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4 G- FOURTH GENRERATION WIRELESS SYSTEMS REQUIREMENTS AND TECHNICAL CHALLENGES

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ABSTRACT

Fourth generation wireless systems(4G) are likely to reach the consumer market in another few years.4G comes with the promise that it will increased bandwidth, higher speeds ,greater interoperability across communication protocols, user friendly, innovative and secure applications. In this article I list out some requirements of the 4G systems only by considering the needs of the user in the future. These requirements can be applicable if technical and business challenges can be overcome. The technical challenges include mobility management, quality of services, interoperability, high data rate, security, survivability, spectrum, intelligent mobile devices, middleware, and networks access.

Keywords: *4G, 3G, Migration, Wireless, Bandwidth, Security*

1. INTRODUCTION:

In this current world the world is experiencing a huge in the usage of mobile devices and mobile services. The worldwide wireless voice adoption rata in different countries are rapidly increasing with country like Hong Kong and Italy experiencing adoption rate exceeding 100%(2009).Although wireless systems are still primary used for voice communication and the demands for wireless data services are growing quickly. Experts believe that the number of mobile internet subscribers will exceed the number of fixed internet subscribes and will reach 2000* million by 2012[2].At about the same time 75% of the network operators will come data traffic. As the population of the world becomes more technologically and practical knowledgeable, the average annual household expenditure for telecommunication services will continue to rise and will reach 2% of the annual household income by 2015.

Clearly notice that, fixed line services and subscriptions are on the decline and wireless subscriptions are on the rise and becoming fully wireless. The Stat/MDR, a consultancy firm from the USA, estimated that about 29.8% of the wireless communication subscribers in the USA will become "mobile only" by 2012[2]. The research and several developments contributed to increasing popularity of wireless systems.

1) The reducing cost of mobile voice and data services.

2) The fast growing interest in new types of applications that depends on wireless system. Example, such application include mobile financial services, mobile gaming and entertainment services, Mobile healthcare, vehicular mobile commerce, mobile travel guide, mobile inventory management etc…

The above applications are fall under mobile commerce and mobile commerce will continue over the next few year and gain popularity among users. At the same time, the wireless telecommunications infrastructure grew significantly in the last decade. The wireless systems rapidly progressed from the first (1st) and second generation (2G) of system to the third generation systems (3G). Although the 3G system is still being deployed in the several countries, leading telecommunications companies are devoting effort and resources to developing the fourth generation of wireless technology. It is generally accept that 4G wireless systems will overcome the limitations of the existing wireless system that support new applications that are increasing in popularity, provide enhanced content management and delivery using higher bandwidth, support of heterogeneous networks, provide efficient resource allocation for maintenance of quality of

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services (QoS)[3]. 4G wireless system must still overcome several challenges before 4G promises can be delivered to the full satisfaction of future customers.

2. DEFINITION OF 4G

In the current scenario 4G is not clearly defined. However, the earliest version about 4G often called as "linear vision" of 4G is that it will be a super enhanced version of 3G.It means that, an entirely packet switched networks with all digital network elements, and a high speed available bandwidth of 1 Gbps standstill and of 100 Mbps in motion. This view is much more prevalent in Asia than other place in world. Another definition of 4G often called as the" concurrent vision" of 4G is that it will be a convergent platform that consist of heterogeneous network and the heterogeneous system[3.4]. This view is more relevant in Europe. The 4G consists of 5 key elements:

1) Provide fully converged services that allow seamless, secure, and personalized delivery of services to users.
2) Mobile access that transcends different types of networks working on different technological standards.
3) Diverse user devices that is adaptable and intelligent
4) Autonomous networks that provides self-management according to the needs of the users
5) Dependency on mobile middleware agents that simplify activities and provide transparency to user.

3. MIGRATION TO 4G

3G was developed in order to reconcile the incompatible standards and to introduce higher data rates.3G allowed better handling of multimedia including voice, data, and video and also provide routing. In 3G system two technical standards are currently in use. They are the CDMA and the WCDMA2000.Moreover the third standard that is being developed by China is known as TDSCDMA.2.5G, 3G technologies promised data transfer up to 384 Kdps a 2Mbps respectively but the average output per user is not excepted to be more than171 Kbps in busy hours. This speed ju8st can be use to met voice, basic data communication, and wireless internet access [5.6]. It is true that 3G can support multimedia Web-based services at higher speed and quality than 2G/2.5G….moreover ,the current version and deployment of 3G include the following limitation:-
A) Bandwidth allocation for 3G
B) Difficult to support high speed mobile access and to provide various services from narrowband voice to wideband multimedia internet browsing
C) Difficult to support the global roaming across heterogeneous networks like cellular, fixed wireless, satellite etc
D) Difficult to satisfy different QoS and performance requirement due to constraint imposed on the core network by air interface standard
E) Difficult to extend to higher data rates with CDMA due to excessive interference between services

Table 1: Table comparisons of wireless systems

Technology	**2.5G**	**3G**	**4G**
Design start time	1985	1990	2000
Implementation	1999	2002	~2010
Technology	Packet switching	Intelligent signal processing	All-IP based
Standards	GPRS,EDGE	WCDMA,CDMA2000	OFDM
Bandwidth	171-384 kbps	2 Mbps	~100 Mbps
Core network	PSTRN	PSTN, some IP network	Internet
Services	Voice, data	Voice,data, multimedia	Voice data ,content high multimedia

4. REQUIREMENTS FOR 4G

In the past few years wireless systems are being used only for military and scientific communication. As technology become overtime, the need of the user and services also changed, the wireless were design only to carry voice communication .As the internet become more popular users felt the need to access the internet through their mobile devices. This change gave raise to the requirement of data communication through wireless systems. The transformation from 1G to 2G improved qualities of voice communication and 2g to 3G was fueled

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by 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. Downloading and sharing of photos, ring tones, movie clips, patient diagnostic images are all bandwidth intensive activities. Moreover new application are introduce include mobile, television, SMS, MMS and are still popular with user. The data connections through cellular networks provide bandwidth below 100 Kbps and less when the user is inside the building indeed the bandwidth must increase.

B) SEAMLESSACCESS, INTEROPERABILITY AND CONVERGENCE

One of the problems that all users of mobile devices currently face is the lack of seamless access due to unavailability of global standard. It will be great advantages to consumer if any type of mobile device is able to work in any type of networks. For example it ca be Wi-Fi cellular, satellite networks. Interoperability implies that there wills no need of laptop for data analysis, mobile phone for conversation, PDA for checking the user calendar and TV for viewing sports events. Life will become simpler if all the devices converge to a universal mobile device that allows plug and play in any type of networks environment and support all activities that users want [8].

C) QUALITY OF SERVICE

We overcome that current wireless systems do not provide an assurance of quality. Latency is the problems that affect all wireless systems. These problems will become more in future as delay sensitive applications become more common. For example remote telemedicine, prioritization of traffic means provides cost savings is needed in the future wireless systems.

D) EFFICIENT USE OF FREQUENCY SPECTRUM

Frequency is a characteristic of wireless system and techniques like FDMA, TDMA and CDMA allow multiplexing of channel frequency between users to allocate a constraint resource among contending users. But the number of mobile services users is increasing at fast rate as well. Although new frequency bands were released for wireless system, it may not be support such large number pf subscribers. Now more advanced techniques for frequency sharing and channel will be required in the future.

E) MOBILE DEVICES

In the last decade the mobile device is more advanced both for appearance and functionality. For example black and white LCDs gave way to multi-pixel color screens. The weight of mobile decreased, chip and battery design improved and internet access become common everywhere. As the functionality provide but mobile devices are not automatic but user driven.

F) PERSONALIZATION

In future and at present mobile devices will act as an agent to represent the user in all activities such as automatic transaction, billing and mobile devices will demand deeper understanding of the user needs and the 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 include streaming or recorded video or interactive gaming is available in wireless systems. But it usually comes from the same content provider and does not change according to the location and needs of the user. It is to expect that wireless system will allow user more choice from a number of content providers than obviously billing will become more complicated because many network service providers content provider will be involved.

H) SECURITY AND PRIVACY

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

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5. TECHNICAL CHALLENGE FOR 4G SYSTEMS

We all know that several technical issues need to be resolved before practical implementation of 4G. Still research is going on to find a feasible solution to overcome the technical obstruction. In this section describes the various technology related challenges that will faced by 4G systems and possible solution that are current technology to meet these challenges.

A) MOBILITY MANAGEMENT

In 4G systems, mobility may occur in two ways: (1) by the user accessing the network using different devices at different place called "TERMNAL MOBILITY". For example a user may access a video message using a desktop computer at work, a PDA on the road, and a laptop at home. It means that I n terminal mobility the user moves through the networks while accessing the application using the same mobile device. (2) By the user moving from one place to place called as PERSONAL MOBILITY. Personal mobility can be achieved by using the Session Initiation Protocol (SIP). It can help to locate one or more IP address where the user can receive multimedia streams so that the user can change the access device without notifying the callers. The Protocol of choice for terminal mobility is mobile IPv6. In mobile IPv6, each mobile device will have a permanent 'home' IP address and a 'care-of' IP address. In the roaming mode, the call be forwarded to the 'care-of' address and the caller will be notified of this forwarding. Because mobile IPv6 is not design for real time communication, service disruptions are also possible during handoff [9]. The most important aspect of terminal mobility is to provide the capability for seamless vertical handoff when the user move between different wireless systems as well as horizontal handoffs when the user move between cells in 4G.In 4G systems, vertical handoff becomes a necessity due to the coverage nature of the networks. Vertical handoff is complicated because several networks are considered before vertical handoff can take place. The entire problem has to be solved before decision to handoff to a different network can take place.

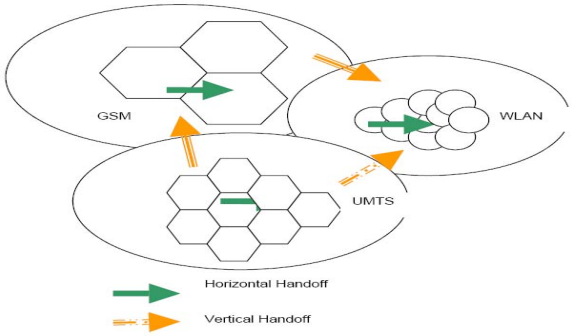

Figure: 4G network showing horizontal and vertical handoff

C) QUALITY OF SERVICES (QOS)

The current version of wireless system can be broadly classified into two categories: non IP based and IP based. With the development of 4G systems, all these networks will converge to a single transparent network. This convergence creates a QoS challenges because wireless system will have different properties such as bit rates, channel, bandwidth allocation and hand off support. The important component of QoS assurance is resource allocation. Since 4G system will need to accommodate different typed of users and application with different QoS needs the appropriate allocation of networks resources will be quite challenging. A possible solution is the presence of network resource manager that monitor the utilization of the network on an end to end or link by link basis and allocate the bandwidth on as needed [10]. The network resource manager will be complemented by al the call admission control manager who will issues global information about all available and in use resources and will have the ability to grant or refuse connections based on the condition of the network.

D) SECURITY

The current existing security schemes for 2G and 3G networks are inflexible and are not suitable for use in 4G networks consisting of different technologies and devices. In 4G networks, flexible security systems need to be designed. One of the major challenges is that different networks in a 4G system may use different security protocol, which may or may not be compatible. Security handling of a transaction during handoff will be compatible and it is probable that a third party security provider will be used to oversee that security protocol transfer take place smoothly during handoffs. For example, tiny SESAME is a light weight, reconfigurable security mechanism that can provide security services for multimedia application in 4g networks [11].

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E) INTEROPRABILITY

Since, the operator will deploy networks with different multiple standards and protocols, 4G systems will allow interconnection with different networks and provide universal mobility. An all-IP based architecture will be used for 4G systems [11, 12]. For example, ATM backbone networks will be replaced by an all-IP backbone that will handle IP traffic and VoIP calls. The all-IP 4G system will be compatible with all common network technologies. The common all-IP based core network will be commonly accessed by five different layers. The below following points are the include layers include:-

1) Digital broadcast layer for television signals
2) Cellular layer for voice traffic
3) Hot spot layer for data traffic
4) Personal network layer for short range communication between household devices
5) Nomadic layer for private wireless data access

F) HIGH DATA RATE

In order to maintain the high data rates, smart antenna systems have been proposed for 4G wireless systems. Smart antenna systems combine multiple antenna elements with intelligent and powerful signal processing like auto-tracking of desired signal and digital beam forming. Since 4G demand more bandwidth, two additional frequency bands were identified in top of those frequency bands used currently by 2G and 3G mobile systems. One of them is range of 5GHz and other is in the range of 60 GHz. Because the operation of 4G in the higher frequency bands loss propagation increases. This loss can be improved by gaining the smart antenna. In order to achieve good channel conditions, Adaptive Modulation and Coding can be used, to respond to feedback received about channel conditions and allow different data rates to be assigned to different user based on their channel conditions. 4G systems will provide repeated frequency change during a single call. This technique will increase the availability bandwidth because frequencies will be reused more often within an area [13].

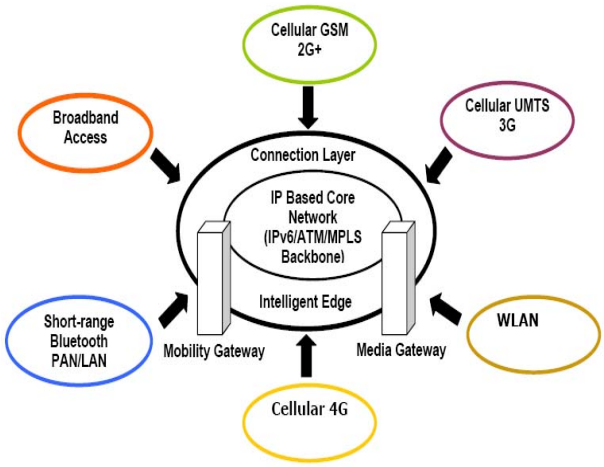

Figure:-ALL-IP Architecture for 4G Networks

G) SURVIVABILITY

4G systems contain more fault tolerance capabilities to avoid unnecessary network failure, poor coverage, and dropped calls. In typical cellular network when any level fails, all levels below it are affected. This condition happen because the network is designed as a tree topology. The 4G network can make use of strategies to reduce the impact of failures. One example is that hierarchical cellular network system or overlapping heterogeneous wireless networks will provide better survivability to 4G systems.

H) SPECTRUM

The allocation frequency spectrum for 4g services is a major problem challenges. The frequency bands in the range of 806-960 MHz and 1710-1885MHz are used by the GSM and PCS systems worldwide. The initial frequency for 3G services includes the 1990-2005 MHz and 2010-2200 MHz bands. We know that in future, as 3G become more popular and the number of subscribers increases. The 4G networks will support a high number of users and high data through rates. Research believe that 4G will operate in high or less congested frequency bands like 5GHz and 60GHz[14].In future we will need a close integration between the spectrum allocation operating worldwide in order to satisfy all parties and the frequency bands allocated that are known to design immediately.

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I) INTELIGENT MOBILE DEVICES

In 4G the mobile device to be used will be much more sophisticated than the ones currently used. It will be used in both the sender and the receiver ends. The most important component device will be the smart multiple antennas that use three techniques:-

1) Diversity:-means that the antenna will be widely separated from one another in order to supported channel be independently, this kind of antenna is necessary for smart antennas in order to handle complex handoffs.
2) Beam forming: - It means that the antenna will be able to combine signals when they received or transmit so that they are directed in a right direction. It will help in establishing better connections and will allow the device to ensure the existing QoS of a connection.

3) Spatial multiplexing:- It means that it allow better utilization of bandwidth by allowing parallel transmission of data from the different at the same time. This arrangement is often called multi-input-multi-output (MIMO). For 4G application MIMO will be necessary to support the high data rate

J) MIDDLEWARE

Research defines middleware as "an enabling layer of software that is used by application developers to connect their application with different operating systems and operating systems and mobile networks without introducing mobile awareness in application. The middleware in 4G will be advanced and will allow reconfigured of the networks according to the needs of the user or the connection. It is possible to serve multiple purposes such as accepting new connections, providing QoS to existing connections, creating new topologies and discovering services and providers of those services [13, 14]. Finally middleware will plays a very important role in security management by controlling location privacy of users, end-to-end security of a connection and protection of metadata related to users and services providers.

K) NETWORKS ACCESS

In 4G systems the mobile devices will need to access multiple networks such as fixed wireless networks, WLAN, satellite network and cellular networks. In order to access multiple networks it may be necessary to have an overlay network with multiple universal access point. Than the access point will perform a number of functions that include translation of protocols and frequencies, negotiation of QoS for connections, seamless handoffs and between networks. An approach that can be used for network access involves use of common wireless access protocols such as wireless ATM [ref-15]. Whether the network access is controlled by overlay network or the mobile terminal or the common access protocol, the first choice of the access network will be determined by several factors such as accessibility, services capabilities, QoS an the cost.

6. CONCLUSION

We know that 4G is the next generation wireless. It promises and believed to overcome the disadvantages of 3G and the become the true seamless and frontier wireless system. For future purpose before 4G becomes and reality and reach the consumers various and several technical challenges need to be resolved. Still several telecommunication services provider are involved in research related to 4G wireless systems that include AT&T, Hewlett mPackard, NTT, Do Como, Sun Microsystems among others. As research is going on still some doubt and confusions still there in 4G, research believe that increased competition and new applications will be the way for this next generation in wireless systems.

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