# Evolution of Mobile communication technology and mobile computing

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***Abstract*—The mobile communication technology has evolved from Analog Systems to sophisticated digital systems. The development of 4G with basic architecture of long term evolution (LTE) will give data speed of higher than 100 Mbits/sec with mobile device. LTE architecture combining the evolved radio network with nonradio system architecture has given the desired speed and flexibility in limited trials.**

***Index Terms*—Mobile computing has also evolved from simple data dissemination, data hoarding and synchronization etc. to flexible Android open platform Open Hand set Alliance (OHA) is making new innovative applications for the mobile devices.**

## I. INTRODUCTION

One of many reasons for developing cellular mobile telephone system over a mobile system are limited service capability, poor service performance and inefficient frequency spectrum utilization. The cellular concept is a novel way to ensure high capacity by utilizing the available radio spectrum by frequency reuse. The area covered by a cellular network is divided into cells. A few cells forming a cluster use the entire radio spectrum and the same frequency is used in different clusters, thereby increasing the user capacity with tolerable co-channel interference. After the basic concept common to most cellular network the specific generation of cellular networks and standards are based on specific implementation as years progressed. The first implementation of the cellular concept constitute the first generation (IG). The system such as AMPS in USA and NMT in European countries were analog based. The problem of no use of encryption, inferior call quality and spectrum inefficiency in analog systems were overcome by use of digital technology in the 2nd generation (2G). The digital systems convert speech into digital code to overcome the deficiencies of the IG system. There are several 2G standards followed in different parts of the world, GSM in Europe, DAMPS in USA, PDC in Japan. Global systems for mobile communication (GSM) is extremely popular 2G system – used in over 100 countries. GSM and other 2G standards were primarily used for voice and low speed data. GSM and others started providing data services over laid on the cellular net work. This was meant to be a stop gap arrangement.

### *A. Evolution of 2G to 3G*

The main objective of 2G was voice calls and low speed data with higher coverage and number of users. It evolved into 2.5 G catering to data speed of 64 to 144 kbps with introduction of GPRS (global packet radio system) in the GSM Technology and CDMA 2000 1X in CDMA technology. Basically packet switches for data are parallelly working with circuit switch. In 3G Phase I EDGE was introduced for existing spectrum and WCDMA/WCDMA – E with new spectrum. It caters to the speed of data from 384 kpbs to 3.6 Mb/s. In the CDMA path CDMA 200 / 1 X Do for new and existing spectrum was introduced. In the fully evolved 3G speed of 14 Mb/s was improved through better techniques of digital modulation and orthogonal frequency division multiplexing (OFDM). The architecture of UMTS which forms the basis for 3G has added a new radio access network (UTRAN), and introduced IMS (IP Multimedia Sub System).

## II. WIMAX

While Telecom service providers were working for evolution of 2G to 3G through generation partnership project (GPP), the wireless local area network (WLAN) was getting standardized by ISO. It evolved in many directions depending on requirement for wireless personal area network (WPAN) through blue tooth, zigbee, uWB. WLAN for less than 10 m catering to speed of 11-54 M bits/sec was standardized in 802.11 a/b/g (hi-fi) Wireless Metropolitan Area Network (WMAN, <50 KM) catering to speed of 75m bits/sec was standardized by 802.16/d/e which is called Wimax. Wimax Technology provides for world wide interoperability for microwave access, working in 10-60 GHz provides portable and eventually mobile wireless broad band connectivity.

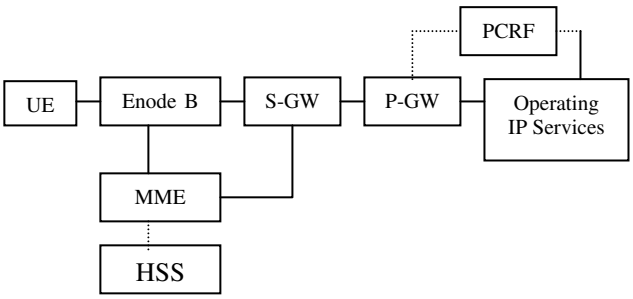
### *A. Evolution of 3G to 4G*

The driving force behind 4G is the effort to develop products for LTE (Long term evolution). The LTE key features include high throughput (> 100 Mbps) low

latency and high Q.O.S (Quality of service) especially for multimedia applications. It is all IP network and provide interoperability with existing network. The LTE key technologies include MIMO: providing for high spectral efficiency, OFDM, Turbo coding, providing minimized requirement of SNR at the receiver. It also includes adaptive modulations to QPSK/16QAM/64 QAM. The LTE advantage include reduced cost per bit, better user experiences, flexible use of existing and new frequency band and open interfaces. It also caters to reasonable terminal power consumption.

LTE supports only packet switched services (IP network). It encompasses the evolution of the universal mobile telecommunication (UMTS) through the evolved UTRAN, it is accompanied by an evolution of the non radio as parts under the system architecture evolution (SAE) which includes the Evolved Packet Core (EPC) network. Together LTE and SAE comprise the evolved packet system (EPS). EPS provides user with IP connectivity to a PDN with a defined Q.O.S, security & privacy.

LTE Architectural overview:




UE: user equipment
Enode B: evolved node B
Radio access network, E-UTRAN of uMTS
S-Gw: serving gateway
P-Gw: PDN gateway
MME: Mobility management entity
HSS: Home subscriber service

Enode B is the Base station equivalent providing radio access.

SGW: All user IP packets are transferred through S-GW which serves as a mobility anchor.

P-GW: Responsible for IP address allocation for the UE as well as Q.O.S. enforcement and flow based charging according to the rules of PCRF.

MME: It process signaling between the UE and core network (CN)

HSS: contains user SAE subscription data such as Q.O.S profile and any access restriction for roaming.

PCRF: It is responsible for policy control decision making as well as constructing the flow based charging functionalities in the P-GW.

*B. Mobile Computing:*

In this section the mobile computing platform in particular Android O.S will be briefly discussed. The mobile computing requires data dissemination by servers through base station and access points. It also requires mobile IP network (Home agent, Foreign Agent) for packet delivery and hand over, location management, registration etc. Mobile TCP Protocol has been devised to take care of the optimal solution for packet loss, bit error rate through a split TCP network. It also requires hoarding and caching of data from data bases, data synchronization etc.

Android as a platform is becoming very popular and it is expected to cross over iphone sales, symbiotic (Nokia OS platform) by 2012. Open Handset Alliance (OHA) has committed to make deployment of Android platform for every mobile operator.

Android: A software platform and operating system for mobile devices, based on Linux & developed by Google and later by OHA. It allows writing managed code in the Java Language. Unveiling of the Android Platform was announced in Nov, 2007 and OHA was founded.

*C. Features:*

Android is a software stack for mobile devices that includes an operating system, middle ware and key applications. Its features include application framework enabling reuse and replacement of components, Delvik Virtual Machine, integrated browser, SQL lite structured data storage, Media support for videos, still images formats, GSM Telephony, 3G, Wifi support.

*D. Application Frame work:*

It provides an open development platform offering developers the ability to build extremely rich and innovative applications. Underlying all applications is a set of services and systems including:

1. A rich and extensible set of views that can be used for building applications.
2. Content provider that enables application to access data from other applications or to share own data
3. A resource manager providing access to non-code resources such as localized strings, graphics and layout files,.
4. A notification manager that enables application to display custom alerts in the status bar.
5. An activity manager that manages life cycle of application and provides a common navigation back stack.

*E. Libraries:*

Android includes a set of C/C++ libraries used by various components of the Android system. These capabilities are exposed to developers through the Android application framework. These libraries include

system c library, media libraries, surface manager, web browser engine, 2D graphics 3D libraries (open Gl ES 1.0) SQL lite a powerful and light weight relational data base engine.

*F. Android run time:*

Android includes a set of core libraries that provides most of the functionality available in libraries of the Java programming language.

*G. Linux kernel:*

Android relies on linux version 2.6 for core system services such as security, memory management. Process management, network stack and driver model. The kernel also act as an abstraction layer between the hardware and rest of the software stack.

## CONCLUSIONS

As it has been shown in the trials of 4G that it is going to provide data at a rate higher than 100 Mbits/Sec with mobile devices there is challenge now to imagine innovative applications such as mobile freely distributed databases and components. With the announcement of the Android software stack on the mobile platform and Open Handset Alliance (OHA), a beginning has been made. There is now complete mobile infrastructure of speed and flexibility to deploy innovative architecture of the applications. A day may not be far when the way we live and transact business will see a paradigm shift.