

Evolution of Networks (2G-5G)

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ABSTRACT

Mobile and wireless networks have made tremendous growth in the last fifteen years. Today 3G mobile systems are on the ground providing IP connectivity for real-time and non-real-time services. Then, the concepts of 4G is already much discussed and it is almost certain that 4G will include several standards under a common umbrella, similarly to 3G, but with IEEE 802.xx wireless mobile networks included from the beginning. The main contribution of this paper is definition of 5G (Fifth Generation) mobile network concept, which is seen as user-centric concept instead of operator-centric as in 3G or service-centric concept as seen for 4G. In the proposed concept the mobile user is on the top of all. The 5G terminals will have software defined radios and modulation scheme as well as new error-control schemes can be downloaded from the Internet on the run. 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. 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. The proposal in this paper is fundamental shift in the mobile networking philosophy compared to existing 3G and near-soon 4G mobile technologies, and this concept is called here - the 5G.

General Terms

Horizontal networking, vertical networking.

Keywords

Networking, 1G, 2G, 2.5 G, 3G, 4G, 5G.

1. 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. Regarding the 4G, its focus is towards seamless integration of cellular networks such as GSM and 3G. 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, integration among different wireless networks (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 is targeted to 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. In the proposed concept the mobile user is on the top of all. The 5G terminals will have software defined radios and modulation scheme as well as new error-control schemes can be downloaded from the Internet on the run. 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. 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. The paper also proposes intelligent Internet phone concept where the mobile phone can choose the best connections by selected constraints and dynamically change them during a single end-to-end connection.

2. EVOLUTION FROM 1G TO 5G

1G, 2G, 3G & 4G ("G" stands for "Generation") are the generations of wireless telecom connectivity. 1G (Time Division Multiple Access and Frequency Division Multiple Access) was the initial wireless telecom network system. It's out-dated now. The analog "brick phones" and "bag phones" are under 1G technology. Cell phones era began with 1G.

The next era, 2G has taken its place of 1G. Cell phones received their first major upgrade when they went from 1G to 2G. This leap effectively took cell phones from analog to digital. 2G and 2.5G were versions of the GSM and CDMA connections. And GSM is still the most popular technology, but with no internet. Fortunately, GPRS, an additional service, is provided over GSM for the purpose of internet access. GPRS has been developed and thus, EDGE was created. It's more secure and faster than GPRS.

Then 3G came, the new Wireless CDMA technology. It is the first wireless telecom technology that provides broadband-speed internet connection on mobile phones. Further

development led to the creation of 3.5G, which provides blazing fast internet connection on phones, up to the speed of 7.2 MBPS. A smart phone can be connected to a PC to share its internet connection and 3G and 3.5G are ideal for this.

4G, which is also known as “beyond 3G” or “fourth-generation” cell phone technology, refers to the entirely new evolution. Developers are now going for 4G (OFDMA), which will provide internet up to the speed of 1 GBPS! It is said to be able to overcome the problems of weak network strength and should provide a much wider network, making sure that the users get high-speed connectivity anytime anywhere. No doubt, 4G will open new doors of revolutionary internet technologies, but for now, 3G and 3.5G are the best. 4G will allow for speeds of up to 100Mbps. 4G promises voice, data and high-quality multimedia in real-time form all the time and anywhere.

2.1. 1G Wireless System

First Generation wireless technology (1G) is the original analog (An analog or analogue signal is any continuous signal for which the time varying feature (variable) of the signal is a representation of some other time varying quantity), voice-only cellular telephone standard, developed in the 1980s. The main difference between two succeeding mobile telephone systems, 1G and 2G, is that the radio signals that 1G networks use are analog, while 2G networks are digital.

Keys:

Developed in 1980s and completed in early 1990's

1G was old analog system and supported the 1st generation of analog cell phones speed up to 2.4kbps

Advance mobile phone system (AMPS) was first launched by the US and is a 1G mobile system

Allows users to make voice calls in 1 country



FIG. 2.1.1 1G Mobile Phone

2.2. 2G Wireless System

2G (or 2-G) is short for second-generation wireless telephone technology. Second generation 2G cellular telecom networks were commercially launched on the GSM standard in Finland by Radiolinja (now part of Elisa Oyj) in 1991. 2G network allows for much greater penetration intensity. 2G technologies enabled the various mobile phone networks to provide the services such as text messages, picture messages and MMS (multi media messages). 2G technology is more efficient. 2G technology holds sufficient security for both the sender and the receiver. All text messages are digitally encrypted. This digital encryption

allows for the transfer of data in such a way that only the intended receiver can receive and read it.

Second generation technologies are either time division multiple access (TDMA) or code division multiple access (CDMA). TDMA allows for the division of signal into time slots. CDMA allocates each user a special code to communicate over a multiplex physical channel. Different TDMA technologies are GSM, PDC, iDEN, IS-136. CDMA technology is IS-95. GSM has its origin from the Group special Mobile, in Europe. GSM (Global system for mobile communication) is the most admired standard of all the mobile technologies. Although this technology originates from the Europe, but now it is used in more than 212 countries in the world. GSM technology was the first one to help establish international roaming. This enabled the mobile subscribers to use their mobile phone connections in many different countries of the world's is based on digital signals, unlike 1G technologies which were used to transfer analogue signals. GSM has enabled the users to make use of the short message services (SMS) to any mobile network at any time. SMS is a cheap and easy way to send a message to anyone, other than the voice call or conference. This technology is beneficial to both the network operators and the ultimate users at the same time.

Keys:

Fielded in the late 1980s and finished in the late 1990s

Planned for voice transmission with digital signal and the speeds up to 64kbps

2G was the digital handsets that we are used today

2G network allows for much greater penetration intensity.



FIG 2.2.1 2G Mobile Phone

2.3. 2.5G Wireless System

2.5G is a stepping stone between 2G and 3G cellular wireless technologies. The term "second and a half generation" is used to describe 2G-systems that have implemented a packet switched domain in addition to the circuit switched domain. It does not necessarily provide faster services because bundling of timeslots is used for circuit switched data services (HSCSD) as well.

The first major step in the evolution of GSM networks to 3G occurred with the introduction of General Packet Radio Service (GPRS). CDMA2000 networks similarly evolved through the introduction of 1xRTT. GPRS could provide data

rates from 56 Kbit/s up to 115 Kbit/s. It can be used for services such as Wireless Application Protocol (WAP) access, Multimedia Messaging Service (MMS), and for Internet communication services such as email and World Wide Web access.

1xRTT supports bi-directional (up and downlink) peak data rates up to 153.6 kbps, delivering an average user data throughput of 80-100 kbps in commercial networks. It can also be used for WAP, SMS & MMS services, as well as Internet access.

2.4. 2.75G (Edge)

GPRS networks evolved to EDGE networks with the introduction of 8PSK encoding. Enhanced Data rates for GSM Evolution, Enhanced GPRS (EGPRS), or IMT Single Carrier (IMT-SC) is a backward-compatible digital mobile phone technology that allows improved data transmission rates, as an extension on top of standard GSM. EDGE was deployed on GSM networks beginning in 2003—initially by Cingular (now AT&T) in the United States.

EDGE is standardized by 3GPP as part of the GSM family, and it is an upgrade that provides a potential three-fold increase in capacity of GSM/GPRS networks. The specification achieves higher data-rates (up to 236.8 Kbit/s) by switching to more sophisticated methods of coding (8PSK), within existing GSM timeslots.

Keys:

In between 2G and 3G there is another generation called 2.5G. 2.5G represents handsets with data capabilities over GPRS. But this had not brought out any new revolution.

2.5 3G Wireless System

International Mobile Telecommunications-2000 (IMT-2000), better known as 3G or 3rd Generation, is a generation of standards for mobile phones and mobile telecommunications services fulfilling specifications by the International Telecommunication Union. The use of 3G technology is also able to transmit packet switch data efficiently at better and increased bandwidth. 3G mobile technologies proffers more advanced services to mobile users. Transmission speeds from 125kbps to 2Mbps.

In 2005, 3G is ready to live up to its performance in computer networking (WCDMA, WLAN and Bluetooth) and mobile devices area (cell phone and GPS).

Data are sent through technology called packet switching.

Voice calls are interpreted using circuit switching.

Access to Global Roaming.

Clarity in voice calls.

Fast Communication, Internet, Mobile T.V, Video Conferencing, Video Calls, Multi Media Messaging Service (MMS), 3D gaming, Multi-Gaming etc are also available with 3G phones.



FIG.2.5.1 3G Mobile Phone

2.6. 4G Wireless System

4G refers to the fourth generation of cellular wireless standards. The bandwidth and location information available to 3G devices gives rise to applications not previously available to mobile phone users. Some of the applications are: Mobile TV – a provider redirects a TV channel directly to the subscriber's phone where it can be watched.

Video on demand – a provider sends a movie to the subscriber's phone.

Video conferencing – subscribers can see as well as talk to each other.

Tele-medicine – a medical provider monitors or provides advice to the potentially isolated subscriber.

Location-based services – a provider sends localized weather or traffic conditions to the phone, or the phone allows the subscriber to find nearby businesses or friends.

mobile ultra-broadband (gigabit speed) access and multi-carrier transmission.

Mobile WiMAX (Worldwide Interoperability for Microwave Access).

Keys:

4G is a conceptual framework and a discussion point to address future needs of a high speed wireless network.

It offers both cellular and broadband multimedia services everywhere.

Expected to emerge around 2010 – 2015.

4G should be able to provide very smooth global roaming ubiquitously with lower cost.



FIG 2.6.1. 4G Mobile Phone

2.7. 5G Wireless System

5G (5th generation mobile networks or 5th generation wireless systems) is a name used in some research papers and projects to denote the next major phase of mobile telecommunications standards beyond the upcoming 4G standards (expected to be finalized between approximately 2011 and 2013). Currently, 5G is not a term officially used for any particular specification or in any official document yet made public by telecommunication companies or standardization bodies such as 3GPP, WiMAX Forum or ITU-R. New 3GPP standard releases beyond 4G and LTE Advanced are in progress, but not considered as new mobile generations. The implementation of standards under a 5G umbrella would likely be around the year of 2020.

Keys :

5G is a completed wireless communication with almost no limitation; somehow people called it REAL wireless world.

Additional features such as Multi-Media Newspapers, also to watch T.V programs with the clarity as to that of an HD T.V.

5G will bring almost perfect real world wireless or called “WWW: World Wide Wireless Web. Real wireless world with no more limitation with access and zone issues. Wearable devices with AI capabilities. Internet protocol version 6 (IPv6), where a visiting care-of mobile IP address is assigned according to location and connected network. One unified global standard. High altitude stratospheric platform station (HAPS) systems.

3. THE 5G TECHNOLOGY

3.1. What Is 5G Technology?

5G Technology stands for 5th Generation Mobile technology. 5G technology has changed the means to use cell phones within very high bandwidth. User never experienced ever before such a high value technology. Nowadays mobile users have much awareness of the cell phone (mobile) technology. The 5G technologies include all type of advanced features which makes 5G technology most powerful and in huge demand in near future.

The gigantic array of innovative technology being built into new cell phones is stunning. 5G technologies which are on hand held phone offering more power and features than at least 1000 lunar modules. A user can also hook their 5G technology cell phone with their Laptop to get broadband internet access. 5G technology including camera, MP3 recording, video player, large phone memory, dialling speed, audio player and much more you never imagine. For children rocking fun Bluetooth technology and Pico nets has become in market.

3.2. What 5G Technology Offers?

5G technology going to be a new mobile revolution in mobile market. Through 5G technology now you can use worldwide cellular phones and this technology also strike the china mobile market and a user being proficient to get access to Germany phone as a local phone. With the coming out of cell phone alike to PDA now your whole office in your finger tips or in your phone. 5G technology has extraordinary data capabilities and has ability to tie together unrestricted call volumes and infinite data broadcast within latest mobile operating system. [5G technology](#) has a bright future because it can handle best technologies and offer priceless handset to their customers. May be in coming days 5G technology takes over the world market. 5G Technologies have an extraordinary capability to support Software and Consultancy. The Router and switch technology used in 5G network providing high connectivity. The 5G technology distributes internet access to nodes within the building and can be deployed with union of wired or wireless network connections. The current trend of 5G technology has a glowing future.

4. CONCEPTS 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.

4.1. Physical Layer

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.



FIG.4.1. 5G Mobile Phone Concept

TABLE 4.1. OSI Layers in the 5G Mobile Terminal Design

Application Layer	Application (Services)
Presentation Layer	
Session layer	Open Transport Protocol
Transport Layer	
Network layer	Upper network layer
	Lower network Layer
Datalink Layer	Open Wireless Architecture
Physical Layer	

4.2. 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 manufactures.

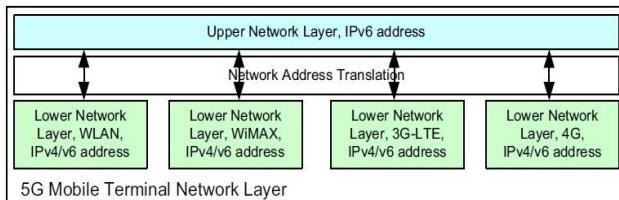


FIG.4.2.1. 5G Mobile Terminal Network Layer

The 5G mobile phone shall maintain virtual multi-wireless network environment. For this purpose there should be separation of network layer into two sub-layers in 5G mobiles (Fig.) i.e.: Lower network layer (for each interface) and Upper network layer (for the mobile terminal). This is due to the initial design of the Internet, where all the routing is based on IP addresses which should be different in each IP network world-wide. The middleware between the Upper and Lower network layers (Fig. 3) shall maintain address translation from Upper network address (IPv6) to different Lower network IP addresses (IPv4 or IPv6), and vice versa.

4.3. 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.

4.4. 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.

5. FEATURES

All paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified. 5G technology offer high resolution for crazy cell phone user and bi-directional large bandwidth shaping.

The advanced billing interfaces of 5G technology makes it more attractive and effective.

5G technology also providing subscriber supervision tools for fast action.

The high quality services of 5G technology based on Policy to avoid error.

5G technology is providing large broadcasting of data in Gigabit which supporting almost 65,000 connections.

5G technology offer transporter class gateway with unparalleled consistency.

The traffic statistics by 5G technology makes it more accurate.

Through remote management offered by 5G technology a user can get better and fast solution.

The remote diagnostics also a great feature of 5G technology.

The 5G technology is providing up to 25 Mbps connectivity speed.

The 5G technology also support virtual private network.

The new 5G technology will take all delivery service out of business prospect

The uploading and downloading speed of 5G technology touching the peak.

The 5G technology network offering enhanced and available connectivity just about the world

6. FUTURE ENHANCEMENT

5G network technology will open a new era in mobile communication technology. The 5G mobile phones will have access to different wireless technologies at the same time and the terminal should be able to combine different flows from different technologies. 5G technology offer high resolution for crazy cell phone user. We can watch TV channels at HD clarity in our mobile phones without any interruption. The 5G mobile phones will be a tablet PC. Many mobile embedded technologies will evolve.

7. CONCLUSION

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. Currently, the 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.

A new revolution of 5G technology is about to begin because 5G technology going to give tough completion to normal computer and laptops whose marketplace value will be effected. There are lots of improvements from 1G, 2G, 3G, and 4G to 5G in the world of telecommunications. The new coming 5G technology is available in the market in affordable

rates, high peak future and much reliability than its preceding technologies.

8. REFERENCES

- [1] Toni Janevski, "AAA System for PLMN-WLAN Internetworking", Journal of Communications and Networks (JCN), pp.192-206, Volume 7, Number 2, June 2005.
- [2] Janise McNair, ang Zhu, "Vertical Handoffs in Fourth-Generation Multinetwork Environments", IEEE Wireless Communications, June 2004.
- [3] Toni Janevski, "Traffic Analysis and Design of Wireless IP Networks", Artech House Inc., Boston, USA, 400 p., May 2003.
- [4] Suk Yu Hui, Kai Hau Yeung, "Challenges in the Migration to 4G Mobile Systems", IEEE Communications Magazine, December 2003.
- [5] Bria, F. Gessler, O. Queseth, R. Stridth, M. Unbehaun, J.Wu, J.Zendler, "4-th Generation Wireless Infrastructures: Scenarios and Research Challenges", IEEE Personal Communications, Vol. 8,
- [6] Willie W. Lu, "An Open Baseband Processing Architecture for Future Mobile Terminals Design", IEEE Wireless Communications, April 2008.