

## 5G TECHNOLOGIES – AN ANECDOTE OF NETWORK SERVICE FOR THE FUTURE

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**Abstract:** Commercial cellular wireless communications have a history of about 3 decades. Currently, the wireless industry is busy with the standardization of the 4th generation (4G) cellular networks, namely, LTE/LTE- Advanced and WIMAX 802.16m. The 4G standards are expected to be concluded in the next year or two. The early commercial deployments could initiate in subsequent years. With 4G networks, wireless internet connectivity will be faster and more affordable which will result in substantial increase in wireless internet usage. Since the 4G concepts have already moved to the standardization phase, we must begin to work on the building blocks of the next generation (which we refer to as 5G) wireless networks. These networks will facilitate the provision of omnipresent and affordable broadband with very high speed wireless connectivity. This paper aims at highlighting some of the key concepts and technologies which will facilitate the affordable provision of very high data rates with virtually ubiquitous coverage in 5G wireless networks. We refer to this goal as enabling the 4A's paradigm i.e. any rate, anytime, anywhere and affordable. In particular, this paper focuses on the features such as broadband internet in mobile phones with a possibility to provide internet facility in the computer by just connecting the mobile and with a speed of 10Gbps and more. Techniques with certain advanced physical layer operations in the presence of advanced radio access network (RAN) architectures, we refer to this design principle as the "integrated cross-layer cross-network design".

**Keywords:** GSM, 5G, 4G, Smartphone, GPRS.

### INTRODUCTION

#### *Evolution of Mobile Technologies*

- **Classical 0G** phones stood for the first generation of mobile phones i.e. Satellite phones developed for boats mainly. Networks such as Iridium, Global Star and Eutelsat were truly worldwide (although for physical reasons, think of a satellite as a fixed point above the equator, some Northern parts of Scandinavia aren't reachable), and everybody thought at that time that satellite phones would become mainstream products as soon as devices got smaller and cheaper. This vision proved wrong when the GSM concretely came to life in 1990-91 in Finland.
- **1G:** Firstly, there were analog GSM systems that existed for a few years. And then came the digital systems.
- **2G:** the second generation of mobile telecommunications still is the most widespread technology in the world; you've basically all heard of the **GSM** norm (GSM stands for *Groupe Spécial Mobile* in French, renamed in Global System for Mobility). The GSM operates in the 850Mhz. and 1900Mhz. bands in the US, & 900Mhz. and 1.8Mhz. bands in the rest of the world (eg did you know Bluetooth stands in the 2.4Ghz. area, just like your...microwave!/? But that's another story, not related to this article) and delivers data at the slow rate of 9.6 Kbytes/sec.
- **2.5G:** For that last reason (9.6 Kbytes/sec doesn't allow you to browse the Net or up/download an image), telco operators came up with the **GPRS** (remember all the hype around the Wap) which could enable much faster communications (115Kbytes.sec). But the market decided it was still not enough compared to what they had at home.
- **2.75G: EDGE**, which is a pretty recent standard, allows for downloading faster. Since mobile devices have become both a TV and a 'walkman' or music player, people needed to be able to watch streaming video and download mp3 files faster – that's precisely what EDGE allows for and that's for the good news. The bad news is that if EDGE rocks at downloading, it's protocol is asymmetrical hence making EDGE suck at uploading ie broadcasting videos of yours for instance. Still an interesting achievement thanks to which data packets can effectively reach 180kbytes/sec. EDGE is now widely being used.
- **3G:** also called **UMTS** (Universal Mobile Telecommunications Standard). Aimed at enabling long expected videoconferencing, although nobody seems to actually use it (do you know any?). Its other name is 3GSM, which says literally that UMTS is 3 times better than GSM. One issue though: depending on the deployment level of the area you are in and your device, your phone will (have to be) handle(d) from the GSM network to the UMTS network, and conversely – making billing more complex to understand for the consumers. One of the major positive points of UMTS is its global roaming capabilities (roaming is the process that allows you, at a cost, to borrow bandwidth from a telco provider that's not yours; you usually use roaming when calling from abroad).

- **3.5G or 3G+:** HSDPA is theoretically 6 times faster than UMTS (up to 3.6 Mbytes/sec)! Practically speaking, this would mean downloading an mp3 file would take about 30 secs instead of something like 2 minutes. It is depicted as shown in the following figure1.

Figure1: Evolution of Technologies

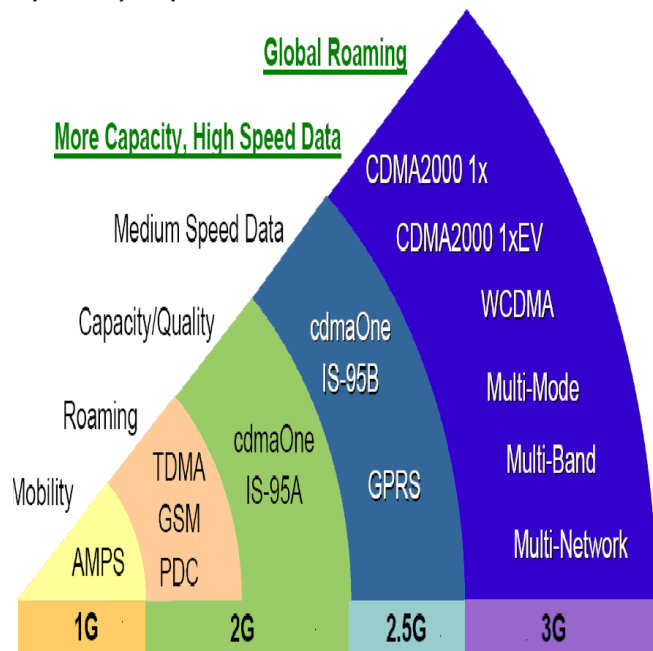


Figure 1: Generations of cellular wireless Technologies

- **4G:** still a research lab standard, at least to my knowledge, that should combine the best of cell phone network technologies with WiMax wireless Internet, voice over IP and IPv6 (a post about the latter soon). Data rates are expected to reach 100 Mbytes/sec[1].
- After the launch of 4G technology in some countries like Unites States of America and United Kingdom, research has started towards the next generation of mobiles that is the fifth generation. The name 5G has not been used by any standardization bodies or any company in telecom sector since 4G standards haven't been standardized fully. After studying the increase in data rates from generation to generation, one can roughly predict that maximum data rates i.e. uploading or downloading rates in 5G would be 10 Gbps. This generation is expected to be rolled out in 2012-13 .
- **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 telecommunication standards beyond the upcoming 4G standards (which is expected to be finalized between approximately 2011 and 2013)[4].
- **5G** offers Peak per terminal throughput – 10 Gbps outdoors, spectral efficiency. – 5 bps/Hz/cell, areal reliability – 99.5%, round trip delay < 1 ms, seamless coexistence with other radios. These goals are significantly ahead of 4G performance. The new tools that can take us these goals may include Opportunistic OFDMA, 20-60 MHz channel bandwidth, cognitive and opportunistic channel structure, flexible ,variable reuse, cooperative methods, interference management, client relay, hierarchical modulation, distributed MIMO and

accumulative methods , see detailed evolution in figure 1and figure 2.

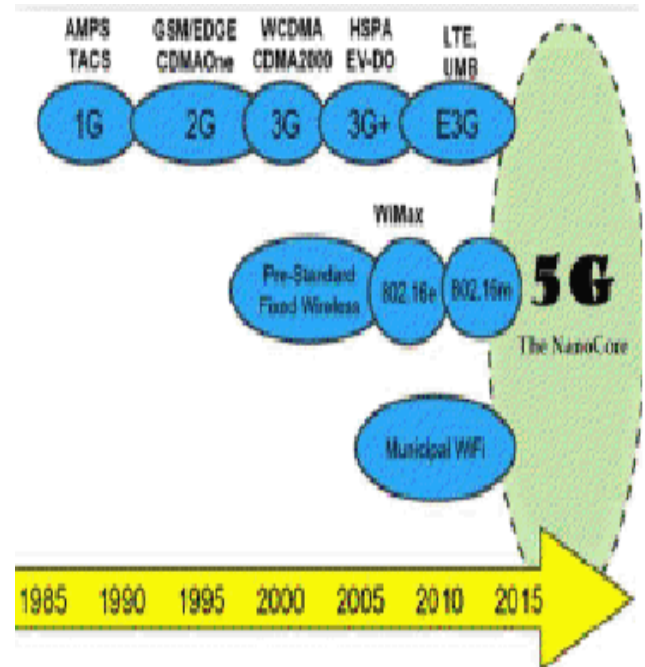


Figure2: Evolutional changes in mobile technologies over the fast two decades

Figure: 2

## WHAT IS 5G NETWORK?

5G network is very fast and reliable. The concept of handheld devices is going to be revolutionized with the advent of 5G. Now all the services and applications are going to be accessed by single IP as telephony, gaming and many other multimedia applications [5]. As it is not a new thing or gadget in market and there are millions of users all over the world who have experienced the wireless services and till now they are obsessed to this wireless technology. It is not easy for them to shrink from using this new 5G network technology. There is only need to make it accessible so that a common man can easily afford the profitable packs offered by the companies so that 5G network could hold the authentic place. There is need to win the customer trust to build fair long term relation to make a reliable position in the telecommunication field. To compete with the preceding wireless technologies in the market 5G network has to tender something reliable something more pioneering. All the features like telephony, camera, mp3 player, are coming in new mobile phone models. 4G is providing all these utility in mobile phone. By seeing the features of 4G one can gets a rough idea about what 5G Network could offer. There is messenger, photo gallery, and multimedia applications that are also going to be the part of 5G. There would be no difference between a PC and a mobile phone rather both would act vice versa. **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 [6].

**Features of 5G**

According to some research papers on 5G technology, the main features the technology might have are as follows:

- A 5G user might be able to connect to different networks at same time or switch between two networks. These networks need not be 5G networks but they can be of any generation.
- Introduction of a new radio system is possible in which different radio technologies will share the same spectrum. This can be done by finding unused spectrum and then adapting to the technology of the radio technology with which the spectrum is being shared.
- Every mobile in a 5G network will have an IP address (IPV6) according to the location and network being used.
- 5G technology is expected to bring a single global standard.
- The technology is also expected to support virtual private networks and advanced billing interfaces.
- With 5G enabled phone, you might be able to connect your phone to your laptop to get access to broadband.
- The other few features that might be offered by 5G are transporter class gateway , subscriber supervision tools , remote diagnostics etc.
- 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

**5<sup>th</sup> GENERATION TECHNOLOGY ARCHITECTURE**

A first remarkable feature of 5G network is the broadband internet in mobile phones that would be possible to provide internet facility in the computer by just connecting the mobile as depicted in figure 3.

**Handheld Computer:** Data sharing in 5G network is very easy. It omits the condition of putting both mobile face to face so that data could be shared. But 5G Bluetooth technology removes this condition and data could be transferred if it is shared in the range of 50m [2]. It is not far away when we see the global mobiles all over the world. A user can move everywhere in the world by holding just 5G mobile network. All the roaming would be exempt from the tariff plans. The rates of the call would not be different area to area.

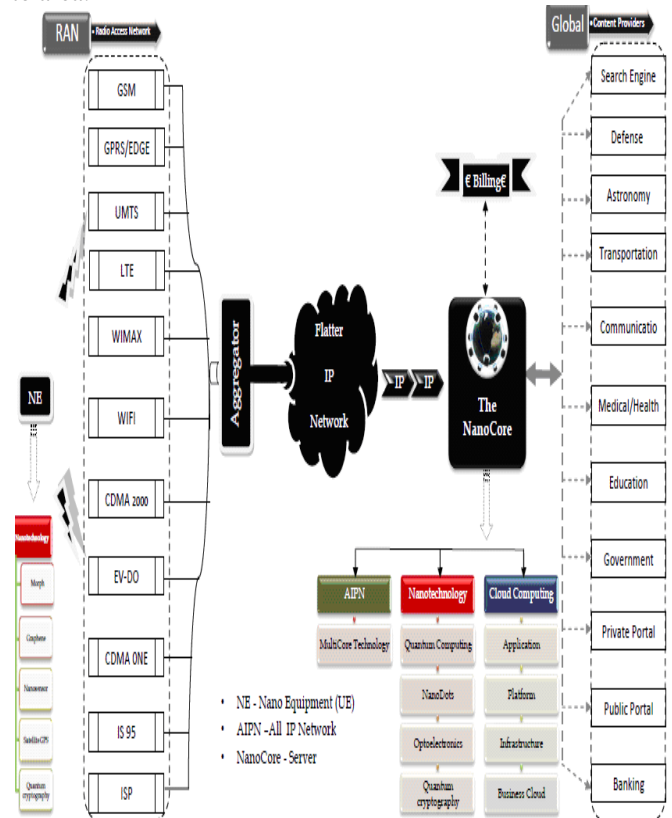


Figure 3: Architecture of 5G Technology

5G enabled smart phones will be a great challenge to laptops due to the extraordinary features offered. With thousands of mobile applications a user will do on his laptop with improve facilities. The tables I, II, III describes the comparison of each generation’s technology and the changes which has come up for improvements.

**SMART PHONES**

The term ‘smart phone’ refers to a multi-functional mobile phone handset that features everything from a camera and web browser to a high-density display and media player. Other key smart phone features include 5G as a vital technology, masses of space and microSD card slots to allow

you to upgrade further and intuitive touch screen user interfaces so you can access all the great functions of the handset quickly and easily.

**Smartphone operating systems & processors:** To keep these super, high-end mobiles running smoothly, smart phones are equipped with powerful micro-processors[3]. These are what enable smart phone users to access more than one function or app simultaneously and ensure that there's minimal lag at all times. Also helping smart phones offer a smooth user experience are the advanced operating systems they run on. These manage the distribution of the handset's resources and are now a key selling point for customers when choosing a smart phone. Some of the operating systems you're most likely to come across include Symbian OS, iPhone OS, RIM's BlackBerry, Windows Mobile, Linux, Palm WebOS and Google's Android.

**Smart Phone Updates:** Periodically, smart phone makers issue software updates for their phones operating systems. These can be sent out automatically over the air through the network, or will require the smart phone owner to download them manually. Updates for smart phones generally add great new features and are also used to fix any faults that might have been present with existing versions. Google is perhaps the most regular issuer of operating system updates, often putting out several new iterations of its Android platform every year. By contrast, Apple usually sends out just one new version each year for the iPhone.

**Smart Phone Applications and Future:** Applications, commonly referred to as apps, are specific pieces software that can be downloaded to enhance a smart phone's functionality. They could be calendar and organizer apps, games, or amp reading tools. If it's useful, somebody will have created an app for it. In order to download apps users can visit the online software store for their operating system. The pace of change in the smart phone market can be overwhelming; with new features and technology that constantly revolutionizes the way we use mobiles. In years to come, the smart phone market is expected to see the arrival of 3D phones, which will allow us to capture and watch 3D footage on our handsets. Also expected to become standard on handsets is augmented reality technology. This overlays digital information over images visible through the onboard camera, meaning that you can read the review for a restaurant simply by pointing your phone at it.

**COMPARITIVE STUDY OF RELATED TECHNOLOGIES**

**2G- Technologies Features**

Table1. Advantages and Disadvantages of 2G

Merits	Demerits
Helped address health concerns.	The weaker digital signal may not be sufficient to reach a cell tower.
Supported SMS & E-mail services .	Under good conditions, signal will sound better. Under slightly worse conditions signal had occasional dropouts.
Greatly reduced fraud.	The lossy compression used by the codecs takes a toll.
Enhanced privacy.	The range of sound that they convey is reduced.

**3G- Technologies Features**

Table2. Merits and Demerits of 3G

Merits	Demerits
The 3G is characterized by convergence of data and voice with the wireless Internet. 3G is a system that is suitable for high data transmissions and advanced multimedia applications.	Expensive Equipment-One disadvantage is that cell phones that use 3G services require equipment that is more expensive.
3G networks have helped network operators in offering its users a vast range of advanced services.	Roaming and data/voice work together has not yet been implemented.
Targeted for applications beyond audio and voice. MP3, video conferencing, motion video and lightening fast Internet access.	Base stations need to be closer to each other (Expensive).
Through improved spectral efficiency, a 3G network is able to achieve greater network capacity.	Need to update current cellular infrastructure and installation of new 3G equipments.
3G networks are able to achieve speed of more than 384 kbps which allows full mobility and could provide speed of 120 km/hour in outdoor settings.	Power Requirements- 3G handsets also require more power and an overhead of big batteries and more bulky handsets.
3G services consist of video calls, broadband wireless, and wide area voice telephony all in a mobile setting.	Because more power is requirements 3G phones are larger and heavier.

**4G- Technologies Features**

Table 3. Merits and Demerits 4G

Merits	Demerits
Error correction data is encoded and packets are numbered for retransmission as and required.	To use packet, all cellular hardware will need to be upgraded or replaced.
Packets are the underlying technology in essentially all data based communication.	Consumers are required to purchase new phones, and providers need to install new equipment in towers.
Current technologies use a variety of methods to break up voice communication into pieces.	The communication system need to be rebuilt from the ground up.
Packets are compatible with various devices and can travel over any network using any of the methods of transmission.	It will suffer setback during natural pace of hardware replacement and incur undue additional costs on cellular companies or consumers
The capacity of packets is expandable. They have moved from carrying short text messages to carrying video, audio, and other huge types of data.	The technological disadvantage of using packets is not really a disadvantage, but more of an obstacle to overcome.
Based on capacity of the transmitter a packet can carry any size of information or in number of small pieces.	As the voice and data networks are merged and with millions of new devices on the network it creates a overhead of address space in entire Internet and networks.

**COMPARITIVE QUOTIENT BETWEEN 5G AND 4G**

4G and 5G are both mobile wireless access technologies offers Ethernet speed on mobile devices to experience the triply play services as explained in table 4. Currently 4G is being deployed in several countries in Europe and North

America. LTE and WiMAX are two different technologies to achieve 4G defined speeds[1]. Whereas 5G is a concept only and not officially defined. 5G is not officially defined term or technology but people refer technologies that can deliver the speed beyond 4G as 5G. It's expected to be finalized somewhere in 2012 or 2013. New standard proposals or releases beyond 4G are submitted to standard bodies like 3GPP, WiMAX Forum or ITU-R. Ideal 5G model should accommodate the challenges and accommodate the short falls of the 4G Technology and 4G deployment experiences. To understand the necessities and uses of 5G could be raised once the 4G rollout is completed and experienced. Thus typical 5G concept would be raised in somewhere around 2013-2015. Expected speed may be multiple of Gigabit Ethernet. This technology would be mainly used in backhauling telecom networks rather than end user access. 4G offers theoretically closer to Gigabit Ethernet whereas users expect multiple Gigabit speed from 5G.

Table 4. Comparison of 4G and 5G Technologies

4G-Technology	5G-Technology
4G networks are almost released.	5G networks release may take nearly 5-6years or may be even more.
4G networks is slow.	5G networks will be faster than 2G,3G & 4G base
4G networks rely on terrestrial base stations	5G would be using HAPS or High Altitude Stratospheric Platform Stations..
4G networks coverage would still be problematic.	5G networks will have excellent coverage
4G networks will be less cost than 5G	5G networks will be more expensive than 2G,3G,4G
4G networks should be able to attain 100mbits/s	5G would attain 10Gbps.
4G is being used in Backhauling Networks as well as user access.	Users expect 5G to be backhauling telecom networks.
4G network offers theoretically closer Ethernet	Whereas users expecting multiple Gigabits of speed from 5G.
4G network is less reliable than 5G.	5G network is more reliable than 2G,3G and 4G.
LTE and WiMAX are used to achieve 4G defined speeds.	5G is a concept only and not officially defined.

## PROGNOSIS

If a 5G family of standards would be implemented, it would likely be around the year of 2012-13 according to some source. A new mobile generation has appeared every 10th year since the first 1G system (NMT) was introduced in 1981, including the 2G (GSM) system that started to roll out in 1992, and 3G (W-CDMA/FOMA), which appeared in 2001. The development of the 2G (GSM) and 3G (IMT-2000 and UMTS) standards took about 10 years from the official start of the R&D projects, and development of 4G systems started in 2001 or 2002. From users point of view, previous mobile generations have implied substantial increase in peak bitrates (i.e. physical layer net bitrates for short-distance communication). If 5G appears, and reflects these prognoses, the major difference from a user point of view between 4G and 5G techniques must be something else than increased maximum throughput; for example lower battery consumption, lower outage probability (better coverage),

high bit rates in larger portions of the coverage area, cheaper or no traffic fees due to low infrastructure deployment costs, or higher aggregate capacity for many simultaneous users (i.e. higher system level spectral efficiency). Those are the objectives in several of the research papers below.

## RESEARCH DIRECTIONS

Key concepts suggested in scientific papers discussing 5G and beyond 4G wireless communications are:

- Pervasive network providing ubiquitous computing: The user can simultaneously be connected to several wireless access technologies and seamlessly move between them. These access technologies can be 2.5G, 3G, 4G, or 5G mobile networks, Wi-Fi, WPAN, or any other future access technology. In 5G, the concept may be further developed into multiple concurrent data transfer paths.
- Group cooperative relay: A major issue in beyond 4G systems is to make the high bit rates available in a larger portion of the cell, especially to users in an exposed position in between several base stations. In current research, this issue is addressed by cellular repeaters and macro-diversity techniques, also known as group cooperative relay, as well as by beam division multiple access [3].
- Cognitive radio technology, also known as smart-radio allowing different radio technologies to share the same spectrum efficiently by adaptively finding unused spectrum and adapting the transmission scheme to the requirements of the technologies currently sharing the spectrum. This dynamic radio resource management is achieved in a distributed fashion, and relies on software defined radio [6].
- Dynamic Adhoc Wireless Network (DAWN), essentially identical to Mobile ad hoc network (MANET), Wireless mesh network(WMN) or Wireless grids, combined with smart antennas and flexible modulation.
- Internet Protocol Version 6 (IPv6), where a visiting care-of mobile IP address is assigned according to location and connected network,
- High –altitude stratospheric platform station (HAPS) systems.
- Wearable devices with AI capabilities.
- *Real wireless world* with no more limitation with access and zone issues [7].
- *User centric* network concept instead of operator-centric (as in 3G) or service-centric (as in 4G) *World wide wireless web* (WWW), i.e. comprehensive wireless based web applications that include full multimedia capability beyond 4G speeds[8]. On July 7, 2008, South Korea announced plans to spend 60 billion won, or US\$58,000,000, on developing 4G and even 5G technologies, with the goal of having the highest mobile phone market share by 2012, and the hope of an international standard[9].

## IMPLEMENTATION REALITIES

Korea is going to take as fast moving nation in the world with the plan of roll out 5G Network in the lines of figure4. They are planning to deploy the 5G network service by the year of 2012. The starting 1G in 1881 then after 10 years 2G was developed and implemented. There also takes 10 more

years for 3G that s in 2002.Now the 4G was deploying in some countries with a view to expand the bandwidth capabilities for easy access to the web and its services[10]. The tech-savvy country aims to stay in front of the cell phone production race by taking lead in the wireless market at the mentioned year, with 5G connectivity being one of the main cornerstones of that plan.

When we think about 5G, we should keep in mind that most of the nations are now under 3G.UK people are still on 3G network and they only hearing some roumers about 4G that will launch in UK in 2012 -2015.Now the 3G will allow people to download data at a rate of up to 21mbps.The 4G lies in the range of 100mbps to 1gbps[12]. No need for such wonder because 5G is coming with a speed more than our thoughts.. South Korea announced plans to spend 60 billion won, or US\$58,000,000, on developing 4G and even 5G technologies, with the goal of having the highest mobile phone market share by 2012, and the hope of an international standard. iPhone 5G will definitely invade the techie world. It will even eat up all the modern communication gadgets. This iPhone 5G will hopefully be released this year. Though there are many imitations in the mobile market of iPhone 5G, for sure Apple Company’s iPhone is incomparable.

**What is the Reason for Delay in Implementing 3G and 4G Mobile Services**

It is very sad to say that the 3G services had only reached with in some towns of china, so that it may take time to reach to other countries. Another major defect of this is that Wide Band Frequency Spectrum, which is needed for 3G, is lacking. Another reason for this is that it a cost bearing item especially for sending data[10]. So for us it is a higher one which could be used only by upper classes. If it should be accepted among all customers, firstly it should be availed at a lower rate, for which the rate of spectrum should be declined. Figure 4 displays high configuration connectivity requirements are in demand to meet the technological interfaces.

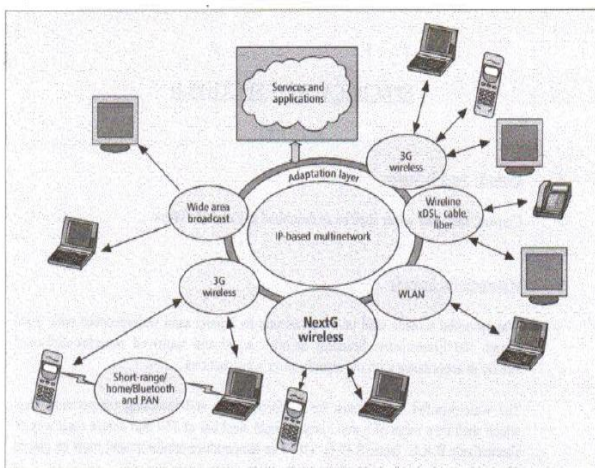


Figure 4. Implication of massive device(s) connectivity

**CONCLUSION**

Nowadays, wireless technology is getting popular and important in the network and the Internet field. In this paper, we briefly introduced the history background of 1G to 5G, compared the differences of 3G and 4G, and illustrated how 4G may work for more convenient and powerful in the future. 4G just right started from 2002 and there are many

standards and technologies, which are still in developing process. Therefore, no one can really sure what the future 4G will look like and what services it will offer to people. However, we can get the general idea about 4G from academic research; 4G is the evolution based on 3G’s limitations and it will fulfill the idea of WWW, World Wide Wireless Web, offering more services and smooth global roaming with inexpensive cost.

A new **revolution of 5G technology** is about to begin because 5G technology is going to give tough competition to normal computer and laptops. There are lots of improvements from 1G, 2G, 3G, and 4G to 5G in the world of telecommunications. The novel impending 5G technology is available in the market in affordable rates, high peak future and much reliability than its preceding technologies.

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