4G and 5G Wireless Technology

Vishnika Veni
AP/CSE-PITS

B. Ajitha
Dept of CSE-PITS

G. Preetha
Dept of CSE-PITS

4G INTRODUCTION

The new age of 4G technology is upon us which is about to reshape our lives. 4G offers us greater bandwidth, higher data rates, efficient spectrum use, and increased interoperability across the globe It supports user friendly, innovative, and secure application environment These systems will support comprehensive personalized services, providing stable system performance and improved quality of service.

During the last few decades, mobile communication has developed rapidly. The 1st Generation deployed in the 1980s was an analog technique. Though Speech chat was the only service available, 1G still laid the basic structure of mobile communications and solved many fundamental problems such as adopting cellular architecture, multiplexing frequency band, roaming across domain, non-interrupted communication etc.2G was based on digital signal processing techniques deployed during 1990s. It is regarded as an evolution from analog to digital technology. The introduction of Subscriber Identity Module-SIM card and supporting capabilities for a large number of users were 2G's main contributions. 2.5G extended the 2G with data service and packet switching methods. It brought the Internet into mobile personal communications. This was a revolutionary concept leading to hybrid communications. 3G provided
higher data rate and broader bandwidth. Based on intelligent DSP techniques, 3G networks transmit various multimedia data communications services.4th Generation of mobile communication standard introduced its first service Long Term Evolution on 14 December, 2009 in Stockholm and Oslo. 4G allow seamless
mobility which supports un-interrupted file transfer in case a terminal moves from one cell (one base station coverage area) to another. While moving the terminal also keeps the same IP address, which means that a mobile server is reachable as long as it is within the coverage area of any server. In 4G systems this mobility is provided by the mobile IP protocol, part of IP version 6 where as in earlier cellular generations it was only provided by physical and data link layer protocols [1]. 4G also provides flexible interoperability between the various kinds of available wireless networks, such as satellite, cellular wireless, PAN, WLAN and systems for accessing fixed wireless networks. 4G is expected to provide a comprehensive and secured IP based mobile broadband solution to laptop computers, wireless modems, smart phones, and other mobile devices. An over view of mobile technologies is given below:

Technology 1G 2G 2.5G 3G 4G Developed 1981 1991 1995 2001 2010 Services Mono Voice Voice, SMS, media Voice, SMS Media, Data Service Superior voice quality & always on Broadband data Converged data & voice over IP, LTE Standard AMPS, TACS, NMT GSM, TDMA GPRS, IMode, HSCSD, EDGE IMT-2000 (UMTS, WCDMA,
CDMA2000) Single Standard based on LTE Advanced Architecture Circuit Switched Circuit Switche d Packet Switched Circuit & Packet Switched Packet Switched Multiplexing FDMA TDMA, CDMA TDMA, CDMA CDMA OFDM+ MIMO, W-OFDM, MC-CDMA & LAS-CDMA
Core Network PSTN PSTNPSTNPSTN& Some IP networks Completely IP based Data Rates - 9.6 to
Kbits/s 64 to 144 Kbits/s 384 Kbits/s to 2 M bits/s 100 M bps to 1G bps

Legend: OFDM- Orthogonal frequency division multiplexing
MIMO - Multiple input multiple outputs PSTN - Public switched telephone network WCDMA– Wideband CDMA LTA - Long Term Evolution W-OFDM - Wide band OFDM LAS-CDMA - Large Area Synchronised CDMA 2012

A. LAS-2000

A proposed evolution to the IS-2000 series of CDMA2000 air interface standards .It is based on Large Area Synchronised (LAS) CDMA technology. LAS-CDMA relies on the use of new spreading codes called LA and LS codes which replace the PN and Walsh codes used in second generation IS-95 systems as well as in IS-2000. Autocorrelations of LA and LS codes have very high peaks with very small side lobes and their cross-correlations contain an interference free window (IFW) or a zero correlation zone (ZCZ). This results in increased capacity and the spectral efficiency.

LAS-2000 FRAME STRUCTURE

The 20 ms IS-2000 frame is divided into one BCh/ACh header and 9 sub-frames.
Each sub-frame is regularly spaced and 2559 chips long. Every sub-frame contains 17 Time Slots arranged according to the LA pulse intervals. A Time Slot is 136 chips long and contains LS coded symbols [2]

1) LA CODES

LA codes are used in LAS-CDMA to create separate multiple access transmission channels on a same RF carrier. These channels can be used by different cell and sectors. LA codes properties ensure that Adjacent Cell Interference is minimal. These codes are used to identify a cell/sector and have Adjacent Cell Interference (ACI) elimination properties. LA codes are identified by three parameters N, K0 & K [3]: – N is the number of pulses – K0 is the

minimum pulse interval
– K is the total LA code length LAS-2000 uses 17, 136 & 2559 LA codes. Same codes are used in W-LAS and TD-LAS.

2) LS CODES

LS codes are used in LAS-CDMA to spread the transmitted signal. These codes are used to create multiple Code Divided transmission channels and have Inter- Symbol Interference (ISI) and Multiple Access Interference (MAI) rejection properties. LS codes are defined according to a tree structure where each LS code is made up of a C component and an S component. These components are complementary orthogonal, the sum of their auto correlation functions does not have side lobes and the sum of theircross correlation function is null within the IFW [4]
FDM
Orthogonal frequency-division multiplexing (OFDM) is a frequency division multiplexing (FDM) scheme that uses a digital multi-carrier modulation method.This data is then divided into several parallel data streams or channels for each sub-carrierMain areas of focus in OFDM are Impulse noise & mitigation (particularly with application to digital television broadcasting), efficient digital signal processing implementation of OFDM and Peak-to-average power reduction in OFDM [6].

4G STANDARDS

A. LTE ADVANCED

LTE (Long Term Evolution) is standardization within the 3GPP (3rd Generation Partnership Project). Since 2010 operators have started to replace GSM and UMTS with LTE mobile communication systems. First LTE 'Release 8' 2008 was All-IP Network with new OFDMA, FDE and MIMO based radio interface. Release 8 was not backwards compatible with previous CDMA interfaces and contained Dual- Cell High Speed Packet Access (HSDPA) wireless broadband standard. 'Release 9' launched in 2009 came with SAES Enhancements, WiMAX and LTE/UMTS Interoperability. 'Release 9' has Dual- Cell HSDPA with MIMO, Dual-Cell HSUPA. 'Release 10' introduced in 2011 also known as LTE Advanced fulfils IMT Advanced 4G requirements.

B. WiMAX 2

WiMAX stands for Worldwide Interoperability for Microwave Access. It provides fixed & mobile Internet. WiMAX 2 also called Wireless MAN- Advanced has become the first true 4G technology to be approved by the IEEE and ITU. WiMAX is backward compatible with Release 1; operators could migrate from release 1 to release 2 by upgrading hardware or software. The IEEE has introduced it as 802.16m and acknowledged WiMAX 2 alongside LTE Advanced as a standard 4G technology. 802.16m systems can provide four times faster data speed than the WiMAX Release 1.WiMAX 2 will allow downlink speeds of up to 300Mbps. This technology supports MIMO, femto cells, self- organizing networks & relays, and multicarrier operation. It supports both 120Mbps downlink and 60Mbps uplink speeds [8].

IMPLEMENTATION CHALLENGES & SOLUTIONS

Technically 4G creates all integrated IP- based environment that supports voice, broadcasting media and Internet which enables users to enjoy both fixed and wireless communication networks. In all this complex hierarchy the user always has full control of privacy and expenditure

4G implementation challenges include:
SECURITY AND PRIVACY
4G is IP based network which is prone to serious security threats. Implementation of internet protocol security which has better encryption and authentication techniques like IPv6 can reduce this venerability.

QUALITY OF SERVICE

Application performance is an area of grave concern. With 4G, wireless users expect easy access to everything from Face Book & E- mail to video from their wireless devices. As a result consumers will judge quality of service based on application performance rather than traditional phone services.

SERVICE & BILLING

To reduce operating costs, devices that operate on 4G networks should have the capability to support different networks. This would reduce the operating cost, simplify design problems and will reduce power consumption. 4G networks are using "multi- mode devices" in which software radio allow the end-user device to adapt and interface to various wireless networks automatically. Due to the heterogeneity nature of 4G networks, wireless devices have to process, discover and connect to signals from different service providers with distinct protocols. These can be incompatible with each other. "System initiated discoveries". This mechanism allows automatic installation of software modules based on the wireless system the user is connected to. Another approach is based on overlay networks which perform all necessary tasks such as protocol translation and Quality of service negotiations. Managing user account and billing them becomes more hectic. Frame work need to be established to perform this task with utmost diligence.

1) DISTINCT SERVICES

Distinct and fresh services which will provide new applications with increased benefits for the users are still scarce. Therefore, it is envisioned that the real advantage in shape of services that future foretell will be based upon the integration of technologies that are structured to match the needs of different segments of market.[10]

VI. CONCLUSION

Though 4G technology is around the corner but there is some work to be done. Deploying LTE-Advanced & WiMAX-2 is of utmost importance. Steps need to be taken now so that we may lay provisions for a global network. This global network will be able to cater the needs of users on personalised bases. Backwards compatibility is the core issue so that the new emerging technology supports the

previous infrastructure. Our best hope is to start developing next generation technologies now.

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5G INTRODUCTION

Mobile and wireless networks have made tremendous growth in the last fifteen years. Nowadays many mobile phones have also a WLAN adapter. One may suppose that near soon many mobile phones will have WiMAX adapter too, besides their 3G, 2G, WLAN, Bluetooth etc. adapters. Using IP for both, 2.5G or 3G Public Land Mobile Networks (PLMN) on one side and WLAN on the other, raised research on their integration, which was mainly divided into loose [1] and tight [2] coupling. Regarding the 4G, its focus is towards seamless integration of cellular networks such as GSM and 3G, WLAN and Bluetooth [3], [4], and [5]. Multimode user terminals are seen as must have for 4G, but different security mechanisms and different

QoS support in different wireless technologies remain a challenge. However, AAA integration among different wireless networks [1] (e.g. PLMN and WLAN) is functioning in practice even today. But, different wireless networks from a single terminal are used exclusively, that is, there is no combining of different wireless access technologies for a same session (e.g., FTP download). The proposed Open Wireless Architecture (OWA) in [6] is targetedto provide open baseband processing modules with open interface parameters to support different existing as well as future wireless communication standards. The OWA is targeted to MAC/PHY layers of future (4G) mobile terminals. The referenced work above provides a ground for definition of a concept for beyond 4G mobile networks, referred in this paper as 5G mobile networks

II. CONCEPT FOR 5G MOBILE NETWORKS

The 5G terminals will have software defined radios and modulation schemes as well as new error-control schemes that can be downloaded from the Internet. The development is seen towards the user terminals as a focus of the 5G mobile networks. The terminals will have access to different wireless technologies at the same time and the terminal should be able to combine different flows from different technologies. The vertical handovers should be avoided, because they are not feasible in a case when there are many technologies and many operators and service providers. In 5G, each network will be responsible for handling user-mobility, while the terminal will make the final choice among different wireless/mobile access network providers for a given service. Such choice will be based on open intelligent middleware in the mobile phone. Now, we will go through all OSI layers (Fig. 1) in the 5G mobile terminal design (Fig. 2).

A. PHYSICAL/MAC LAYERS

Physical and Medium Access Control layers i.e. OSI layer 1 and OSI layer 2, define the wireless technology. For these two layers the 5G mobile networks is likely to be based on Open Wireless Architecture [6].

B. NETWORK LAYER

The network layer will be IP (Internet Protocol), because there is no competition today on this level. The IPv4 (version 4) is worldwide spread and it has several problems such as limited address space and has no real possibility for QoS support per flow. These issues are solved in IPv6, but traded with significantly bigger packet header. Then, mobility still remains a problem. There is Mobile IP standard on one side as well as many micro-mobility solutions (e.g., Cellular IP, HAWAII etc.). All mobile networks will use Mobile IP in 5G, and each mobile terminal will be FA (Foreign Agent), keeping the CoA (Care of Address) mapping between its fixed IPv6 address and CoA address for the current wireless network. However, a mobile can be attached to several mobile or wireless networks at the same time. In such case, it will maintain different IP addresses for each of the radio interfaces, while each of these IP addresses will be CoA address for the FA placed in the mobile Phone. The fixed IPv6 will be implemented in the mobile phone by 5G phone manufacturesC. Open Transport Protocol (OTA) layer The mobile and wireless networks differ from wired networks regarding the transport layer. In all TCP versions the assumption is that lost segments are due to network congestion, while in wireless networks losses may occur due to higher bit error ratio in the radio interface. Therefore, TCP modifications and adaptation are proposed for the mobile and wireless networks, which retransmit the lost or damaged TCP segments over the wireless

link only. For 5G mobile terminals will be suitable to have transport layer that is possible to be downloaded and installed. Such mobiles shall have the possibility to download (e.g., TCP, RTP etc. or new transport protocol) version which is targeted to a specific wireless technology installed at the base stations. This is called here Open

Transport Protocol - OTP.

D. Application layer Regarding the applications, the ultimate request from the 5G mobile terminal is to provide intelligent QoS management over variety of networks. Today, in mobile phones the users manually select the wireless interface for particular Internet service without having the possibility to use QoS history to select the best wireless connection for a given service. The 5G phone shall provide possibility for service quality testing and storage of measurement information in information databases in the mobile terminal. The QoS parameters, such as delay, jitter, losses, bandwidth, reliability, will be stored in a database in the 5G mobile phone with aim to be used by intelligent algorithms running in the mobile terminal as system processes, which at the end shall provide the best wireless connection upon required QoS and personal cost constraints.

III. CONCLUSIONS

In this paper we have proposed 5G mobile phone concept, which is the main contribution of the paper. The 5G mobile phone is designed as an open platform on different layers, from physical layer up to the application.

Keyboard

1) Download new OWA Download new OTP Download new Application Screen extension

2) Screen extension Sensors

3) Entertainment Mobile Office Mobile Management Currently, the

GPS

4) Radio

5) 5G mobile

Fig. 2. 5G mobile phone design. Network Address Translation Upper Network Layer, IPv6 address
Lower Network Layer, WLAN, IPv4/v6 address
Lower Network Layer, WiMAX, IPv4/v6 address
Lower Network Layer, 3G-LTE, IPv4/v6 address
Lower Network Layer, 4G, IPv4/v6 address
5G Mobile Terminal Network Layer Fig. 3. 5G mobile phone network layer.

The proposed concept adapts Open Wireless Architecture proposed for 4G mobile terminals, and provides further changes from network up to application layer. The network layer is divided into two sub-layers to provide all-IP connectivity in environment with plenty of wireless/mobile technologies as well as network and/or service providers. Open Transport Layer is proposed with aim to allow usage of wireless specific implementations of transport protocols. Finally, we propose possibility for selection of different wireless technologies upon different QoS constraints (and cost constraints) for different services, real-time (VoIP, streaming, IPTV etc.) or non-real-time (web, messaging, gaming etc.). For such purpose, 5G mobile terminals should maintain database which will keep statistical information regarding the services and the available wireless technologies in the phone.

ongoing work is on the modules that shall provide the best QoS and lowest cost for a given service using one or more than one wireless technology at the same time from the 5G mobile phone.

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