4G Wireless Networks

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***Abstract* - The better the technology, the more user friendly it becomes. This is what 4G brings to us than 3G. 4G provides us 3 timesfaster speed than 3G technology.4G is the short name of fourth generation of wireless /mobile communication That willenable things like IP –based voice, data, gamming services & high quality streamed multimedia on portable devices withcable modem like transmission speed. The expectation for the 4G technology is basically the high quality audio/videostreaming over end to end Internet Protocol. Third generation mobile, data rates are 384 Kbps (download) maximum,typically around 200kbps, and 64kbps upload. These are comparable to home broadband connections. Fourth generationmobile communications will have higher data transmission rates than 3G. 4G mobile data transmission rates are plannedto be up to 100 Mbps on the move and 1Gbps stationary, this is a phenomenal amount of bandwidth, only comparable tothe bandwidth workstations get connected directly to a LAN**

I. INTRODUCTION

The existence of 4G Networks in today's technology-driven society is important indicators of advancement and change. 4G, or Fourth Generation networks, are designed to facilitate improved wireless capabilities, network speeds, and visual technologies. It is anticipated that as these networks continue to thrive, the demand for advanced related technologies will also grow, thereby creating new alternatives for savvy technology users to exceed their desired expectations. The following discussion will evaluate the current state of 3G Networks and will examine the future potential of these networks in expanding technology-based capabilities for consumers and industries alike.

In this paper we present an overall vision of the 4G networks starting by presenting some of the key features they will provide, and then discussing key challenges the researchers and vendors are attempting to resolve, and finally briefly describing some of the proposed solutions to these problems.

II. DEFINITION OF 4G

4G takes on a number of equally true definitions, depending on whom you are talking to. In simplest terms, 4G is the nextgeneration of wireless networks that will replace 3G networks sometimes in future. In another context, 4G is simply aninitiative by academic R&D labs to move beyond the limitations and problems of 3G which is having trouble getting deployedand meeting its promised performance and throughput. In reality, as of first half of 2002, 4G is a conceptual framework for ora discussion point to address future needs of a universal high speed wireless network that will interface with wire linebackbone network seamlessly. 4G is also represents the hope and ideas of a group of researchers in Motorola, Qualcomm,Nokia, Ericsson, Sun, HP, NTT DoCoMo and other infrastructure vendors who must respond to the needs of MMS, multimedia and video applications if 3G never materializes in its full glory.

III. MIGRATION TO 4G

3G was developed in order to reconcile theincompatible standards and to introduce higherdata rates.3G allowed better handling ofmultimedia including voice, data, and video andalso provide routing. In 3G system two technicalstandards are currently in use. They are theCDMA and the WCDMA2000.Moreover thethird standard that is being developed by China is known as TDSCDMA.2.5G, 3G technologiespromised data transfer up to 384 Kdps a 2Mbpsrespectively but the average output per user isnot excepted to be more than171 Kbps in busyhours. This speed ju8st can be use to met voice,basic data communication, and wireless internetaccess [5.6]. It is true that 3G can supportmultimedia Web-based services at higher speedand quality than 2G/2.5G….moreover, thecurrent version and deployment of 3G include
the following limitation:-

- Bandwidth allocation for 3G
- Difficult to support high speed mobile accessand to provide various services from narrowband
- voice to wideband multimedia internet browsing
- Difficult to support the global roaming acrossheterogeneous networks like cellular, fixedwireless, satellite etc
- Difficult to satisfy different QoS andperformance requirement due to constraintimposed on the core network by air interfacestandard
- Difficult to extend to higher data rates withCDMA due to excessive interference betweenservices

IV. REQUIREMENTS FOR 4G

In the past few years wireless systems are beingused only for military and scientificcommunication. As technology becomeovertime, the need of the user and services alsochanged, the wireless were design only to carryvoice communication .As the internet becomemore popular users felt the need to access theinternet through their mobile devices. Thischange gave raise to the requirement of

datacommunication through wireless systems. Thetransformation from 1G to 2G improved qualitiesof voice communication and 2g to 3G was fueledby the need to allow vice and data communication through the mobile devices. Again here raise an important question what will be the requirement that will speed up the transformation from 3G to 4G[7].Some important points are given below

A. BANDWIDTH

In this global world we can easily see that the bandwidth needs of the users are changing

B. SEAMLESSACCESS, INTEROPERABILITY AND CONVERGENCE

One of the problems that all users of mobiledevices currently face is the lack of seamlessaccess due to unavailability of globalstandard. It will be great advantages toconsumer if any type of mobile device isable to work in any type of networks. Forexample it ca be Wi-Fi cellular, satellitenetworks. Interoperability implies that therewills no need of laptop for data analysis,mobile phone for conversation, PDA forchecking the user calendar and TV forviewing sports events. Life will becomesimpler if all the devices converge to auniversal mobile device that allows plug andplay in any type of networks environment and support all activities that users want [8].

C. QUALITY OF SERVICE

We overcome that current wireless systemsdo not provide an assurance of quality.Latency is the problems that affect allwireless systems. These problems willbecome more in future as delay sensitiveapplications become more common. For Example remote telemedicine, prioritizationof traffic means provides cost savings isneeded in the future wireless systems.

D. EFFICIENT USE OF FREQUENCY SPECTRUM

Frequency is a characteristic of wirelesssystem and techniques like FDMA, TDMAand CDMA allow multiplexing of channelfrequency between users to allocate aconstraint resource among contending users.But the number of mobile services users isincreasing at fast rate as well. Although newfrequency bands were released for wirelesssystem, it may not be support such largenumber pf subscribers. Now more advancedDownloading and sharing of photos, ring tones,movie clips, patient diagnostic images are allbandwidth intensive activities. Moreover newapplication are introduce include mobile,television, SMS, MMS and are still popular withuser. The data connections through cellularnetworks provide bandwidth below 100 Kbpsand less when the user is incide the building indeed the bandwidth must increase techniques for frequency sharing and channel will berequired in the future.

E. MOBILE DEVICES

In the last decade the mobile device is moreadvancedboth for appearance and functionality. For exampleblack and white LCDs gave way to multi-pixel colorscreens. The weight of mobile decreased, chip andbattery design improved and internet access becomecommon everywhere. As the functionality providebut mobile devices are not automatic but user driven.

F. PERSONALIZATION

In future and at present mobile devices will act as anagent to represent the user in all activities such asautomatic transaction, billing and mobile devices willdemand deeper understanding of the user needs andthe time of a specific need. It means that recommendation system will be an integral part of mobile devices [8].

G. CONTENT AND BILLING

At present, multimedia rich content that includestreaming or recorded video or interactive gaming available in wireless systems. But it usually comes from the same content provider and does not changeaccording to the location and needs of the user. It isto expect that wireless system will allow user morechoice from a number of content providers thanobviously billing will become more complicatedbecause many network service providers contentprovider will be involved.

H. SECURITY AND PRIVACY

Viruses and spam is the common feature affecting mobile services. For example, more than 30 variantsof mobile virus are known. As more commercialactivities take place, increase in threats of malware[8, 9].The next generation wireless systems need tobe more secure in terms of better authorization,authentication, integrity, non-reputation and need toimprove the user perception about the security of the provided services

V. OPPORTUNITIES

In general, it is believed that the existence of the 4G network is designed to facilitate the development of a superior alternative to the existing 3G strategy in terms of quality and data transmission speed. For developers of 4G Networks, there is a great dependence upon advanced technologies and increased speed in order for the network to be a success. It is known that in terms of the 4G Network, “it requires substantial improvements to multimedia messaging services, including video services, in order to approve a new generation. It wants a data speed transfer rate of at least 100 megabits per second while a user is physically moving at high speeds and a one gigabit per second data rate in a fixed position” [5]. From this perspective, it is important for the new data network to meet the expected demand of the consumer and of different industries, which have come to depend upon high-speed data networks with minimal interruptions for a variety of needs.

A. Cost and Affordability

In terms of 4G Network cost and affordability, there are a number of issues to consider that reflect some degree of risk, as well as opportunity, so that these networks are successful once rolled out to the general public, and in general, 4G Networks are designed in order to create an environment that supports high-speed data transmission and increased profit margins for organizations that utilize these capabilities [2]. Developing a successful 4G Network platform is a positive step towards the creation of a wireless and broadband environment that possesses rapid transmission speeds, data integrity modules, and other related events that encourage users to take additional risks in promoting successful utilization of these 4G tools.

B. Capabilities and Features

Although the 4G Network platform is not brand new, many telecommunications providers have not yet developed their own alternatives that will support this network in full. Therefore, 4G-related products are still in the development phase, with additional products to be developed and rolled out on a periodic basis. With the creation of these alternatives, it is likely that 4G Networks will continue to expand their scope and promote their own brand of personalization for consumers that seek these types of alternatives [16]. In general, the possibilities associated with 4G Networks are endless, as high-speed data transmission and associated capabilities are more feasible than ever. This supports the notion that the demand for more complex networks and related capabilities are stronger than ever, as a greater number of consumers continue to buy into the potential that exists with advanced networks, such as 4G.

With the appropriate combination of resources, it is possible for 4G Networks to create alternatives that exceed consumer and industry expectations. Therefore, 4G developers must consider the appropriate security measures, the promotion of high-speed data transmission across the network, and must also consider the ways in which data quality and integrity might be preserved in order to provide the most satisfactory results.

This 4G is intended to replace the current 3G systems within few years. The ambitious goal of 4G is to allow everyone to access the Internet anytime and everywhere. The provided connection to Internet will allow users to access all type of services including text, databases, and multimedia. 4G, unlike 3G, is IP based, that is every user connected to the Internet will have an IP address. This feature makes it easier to integrate the infrastructure of all current networks and consequently will it easier for users to access services and applications regardless of the environment. 4G will also provide higher bandwidth, data rate, lower authentication overhead, and will ensure the service is constantly provided to the user without any disruption.

Another key feature of 4G networks is high level of user-level customization. That is, each user can choose the preferred level of quality of service, radio environment, etc. Accessing 4G networks will be possible virtually by using any wireless device such as PDAs, cell phones, and laptops. Figure 1 illustrates elements and techniques to support the adaptability of the 4G domain

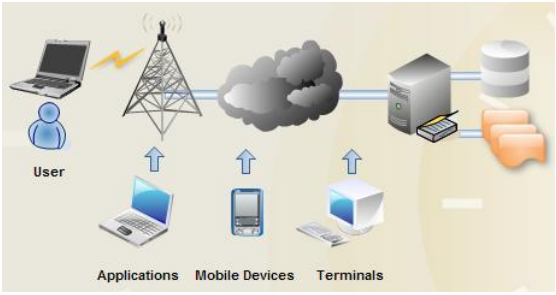

Figure 1: 4G will allow everyone to access the Internet from everywhere using almost any wireless device

VI. NEW CHALLENGES

A. Security and Privacy

In the development of 4G Networks, security measures must be established that enable data transmission to be as safe as possible. Specifically, "The 4G core addresses mobility, security, and QoS through reuse of existing mechanisms while still trying to work on some mobility and handover issues" [3]. Therefore, it is necessary for the organization to develop an effective series of tools that support maximum 4G security measures as a means of protecting data that is transmitted across the network from hackers and other security violations. Because of the nature of the 4G network, there is an increased likelihood of security attacks, and therefore, multiple levels of security, including increased requirements for authentication, will be necessary to protect data and information that is transmitted across the network [3].

One of the main goals of G4 networks is to blanket very wide geographic area with seamless service. Obviously, smaller local area networks will run different operating systems. The heterogeneity of these wireless networks exchanging different types of data complicates the security and privacy issues. Furthermore, the encryption and decryption methods being used for 3G networks are not appropriate for 4G networks as new devices and services are introduced for the first time in 4G networks. To overcome these security and privacy issues, two approaches can be followed. The first is to modify the existing security and privacy methods so that they will be applicable to heterogeneous 4G networks. Another approach is to develop new dynamic reconfigurable, adaptive, and lightweight mechanisms whenever the currently utilized methods cannot be adapted to 4G networks [14].

B. Quality of Service

With respect to network quality, many telecommunications providers are promising that there will be enhanced connectivity, and the quality of data that is transmitted across the network will be of the highest possible quality, as in the case of Ericsson's 4G

Network for TeliaSonera [7]. The company promises that "The new 4G network will do for broadband what mobile telephony did for voice. With real-time performance, and about 10 times higher data rates compared to today's mobile broadband networks, consumers can always be connected, even on the move" [7]. As a result, it is important for providers to develop an effective approach to the 4G Network that will enhance quality, provide effective security measures, and will ensure that all users are provided with extensive alternatives for downloading video, music, and picture files without delays.

The main challenge that 4G networks are facing is integrating non-IP-based and IP-based devices. It is known that devices that are not IP address based are generally used for services such as VoIP. On the other hand, devices that are IP address based are used for data delivery. 4G networks will serve both types of devices. Consequently, integrating the mechanisms of providing services to both non-IP-based as well as IP-based devices is one of key challenges 4G networks have to address [17, 19].

C. Complex Architecture

- *Multimode End-User Terminals*

To reduce operating costs, devices that operate on 4G networks should have the capability to operate in different networks. This will not only reduce the operating cost but will also simplify design problems and will reduce power consumption. However, accessing different mobile and wireless networks simultaneously is one of the major issues 4G networks have been addressing. One mechanism that has been proposed to handle this problem is termed "multi-mode devices". This mechanism can be achieved through a software radio that allows the end-user device to adapt itself to various wireless interfaces of the networks. Figure 2 shows an example of such solution

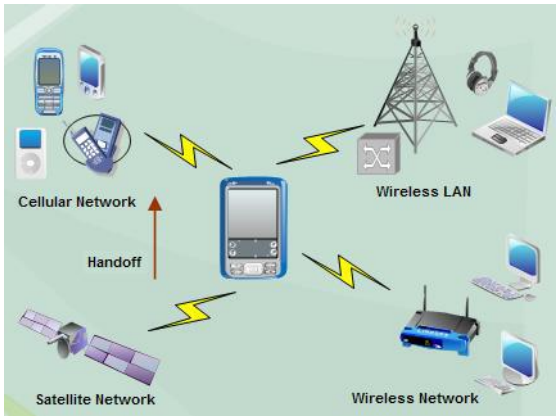

Figure 2:Multimode End User

- *System Discovery and Selection*

Due to the heterogeneity of 4G networks, wireless devices have to process signals sent from different systems, discover available services, and connect to appropriate service providers. Various service providers have their own protocols which can be incompatible with each other as well as with the user's device. This issue may complicate the process of selecting the most appropriate technology based on the time, place and service provided, and thus, may affect the Quality of service provided to the end user.

One solution to resolve this issue is called "System-initiated discoveries". This mechanism allows automatic download of software modules based on the wireless system the user is connected to [12]. Another approach to handle this problem is based overlay networks. In such case, the end-user device is connected to different networks through an overlay network. The overlay network performs all necessary tasks such as protocol translation and Quality of service negotiation as depicted in Figure 3.

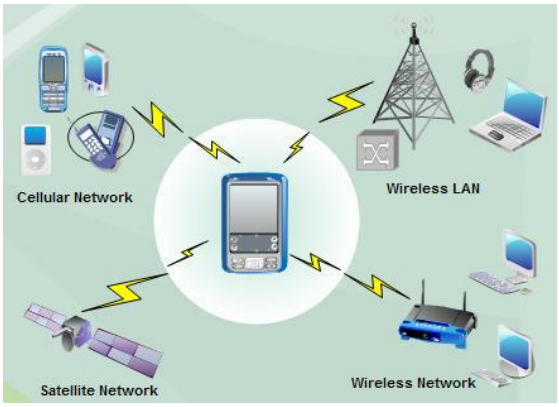

Figure 3: Automatic system discovery is one of the features provided by 4G networks

- *Service and Billing*

Managing user accounts and billing them has become much more complicated with 4G networks. This is mainly due to heterogeneity of 4G networks and the frequent interaction of service providers. The research community addressed this concern and proposed several frameworks to handle the customers' billing and user account information [8, 9].

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4G wireless networks not only enable more efficient, scalable, and reliable wireless services but also provides wider variety of services. These opportunities come with a need for rethinking our security, privacy, architect and billing technologies have been used for previous generations. We believe, however, that future research will overcome these challenges and integrate newly developed services to 4G networks making them available to everyone, anytime and everywhere

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