

#### **5.4 GSM/WLAN Convergence Features**

- Simultaneously Active GSM/GPRS and WLAN Radio Interfaces
- Incoming Calls from Both GSM and WLAN/VoIP
- Automatic and Manual Switch for Outgoing Voice Calls between GSM and WLAN
- Automatic and Manual Switch for Data Applications using GPRS or WLAN
- Unified Phone Book

#### **5.5 Security**

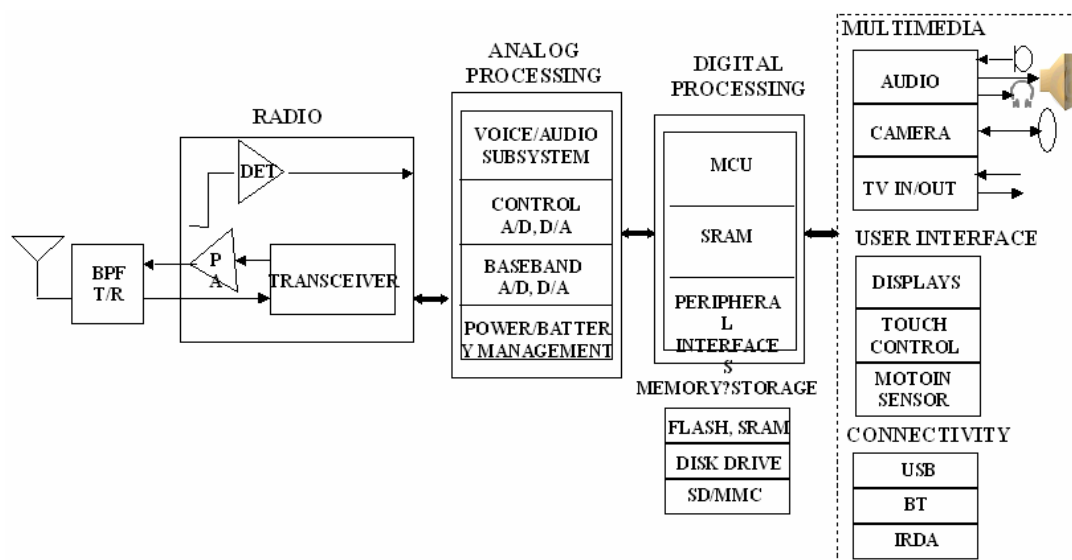
- Support VPN (IP Sec.)
- Support IP Sec/IKE NAT Pass Through

#### **6.0 Important Issues related to chips**

- DSP for base band and multimedia processing should be low power and high speed.
- Progress power management for longer battery life for good and consistent call quality it should support low noise, high accuracy.
- High performance audio I/C for better voice and music and TV and Video connectivity ICS for enhanced multimedia function.
- High linearity, low power RF for power performance.
- Suitable memory and response for various applications.

**RF Unit:** - RF front consists of transmitting and receiving paths. It has antenna diversity control switching circuit for selecting an appropriate antenna of

switching circuits for controlling ON/OFF states of transmitting/receiving paths of the RF front-end unit.



**Figure 3: Hardware Architecture of Dual Mode Phone**

Radio Frequency Integrated Circuit (RFIC) Coupled to Broad Band Integrated Circuit (BBIC), both are coupled to interface unit.

Tx signal is sent to the power amplifier, the amplified signal is then filtered by the low power filter and filtered signal is routed to the dual band antenna.

Rx signal from the dual band antenna, first filtered by the band pass filter and filtered signal is transferred into RFIC.

## Analog Processing and Digital Signal Processing

**Analog Processing:** - It performs Analog to Digital and Digital to Analog Control of signal along with power management functions.

It provides the radio interface of the signal.

**DSP (Digital Signal Processor):** -

Digital Signal Processors are device designed to manage computation-intensive processing of real time signals in different applications. It supports voice processing algorithms (voice compressions and decompression), line Echo cancellation, voice activity detection, user interface function application program interfacing with other application.

**Multimedia:** -

Multimedia applications run with suitable user interface and connectivity to enhance accessibility and related features. For Audio & Video function there is provision of Speaker, Mic, Display unit may be with touch screen facility.

## 7.0 Operational Requirements

### 7.1 GSM Network

There should be appropriate strength of GSM network available. Many of the features like GPRS, MMS and call control features are mainly depending on the GSM service provider of the network

## 7.2 Wi-Fi to Cellular Handover

### Handover Scenario

A subscriber having WiFi connection at residence or office by WiFi hotspot when using it in a building where as communicate wirelessly Via GSM cellular network when outside the building.

The following steps occurred/involved for WiFi to cellular handover.

1. Mobile VoIP call over WiFi is set up with help of SIP client. (Refer Figure 6 below)
2. On sensing weak WiFi Signal (due to leaving building or any other reason).
3. Handover initiated. (Refer Figure 4&5 below)
4. Cellular Trans-receiver radio turned on.
5. Call is set up in cellular network.
6. Registration & Authentication established on cellular network.
7. Voice bearer path on cellular network established.
8. Handover made to cellular. (Refer Figure 6 below)
9. Drop SIP WiFi link.
10. Hand off complete.

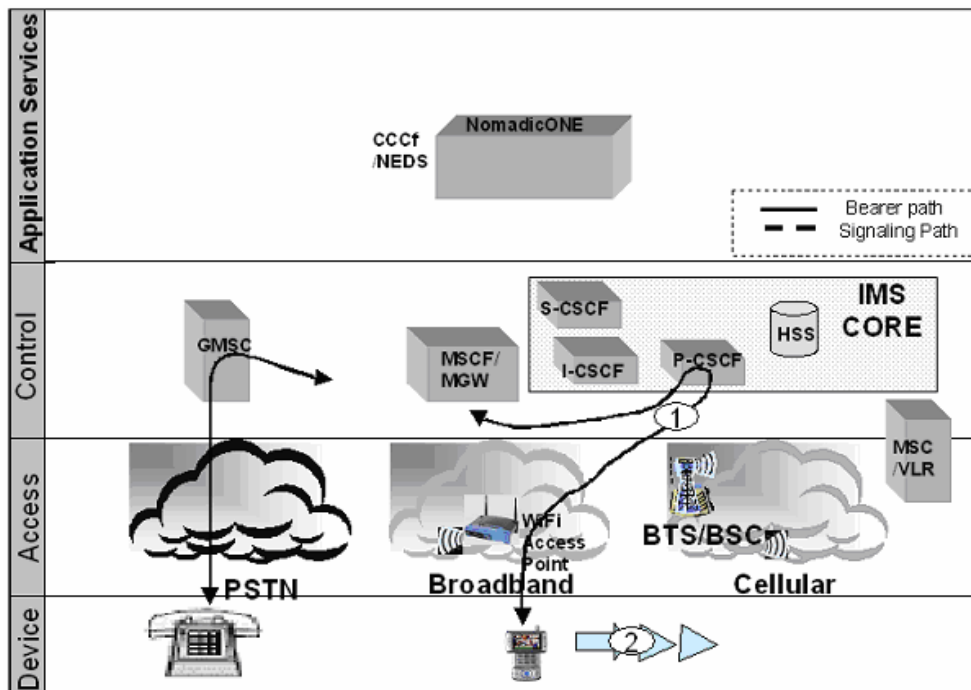


Figure 4: Wi-Fi to Cellular Handover

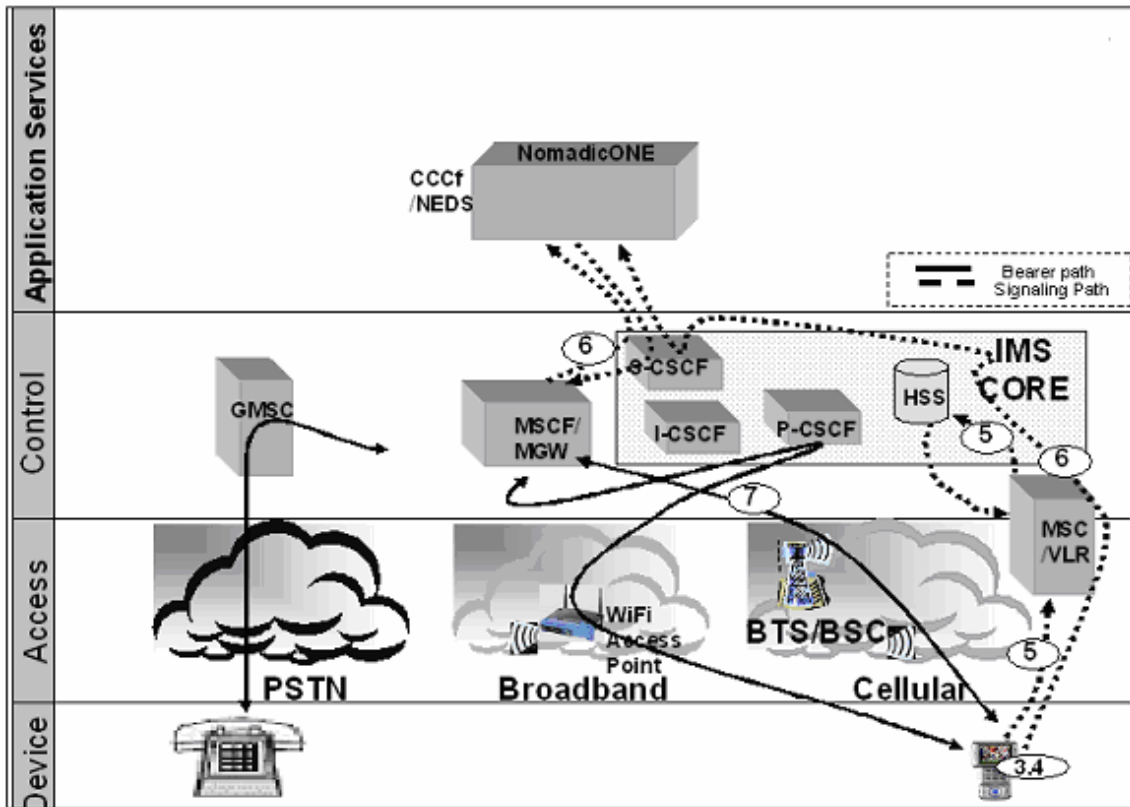


Figure 5: Wi-Fi to Cellular Handover

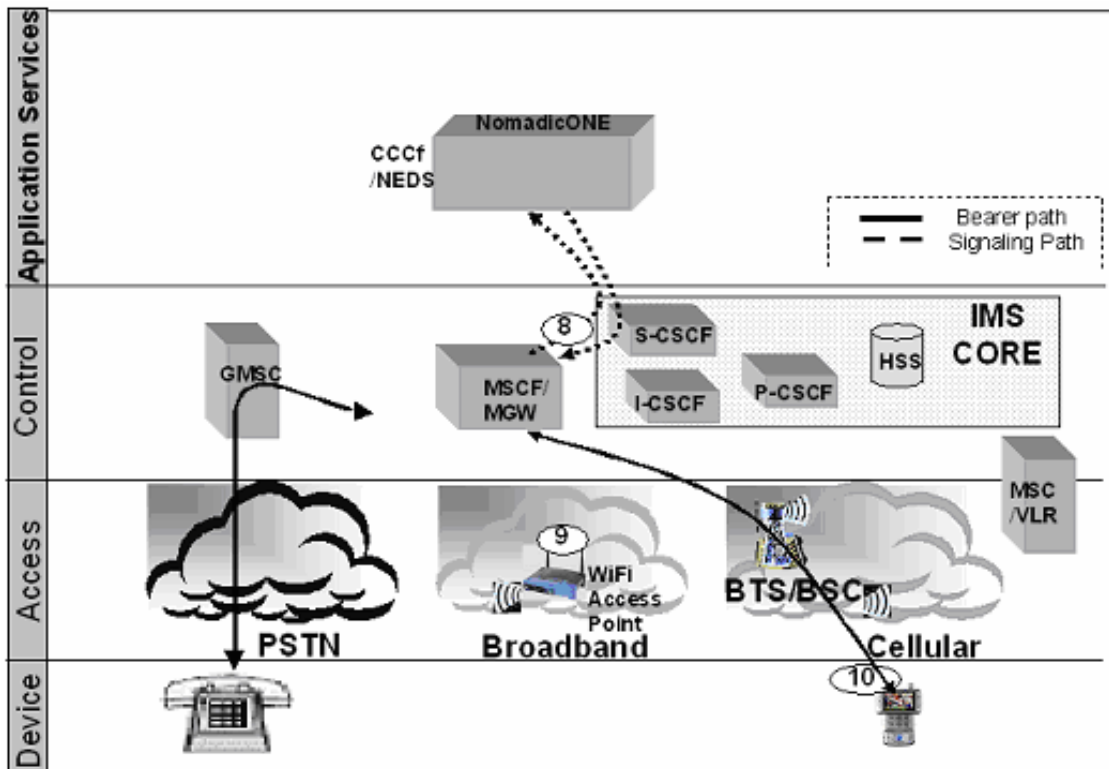


Figure 6: Wi-Fi to Cellular Handover

### **7.3 WiFi Hotspots**

The WiFi hotspot network should be providing sufficient signal strength to the Dual Mode Phone device. The hotspots in vicinity should have enough overlapping over the range so that the VoIP call should not get disconnected due to WiFi disconnection & re-connection during roaming.

To cater to VCC requirement, the WiFi network also should be capable of initiating the automatic active call switch between GSM & VoIP, depending on the user settings in the device as well as the related signal strength during the active call.

The operational Network should support the IP Multimedia Subsystem (IMS) Based IMS-Voice Call Continuity (VCC) 3GPP Specifications [TS 23.228]:

- The network shall provide voice call continuity (VCC) when the user is moving between GSM (Global System for Mobiles) CS (Circuit Switched) Domain and IMS (IP Multimedia Subsystem) Domain.
- The network shall be possible to perform correlation of charging that is performed in GSM/UMTS CS Domain and for the IMS session when service continuity between the domains is performed.
- The Network architectural solution shall support a mechanism for selecting how to route the terminating voice to the UE (User Equipment).
- It shall be possible for a user to be reached via the same identity (i.e., MSISDN) in both IMS and GSM / UMTS CS Network.
- Voice call continuity should be provided such that from the end user's perspective minimal service disruption is perceived.
- Initiation of the CS to IMS call continuity procedure for an on going voice call may be based on radio condition; initiation of the IMS to CS call continuity procedure for an on going voice call may be based on radio condition and IP connectivity quality to IMS domain.

#### **7.3.1 Advantages and Supporting issues for VoWiFi /mobile:**

- WiFi is easy to deploy and less costly than cellular service
- New technology development such as dual mode handsets, SIP, soft phones helps to develop VoWiFi technology in much better way and has advantages of low cost.
- With GSM and WiFi seamless roaming result in transmit and access information and use applications continuously while traveling outside this office of WiFi area.
- Now GSM providers with VoWiFi solution can offer low cost Services to customers including voice, data and video.

#### **7.3.2 Disadvantages:**

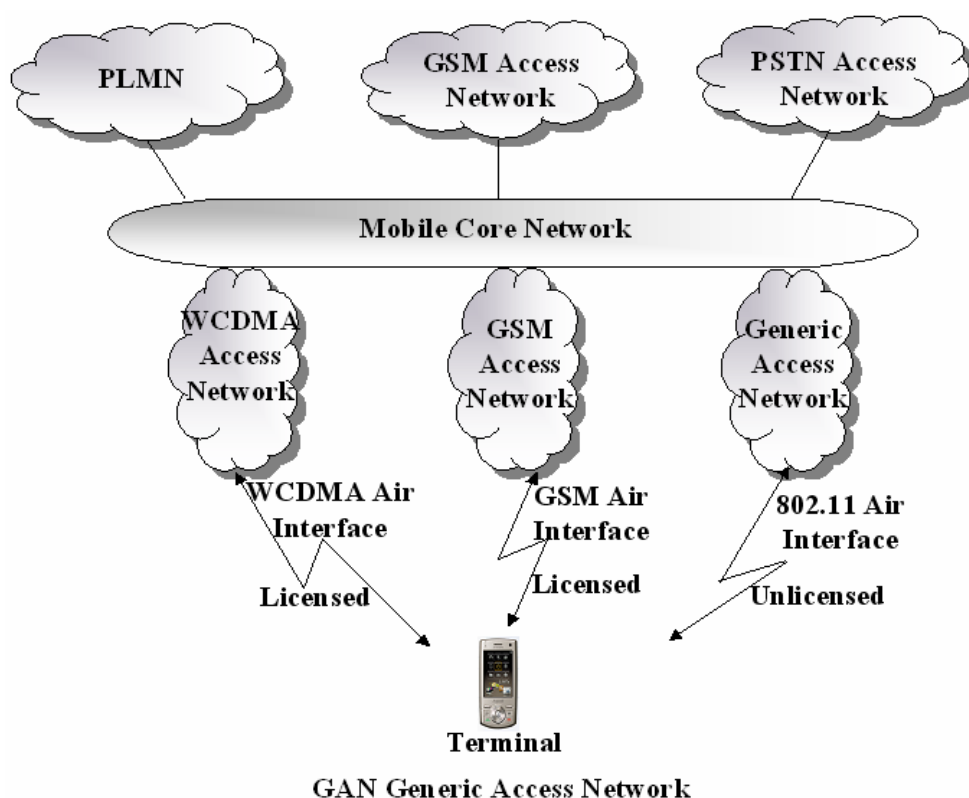
- Revenue base of pure GSM service provider may go down.
- Interoperability between different access point, gateway, devices like WiFi/GSM handsets may be the issues.

- Security issues.

## 7.4 GAN:

3GPP has approved GAN (Generic Access Network) i.e.GSM/GPRS-Wi-Fi conveyance system. It was initially developed as UMA.

GAN refers to a system in which mobile phone function seamlessly between local area networks (Wi-Fi) and Wide-Area networks (GSM/GPRS). Through this technology a cell phone subscriber can communicate voice ,data and multimedia through GSM/GPRS cellular and Wi-Fi systems. All hand-offs between systems occur without interrupting the communications session.



GAN Generic Access Network  
**Figure 7: GAN Generic Access Network**

Under GAN system, when a handset detects a Wi-Fi it establishes a secure IP connection through a security gateway to a server called a GAN Controller (GANC) on the carrier network. The GANC translate the signals coming from the handset to make it appear to be coming from another base station. Thus, when a mobile moves from a GSM to a WiFi NETWORK, it appears to the core network as if it is simply on a different base station.

### 7.4.1 Advantages:

- Unlicensed Mobile Access (UMA) technology enables access to GSM and GPRS mobile services over unlicensed spectrum including Bluetooth and Wi-Fi.
- Seamless delivery of mobile voice and data services over unlicensed wireless networks.

- Provides the same mobile identity on cellular Ran and unlicensed wireless networks
- Seamless transition (roaming and handover) between cellular RAN and unlicensed wireless networks.

#### **7.4.2 Disadvantages:**

- UMA is only 2G solution.
- No Video Sessions
- Requires a carrier based UMA Network Controller (UNC) for GSM Voice and GPRS data services.
- No fixed line service transparency
- No VOIP (i.e. No VOIP IP-PBX , only works for GSM/GPRS features)

### **7.5 Issues:**

#### **7.5.1 Battery and Wi-Fi Antenna:**

Inefficient Wi-Fi- antenna can affect Handset battery life due to VSWR (Voltage Standing Wave Ratio) factor of Antenna. With VSWR low along with adequate antenna gain and pattern coverage, the maximum device life can be achieved with minimum power.

#### **7.5.2 Voice over Wi-Fi :**

Conversation gets affected by other factors like high latency, jitter, echoes and packet loss.

#### **7.5.3 Black Spots:**

It should be reduced by providing antenna receiver and transmit signals equally well in all direction by omni directional gain antenna radiation patterns.

#### **7.5.4 Antenna Planning:**

In dual mode handsets there are separate radios and antennas for Wi-Fi and GSM. Present trend for small sets/ antenna means potentially interfering components that needs to be closely managed to ensure optimum performance.

### **8.0 Conclusion:**

Dual- mode handset technology is basically one of the simple methods for fixed – mobile convergence. It helps customers to communicate anytime, anywhere and with any device in converged environment of service, terminal, network and industry.

### **9.0 Abbreviations:**

- 3GPP                                      3rd Generation Partnership Project
- BTS                                        Base Transceivers Station
- CDMA                                      Code Division Multiple Access

## White paper on Dual Mode Phone (GSM & Wi-Fi)

- CS Circuit Switched
- CSCF Call Session Control Function
- DECT Digital Enhanced Cordless Telecommunication
- FMC Fixed mobile convergence
- GAN Generic Access Network
- GANC Generic Access Network Cordless
- GPRS General Packet Radio System
- GSM Global System for Mobile communication
- HSS Home Subscriber Server
- IMS IP Multimedia Sub-system
- IP Internet Protocol
- ISIM IMS SIM
- ITU International Telecommunication Union
- MAC Media Access Control
- MMS Multimedia Messaging Service
- NGN Next Generation Network
- PLMN Public Land Mobile Network
- PSTN Public Switched Telephone Network
- QoS Quality of Service
- SIM Subscriber Identity Module
- SIP Session Initiated Protocol
- SMS Short Messaging Service
- UE User Equipment
- UMA Unlicensed Mobile Access
- UMTS Universal Mobile Telecommunication System
- VCC Voice Call Continuity
- VoIP Voice over Internet Protocol
- VoWiFi Voice Over WiFi
- VoWLAN Voice over Wireless LAN
- VPN Virtual Private Network
- VSWR Voltage Standing Wave Ratio
- WCDMA Wideband code Division Multiple Access
- WiFi Wireless fidelity
- WLAN Wireless Local Area Network