Review on NEXT Generation Technologies of Wireless Communication

[1]Mr. Arunabha Debnath, [2]Mr. Abhinandan
[1,2]*VI Semester Student, Department of Electronics and Communication Engineering*
Dronacharya college of Engineering, Gurgaon-123506
arunabhadebnath@ymail.com, abhi.fifa.22@gmail.com

Abstract: -Cellular communication has brought in an unparallel revolution in the field of communication during the past two decades. The mobile communication industry growth has surpassed growth of all other fields. Even our own country is not left behind. The number of mobile subscribers in the country rose to over 911 m in Mar 2012. 3G system has been introduced in line with other countries. Talks have started about 4G / 5G. The implementation of 4G /5G will most probably be the ultimate goal in the field of communication.

Keywords : Mobile communication, 1G,2G,3G,4G, 5G,Satellite Communication.

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1. INTRODUCTION

The ability to communicate with people on the move has evolved remarkably since Marconi first demonstrated radio's ability to provide continuous contacts with ships sailing in English channel in 1897. Since then new wireless communication methods and services have been adopted by people throughout the world. Particularly during the last two decades the wireless communication industry growth has been remarkable. The digital switching techniques,new large scale integration and other miniaturization technologies have been major contributory factors in this regard. 3G has has also been launched in India in line with other countries of the world.There were over 911 m mobile users in India in Mar 2012 (1). This is expected to reach 1b in 2015. As regards mobile users are concerned, India's figures are still low as compared to other advanced countries as can be seen from the table (2)

2. COMPARISON OF 1G TO 5G SYSTEMS

2.1 1G systems

They were analog based and evolved in early 80's. They were called AMPS --- Advanced Mobile Phone System, released in 1983 [3] and employed in North and South America, China, Australia etc.

S.No	Country	Population in m	Mobile users in m	Mobile %
1	China	1341	1010	75.32
2	India	1210	911.68	75.42
3	USA	310	327	104
4	Russia	142	224	154
5	UK	61	75	122
6	Germany	81	107	130
7	Japan	127	121	95
8	Pakistan	178	114	66.5
9	Brazil	192	245	127

Features of 1G Systems

Base station Tx band	869 – 894 M Hz
M U Tx band	824 – 849 M Hz
Channel Bandwidth	30 k hz
No of voice channels	790
No of control channels	42
M U max power	3 W
Cell size radius	2 –20 km
Modulation voice channels	FM
Modulation control channels	FSK

Limitations of 1G systems

It as limited capacity, Low calling capacity, No room for spectrum growth, Poor data communications, Minimal privacy, Inadequate fraud protection.

2.2 2G Systems

They are based on digital technology. They are either TDMA or CDMA based. TDMA is used in GSM (Global System of Mobile Communication).

Features of 2G Systems

Make use of CODEC (compression and multiplex algorithm) to compress and multiplex digital voice data. It can handle more calls per amount of bandwidth vis a vis 1G systems. Hand sets are usually smaller, lighter and more robust. It emits less radio power. It is safer for consumers to use. The battery life of hand-sets lasts longer. It offers additional services like SMS, s and e-mails. The error checking has improved sound quality. There is reduction in noise levels. The digital voice encoding has made calls less susceptible to eavesdropping from third parties due to use of radio scanner. It ensures rapid call set up. It enables talking to number of parties simultaneously. It enables to place a call on hold while one accesses another call. It notifies one of anotyer call whilst on a call Encrypted conversation that can not be easily tapped. It provides ability to use same phone in

number of countries.In GSM - carrier bit rate is 270.8 kbps & speech coding bit rate is 13kbps,Channel Bandwidth 200 k Hz in GSM, 8 users per channel, Mobile Unit max power is 20 w

2.3 3G Systems

The 3G system represents convergence of 2G wireless systems into a single global system. It was first adopted in Japan and South Korea in 2001 and in USA in 2003. It was launched in India in 2008. Upto Mar 2010 , as many as 380 cities had been covered under 3G systems**.**

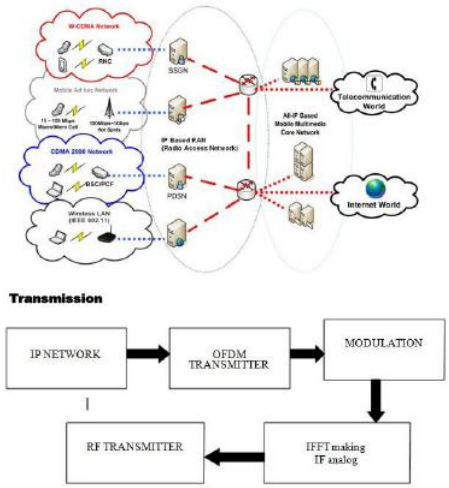
Features of 3G Systems [5]

Enhanced multimedia (voice ,data ,video and remote control), Usability on all popular models (cellular phones , e-mails , pagers , fax , video conferencing and web browsing), Broad bandwidth and high speeds (upwards of 2 MBPS), Bandwidth 5 – 20 Mbps, Access WCDMA / CDMA 2000, Frequency Band 16 – 25 G Hz, Component Design -- Optimised antenna multiband adapters, Has both circuit / packet switching, Routing flexibility (repeater , satellite and LAN), International roaming capability, Excellent quality of voice, Applications include: Still photography, video data transmission service, file transfer from internet, multimedia e-mail, Web Browsing, on-line services, time schedules

2.4 4G Network

Figure shows the basic concept of 4g network. The future 4G infrastructure will consist of a set of various networks using internet protocol. As a common protocol so that the users are in control as they will be able to choose every application and environment.(6)

Accessing information anywhere, anytime with seamless connection to a wide range of information, obtaining services, receiving a large volume of information, data, pictures, video and so on are the key of 4G infrastructure.



An OFDM transmitter accepts data from an IP network, converting and encoding prior to modulation .An IFFT(inverse fast Fourier transform) transforms the OFDM signal into an IF signal, which is sent to RF transmitter. With orthogonal sub-carriers, the receiver can separate and process each sub-carrier without interference from other sub-carriers. OFDM provides better link and communication quality. It is more impervious to fading and multi-path delays than other transmission techniques.

Architecture in prospects

End-to-end Service Architectures for 4G Mobile Systems:-(7)

A characteristic of the transition towards 3G systems and beyond is that highly integrated telecommunications service suppliers fail to provide effective economics of scale. This is primarily due to deterioration of vertical integration scalability with innovation speedup. Thus, the new rule for success in 4G telecommunications markets will be to provide one part of the puzzle and to cooperate with other suppliers to create the complete solutions that end customers require. A direct consequence of these facts is that a radically new end-to-end service architecture will emerge during the deployment of 3G mobile networks and will became prominent as the operating model of choice for the Fourth Generation (4G) Mobile Telecommunications Networks. This novel end-to-end service architecture is inseparable from an equally radical transformation of the role of the telecommunications network operator role in the new value chain of end service provision. In fact, 4G systems will be organized not as monolithic structures deployed by a single business entity, but rather as a dynamic confederation of multiple sometimes cooperating and sometimes competing-service providers.

End-to-end service architectures should have the following desirable properties:

• Open service and resource allocation model.
• Open capability negotiation and pricing model.
• Trust management. Mechanisms for managing trust relationships among clients and service providers, and between service providers, based on trusted third party monitors.
• Collaborative service constellations.
• Service fault tolerance.

Middleware Architecture:-

The service middleware is decomposed into three layers; i.e. user support layer, service support layer and network support layer(8). The criteria on for using a layered approach are to reuse the existing subsystems in the tradition al middleware. The user support layer has autonomous agent aspects that traditional service middleware lacks. It consists of 4 sub-systems: ‘Personalization’,‘Adaptation’, ‘Community’ and

'Coordination', to provide mechanisms for context awareness and support for communities and coordination. Introduction of this functional layer enables the reduction of unnecessary user interaction with the system and the provision of user centric services realized by applying agent concepts, to support analysis of the current context, personalization depending on the user's situation, and negotiation for service usage.

The middle layer, the service support layer, contains most functionality of traditional middleware. The bottom layer, the network layer supports connectivity for all-IP networks. The dynamic service delivery pattern defines a powerful interaction model to negotiate the conditions of service delivery by using three subsystems:

'Discovery & Advertisement',' Contract Notary' and 'Authentication & Authorization'.

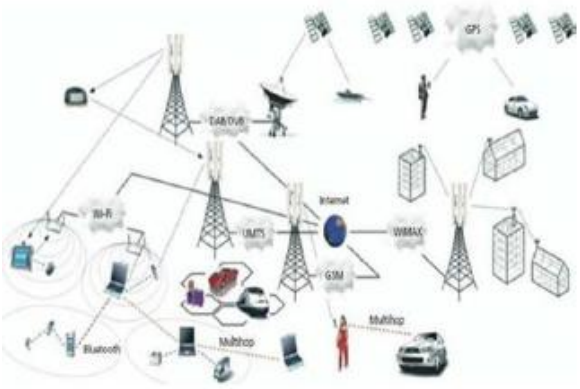
Network Architecture:-

It is clear that more fundamental enhancements are necessary for the very ambitious throughput and coverage requirements of future networks. Towards that end, in addition to advanced transmission techniques and antenna technologies, some major modifications in the wireless network architecture itself, which will enable effective distribution and collection of signals to and from wireless users, are sought. The integration of "multihop" capability into the conventional wireless networks is perhaps the most promising architectural upgrade. In a Multihop network, a signal from a source may reach its destination in multiple hops (whenever necessary) through the use of "relays". Since we are here concerned with infra structure-based networks, either the source or destination is a common point in the network base station (or, access point, in the context of WLANs).

The potential advantage of relaying is that it allows substituting a poor-quality (due to high path loss) single-hop wireless link with a composite, two or more hop, better-quality link whenever possible. Relaying is not only efficient in eliminating black spots throughout the coverage region, but more importantly ,it may extend the high data rate coverage range of a single BS ; therefore cost effective high data rate coverage may be possible through the augmentation of the relaying capability in conventional cellular networks.

Advantages:-

• Property owners can install their own access points.
- Spreads infrastructure cost.
•Reduced network access operational cost:
- Access points configure into access network.
- Some access points may be moving (bus, train)
• Multihop also could reduce costs in heterogeneous 3G networks.



e.g. of Heterogeneous network

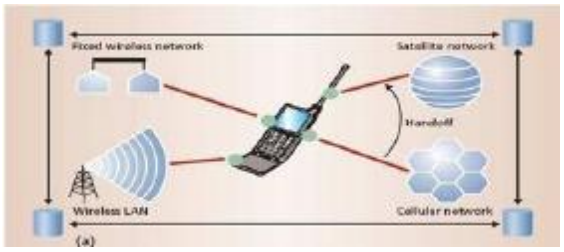
Overlay network:-

In this architecture, a user accesses an overlay network consisting of several universal access points (UAP). These UAPs in turn select a wireless network based on availability, QoS specifications, and user defined choices. A UAP performs protocol and frequency translation, content adaptation, and QoS negotiation-renegotiation on behalf of users .The over lay network, rather than the user or device, performs handoffs as the user moves from one UAP to another. A

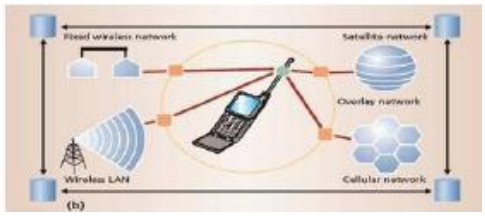
UAP stores user, network, and device information, capabilities, and preferences

.Because UAPs can keep track of the various resources a caller uses; this architecture supports single billing and subscription.

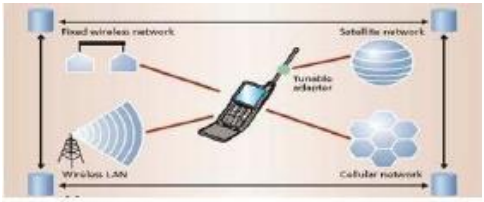
(a)A multimode device lets the user, device, or network initiate handoff between networks without the need for network modification or interworking devices.



(b)An overlay network consisting of several universal access points (UAPs) that store user, network, and device information—performs a handoff as the user moves from one UAP to another.



(c)A device capable of automatically switching between networks is possible if wireless networks can support a common protocol to access a satellite-based network and another protocol for terrestrial networks.



Attempts are already underway to provide the ultimate in wireless communication. Developments have been made by Japanese Company DoCoMo , Samsung and Apple Inc. 4G is expected to be operational by 2012 and is described as MAGIC (6) which means

M Mobile Multimedia
A Anytime Any-Where
G Global Mobility
I Integrated Wireless Solution
C Customised personal Service

Objectives of 4G

Inexpensive wireless broadband access for cost-conscious consumers and businesses will be a complete replacement for current networks and be able to provide a comprehensive and secure IP solution where voice, data, and streamed multimedia can be given to user on an "Anytime, Anywhere" basis, and at much higher data rates than previous generation.A nominal data rate of 100 Mbit/s while the client physically moves at high speeds relative to the station, and 1 Gbit/s while client and station are in relatively fixed positions as defined by the ITU-R, A data rate of at least 100 Mbit/s between any two points in the world, Smooth handoff access, Seamless connectivity and global roaming, High QoS(quality of service), IP , packet switched based network, Compatibility with all existing network types, Peak link spectral efficiency of 15bit/s/Hz in downlink and 6.75bit/s/Hz in uplink, System spectral efficiency of up to 3bit/s/Hz/cell in downlink and 2.25bit/s/Hz/cell for indoor usage, Adaptive processing and smart antennas will be used. To make use of OFDM (orthogonal frequency division multiplexing). This will not only enhance spectral efficiency but also result in high resiliency to RF interference and lower multi- path distortion.

Benefits of 4G:

Virtual presence --- will give mobile users a virtual for example ,on connections to keep people on event. Visualised virtual navigation --- a remote database will contain graphical representation of streets ,buildings and physical characteristics of a large meteropolis. Blocks of databases will be transmitted in rapid sequence to the vehicle. Teleprocessing --- Queries dependent on location information of several users in addition to temporal aspects have applications like crises management, life saving telemedicine, VOIP for ipv6. Will provide comprehensive and secure all IP based solution involving facilities such as IP telephony,ultra-broadband internet access, gaming services.

2.5 5G Systems

Developments are not only underway on 4G systems but key concepts for 5G systems have also been framed. It is expected to be launched by2020.

Key concepts of 5G systems

One unified global standard, Peak download /upload speeds more than 1 Gbps, Real wireless world with no more limitations with access and zone issues, Internet Protocol Version (IPV6) where a visiting care of mobile IP address is assigned according to location and connected network. Multiple concurrent data transfer path, Cognitive Radio Telephony----- Also known as Smart- Radio allowing different radio technologies to share spectrum efficiently by adaptively finding unused spectrum and adopting the transmission scheme to the requirements of the technologies currently sharing the spectrum. To provide High Altitude Stratospheric Platform Station (HASP System), To make use of Beam Division Multiple Access (BDMA) and group co-operative relay technique. To ensure .user could be simultaneously connected to several technologies and seamlessly move between them. Up to 4G, the wireless evaluation is following path of Moore's law. The newer generations were identified by increased bit rate (2G (9.6 Kbps) to 4G (1 Gbps)). There is belief that, 5G will be generation will defy the Moore's law and it will be phase of integration of network technologies, rather expansion or evaluation of new wireless standard. As discussed 4G network should fulfill the promise of providing adequate RF coverage and capacity of high volume data applications and acceptable latency for voice applications. Beyond 4G, there will no need of new access technology as 4G technology (as promised) will convert each mobile connection into Broadband connection. Thus telecom operators will invest in developing new Applications rather than developing newer wireless standards. New network applications will be developed to integrate various engineering practices as mechanical, health care, Chemical, Banking etc. to provide seamless, continual and versatile mobile experience to user. Telecom operators will be moving to customer centric approach then technological approach as they are currently using.

Future in 5G

5G would be about "ubiquitous computing", that is, having the ability to access the applications we want from any platform, anywhere, anytime. To create such an environment, one needs to integrate various applications, emerging from various engineering practices. Human life

will be surrounded by intelligent sensors, which will bring radical change in human life's daily approaches of doing things, as:

- Your intelligent car will send SMS to your cell phone, if someone tries to open the door, while you are away from you car
- Your home security camera is attached to secured internet. So that you can view your sitting room on your laptop/mobile phone screen, by accessing secured website.
- You will have single bill for all telecom services, regardless of application or network operator.
- You will receive regular MMS from your hospital about your medication need and next doctor appointment.(9)

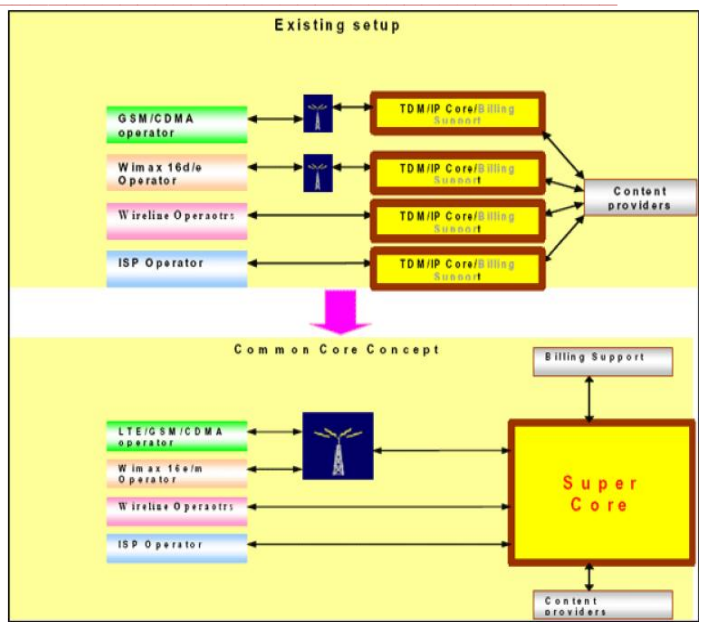
Key Challenges

Integration of various standards: Each engineering practice has their own standard (F.eks Telecom has 3GPP, 3GPP2, ITU, IETF, etc). To integrate these various standards, requires systematic and time consuming approach.

Common Platform: There is no common architecture for interconnecting various engineering practices. One common governing body is required, which creates a common platform for all engineering practices to regularize the interconnectivity issues as well as knowledge sharing.

5G architecture: Super Core concept

Existing telecom networks are fashioned in hierarchical way, where subscriber traffic is aggregated at aggregation point (BSC/RNC) and then routed to gateways. (As shown in figure)(10) . Flat IP architecture will lessen burden on aggregation point on traffic will directly move from Base station to Media gateways. When transition from legacy (TDM, ATM) platforms to IP will be concluded (Flat Network concept, described in previous section) a common ALL IP platform will be emerged. Vision of Super Core is based on IP platform. All network operators (GSM, CDMA, Wimax, Wireline) can be connected to one Super Core with massive capacity. This is realization of single network infrastructure. The concept of Super Core will eliminate all interconnecting charges and complexities, which is right now network operator is facing. It will also reduce number of network entities in end to end connection, thus reducing latency considerably.



CONCLUSION

As data traffic has tremendous growth potential, under 4G existing voice centric telecom hierarchies will be moving flat IP architecture where, base stations will be directly connected to media gateways . 5G will offer even more flatter architecture by using advanced semiconductor technologies as 22mN CMOS. 5G will promote concept of super core, where all the network operators will be connected one single core and have one single infrastructure, regardless of their access technologies.

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