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AN OVERVIEW OF 4G WIRELESS TECHNOLOGIES

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ABSTRACT

In the last several decades the development of wireless broadband technologies has been a response to rising demand for mobile Internet and wireless multimedia applications such as live TV, live movies, video conferencing, and so on. In the telecommunications industry, mobile communication is critical. WiMAX and LTE have facilitated the convergence of mobile and fixed broadband networks through a common wide area radio access technology and flexible network architecture. Since 2007, the IEEE 802.16 working group has been working on a new revision of the IEEE 802.16 standards as a higher level air interface to satisfy the ITU-R/IMT-advanced requirements for 4G systems and the next generation. 4G mobile technology ensures great mobility by providing high data rates and high capacity IP-based services and applications. The 4G wireless system, its design, security services, advantages, and difficulties are all described in this article.

KEYWORDS: *LTE, Mobile Communication, Networks, Wireless Technology, 4G Networks.*

1. INTODUCTION

A packet switched wireless system with broad area coverage and high throughput is referred to as a 4G wireless system. It is cost-effective and spectrally efficient. Orthogonal Frequency Division Multiplexing (OFDM), Ultra Wide Band (UWB), and Millimeter wireless are all used

in 4G wireless. A 20 megabit per second data rate is used. The maximum mobile speed will be 200 kilometers per hour[1]. Long-term channel prediction, both in terms of time and frequency, user scheduling, and smart antennas coupled with adaptive modulation and power management are all used to accomplish the high performance[2]. 2 to 8 GHz is the frequency range. It allows users to access mobile phones from anywhere in the globe. 4G improvement promises to take the wireless experience to a whole new level with amazing user applications including complex graphical user interfaces, high-end gaming, high-definition video, and high-performance photography[3].

Consumer expectations for mobile phones and other comparable goods are evolving. Consumers want a better user experience as well as more sophisticated and helpful apps on a more ergonomic device. To enable future 4G applications such as three-dimensional (3D) and holographic games, 16 megapixel smart cameras, and high-definition (HD) camcorders, existing 3G devices will need to increase in areas like as imaging and computing power. These types of apps will require more processing capacity than existing 3G phones can provide, necessitating the development of more effective application processors[4]. The development of mobile and wireless communication technology has been fast. Gadgets continue to shrink in size while increasing in processing power. Power. Users, on the whole, prefer more complex and sophisticated products. Apps that are useful As a result, capacity development is essential[5].The most important need in wireless communications .Various mobile services have evolved since their inception. The transition from 1G to 4G (first to fourth generation) has started.In the following manner:

1. 1G: The first-generation (1G) wireless network. Essentially, it was made up of an analog cellular system and architecture of a circuit switched network These wireless devices. Only rudimentary voice telephony was provided by networks, and Low capacity and restricted coverage are the major issues they face. region. As a result, there has been considerable rise in the telecommunications industry. High frequency ranges were required, which opened the door for With the invention of digital transmission methods techniques for analog transmission [6].
2. 2G: In the early 1990s, second generation (2G) wireless technology was introduced. Technology was developed to fulfill the capacity needs of Voice and telephone are growing in popularity, but circuit switching is restricted. Text messaging and data services This technique was used. A digital transmission system is one that can send and receive data in real time. Reducing the signal's size and compressing it more effectively as compared to analog systems, yet at the same time more packets may be sent in the same amount of time as time permits. Broadband with lower power[7].
3. 2.5G: 2.5G is an intermediate step made after 2G but before 3G. The transition from 2G to 3G was essentially a refinement of the two main 2G technologies. technologies. This technology allowed for a better experience. Capacity on 2G radio frequency (RF) channels, as well as reported data rates of up to 384 kbps throughput [3]. 3G refers to the third generation of mobile and wireless technology. technology, which succeeds 2G and comes before 4G. 2.5G was a transitional technology between 2G and 3G. 3G is used to provide high data speeds. As a result, 3G wireless Technology was developed to provide faster data transfer rates, increased network capacity, and other benefits. network services that are more

complex and improved. In May of that year, The first pre-commercial 3G service was offered by NTT DoCoMo. FOMA is a Japanese television network[6]. After that, after that, after that, after that, after that, after that, after NTT DoCoMo was the first company to offer a pre-commercial service. In October 2001, Japan launched its first commercial 3G network.

4. 4G: 4G stands for fourth-generation cellular service. It has improved from 3G and is now the most widely used. Wireless service that is widely available, quick, and high-speed. 4G is currently only accessible in a few areas. 4G The wireless service was created to provide high-speed data. Regardless of the technology that powers 4G. For instance Sprint makes use of a technology known as WiMax. Verizon Wireless, on the other hand, uses Long Term Evolution (LTE). LTE stands for Long Term Evolution. 4G wireless is, on average, more expensive than 3G wireless. Data speeds of four to ten gigabits per second are anticipated to be available via technology. 10 times more powerful than today's 3G networks. Because 4G is a multifunctional and flexible technology, it can make use of almost all packet switching technologies.

Both orthogonal frequency division multiplexing (OFDM) and orthogonal frequency division multiple access (OFDMMA) may be used (OFDMA). The OFDM method divides a digital signal into narrowband and frequency segments. The capacity of 4G to reduce the interaction among symbols and channels connected with data streaming is the rationale for its adoption. Multiple input/multiple output technology is also possible with 4G. (MIMO). 4G includes the Universal Mobile Telecommunication Service (UMTS), which is essentially a broadband 3G technology. Frames or packets are used to transmit data with this broadband technology. As a result, it can transport audio, video, text, and other kinds of multimedia datagrams at a speed of 2 megabits per second. UMTS is a component of 4G since it allows 4G to utilize GSM-based international mobile phone roaming (Global system for Mobile Communications). Time division synchronous code division multiple access (TD-SCDMA), a wireless telecommunications technique, enables 4G to transmit both circuit switched and packet switched data[8].

1.1 History 4G Wireless Networks:

The International Mobile Telecommunications-Advanced (IMT-Advanced) standard launched the first stages of what became known as 4G in 2008. Although competing approaches such as LTE and WiMAX (Worldwide Interoperability for Microwave Access) aimed to fill the gap between 3G and 4G, no mobile network or cellular carrier was able to achieve the 100 Mbps speed that 4G stipulated in 2008, there were competing approaches such as LTE and WiMAX (Worldwide Interoperability for Microwave Access) that directed to fill the gap between 3G and 4G. Sprint was a big supporter of WiMAX, while Verizon pushed for LTE. WiMAX and LTE vary in that WiMAX does not utilise OFDM, which has been a critical component of alcommercial 4G installations over time. Sprint shifted gears in 2011 and started to offer LTE throughout its network, while WiMAX began to go away. Since 2011, LTE has gradually improved in speed and performance, with 4G LTE-A technology delivering the full 100 Mbps of network throughput specified by the original IMT-Advanced standard to cellular networks. The development and deployment of 4G's successor, 5G, will take many years. A new generation of technology takes many years to roll out, just as it did with previous generations. The deployment of new carrier technology and antennas, as well as mobile devices that accept the new standard, are all part of the 5G rollout. It will take time for all of those efforts to bear fruit. As with 1G,

2G, and 3G networks, 4G networks will eventually be phased out in favour of future generations at an undetermined period[9].

1.2 Benefits of 4G networks :

- *Technology Performance Improvement*: Increases uplink and downlink throughput while lowering latency and expanding network possibilities. In the next years, it is widely expected that mobile data traffic would continue to increase substantially. Regardless of the 4G technology utilized (LTE or WiMAX) in contrast to 3G, the bulk of the fundamental transport and throughput constraints will definitely be provided by the technology itself. 4G technologies provide at least a twofold increase in spectrum efficiency, improved support for real-time applications, and higher maximum speeds. Though there are other network and capacity challenges, such as edge or gateway management, signaling management, that must be completely addressed in order to maximize the upgrade's advantages.
- *New Mobile Application Enablement*: This feature allows new mobile apps to be developed to complement current ones (Streaming Music). The improved 4G bandwidth and latency will benefit a variety of 4G services, such as digital storage and smart home monitoring. Other services, such as MMS, digital picture frames, and various near-field communication applications, will not benefit from using a 4G network. As a result, it's critical to take a close look at the services and applications that are likely to benefit from 4G advancements. We can see that video streaming, MMOG/gaming, and expertise applications like interactive learning benefit the most from the deployment of 4G technology.
- *Addressable Device Expansion*: Network potentials and chipset scale may allow for the expansion of connectivity to a variety of innovative devices. Smart phones and more specialized gadgets continue to evolve handset technologies to include a wide range of features and value added services. The Terminal operating model has always supported a carrier-controlled service experience. Commercial operating systems like Windows Mobile and RIM have attracted heavy data users, causing network congestion by reducing control. Furthermore, the growing open eco-systems, which are further enabled by 4G, present a difficult opportunity for operators, as third parties develop services, applications, and customization tools to meet user needs. Because to open standards, gadgets are becoming more configurable, and more specialized devices such as netbooks, readers, and tablets are entering the market. We believe that manufacturers should consider a micro-segmentation-based device roadmap to satisfy the requirements of smaller user segments; different new distribution channels are required to enable the acceptance of Converged Mobile Gadgets and 4G apps.
- *Differentiated Customer Experience*: It allows you to manage the user's expectations and experience when using new features and services. We consider the user's experience in gaining a deep understanding of how these services are completely facilitated and how they integrate into the fabric of our lives, the need or capability to deploy expertise or configured gadgets to support enhancement, and finally, how to make money and when to share the revenue from service delivery. It has been insufficient in comprehending the experience of a 4G user until now, and it is unclear how much the user experience will change as more and different 4G services become available [5]. We are well aware that customer expectations in

terms of price points are shifting, with increasing expectations to pay "a little for a little," which contrasts with current pricing and expects an extra bundling of services and apps into a "solution" that helps them live better. As a result, the adoption of 4G services will rely heavily on addressing the most likely Use-Cases for 4G services.

- *Changes in Business Models*: 4G wireless technology will be critical in enabling new collaboration and monetization models. The industry has been exposed to the illusion of all-you-can-eat pricing structures, or flat-rate phone and data plans, during the last several years. This has driven performance in line with Pareto's data consumption rule, which states that 4 percent of users consume more than 70% of the bandwidth. In areas with a large number of smart devices, the resulting network bottlenecks limit access [5]. According to the bandwidth needs of many 4G use cases, the aforementioned issue will only grow worse if current pricing mechanisms are not changed. One option now being explored by operators is to move toward tiered pricing depending on traditional characteristics such as time, speed, and service quality. The bandwidth on demand service model, as well as the related pricing technique of charging premium price for these burst needs, is another viable service type. This may be useful for organizing high-bandwidth events like video streaming or live television. Given what we know now, 4G wireless technology will need a shift in pricing structures to favor smaller upfront costs (subscriptions, one-time purchases, ad-based, fermium, and per-use). Open development manifestos and collaborative solution deployment/creation techniques, on the other hand, may have an impact on how various pricing models operate. Without a doubt, the new 4G service eco-system and use-cases arrangements raise the important question of who will pay for the services and how the revenue will be divided.

1.3 Challenges of 4G Networks :

- *Security and Privacy*: When developing 4G Wireless Networks, security measures must be implemented to ensure the safest possible data transmission technique. "The 4G core delivers mobility, security, and QoS by reusing existing methods while still working on a few mobility and handover concerns," the authors state explicitly [5]. As a result, in order to protect data being transmitted across the network from hackers and other security breaches, the organization must develop an efficient and effective set of tools that will support the most stringent 4G security measures. Because of the nature of the 4G wireless network, there is a higher risk of security breaches, so multiple levels of security, including increased validation requirements, will be required to protect data and information transmitted across the network. One of the main goals of 4G wireless networks is to provide faultless service to a large geographic area. Smaller local area networks, obviously, will use various operating systems[10]. The diversity of these networks, which exchange various types of data, exacerbates privacy and security concerns. Furthermore, because new gadgets and services are introduced in 4G wireless networks for the first time, the encryption and decryption schemes used in 3G wireless networks are incompatible with 4G wireless networks. There are two approaches that may be used to overcome these problems. The first method entails adapting existing privacy and security techniques for use in heterogeneous 4G wireless networks. When existing methods fail to adapt to 4G wireless networks, the latter method relies on developing new, fresh dynamic reconfigurable, lightweight, and adaptive mechanisms.

- *Quality of Service*: In terms of network quality, various telecommunication service providers, such as Ericsson's 4G Wireless Networks for Telia Sonera, assure users of enhanced connectivity and the highest possible data quality that is transmitted across the network. It allows users to stay connected at all times, even while "on the move," thanks to data rates nearly ten times higher than today's conventional mobile broadband networks and real-time performance. As a result, service providers must develop an efficient and effective method for 4G Wireless Networks that improves quality, implements effective security measures, and ensures that all users have access to a wide range of options for downloading music, video, and picture files without delay. Integrating IP-based and non-IP-based devices is a significant challenge for 4G wireless networks. We all know that non-IP address based devices are often utilized for applications like VoIP. IP address-based devices, on the other hand, are often employed for data delivery [5].

1.4 Evolution Of Mobile Wimax Technology :

Mobile WiMAX has proven to be an essential component of today's contemporary, digital environment. As a consequence, individuals are becoming more reliant on mobile computers. The demand for high-speed data downloading and transport on mobile devices has prompted the development of new techniques to meet the various requirements of mobile computing. In the past two decades, our globe has seen many innovative developments in the area of wireless networks. Today, wireless networks have become an important part of people's daily lives, and they are becoming more popular with each passing day due to the need for mobility and high-speed broadband access. In the area of wireless networks, new and rapidly developing technologies are now being developed that enable high-speed broadband wireless access. Mobile WiMAX (Worldwide Interoperability for Microwave Access) is a sophisticated next-generation mobile broadband wireless network that supports 4G and is based on IEEE 802.16e-2005[7].

It was originally designed to solve problems with wired networks, but it later evolved into a 4G wireless network with upgrades from 802.16-2004, 802.16e-2005, and 802.16m. IEEE 802.16e -2005 is an upgrade to IEEE 802.16 -2004[8], which was the fixed data transmission technique for broadband connections to MAN at the time. The Wireless MAN-OFDMA specification helps to provide an improved air interface for use in unlicensed or licensed bands. Nowadays, users want to be able to stay online at all times, as well as have fast data transmission at a low cost with no data loss. Currently, a large number of PDAs (Personal Digital Assistants) on the market are capable of flawless wireless data transmission while maintaining mobility. Such requirements will become increasingly common in the future, so developers (such as the WiMAX Forum) are on the lookout for them in order to make these devices more user-friendly. For such issues, WiMAX (802.16e-2005) is the solution. WiMAX has a range of nearly 30 miles and can support data rates of up to 75 Mbps.

2. DISCUSSION

Fourth (4th) Generation Technology is abbreviated as 4G.4G technology is essentially a 3G technology extension with increased capacity and service offerings. However, no one knows what the actual meaning of 4G is at this moment. Some argue that 4G technology is a future technology that is mainly in its maturation stage. The main expectation for 4G technology is high-quality audio/video streaming via an end-to-end Internet Protocol connection. Nothing of

this may matter if the Internet Protocol (IP) multimedia subsystem movement accomplishes its goals. WiMAX or mobile structural design will become more transparent over time, making the adoption of many designs by a single network operator more common. Application flexibility and high dynamism consumers traffic, radio environment, air interfaces, and quality of service are the key characteristics of 4G services that users are interested in. The wireless industry will benefit from numerous advances in fourth generation (4G) technology, including downlink data speeds well above 100 megabits per second (Mbps), reduced latency, efficient spectrum utilization, and low-cost implementations. With impressive network capabilities, 4G enhancements promise to take the wireless experience to a whole new level with impressive user applications like sophisticated graphical user interfaces, high-end gaming, high-definition video, and high-performance Ad hoc and multi hop networks (multi hop networks are required for voice due to the strict delay requirements).

3. CONCLUSION

This paper provides an overview of 4G wireless networks and technologies, as well as the development of WiMAX and LTE network design and the OFDMA method. We've seen that the number of people using wireless internet has exceeded the number of people using fixed broadband. As a result, in an increasingly digital and wireless world, technologies with greater throughputs are becoming more important. Coverage and capacity are critical components of a successful and advanced 4G wireless network. The most viable technologies for a successful 4G rollout are LTEAdvanced and WiMAX. As a result, a new technology that is cost-effective, has greater throughput, better coverage, and capacity is required in today's world. It is clear that 4G technologies will have a global impact on web-based communications. Improved applications such as telemedicine, which may save lives, will be possible thanks to 4G technology. It is a completely IP-based network that will vastly enhance data transmission. There will be minimal signal interruptions, and downloads will be completed in a couple of seconds, quicker than ever before. A 5G cell phone, as well as a 5G network based on 4G technology, will be released in the near future, enabling the whole globe to connect indefinitely.

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