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Comparision of 3G Wireless Networks and 4G Wireless Networks:

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Abstract

By examining the two papers on 4G and 3G, namely wireless networks: opportunities and challenges by Hassan Gobjuka, Verizon, 919 hidden bridge irving, Tx 75038 and wireless network: opportunities and challenges emphasis us to throw light on the differences between the two networks. This task is being done in order to list out the drawbacks and merits of these two evolutions of the networks and further to implement R&D research to bring out their sparks in this modern era.

The differences are done on the following Index terms: Background difference, definitions, technologies progress, speed/ rate of transmission, switching technologies used, network, band width, design specification, QoS, service and billing, features and capabilities.

Keywords: RAN, SONET, UTRAN, FLASH OFDM, CORE NETWORK,SGSN

1. Introduction:

3G is also called third generation. It is named as such because it is the third generation of the standards of telecommunication hardware. It is also the general technology for mobile networking, passing the recent 2.5G. The technology is founded on the ITU or International Telecommunication Union group of standards which belongs to the IMT-2000.

4G is the fourth generation of mobile phone mobile communications standards. It is a successor of the third generation (3G) standards. A 4G system provides mobile ultra-broadband Internet access.

2. Background difference:

In 3g technology which is founded on the ITU or International Telecommunication Union group of a standard which belongs to the IMT-2000 use W-CDMA technology. It allows operators to provide users a bigger range of the latest services, as it gets bigger network capacity via heightened spectral efficiency. The included services are video calls, wide-area wireless voice telephone and broadband wireless information all included within the mobile environment. Whereas 4G technology which was started within cable television industry in 2009 which make users to explore new downloading speeds and capabilities. The utilization of LTE mobile broadband technology is an opportunity for the corporation to expand its horizons into 4G territory, upstaging current 3G capabilities. The necessity for 4G networks is associated with the increased utilization of data websites such as You Tube and Facebook, which require tremendous bandwidth in order to be used successfully.

2.1 3G stands for 3rd generation while 4G stands for 4th generation:

3G is currently the world's best connection method when it comes to mobile phones, and especially mobile Internet. 3G stands for 3rd generation as itÂ is just that in terms of the evolutionary path of the mobile phone industry. 4G means 4th generation. This is a set of standard that is being developed as a future successor of 3G in the very near future.

Architectural difference: both the Figures below provide the key components of these two architectures.

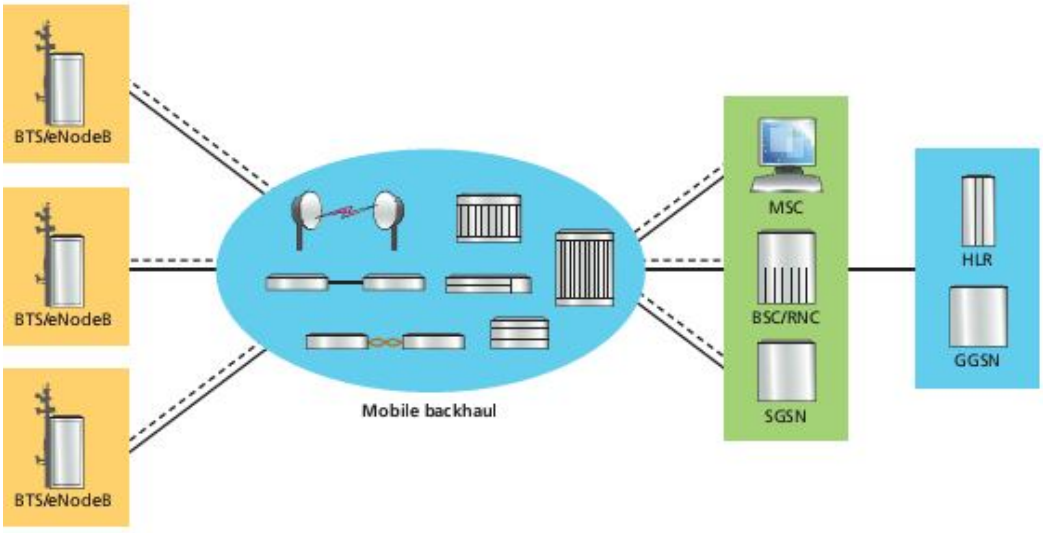

Fig: 1 3G architechture

Several key differences in a LTE network enable more flexibility in its architecture than in a 3G . A functional representation of 3G network architecture is shown in Figure 1. In this network, the Base Terminal Station (BTS)/NodeBs aggregate the radio access network (RAN) traffic and transport it over a mobile

backhaul network to the Radio Network Controllers (RNCs)/Base Station Controller (BSCs). Typically this transport is over T1/E1 copper facilities. If fiber is available at or near the cell site, then the cell traffic is transported over SDH/SONET rings or, more recently, a carrier Ethernet network when the eNodeBs are equipped with IP/Ethernet interfaces. The bearer traffic from a number of RNCs/BSCs is multiplexed at the Mobile Telephone Switching Office (MTSO) and then transported via direct tunneling to the Gateway GPRS Serving Nodes (GGSNs) in the hub data center. This transport is normally over a SDH/SONET ring or a carrier Ethernet network. This tiered aggregation and transport structure lends itself to a point-to-point network topology to minimize both the amount of aggregation equipment required and the transport backhaul expense.

In a 3G pre-Release 8 network, the RNCs and SGSNs are designed to support both the signaling and bearer plane processing and bandwidth requirements. The emphasis in the design for these network elements is in providing the processing necessary to support the high subscriber counts and Packet Data Protocol PDP contexts as the bandwidth requirements for delivery of the initial 3G data services (text and e-mail) were not significant. Since the data services that typically ran over these systems is not real-time neither QoS or latency was an issue. Therefore, the placement of these elements is usually in locations that primarily meet the PDP context and network latency requirements. Thus, the current 3G packet core architecture is typically a centralized network design with the GGSNs deployed in major data centers, and all the data services are backhauled from the SGSNs which are strategically deployed in regional serving offices. Because the aggregate bandwidth for these services did not increase significantly until the past few years, the backhaul transport costs were manageable and could be supported with leased TDM or lower rate OC-n/STM-n interfaces.

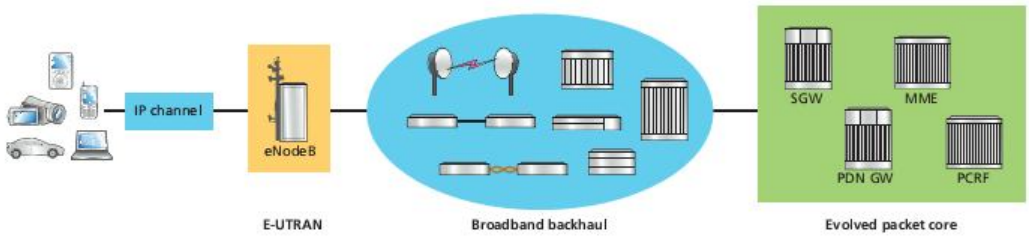

Fig2: 4G architechture

Above fig.2 provides a high-level functional representation of a LTE/4G network. This network is composed of three major sub-networks: the Evolved Universal Terrestrial Radio Access Networks (eUTRAN),which provides the air interface and local mobility management of the user equipment (UE), the evolved packet core (EPC), and the broadband backhaul network that provides the aggregation of cell traffic and transport back to the EPC. The 3GPP LTE standards defined the EPC as a set of logical data and control plane functions that can be implemented either as integrated or as separate network elements. The four EPC functions are: the Serving

Gateway (SGW), the Packet Data Network Gateway (PGW) that supports the data or bearer traffic; and the Mobility Management Entity (MME) and the Policy Charging and Rules Function (PCRF) which support the dynamic mobility management and policy control traffic. The backhaul network either is owned by the wireless operator or is leased from a third party backhaul access provider. Any number of transport technologies can be used for backhaul including packet microwave, packet optical, Carrier Ethernet, IP/MPLS, GPON and xDSL.

3. Network.

3G technologies are in widespread use while 4G compliant technologies are still in the horizon:

The biggest difference between the two is in the existence of compliant technologies. There are a bunch of technologies that fall under 3G, including WCDMA, EV-DO, and HSPA among others. Although a lot of mobile phone companies are quick to dub their technologies as 4G, such as LTE, WiMax, and UMB, none of these are actually compliant to the specifications set forth by the 4G standard. These technologies are often referred to as Pre-4G or 3.9G.

3.1 4G speeds are much faster compared to 3G:

4G speeds are meant to exceed that of 3G. Current 3G speeds are topped out at 14Mbps downlink and 5.8Mbps uplink. To be able to qualify as a 4G technology, speeds of up to 100Mbps must be reached for a moving user and 1Gbps for a stationary user. So far, these speeds are only reachable with wired LANs. The fourth generation is faster, it is said to be four times faster than its predecessor. This allows for a connection speed more comparable to DSL and home cable networks. It is great news for those completing work and accomplishing important tasks away from their home and office. When uploading large documents and communicating via the internet, a fast connection is important. Whereas 3g doesn’t favour such speed as compared to that of 4G.

3.2 3G is a mix of circuit and packet switching network while 4G is only a packet switching network:

Another key change in 4G is the abandonment of circuit switching. 3G technologies use a hybrid of circuit switching and packet switching. Circuit switching is a very old technology that has been used in telephone systems for a very long time. The downside to this technology is that it ties up the resource for as long as the connection is kept up. Packet switching is a technology that is very prevalent in computer networks but has since appeared in mobile phones as well. With packet switching, resources are only used when there is information to be sent across. The efficiency of packet switching allows the mobile phone company to squeeze more conversations into the same bandwidth. 4G technologies would no longer utilize circuit switching even for voice calls and video calls. All information that is passed around would be packet switched to enhance efficiency.

3.3 Network:

Another difference between the two is the network. When the 3G was introduced, cell phone users were finally able to talk and access data at the same time and with higher data rates. This allowed for a better full service for cell phone users wishing to access the internet. And what is even greater is the 4G data rates are expected to be even higher. Users will have the capability of accessing more data at higher speeds while talking on their cell phone. In addition, the fourth generation permits more data transmission of such services as games and multimedia. It also allows a larger amount of internet support.

3.4 Bandwidth:

The next difference between the third and fourth generation to is bandwidth. At first glance, the bandwidth of both 3G and 4G are the same, numbered at between 5 and 20 MHz. However, the rate of data is what makes the difference between the two. While the data rate of the third generation only goes up to 2 Mbps, the fourth goes all the way up to between 100 Mbps to 1 Gbps.

4. Design specification:

The 3G technology provides both circuit design and packet design. Circuit design, being the oldest, has greater ability to hold the connection for a longer duration. On the other hand the packet design is a wireless technology and is the core part of internet data transmission. The combination of these two patterns helps 3G technology to perform better and faster. However, the 4G technology is kept free from circuit design with an intention to gives nanosecond wings to data transfer and so has packet design only.

4.1 Data transmission rate (performance delivered):

3G system is based on wideband CDMA that operates in 5 MHz of bandwidth and can produce download data rates of typically 384 kb/s under normal conditions and up to 2 Mb/s in some instances.3g phone standards have been expanded and enhanced to further expand data speed and capacity. The WCDMA phones have added high speed packet access (HSPA) that use higher level QAM modulation to get speeds up to 21 or 42 Mb/s downlink (cell site to phone) and up to 7 and/or 14 Mb/s uplink (phone to cell site).whereas in 4G also known as LTE uses a completely different radio technology. Instead of CDMA, it uses orthogonal frequency division multiplexing (OFDM) and OFDM access. This modulation technique divides a channel usually 5, 10 or 20 MHz wide into smaller subchannels or subcarriers each 15 kHz wide. Each is modulated with part of the data. The fast data is divided into slower streams that modulate the subcarriers with one of several modulation schemes like QPSK or 16QAM. It also defines multiple input multiple output (MIMO) operation that uses several transmitter-receiver-antennas. The data stream is divided between the antennas to boost speed and to make the link more reliable. Using OFDM and MIMO lets LTE deliver data at a rate to 100 Mb/s downstream and 50 Mb/s upstream under the best conditions. In 4G the theoretical upper data rate is 1 Gb/s. That remains to be

seen in practice.

4.2 Quality of service:
In 3G, network based Qos depends on following factor to provide a satisfactorily service as: Throughput, Packet Loss Rate, Packet Loss Rate, reliability and delay. Where as in 4G 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. 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.

4.3 Service and Billing:
3G networks that are capable of supporting an ever-increasing variety of data services from streaming video, to gaming, to proprietary business applications, to mobile commerce transactions for tangible goods and services. However, as 3G finally makes it into the mainstream, its success is inextricably linked to how the CSPs(Communications Service Providers) charge and bill for services in ways that are both intuitive and acceptable to the end user while also being relevant to the CSP's costs and billing capabilities. Where as in 4G 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.

4.4 Features and capabilities:
3G has features with Speed of mobile communication in 3G ranges from 600-800 Kbit/sec.Also it provides high quality wireless sound and facilitates with global roaming. It accommodates distance surveillance and enables mobile TV. Whereas 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 will also provide higher bandwidth, data rate, lower authentication overhead, and will ensure the service is constantly provided to the user without any disruption.
Table 1: comparison between 3G and 4G.

Specifications	3G	4G
Frequency Band	1.8 – 2.5 GHz	2 – 8 GHz
Bandwidth	5-20 MHz	5-20 MHz
Data rate	Up to 2Mbps	20 Mbps or more
Access	Wideband CDMA	Multi-carrier – CDMA or OFDM(TDMA)
FEC	Turbo-codes	Concatenated codes
Switching	Circuit/Packet	Packet

Table2: Comparison in brief:

Attributes ↓	3G	4G
Data Throughput:	Up to 3.1mbps	3to5mbps but potential estimated at a range of 10 to300 mbps.
Peak Upload Rate:	50 Mbit/s	50 Mbit/s
Peak Download Rate:	100Mbit/s	1Gbit/s
Switching Technique:	packet switching /circuit switch	packet switching, message switching
Network Architecture:	Wide Area Cell Based	Integration of wireless LAN and Wide area.
Services And Applications:	CDMA 2000, UMTS, EDGE etc	Wimax2 and LTE-Advance
Forward error correction (FEC):	3G uses Turbo codes for error correction	Concatenated codes are used for error correctionsin4G.
Frequency Band:	1.8 – 2.5GHz	2 – 8GHz

5. Conclusion

1. For better performance we have to make 3G as IP based which will allow higher data transmission rate.
2. We have to use only packet switching so that we can achieve higher internet speed eliminating circuit switching which makes internet speed slow.
3. To have the better performance we have to use OFDM technology with QPSK and 16 QAM modulation rather than simple QAM modulation technology.
4. The 3G should be integrated with the IP based technology so that it can have the tremendous data transmission and support VoIP as well.
5. We have to increase the band width of the 3G networks by using technology such as orthogonal frequency division.
6. If we are able to integrate it with the wireless LAN for better quality of service.
7. At an early stage the Flash-OFDM (Fast low-latency access with seamless handoff orthogonal frequency division multiplexing (Flash-OFDM), also referred to as F-OFDM) system was expected to be further developed into a 4G standard.
8. No source suggests peak download and upload rates of more than the 1 Gbps to be offered by ITU-R's definition of 4G systems. If any further generation appears, and reflects these prognoses, the major difference from a user point of view between 4G and next Generation 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).

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