Volume 2, No. 2, Mar-Apr 2011
ISSN No. 0976-5697
International Journal of Advanced Research in Computer Science
REVIEW ARTICLES
Available Online at www.ijarcs.info

Emerging Technology in wireless network: Evolution of 4G

Mr. Shekhar P. Malvi *
ME IstYear
Department of Computer Engineering,
SIPNA COET
Amaravati, India
Shekharmalvi1210@gmail.com

Prof. Pritish A. Tijare
Department of Computer Science Engineering
SIPNA COET
Amaravati, India
pritishtijare@rediffmail.com

Abstract: Wireless networks are now advancing to third generation (3G) capabilities, providing increased data transfer rates that make it easier to access applications and the Internet from mobile devices. Individual wireless access networks show limitations that can be overcome through the integration of different technologies into a unified platform (i.e. 4G system) . Based on the study, 4G mobile technology is in a determining and standardization stage. Although 4G wireless technology offers higher data rates and the ability to roam across multiple heterogeneous wireless networks. Since 4G is still in the cloud of the sensible standards creation, ITU and IEEE form several task forces to work on the possible completion for the 4G mobile standards as well. 3GPP LTE is an evolution standard from UMTS, and WiMAX is another candidate from IEEE. These technologies have different characteristics and try to meet 4G characteristics to become a leading technology in the future market. A 4G system is expected to provide a comprehensive and secure all-IP based solution where facilities such as ultra broadband (giga-bit speed) Internet access, IP telephony, gaming services, and streamed multimedia may be provided to users.

Keywords: 3G,4G Mobile Technologies, UMTS, WiMAX, ITU, WiBro,IMT Advanced

I. INTRODUCTION

In a world of fast changing technology, there is a rising requirement for people to communicate and get connected with each other and have appropriate and timely access to information regardless of the location of the each individuals or the information[6]. The increasing demands and requirements for wireless communication systems ubiquity have led to the need for a better understanding of fundamental issues in communication theory and electromagnetic and their implications for the design of highly-capable wireless systems. In continuous development of mobile environments, the major service providers in the wireless market kept on monitoring the growths of 4th generation (4G) mobile technology. 2G and 3G are well established as the mainstream mobile technology around the world. 3G is stumbling to obtain market share for a different reasons and 4G is achieving some confidence. The trail going to 4G mobile technology embraces lots of significant trends. Major mobile players have been investing to 2G and the succeeding technology. 4G mobile technologies are perceived to provide fast and high data rate or bandwidth, and offer pocketsize data communications. Since 4G is still in the cloud of the sensible standards creation, ITU and IEEE form several task forces to work on the possible completion for the 4G mobile standards as well. Users' experiences of latest booming Internet forces industry to investigate means to provide high data rate regardless of mobility. 4G is being discussed as a solution to the inquiry and its vision and requirements are being standardized in various standardization bodies. 4G service vision is given from this research. There still have large room for the purpose of service application vision: 3G is being delayed in its commercialization and about a decade of change is left for 4G. However, we believe this paper will promote discussion of 4G services by presenting our vision of 4G services

II. THE CURRENT STAGE OF 3G

Before beginning a discussion of 4G technologies and business applications, it is important to understand the current state of 3G networks[4]. There is no official definition by a standards group of what constitutes 3G. The term evolved in the wireless industry and generally includes the International Standards Union's (ITU) IMT-2000 technology definition and related features. IMT-2000 is an ITU term that defines globally recognized 3G technologies for use in IMT-identified radio frequency bands. Technologies currently recognized as meeting these requirements include WCDMA, CDMA2000, TD-CDMA and EDGE. Over the last decade, several incremental improvements in radio technology and command-and-control software have been classified as 3G technologies[1]. To denote their significance properly, the technologies are commonly (and unofficially) named as higher and higher variants of 3G such as 3.5G and 3.9G. The different 3G technologies use more or less the same repertoire of tools with different combinations and variations to optimize bandwidth usage.

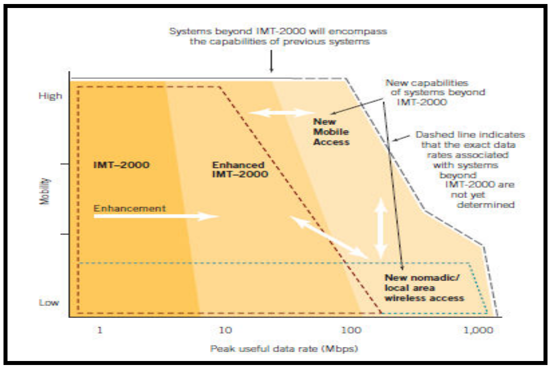

Figure1; Boundries of IMT system[4]

III. ITU IMT- STANDARD

The ITU may emerge as the authority to define what constitutes 4G. ITU's IMT Advanced (IMT-A) is a concept that intends to build on the success of IMT-2000 as a benchmark for 3G. IMT-A systems are envisioned to have capabilities surpassing those of IMT-2000 by orders of magnitude[7]. IMT-2000-based 3G systems generally provide peak data rates of around 1–5 Mbps. The IMT-A concept outlined in the ITU IMT- 2000 document states: "With the expectation that there will be a need for commercial services in multi-user environments targeting peak data rates approaching 100 Mbps for 'highly mobile' users, and up to 1 Gbps for nomadic (low mobility or stationery) users, the IMT-A concept requires mandatory backward compatibility with prior systems to match these high data rates." Highly mobile users are further defined as accessing the network at speeds up to 125 KMph[1], while maintaining network connectivity at speeds of up to 350 KMph. Data rates are not yet specified. 3G radio improvements are considered as IMT-2000 Enhanced[4]. Additional capabilities will also be available from an integrated network under the IMT-A or 4G umbrella[3]. Under 4G, access is not confined to mobile users only, but is expanded to stationary or nomadic users just as the network itself is not limited to Radio Access Networks (RANs), but includes the whole: wire line access, wireless radio access, core command, and control and back office functions in a unified system.

IV. 4G TECHNOLOGY

4G refers to the fourth generation of cellular wireless standards. It is a successor to 3G and 2G families of standards. In naming its 4G initiative IMT-Advanced, the ITU has consciously reused the first part — "IMT" from the 3G IMT-2000 program[1]. This naming is significant because it has been agreed that spectrum currently allocated for exclusive use by IMT-2000 technologies will now be known as just "IMT" spectrum and will also be made available for IMT-Advanced. Crucially, there are no plans for exclusive IMT-Advanced spectrum. This is pragmatic since spectrum is scarce and largely occupied.

V. HUMAN REQUIREMENTS

Finally, how people use wireless networks is a consideration when defining 4G. Figure 2 summarizes the evolution of how the basic senses of sound and sight as well as knowledge are fulfilled by various generations of mobile wireless networks Figure 2. Mobile wireless generations and applications

The Generation	Access Protocols	Key Features	Level of Evolution
1G	FDMA	Analog, primarily voice, less secure, support for low bit rate data	Access to and roaming across single type of analog wireless networks
2G and 2.5G	TDMA, CDMA	Digital, more secure, voice and data	Access to and roaming across single type of digital wireless networks and access to 1G
3G and 3.5G	CDMA2000, W-CDMA, HSDPA, TD-SCDMA	Digital, multimedia, global roaming across a single type of wireless network (for example, cellular), limited IP interoperability, 144Kbps to several Mbps	Access to and roaming across digital multimedia wireless networks and access to 2G and 1G
4G	TBD	Global roaming across multiple wireless networks, 10Mbps-100Mbps, IP interoperability for seamless mobile Internet	Access to and roaming across diverse and heterogeneous mobile and wireless broadband networks and access to 3G, 2G, and 1G

Figure 2. Mobile wireless generation and application[2]

VI. DEVELOPMENTS ON THE ROAD TO 4G

Some service providers and equipment manufacturers have already staked claims to 4G service by providing mobile access rates above 3G's 1–5 Mbps along with lower latencies. Rival camps claim services with higher data rates under the banner of 3.5 or even 3.9G. But, just improving access speeds alone should not qualify as 4G without an entire suite of network-level integration[3].

The dilemma faced by 3G groups — 3GPP and 3GPP2 — is that they cannot claim anything to be 4G under their 3G banner. The notion of 3G LTE has been established for a number of years now.

But, technology developments outpace the reality of the standard making process. Today, 3G is deployed in most developed countries. 3GPP beganwith the 2G GSM base to evolve via WCDMA as the core technology.3GPP2 evolved from CDMA to CDMA2000. Both standards groupspromise comparable performance consistent with availability of radiospectrum. Both have adopted OFDMA as the standard for at leastthe downlink (base station to mobile user) direction and have further promised to allow IP as the preferred packet format, beyond unique MAC layers. Networks based on 3G LTE are expected to be available by the 2010–11 timeframe, enabling a convenient entry for 4G in the subsequent years[3]. According to this schedule, there is no room for a near-term 4G-network deployment. So what about WiMAX,
the 4G wannabe?

VII. EXPANDING 4G BEYOND WIRELESS

Figure 3. shows the concept of a unified architecture employed by the IMT-A network that is built on IP as the common transport layer protocol. A rich interface regime fosters and facilitates new services that enable the use of communication networks by devices yet- to be developed. With substantial improvements in access speeds, applications popular in the wireless world can be ported under the advanced wireless networks in a uniform, seamless way so the participating end users do not notice nor care how they access a service. the IMT-A vision of various access systems ("networks") interconnected to provide services in a cooperating manner. To achieve this vision , ITU defines layers of network based on the geographic scope of coverage and extent of mobility offered by each layer.

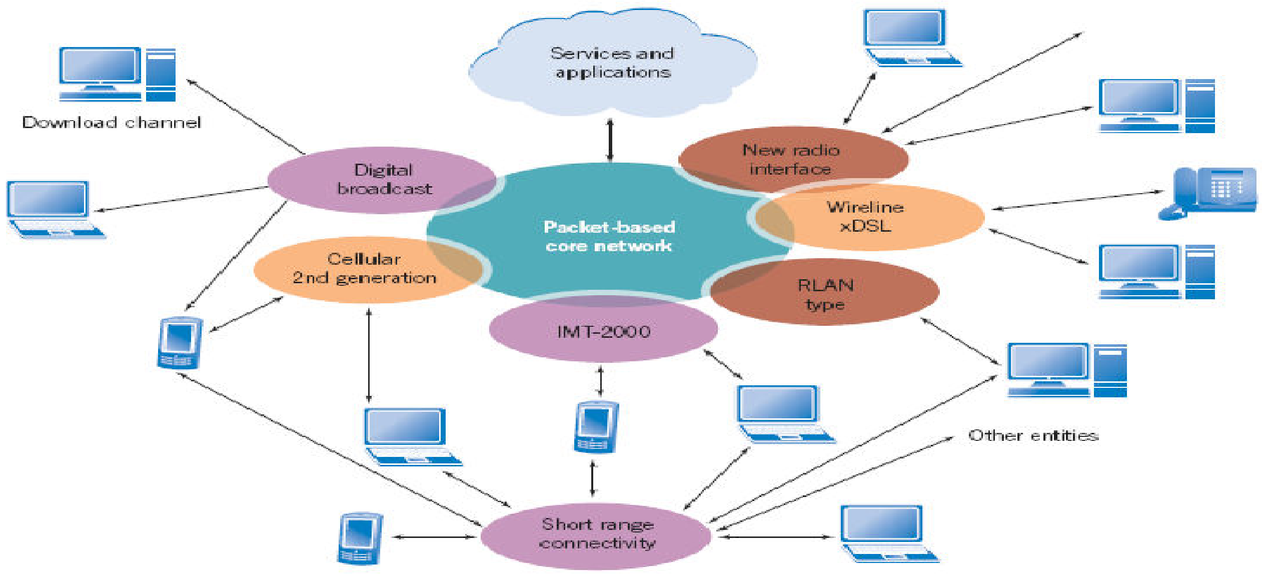

Figure.3 Unified architecture for IMT-Advanced systems

.A. *There are four access layers*

1. Fixed (i.e., DSL, cable, fiber) — fixed wireline networks
2. Personal (i.e., Bluetooth, UWB) — cars, cell phones, PDAs
3. Hot-spot (i.e., Wi-Fi/802.11) — restaurants, coffee shops, planes
4. Cellular (i.e., UMTS, WiMAX) — highly-mobile users

VIII. 4G SCENARIO

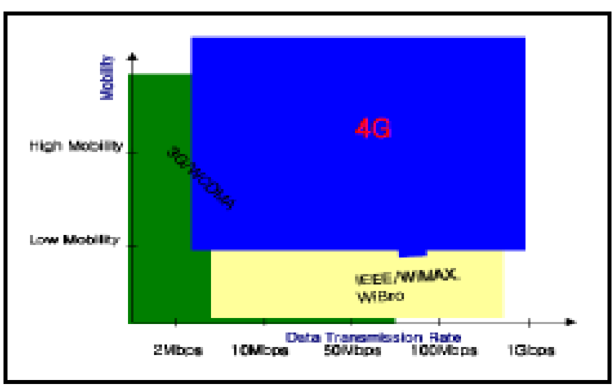

Figure 4: Options of evolution path toward 4g [6]

..

Several scenarios are described to display the situations of the wireless communication industry as the 4G. These scenarios are based on different wireless access technologies such as WiMAX, WiBro, 3G LTE, and IEEE802.20. Figure 4: Options of evolution path toward 4G. In the on-going 4G studies in the standardization bodies and relative industries, one of the aims is to establish an integral wireless system that would seamlessly connect the enhanced forms of existing 3G wireless systems such as WCDMA with HSDPA. In this scenario, existing carriers will maintain present customer base and services are integrated 4G[2]. On the other hand, however, it has become possible by technological innovation that non-3G wireless services develop as competitors against 3G services such as WiMAX, or further enhanced IEEE 802 standards. In addition, individuals and organizations have started providing open and free wireless communication services by opening up, through various technologies. Figure 3 shows that these different evolution path toward 4G. For the scenarios we provided in the paper, we assumed that the advent of 4G service will be after 2012. 4G service will be determined whether it can support 4G characteristics technically, and hold the market with service differentiation from competitors. In order to forecast the form of realization of 4G systems.

These data rates suggest higher spectral efficiencies and lower cost per bit will be key requirements for such future systems. Additional important and expected features are likely to be increased flexibility of mobile terminals and networks, multimedia services, and high-speed data connections. Future convergence systems will clearly be another feature. Based on these visions and characteristics of the 4th generation (4G) for future wireless telecommunication, new spectrum allocation issue, and technology feasibility, the advent of 4G service will bring a number of changes of competition environment, regulation and policy as well as service change into future wireless communication. Accordingly, it is very important we expect what kinds of possibility we have for the 4G service to prepare well.

IX. EVALUATING 4G

So how should 4G be evaluated given the history of previous generations? We could analyze many factors — but one undeniable truth supporting the phenomenal growth in the wireless market has been the parallel growth in system capacity[5]. This should be no surprise since capacity is the raw material required to deliver value-added services. If capacity is not growing then neither is the industry. Most of the capacity in today's infrastructureis consumed with telephony and messaging, with demandbeing fueled by growth in subscriptions of typical voice usage,which averages globally at around three hours per user permonth. However, the advent of higher-rate data services changesthis model and it is now possible for one user to demand far more capacity from the system than was possible with voice. If higher-rate 3G and 4G services are to be viable there has to be a corresponding growth in system capacity.

Figure 5 presents a simple model for evaluating system capacity with three axes: spectrum, spectral effi ciency and number of cells (which is a form of frequency reuse). The product of these three axes represents the volume or capacity of the system. Over the last 50 years there has been phenomenal capacity growth of around one million. Further analysis shows that effi ciency has improved 20x and spectrum by around 25x, but the number of cells has grown by a staggering 2000x, making this axis 80 to 100x more signifi cant[5].

The trends shown are based on a European model and are valid in general, though not necessarily in the fi ne detail. The Y scale is the peak data rate in kbps and the other traces (normalized to single-band GSM in 1992) are: average efficiency (b/s/Hz/cell); spectrum; and their product, which is cell capacity (b/s/cell).

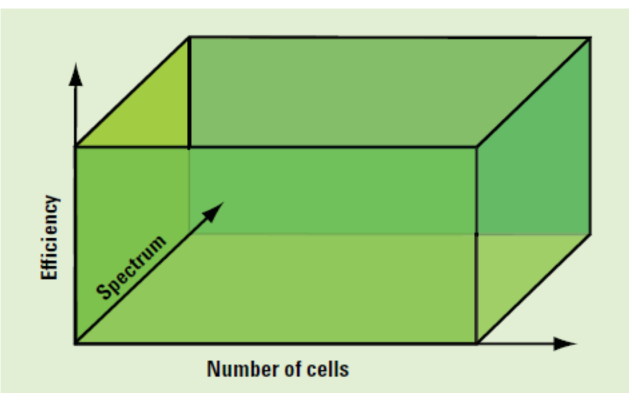

Figure 5 Volume model for wireless system capacity [5]

The efficiency figures are taken from various sources with the value in 2015 being projected at 1.3 b/s/Hz/cell, which is a safer fi gure to use than the 2.6 b/s/Hz/cell 4G target based on 4x2 MIMO. The spectrum growth follows the GSM900, DCS1800,E-GSM, UMTS2100 historical progression with projections for700 MHz, 2.6 GHz and 3.5 GHz leading to a total of 680 MHz by2015.

In the early days, 2G systems were deployed to operate at apeak rate of around 10 kbps at the cell edge, enabling uniform,if somewhat ineffi cient, service. In later generations, many techniques have been used to increase average effi ciency by exploiting better radio conditions further into the cell. The result is better effi ciency — but service coverage is no longer uniform [5].

Until about 2002, the peak data rates tracked the growth in cell capacity, meaning that, on average, a loaded cell could deliver the higher rates to its users. The number of users will obviously vary depending on the service, but if we take as a reference the number of users in the original GSM cell at its capacity, then these same users would experience a nearly 50x growth in data rates in ten years — quite impressive! However, after 2002 we see a growing gap between cell capacity and the peak rates possible for single users. This is signifi cant because our same set of users will, on average, see only one-tenth of the possible peak data rates today's unloaded systems can deliver [5].

X. VISION OF 4G

The vision of 4G is a framework for an advanced infrastructure consisting of architecture, core technologies and open interfaces for building, deploying and providing applications to achieve ubiquitous, converged broadband services. 4G is much more than high access speeds — it is a whole new "whole."

A. Ubiquitous[2]

Any service at any place and any time via any network to any person on any device.

B. Converged [2]

Portability, seamlessness and continuity.

C. Broadband[2]

Capacity-agnostic services If a financially sound business model evolves to support the 4G vision, how do service providers and vendors evolve in a timely manner to foster its existence and growth?

- What can the user community do with it?
- What are the costs?
- Is the cost low enough to make it attractive to users?
- Can usage patterns encourage application developers to continue to innovate? The short answer to the "Why 4G?" question is not why, but when. There are several factors to consider:

D. Business Need and Opportunity [3]

3G operators are learning that future average revenue per user (ARPU) does not come from traditional service like voice and allied products (like ring tones). Rather, data services such as mobile, video, music, games, Internet access, navigation and messaging (SMS and MMS) are the path to greater revenue. The trend is unmistakable and leads to more services that exploit infrastructure offered by advanced technology.

E. Technology Pull [3]

As Figure 4 shows, the key processor and component semiconductor technology required to make progress towards 4G is likely to reach economical levels as 4G comes to fruition. Advances in power technology and radio receiver technology are likely to converge with processor technology to make the solutions viable.

F. Rate of Innovation[2]

Adoption of application software that combines media, location, user profiles and security fosters a higher rate of innovation. This in turn hastens the march towards solving the complex problems related to ubiquity via presence technologies.

G. Disruptive Technologies [2]

Always a wild card, new technologies tend to accelerate the pace of growth and at times cause fragmentation. In the past, disruptions have steered the industry off a planned path and actually slowed the pace of growth. The factors behind disruptions such as technical talent, venture capital financing and a willing buyer of the end product are very real.

H. Standardization [2]

Use of a higher Layer Protocol (IP) as transport medium affords intelligence at every stage within the network relative to a service. IP's unparalleled scalability can only be an asset and its flexibility as a tool in forging a resilient and fault tolerant infrastructure can help support functions such as security. Standards in the area of Radio Technology such as affordable Software Defined Radio (SDR) are likely to help as well.

I. New Revenue Opportunities [2]

There is a growing cultural acceptance of ad-based business models and entry-level service packages for broadband. Tiered services with premium offerings that include advanced features are also becoming popular. This trend bodes well as a way to offset expensive infrastructure build-outs.

XI. SWOT ANALYSIS OF 4G

Considering 4G characteristics, expected scenarios and market trends, we can find out strengths, weaknesses, opportunities and threats of 4G with better understandings. The lists and findings follow.

A. Strengths in 4G: [6]

- 4G visions take into account installed base and past investments
- Strong position of telecommunications vendors expected in the marketplace.
- Faster data transmission and higher bit rate and bandwidth, allow more business applications and commercialization
- Has advantage for personalized multimedia communication tools

B. Weakness in 4G:[6]

- No large user community for advanced mobile data applications yet
- Growing divergence between telecommunications vendors and operators
- Not possible to offer full internet experience due to limited speed and bandwidth
- Comparatively higher cost to use and deploy infrastructure compared fast mobile generation

XII. CONCLUSION

There are many complex and interdependent moving parts that must work together before a standard definition of 4G is solidified[7]. The benefits to service providers and end users drive the adoption of 3G services that, in turn, lead to the demand for even more advanced services. The realization of 4G tears down the wall between wireless and wireline services, a challenging endeavour. Realistically, wide scale availability of 4G is several years away somewhere in the middle of the next decade.

XIII. REFERENCES

[1] Suk Yu Hui; Kai Hau Yeung (December 2003). "Challenges in the migration to 4G mobile systems".Communications Magazine, IEEE (City Univ. of Hong Kong,China) 41: 54. doi:10.1109/MCOM.2003.1252799.

[2] Jawad Ibrahim (December 2002). "4G Features" (PDF). Bechtel Telecommunications Technical Journal. http:// www.bechteltelecoms.com/docs/bttj_v1/Article2.pdf. Retrieved 2007-03-26.

[3] Young Kyun, Kim; Prasad, Ramjee (2006). 4G Roadmap and Emerging Communication Technologies. Artech House 2006. pp. 12–13. ISBN 1-58053-931-9.

[4] 3GPP specification: Requirements for further advancements for E-UTRA (LTE-Advanced) (http:// www.3gpp.org/ftp/ Specs /html-info/36913.htm).

[5] Moray Rumney, "IMT-Advanced: 4G Wireless Takes Shape in an Olympic Year" Agilent Measurement Journal, September 1, 2008 IEEE 802.16TGm, "IEEE 802.16m System Description Document" 802.16m-08/003r3, June, 2008

[6] Qualcomm Report, "IEEE 802.20: Mobile Broadband Wireless Access – A Technical Overview", June 2006.

[7] Carney, W. and Solomon, Y. The future of wireless LANs will be multimode.Texas Instruments White Paper SPLA001 (Nov. 2002); focus.ti.com/pdfs/vf/bband/80211_wpmultimode.pdf

[8] Sunil Vadgama, Stephen Truelove, "Evaluation of Software Defined Radio Technology", February, 2006.