Analysis of 4G Wireless Technology: Worldwide Wireless Web (wwww)

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ABSTRACT

In today's era wireless services are the most preferred and dominating means of services of the world. The rapid increase in the service is due to the advancement of technology, especially the wireless technology. The worldwide revolution in mobile and internet technology have changed our way of living life. 4G will be the fourth generation of wireless networks, which is expected to dominate the current generations in the coming decades. In today's technology of mobile networks and wireless systems most users are using 3G, which is the 3rd generation of mobile networks and almost every single user is enjoying this wonderful wireless technology. But a true confess is that most users are already waiting for the next generation of mobile networks, which is called 4G. This paper gathers and reviews the emerging 4G wireless technology which is coined as Worldwide
Wireless Web (wwww)

***Keywords**: wwww, 4G, Worldwide Wireless Web, Dynamic Adhoc Wireless Networks (DAWN), Small Cells or Millimetre Wave Links, Cloud Radio Access Network (C-RAN), Wireless Local Area Network (WLA,), Wireless Metropolitan Area*
Network (WMAN), Wireless Personal Area Network (WPAN)

1 Introduction

In modern era of communication diverse types huge of devices are in use. In early 1980's radio waves were used as wireless transmission technology. This technology quickly drew attention of masses and was wide spread facility for voice call. The feature that lacked in this technology was ―unavailability of data transfer‖. We can safely call this technology as Pre-Digital Generation of Wireless Communication or short it as 0G (Zeroeth Generation) Technology. We can even classify a new generation as 0.5G where we could observe an improvement in voice clarity [3][4].

Then came 1G technology, which not only provide the voice call facility but allowed the data transfer facility with a maximum speed of 10kbps. 1G used the analog signals as its means of data transfer, whereas its successor 2G used digital signals as means of its communication [1]. 2G served as a revolutionary work done in the field of wireless communication as it provided very good voice clarity and even increased the data transfer speed up to 64kbps. An intermediate 2.5G provided speed of 144kbps [9].

As technology advanced near our time there came 3G which provided facility even for video calls at a data transfer rate of 3 Mbps.

As we proceed to our times the technological advancement of wireless communication moved on to 3.5G which gives us blazing speed up to 14.4 Mbps.

In near future wireless communication technology will move to 4G which can provide streaming of high definition video with speeds up to 100 Mbps.

The aim of this review work is to describe and discuss the emerging technology behind the 4G systems, which is the Fourth Generation of the mobile networks and wireless systems.

The Future of Wireless Networks is 4G – Worldwide Wireless Web (wwww) which aims at providing infinite capability to mobile users with maximum throughput with Wireless-based web applications that include full multimedia capability beyond 3G speeds. In 4G, research is being made on development of World Wide Wireless Web (wwww), Dynamic Adhoc Wireless Networks (DAWN) and Real Wireless World. The most significant technologies for 4G are Wireless Local Area Network (WLAN), Wireless Metropolian Area Network (WMAN), and Wireless Personal Area Network (WPAN) in digital communication. The cellular networks that have provided steady progress in wireless communications capabilities (up to and including 3G) are evolving into new forms that rely increasingly on local communications over short distances (e.g., Small Cells or Millimetre Wave Links, Cloud Radio Access Network or C-RAN). 4G's Long Term Evolution (LTE) networks now incorporate small cells to increase capacity. Most announcements about future 4G network designs include some reference to small cell concepts, albeit at a more advanced level of technology than what is in use today. Recent descriptions of 4G emphasize improvements in network speed and capacity and the introduction of new communications technologies. Speed and capacity will be needed to support the communications of potentially billions of wireless devices [12], from tiny sensors to unmanned aerial vehicles, many of which will connect to each other through the Internet. 4G will combine LTE cellular network and IEEE WiFi standards, supplemented by new technologies. Views diverge on whether 4G will remain within the suite of cellular technologies—a further advance of LTE—or represent a new direction in network architecture with an important role for breakthrough technologies in delivering 4G.

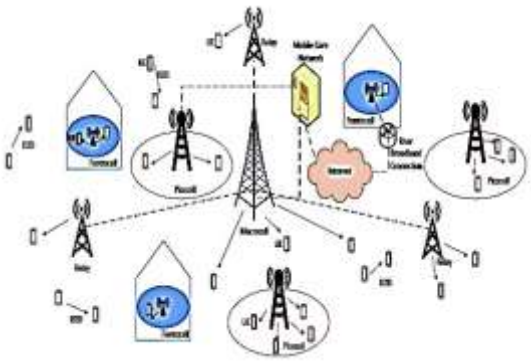

Figure 1: An Example 4G Network

As the take-up of Long Term Evolution (LTE)/4G cellular accelerates, there is increasing interest in technologies that will define the next generation (4G) telecommunication standard. This review work gathers and identifies several emerging technologies which will change and define the future generations of telecommunication standards. Some of these technologies are already making their way into standards such as 3GPP LTE, while others are still in development.

4G technologies will allow high-bandwidth to users to access their phones, and people are also going to experience a much more effective level of call volume and data transmission never experienced before. The services that 4G will offer compared to the present generation of mobile networks can be described as: services in product engineering, documentation, supporting electronic transactions and much more. The supporting electronic transactions can further be describes as e-payments and e-transactions. Another ability and service that 4G will offer is you can use 4G cell technologies to connect your phone to your laptop and the aim of doing this is to earn the broadband internet access [2].

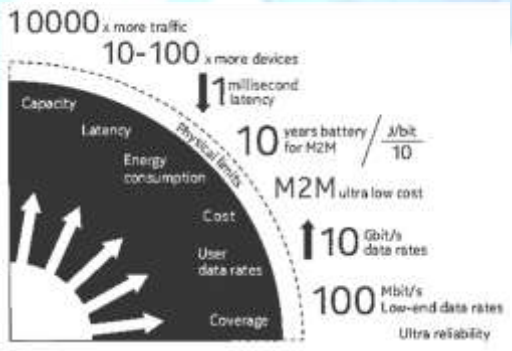

Figure 2: Technological challenges of 4G Networks

Figure 2 demonstrates the challenges that 4G network place and the benefits it is going to offer to all of the users. The challenges of 4G are: capacity (10000 times more traffic and 100 times more devices), latency (the latency reduces), energy consumption (10 years battery for M2M / ((J/bit)/10), cost (M2M ultra low cost), user data rates (user data rates will rise) and coverage (100 Mbit/s Low-end data rates, Ultra reliability).

The most interesting distinguishing factor between 3G and 4G is the data rates. For instance 4G can

For mobile and wireless technologies, the limited spectrum was a challenge. The limited frequency and time are divided to be used among number of users, and because of this condition it is expected to improve the effectiveness to enhance the capacity and the quality of the system. The multiple access systems that are used today consist of:

- Orthogonal Frequency Division Multiple Access (OFDMA)
- Frequency Division Multiple Access (FDMA)
- Time Division Multiple Access (TDMA)
- Code Division Multiple Access (CDMA)

In these multiple access systems, the capacity of a mobile communication system depends on time and frequency. This will be a challenge to develop a similar access system, multiple access system, which is able to resolve the dependencies of capacity to the limited frequency spectrum.

Table 1: Comparison of Generations of Mobile Technologies

Features ↓ / Technology →	1G	2G	3G	4G
Start / Deployment	1970 – 1980	1990 – 2004	2004 – 2010	Now
Data Bandwidth	2 kbps	64 kbps	2 Mbps	1 Gbps
Technology	Analog Cellular Technology	Digital Cellular Technology	CDMA 2000 (1xRTT, EVDO) UMTS, EDGE	WiMax LTE, Wi-Fi
Service	Mobile Telephony (Voice)	Digital voice, SMS, Higher capacity packetized data	Integrated high quality audio, video and data	Dynamic Information access, Wearable devices
Multiplexing	FDMA	TDMA, CDMA	CDMA	CDMA
Switching	Circuit	Circuit, Packet	Packet	All Packet
Core Network	PSTN	PSTN	Packet Network	Internet

support at least 100 Mbps peak rates in full mobility wide area coverage and 1 Gbps in low mobility local area coverage, but 3G can support up to 2Mbps, which is much lower compared to 4G speed. According to the experts, the 5th generation of mobile networks will introduce the real and the perfect world of wireless to us.

A brief comparison of Generations of Mobile Technologies is given in Table 1

2 Requirements of 4G

As can be analysed from Figure 3, the future 4G network shall provide adequate broadband and capacity in order to support the high upload/download speed and peak speed of terminal devices compared with that of 4G. At the same time the total network flow of the entire 4G network will be 1000 times higher than that of current network, so does the total throughput (more than 100 Gbps/km^2).

In addition, the 4G network has to support more accessed devices (ca

100 times) than current accessed mobile devices [11].

3 Heterogeneous Networks: Integration of Small Cells

As the demand for higher data rates increases, one of the solutions available to operators is to reduce the size of the cell. By reducing the size of the cell, area spectral efficiency is increased through higher frequency reuse, while transmit power can be reduced such that the power lost through propagation will be lower. Additionally, coverage can be improved by deploying small cells indoors

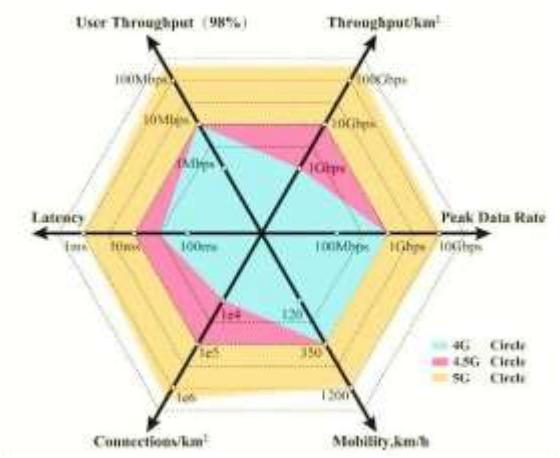

Figure 3: Expected requirements and abilities of 4G

where reception may not be good and offloading traffic from macro cells when required. This solution has only been made possible in recent years with the advancement in hardware miniaturization and the corresponding reduction in cost. Additionally, changes to the functional architecture of the access network allowed data and control signals to tunnel through the Internet, enabling small cells to be deployed anywhere with Internet connectivity. Small cells can have different flavours, with low powered femto-cells typically used in residential and enterprise deployments, and the higher powered pico-cells used for wider outdoor coverage or filling in macro cell coverage holes.

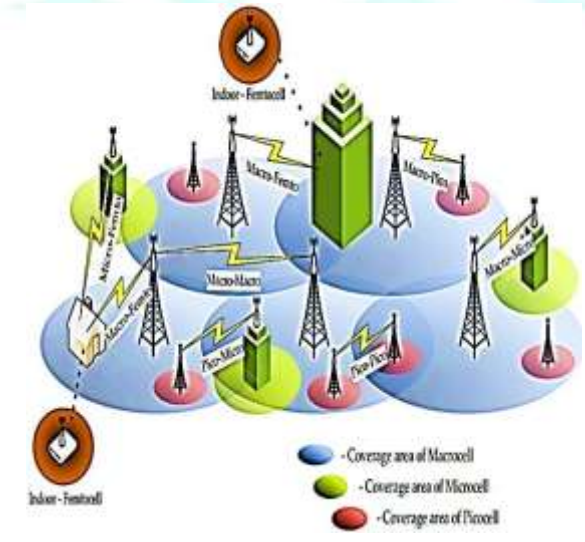

Figure 4: HetNet Topology

The concurrent operation of different classes of base stations, macro-, pico-, and femto- base stations, is known as heterogeneous networks (or HetNets). This is used to provide a flexible coverage area and improve spectral efficiency. Overlaying different classes of base stations can also potentially provide a solution for the growing data traffic, especially when the transport of data is optimized to take advantage of the characteristics of heterogeneous networks. 3GPP has identified various scenarios and requirements for the enhancement of small cells in [3]. Figure 4 depicts HetNet topology.

4 Network Architecture

Figure 5 shows the system model that proposes design of network architecture for 4G wireless systems, which is all-IP based model for wireless and mobile networks interoperability. The system consists of a user terminal (which has a crucial role in the new architecture) and a number of independent, autonomous radio access technologies. Within each of the terminals, each of the radio access technologies is seen as the IP link to the outside Internet world.

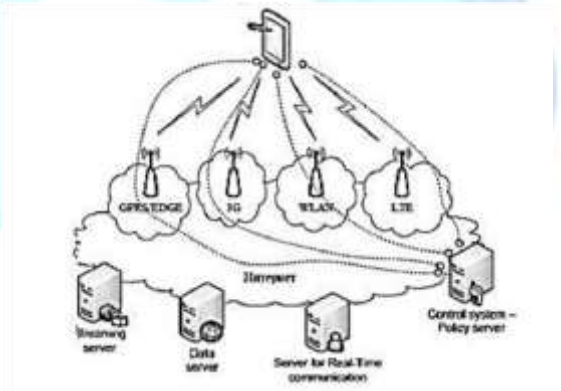

Figure 5: Network Architecture for 4G Wireless Systems

However, there should be different radio interface for each Radio Access Technology (RAT) in the mobile terminal. Routing of packets should be carried out in accordance with established policies of the user. Application connections are realized between clients and servers in the Internet via sockets. Internet sockets are endpoints for data communication flows. Each socket of the web is a unified and unique combination of local IP address and appropriate local transport communications port, target IP address and target appropriate communication port, and type of transport protocol.

5 Millimetre Wave

An obvious way of increasing the throughput will be through bandwidth expansion. However, the available bandwidth below 6 GHz is limited, and re-farming analogue TV spectrum will not sufficiently meet the burgeoning demand. Already, there are efforts to look beyond 6 GHz and also at the millimetre wave frequencies to evaluate their feasibility for use in future networks. However, the characteristics of higher frequencies are not well studied, and measurement campaigns and channel modelling for different scenarios and environments will be required before transmission technologies can be designed for them. It is believed that millimetre wave frequencies hold the most promise, and there are already on-going efforts to make this a possibility. In [5], millimetre wave frequencies of 28 GHz and 38 GHz are extensively studied to understand their propagation characteristics in different environments, paving the way for their use in future wireless systems.

6 Cloud Radio Access Network (C-RAN) architecture

In traditional architecture of cellular networks, users communicate with a Base Station (BS) that is statically assigned to them [6]. Radio and baseband processing units are located close to each other within a few meters range, connected by loss RF coaxial cables. In a distributed architecture known as D-RAN, the base station is divided into radio unit and signal processing unit. Radio unit is called Remote Radio Head (RRH) and performs digital signal processing, digital to analogue conversion, power amplification, filtering and optical conversion. The signal processing part is called Baseband Unit (BBU). Common Public Radio Interface (CPRI) is the radio interface protocol used for data transmission between RRH and BBU.

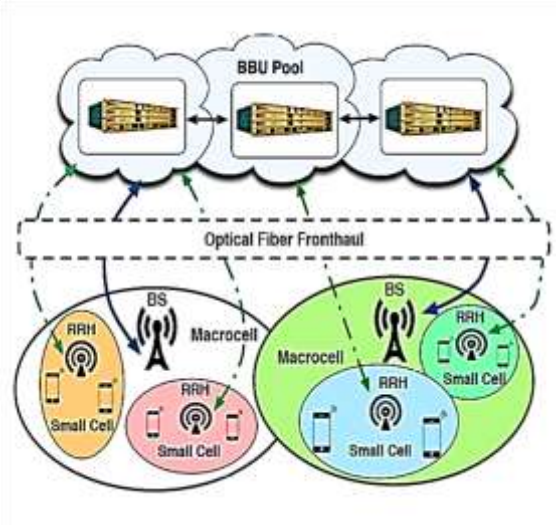

Figure 6: Cloud Radio Access Network Architecture

C-RAN is a novel base station architecture where baseband processing is shared among several RRH in a centralized virtual baseband unit pool. Centralized signal processing greatly reduces the number of site's equipment room needed to cover the same areas; Co-operative radio with distributed antenna equipped by Remote Radio Head (RRH) provides higher spectrum efficiency, compared to traditional or distributed architecture, where the assignment is static [7][8]. Figure 6 depicts the CRAN topology.

Mobile operators can exploit C-RAN to quickly upgrade their network. They only need to install new RRHs and connect them to the BBU pool to expand the network coverage or split the cell to improve capacity [8]. C-RAN can achieve significant savings in both capital and operating expenditures (CAPEX & OPEX) through the exploitation of real-time Cloud infrastructure based on open platform and BS virtualization.

Furthermore the latter techniques enable C-RAN to reduce the power consumption and increase the infrastructure utilization rate more.

7 Conclusion

4G is going to have a much tougher process behind its development level. The 5th generation will support more connected devices worldwide compared to the generations before and it also will be more efficient compared to them. By making

advantage of IP version 6, 4G will have a higher security compared to its previous generation.

In order to achieve more optimization than 4G LTE, operators have to first provide a richer network infrastructure in terms with adequate network broadband and capacity as well as less latency and more reliability. Then in order to approach optimization of the network, it has to come up with some innovative methods such as dense the network based on dense the small cell for hotspot and indoor (LTE-Hi) technique targeting on providing broadband mobile data within highfrequency hotspot, providing more flexible, reliable network and connectivity, more intelligent network and wireless resources management.

In 4G, Network operators by will exploit intelligent management of cellular network infrastructures, such as C-RAN and HetNet, to support the increasing number of connected devices and the traffic demand while decreasing their capital and operational costs. These technologies let them to easily upgrade their existing networks and enhance their coverage.

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