4G Technology, Its Applications & Beyond-An Overview

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Abstract: **With the increasing demands in the field of mobile & data communications, the sole aim is to connect users as fast as possible. 4G provides high mobility with high speed data rates and also supports high capacity IP-based services and applications while it also maintains full backward compatibility. It is also based on wireless communication that is IP based and is slated on Advanced MIMO technology. WiMAX, LTE, Advanced LTE Technologies, etc are part of 4G. In this paper, we portray what the 4G technology actually is including its Technical aspects, Key Features, Challenges, etc and how easy it is to implement 4G showing its Cost effectiveness. Some propositions has been made in order to understand the proper advantages and challenges of 4G System for effective implementation, for e.g.: 4G Network access requires large number of Transmitters & Receivers in the Device which result in heavy consumption of battery. This paper emphasizes on such constrains and its removal. Further, application of multimode software is explained by which different networks can be maintained. Another proposal of Coding Strategies for 4G Wireless Networks in case of Video is mentioned in the paper. Finally, a snapshot of Future Technologies such as 5G, 6G & 7G has been given which has immense scope for innovative research and development.**

Keywords: **4G, LTE Advanced, MIMO, WIMAX, 5G, 6G, 7G, Coding Strategies, Multimode Software, Cost effecttiveness.**

I. INTRODUCTION

4G is the Fourth Generation of mobile communication. A successor to 3G standards, it promises higher speed and better performance. ITU-Advanced specifications state that it should be able to provide 1Gbps speed for low mobility and at least 100Mbps for high mobility. With this feature, users will have access to different services, increased coverage, the convenience of a single device, one bill with reduced total access cost, and more reliable wireless access even with the failure or loss of one or more networks. 4G technologies follows Multiple Input Multiple Output Technology that uses signal multiplexing between multiple transmitting antennas (space multiplex) and time or frequency. In Figure 1, the successive generations have been shown. The following sections in this paper attempt to focus on the features of 4G and also its challenges. This new technology can be made to work on the existing platforms (towers and available antennae) quite proficiently, thus eliminating new hardware investment costs. But, with the onset of 4G, the problem of availability of network in remote places would become more than prominent as this technology is far more advanced than the previous standards. [1]-[2] Also, 4G network access requires substantial increase in the number of transmitters and receivers in the device, which means lowering of available battery backup which can be removed by efficient charger design for 4G device. The applications of 4G are many, amongst which multimode software; video coding strategies are the ones that are discussed in this paper. As it is widely known and accepted, that every new technology enhances scope for betterment and improvement, thus leading to innovation of a newer one. Following the same queue, valid ideas will be shared that leave room for creation of more advanced standards following 4G such as 5G, 6G and 7G.

II.   KEY FEATURES OF 4G TECHNOLOGIES

- Network Detection and Network Selection — A mobile terminal that features multiple radio technologies or possibly uses software-defined radios if economical, allows participation in multiple networks simultaneously, thereby connecting to the best network with the most appropriate service parameters (cost and capacity among others) for the application.

- Seamless Handover and Service Continuity — A "base station" that features intra- and inter-technology handovers, assuring service continuity with zero or minimal interruption, without a noticeable loss in service quality. Support for this function requires continuous transparent maintenance of active service instances and inclusion of various access technologies, from WiFi to OFDMA. [1].

A. WiMax, LTE & MIMO as Next Generation Technologies

The emergent 4G technologies such as WiMAX and LTE are stronger as compared to Wi-Fi. These technologies are having strong QOS and wider coverage. In some key aspect WiMAX and LTE resemble each other including operating in licensed spectrum bands, strong QOS support, wider coverage range. Based on point-to-multipoint connections, both WiMAX and LTE telecommunications technologies provide broadband wireless service. Through Base Station (BS), mobile subscribers (MS) such as smart phones/laptops get connected to internet, while BS controls the channel access of mobile subscribers. Frequency-division duplex (FDD) as well as time-division duplex (TDD) systems are being supported by both WiMAX and LTE. MU-MIMO (Multiple User MIMO) is a technology that deals in transmitting parallel & unique data streams in the same frequency-time to multiple users. (Spatial multiplexing) and also thereby improves sector/site capacity throughput [3]-[4].

III.   CHALLENGE OF 4G

A. Security

 The first step in analyzing cellular wireless security is to identify the security objectives. The goals that the security policy and corresponding technology should achieve are to ensure that information generated by or relating to a user is adequately protected against misuse or misappropriation. It is to be ensured that the level of protection afforded to users and providers of services is considered to be better than that provided in contemporary fixed and mobile networks. Further, it is to be seen that the implementation of security features and mechanisms can be extended and enhanced as required by new threats and services.[2]

B. Hand off Delay

Handoff delay poses another important QoS-related issue in 4G wireless networks. During the handoff process, the user may experience a significant drop in QoS that will affect the performance of both upper-layer protocols and applications. Deploying a priority-based algorithm and using location-aware adaptive applications can reduce both handoff delay and QoS variability. When there is a potential for considerable variation between senders' and receivers' device capabilities, deploying a receiver-specific filter in part of the network close to the source can effectively reduce the amount of traffic and processing, perhaps satisfying other users' QoS needs.[9]

C. 4G supportive devices showing less Battery Backup

In 4G supportive Devices due to presence of large number of Transmitters & Receivers, the battery of the Device runs off quite quickly. With technological developments the devices are getting smaller in size Due to Large Scale Integration and micro architecture. Hence in 4G devices if we want to enhance the battery life by designing a much powerful Li-on Battery ,then the backup would increase no doubt but Also the size o the device would increase i.e. not highly recommended. Thus, we have discussed about Solving this problem in the following section [5].

IV.   IMPLEMENTING 4G IN A COST EFFECTIVE MANNER

Embedding broadband in all types of consumer devices is a goal of 4G. To achieve the vision, of cost effective application of 4G ITU defines access layers of network such as Fixed (i.e. DSL, cable, fiber) — fixed wire line networks, Personal (i.e., Bluetooth, UWB) —cars, cell phones ,Hot-spot (i.e., Wi-Fi/802.11) , Cellular (i.e. UMTS, WiMAX) — highly-mobile users. These include higher speeds and more advanced network integration and enablement for service

offerings. In terms of 4G Network cost and affordability, there are a number of issues to consider that reflect some degree of risk. Developing a successful 4G Network platform is a positive step towards the creation of a wireless and broadband environment that possesses rapid transmission speeds, data integrity modules, and other related events that encourage users to take additional risks in promoting successful utilization of these 4G tools[6]-[7]-[8].

V. PROPOSED DESIGN OF EFFICIENT BATTERY CHARGER FOR 4G ENABLED DEVICE

A. Li-Ion charging Information

A Li-Ion battery is unique, as it is charged from a fixed voltage source that is current limited (this is usually referred to as constant voltage charging). We have designed an efficient single cell 150 mA chargers which can be implemented in large scale thereby resulting in Li-on 4G device compatible charger that can charge a 1500-1800 mAh battery at ease and that too very fast. This can be done by changing the circuit parameters and also using 3cell Li-on. Figure 2 gives shows the proposed design or circuitry for the charger [12].

B. Constant Voltage Charging

A constant voltage (C-V) charger sources current into the battery in an attempt to force the battery voltage up to a pre-set value (usually referred to as the set-point voltage or set voltage). If the voltage is too low, the cell will not be fully charged. The design presented next shows a simple solution for slow charging a single Li-Ion cell. An LP2951 regulator was selected because it has an output voltage that is very stable over temperature. The LP2951 is set for an output voltage of 4.20V using the resistors shown. The C1 capacitor is needed to prevent instability due to noise at the high-impedance feedback node. Large resistor values are used in this design to keep the "OFF" current drain below 2mA. A blocking diode is used at the output of the LP2951 to prevent battery current from flowing back into the LP2951 output pin if the input power source is removed[10].

VI.   APPLICATIONS OF 4G

A. Multimode Software Application

4G technology has a unique application of accessing several wireless networks. It is capable of high level of customization at the user-level end. This feature integrates the infrastructure of all available networks and steadily it will be easier for users to access services and applications regardless of the environment. One can easily access different mobile and wireless networks simultaneously. Multimode software is a software that allows the user device to adapt itself to various wireless interfaces networks in order to provide constant net access with high data (packet based) rate. Figure 3 shows how multiple networks are accessed through multimode operation. All the networks will be compatible once the switch is completed, eliminating roaming and areas where only one type of phone is supported. Once the voice and data networks are superposed there will suddenly be millions of new devices on the network cloud. This will require either reconstruction of the address space for the entire Internet or using different address spaces for the existing wireless networks. The multimode device architecture may improve call completion and expand effective coverage area. [2]-[11]-[13].

B. Video Network Coding for 4G Wireless network

 High Definition (HD) demand is increasing day by day more than that of the bandwidth support available. Network Coding allows to reduce the required number of packets to complete a transmission over noisy or unreliable networks compared non coded version, hence increasing throughput. Network coding offers exciting possibilities for the efficient transmission of video over wireless and bottleneck networks [14]. By sending combinations of packets and considering traffic as algebraic information not just bits, 4G networks is ideally suited to Network Coding i.e. they are resources, need to serve a variety of different devices and fem to cells connected to WIFI. However, it is also noted that the complexities that Network Coding can face in decoding nodes can accelerate the capabilities of embedded systems. This problem can be discarded by use of codes defined on small Galois Fields (GFThus, it is inferred that Network Coding could be doing peer to peer high definition video streaming and also thereby can be incorporated into more consumer-oriented devices In the next section, the proposed strategy for Video Centric Network Coding briefly portrayed.[3].

C. Network Coding for 4G wireless Network: Proposed Strategy

In this section, a novel proposal has been made that puts forward a variety of network coding approaches, and provides an efficient way to resolve the issues in Network Coding by encoding at the source, the core nodes as well as decoding at the edge. Mechanisms like progressive downloads have been designed to compensate for routing and decoding delays that can cause betterment to the video experience. Video streaming on the Internet heavily rely on file transfer to provide the video end to end. The decoding delays associated with these codes can however be very "expensive" for video quality. In addition, source based solutions can burden a network along the packet route when only the edges requires added reliability. Here a Network Coding solution can recover packets efficiently since the "lost" packet is part of a linear combination of transmitted packets. In Figure 4, the network coding principle is illustrated [15].

VII.   BEYOND 4G

A. 5G Technology- The Fifth Generation (5G)-Real Wireless World System

5G Technology stands for 5th Generation Mobile technology. 5G mobile technology has changed the means to use cell phones within very high bandwidth. User never experienced ever before such a high value technology. Nowadays mobile users have much awareness of the cell phone (mobile) technology. The 5G technologies include all type of advanced features which makes 5G mobile technology most powerful and in huge demand in near future. A user can also hook their 5G technology cell phone with their Laptop to get broadband internet access.5G technology including camera, MP3 recording, video player, large phone memory, dialing speed, audio player and much more you never imagine. [16] 5th wireless mobile multimedia internet networks can be completed wireless communication without limitation, which bring us perfect real world wireless – World Wide Wireless Web (WWWW). [6].

B. 6G & 7G Technology

6G will integrate all wireless mobile networks with satellites to get global coverage. This will be the under developed concept for "Sixth Generation" cellular network. It is assumed that 6G will proffer the speed of 1GB data transfer.6 generation mobile communication networks can integrate satellite communication networks and 5G to make global coverage. Satellite communications networks consist of navigation satellite networks, telecommunication satellite networks and Earth imaging satellites networks.[15]The navigation satellite networks are used for global position, the telecommunication satellite networks are used for global telephony, multimedia video and high speed Interact connectivity and the Earth imaging satellite networks are used for resource monitoring and weather information. The 7G system can be supported by the global navigation satellite system, the telecommunication satellite system, the earth image satellite system and the 6G cellular system. The global navigation satellites systems are essentially determine a use's position. The earth image satellite system contains the weather information as extra service for mobile users. Comparing with the satellites cellular base stations are much cheaper and stable. The satellites are very expensive and needs to do movement to cover larger area. Also, the handoff roaming must happen between each satellite [3]
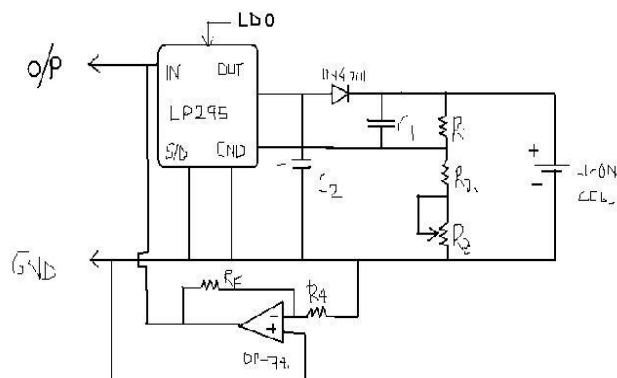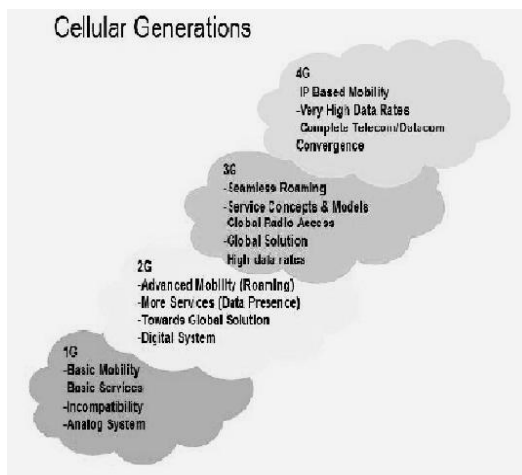
VIII.   FIGURES

Fig.1: 1G to 4G transition of Cellular Generations.   Fig. 2: Proposed Circuitry for Single Cell Li-on Charger.
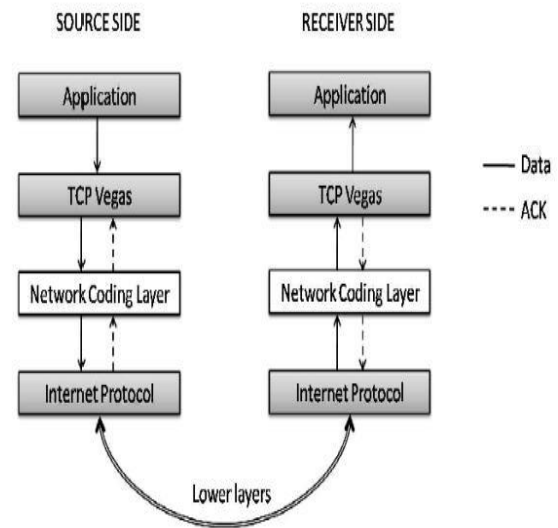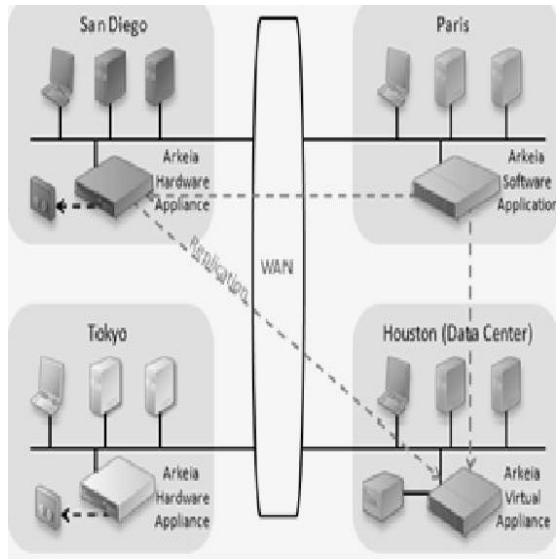
Fig. 3: Multiple Network Access through Application   **Fig. 4: Principles of Network Coding Multimode Software**

IX.   CONCLUSION

The realization of 4G tears down the wall between wireless and wire line services, a challenging endeavor. Realistically, wide-scale availability of 4G is several years away, but operators and standards bodies are making progress. 4G wireless networks not only enable more efficient, scalable, and reliable wireless services but also provide wider variety of services. These opportunities come with a need for rethinking about the security, privacy, architect and billing technologies that have been used for previous generations. We believe, however, that future research will overcome these challenges and integrate newly developed services to 4G networks making them available to everyone and anytime. Further moving on to further communications generations, it is expected that soon worldwide wireless web will be widespread acros the globe and also data and voice communications may take place solely with respect to satellite interaction.[4] We hope that this Paper helps to promote stronger links between people working in different fields creating future concepts of mobile communication, Internet services, etc. We conclude that it is a great time to invest in startups. Nowadays mobile users have much awareness of the cell phone (mobile) technology. The 5G, 6G &7G technologies include all type of advanced features which makes mobile technology most powerful and in huge demand in near future.

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