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Wireless Communication in 4G Technologies

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Abstract--- Consumers demand more from their technology. Whether it is a television, cellular phone, or refrigerator, the latest technology purchase must have new features. With the advent of the Internet, the most-wanted feature is better, faster access to information. Cellular subscribers pay extra on top of their basic bills for such features as instant messaging, stock quotes, and even Internet access right on their phones, E-mail, video calling. To support such a powerful system, we need pervasive, high-speed wireless connectivity. A number of technologies currently exist to provide users with high-speed digital wireless connectivity; Bluetooth, 802.11 and HIPERLAN are examples. These two standards provide very high-speed network connections over short distances, typically in the tens of meters. The goal is the same: long-range, high-speed wireless, which for the purposes of this report will be called 4G, for fourth-generation wireless system. Fourth-generation is characterized by new frequency bands, higher data rates and non backwards compatible transmission technology. The first release of the 3GPP Long Term Evolution (LTE) standard does not completely fulfill the ITU 4G requirements called IMT-Advanced. First release LTE is not backwards compatible with 3G, but is a pre-4G or 3.9G technology, however sometimes branded "4G" by the service providers. Its evolution LTE Advanced is a 4G technology. WiMAX is another technology verging on or marketed as 4G

Keywords--- CDMA: Code Division Multiple Access, TDMA: Time Division Multiple Access, MIMO: Multiple Input Multiple Output, QoS: Quality of Service, OFDMA Orthogonal Frequency Division Multiple Access, WiBro: Wireless Broadband MANET: Mobile Ad-Hoc Network.

I. INTRODUCTION

Until the controversial spectrum scams were brought up in the lime light many were ignorant of what 1G, 2G or 3G stood for and all of a sudden a hike was found out amongst laymen so as to be knowledgeable about it. Still a number of people are unaware of 1G or 2G when the world has moved on to 4G. The telecommunication service in World had a great leap within a last few year. . 6 billion people own a mobile phones so we are going to analyze the various generations of cellular systems as studied in the evolution of mobile communications from 1st generation to 5th generation .Now almost all the service provide as well as the customers seek for availing these 3G and 4G services. We can analyze that this could be due to increase in the telecoms customers day by day. In the present time, there are four generations in the mobile industry.

These are respectively 1G the first generation, 2G the second generation, 3G the third generation, and then the 4G the fourth generation. Ericson a Swedish company is launching this high tech featured mobile into the market. It is being first introduced in the Swedish Capital city, Stockholm. The Brief description of the generations of mobile communication is given in below.

1G (or 1-G) refers to the first-generation of wireless telephone technology, mobile telecommunications. These are the analog telecommunications standards that were introduced in the 1980s and continued until being replaced by 2G digital telecommunications. The main difference between two succeeding mobile telephone systems, 1G and 2G, is that the radio signals that 1G networks use are analog, while 2G networks are digital.

2G (or **2-G**) is short for second-generation wireless telephone technology. Second generation 2G cellular telecom networks were commercially launched on the GSM standard in Finland by Radiolinja in 1991. Three primary benefits of 2G networks over their predecessors were that phone conversations were digitally encrypted; 2G systems were significantly more efficient on the spectrum allowing for far greater mobile phone penetration levels; and 2G introduced data services for mobile, starting with SMS text messages.

3G or 3rd generation mobile telecommunications is a generation of standards for mobile phones and mobile telecommunication services fulfilling the International Mobile Telecommunications-2000 (IMT-2000) specifications by the International Telecommunication Union. Application services include wide area wireless voice telephone, mobile Internet access, video calls and mobile TV, all in a mobile environment. ITU has not provided a clear definition of the data rate users can expect from 3G equipment or providers.

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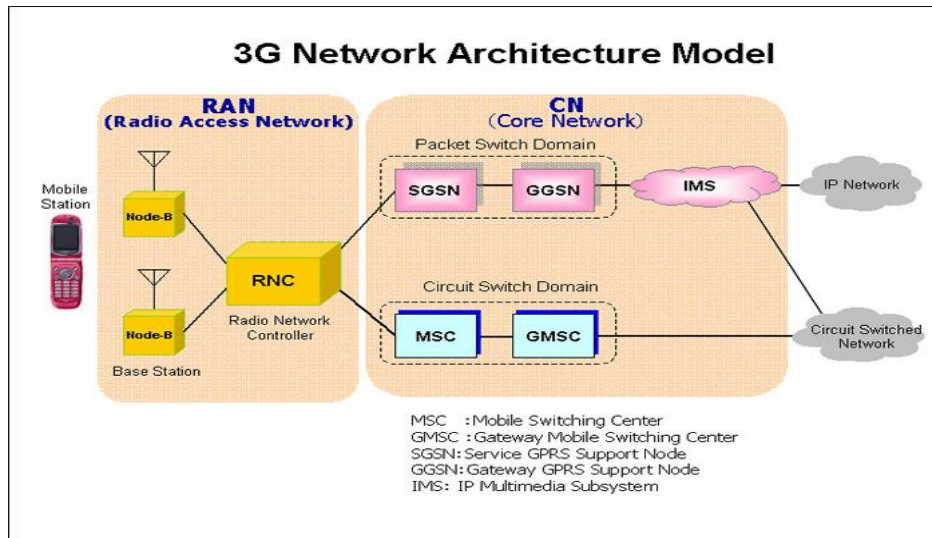


FIG-1: 3G ARCHITECTURE MODEL

3G networks offer greater security than their 2G predecessors. By allowing the UE (User Equipment) to authenticate the network it is attaching to, the user can be sure the network is the intended one and not an impersonator. 3G networks use the KASUMI block crypto instead of the older A5/1 stream cipher. 3G can implement various network technologies such as UMTS, GSM, CDMA, WCDMA, CDMA200, TDMA and EDGE.

4G Fourth generation (4G) also called Next Generation Network (NGN) offers one platform for different wireless networks. A successor of 2G and 3G, 4G promises a downloading speed of 100Mbps and is yet to shower its wonders on. Then with the case of Fourth Generation that is 4G in addition to that of the services of 3G some additional features such as Multi-Media Newspapers, also to watch T.V programs with the clarity as to that of an ordinary T.V. In addition, we can send Data much faster than that of the previous generations. A 4G system is expected to provide a comprehensive and secure all-IP based mobile broadband solution to laptop computer wireless modems, Smartphone's, and other mobile devices. Facilities such as ultra-broadband Internet access, IP telephony, gaming services, and streamed multimedia may be provided to users. In 4G the integration of network and its applications is seamless therefore there is no risk of delay. While implementing 4G the cost issue needs to be taken into consideration so that users can benefit from this technological development fully.

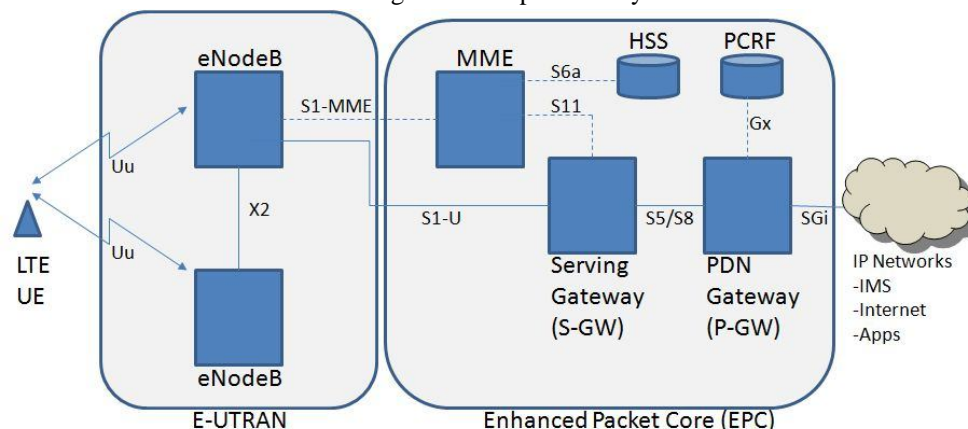


Fig-2: 4g mobile Network

Present technology especially in areas of memory, bandwidth, and power, as well as new technological solution that should be available in near future are investigated in this paper. This paper should be able to present a picture of the physical constraints of MANET at present and also suggests some areas where previously considered as limitations may no longer exist, or will vanish in the near future. This paper is organized in the following way: Section 1 introduces the different types of wireless mobile generations. Section 2 presents Applications of the 4G design. The following sections describe the definition of 4G as a significant

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factor influencing wireless networks. Section 3 details how 4G technology might influence networks. Section 4 highlights security issues of 4G, section 5 describes the Quality of Service in 4G. Finally, Section 6 concludes and describes future work.

II. CURRENT TECHNOLOGY

The two Technologies currently used are time-division multiple access (TDMA) or code-division multiple access (CDMA) these two technologies are collectively referred to as second generation, or 2G.

A. TDMA

TDMA, or Time Division Multiple Access, is a technique for dividing the time domain up into sub channels for use by multiple devices. Each device gets a single time slot in a procession of devices on the network, as seen in Figure 3. During that particular time slot, one device is allowed to utilize the entire bandwidth of the spectrum, and every other device is in the quiescent state.

B. CDMA

CDMA, or Code Division Multiple Access, allows every device in a cell to transmit over the entire bandwidth at all times. Each mobile device has a unique and orthogonal code that is used to encode and recover the signal (Leon-Garcia and Widjaja 2000). The mobile phone digitizes the voice data as it is received, and encodes the data with the unique code for that phone. This is accomplished by taking each bit of the signal and multiplying it by all bits in the unique code for the phone. Thus, one data bit is transformed into a sequence of bits of the same length as the code for the mobile phone. This makes it possible to combine With other signals on the same frequency range and still recover the original signal from an arbitrary mobile phone as long as the code for that phone is known. Once encoded, the data is modulated for transmission over the bandwidth allocated for that transmission.

C. Applications Of 4G

With the increase in the data rates, the mobile phones are made to perform higher performance applications. In 4G the mobile phone is not only for calling but it's something extraordinary device that can be used for variety of purposes. One such application in 4G is context awareness. For example if the mobile user is passing by an office where he/she is having an appointment to meet someone and they have forgotten the appointment. If the office location, address and geographical location matches the one user has already stored in the phone, he/she will receive information about the appointment and will be reminded that you need to perform this activity. Telemedicine is another application of 4G [8]. Using telemedicine a patient can send general reading like temperature, glucose level and blood pressure to the doctor online or if someone needs to know about their family member's health continuously they can receive all the information through telemedicine by using 4G technologies.

D. LTE

Long Term Evolution is an emerging technology for higher data rates. It is also referred as 3.9 G or super 3G technology. LTE is developed as an improvement to Universal Mobile Telecommunication System by 3G Generation Partnership Project (3GPP). LTE uses Orthogonal Frequency Division Multiple Access (OFDMA). The download rate in LTE is 150Mbps and it utilizes the available spectrum in a very sophisticated way. In LTE the IP packet delay is less than 5 mille seconds which provides the experience of wired broadband internet access in wireless environment. The mobile TV broadcast is facilitated by LTE over LTE network. LTE is a standard for wireless data communications technology and an evolution of the GSM/UMTS standards. The goal of LTE is to increase the capacity and speed of wireless data networks using new DSP (Digital Signal Processing) techniques and modulations that were developed in the beginning of the new millennium. Its wireless interface is incompatible with 2G and 3G networks, and so it must be operated on a separate wireless spectrum. The LTE specification provides down-link peak rates of 300 Mbit/s, uplink peak rates of 75 Mbit/s and QoS provisions permitting round-trip times of less than 10ms.

E. WiMAX

WiMAX (Worldwide Interoperability for Microwave Access) is a communication technology for wirelessly delivering highspeed Internet service to large geographical areas. It is a part of a "fourth generation," or 4G, of wireless-communication technology, WiMAX far surpasses the 30-metre (100-foot) wireless range of a conventional Wi-Fi local area network (LAN), offering a metropolitan area network with a signal radius of about 50 km (30 miles). WiMAX is based upon IEEE Std 802.16.

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III. NETWORKS OF 4G

Although there are different ideas leading towards 4G, some concept and network components frequently come up as a supporting and significant solutions that help achieve progress towards 4G. In this section we are going to investigate and explain technological innovations such as MIMO (Multiple-Input Multiple-Output), OFDMA (Orthogonal Frequency Division Multiple Access) that could significantly increase security, mobility and throughput of 4G.

A. MIMO

Multiple-input and multiple-output, or MIMO is the use of multiple antennas at both the transmitter and receiver to improve communication performance. It is one of several forms of smart antenna technology. MIMO can be sub-divided into three main categories, precoding, spatial multiplexing or SM, and diversity coding. Precoding is multi-stream beam forming, in the narrowest definition. In more general terms, it is considered to be all spatial processing that occurs at the transmitter. In (singlelayer) beam forming, the same signal is emitted from each of the transmit antennas with appropriate phase (and sometimes gain) weighting such that the signal power is maximized at the receiver input.

Spatial multiplexing requires MIMO antenna configuration. In spatial multiplexing, a high rate signal is split into multiple lower rate streams and each stream is transmitted from a different transmit antenna in the same frequency channel. If these signals arrive at the receiver antenna array with sufficiently different spatial signatures, the receiver can separate these streams into (almost) parallel channels. Spatial multiplexing is a very powerful technique for increasing channel capacity at higher signal-to-noise ratios (SNR). Spatial multiplexing can also be used for simultaneous transmission to multiple receivers, known as space-division multiple accesses.

Diversity Coding techniques are used when there is no channel knowledge at the transmitter. In diversity methods, a single stream (unlike multiple streams in spatial multiplexing) is transmitted, but the signal is coded using techniques called bspace-time coding. The signal is emitted from each of the transmit antennas with full or near orthogonal coding. Diversity coding exploits the independent fading in the multiple antenna links to enhance signal diversity. Spatial multiplexing can also be combined with precoding when the channel is known at the transmitter or combined with diversity coding when decoding reliability is in trade-off. Increasing speed and range, MIMO is already accepted by researchers as one of the main components of projects such as WiBro, WiMAX, WLAN, 802.11n, UMTS R8 LTE, and UMB.

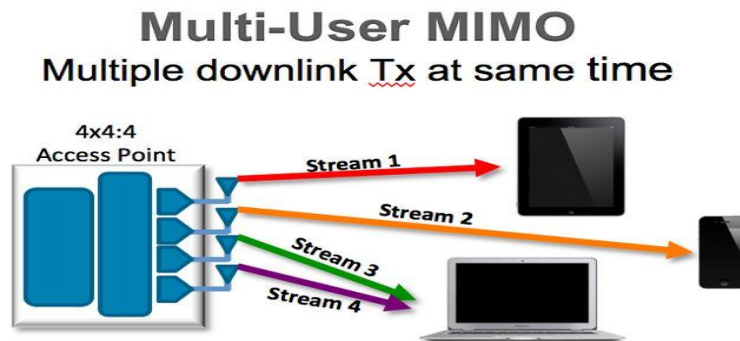


Fig-3 MIMO WORKS

B. OFDMA

Research Company proposed the simplest way to implement MIMO is by sharing frequency using OFDM, that together significantly can increase performance by extending range, boosting speed and Improving reliability. OFDMA can also be described as a combination of frequency domain and time domain multiple access, where the resources are partitioned in the time-frequency space, and slots are assigned along the OFDM symbol index as well as OFDM sub-carrier index. OFDMA is considered as highly suitable for broadband wireless networks, due to advantages including scalability and MIMO-friendliness, and ability to take advantage of channel frequency selectivity. Together with MIMO, OFDMA is another component of 4G that as the alternative to CDMA, promises high data capacity and spectral efficiency.

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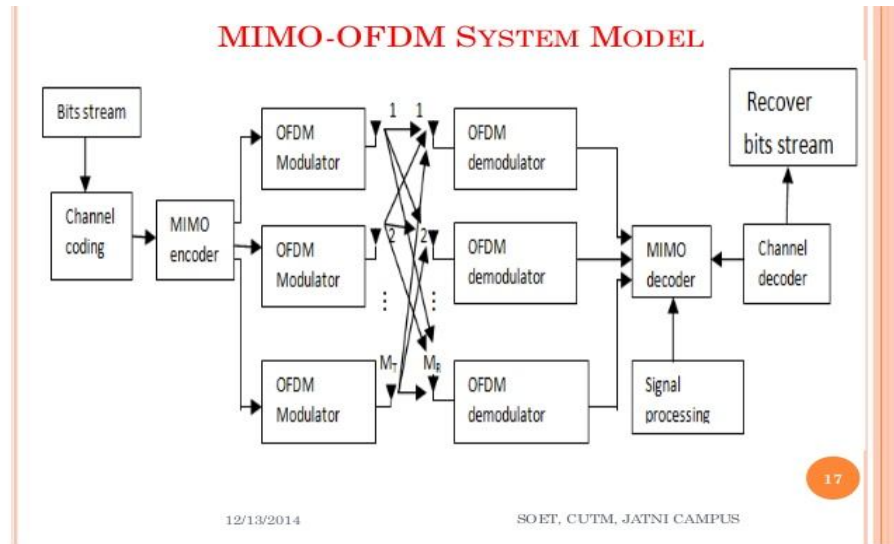


Fig- 4: MIMO-OFDMA SYSTEM MODEL

Some of the major advantages are its flexibility of deployment across various frequency bands with little needed modification to the air interface. Averaging interferences from neighboring cells, by using different basic carrier permutations between users in different cells. Interferences within the cell are averaged by using allocation with cyclic permutations. Enables Single Frequency Network coverage, where coverage problem exists and gives excellent coverage. Offers Frequency diversity by spreading the carriers all over the used spectrum. Allows per channel or per sub channel power control.

C. Security

Security in digital world means to protect the digital systems from criminal and unauthorized usage. In terms of computers and mobile communications the need for security has increased overwhelmingly with the improvement in technology. In attempting to avoid security problems like those that plagued the first-generation cellular systems, engineers must design security into any new technology it cannot be added as an afterthought. Unfortunately, this is no easy task. Implementing good security requires that security be designed into every aspect of the system; otherwise, a security leak exists. There can be many attacks on digital data some of them are eavesdropping, man in the middle attack, denial of service (DOS) attack, spoofing and lot more. Before seeking to design and implement wireless security, however, one first needs to understand what this elusive concept of security really means. In this case, wireless security is really a combination of wireless channel security (security of the radio transmission) and network security (security of the wired network through which the data flows). These collectively can be referred to as “wireless network security”.

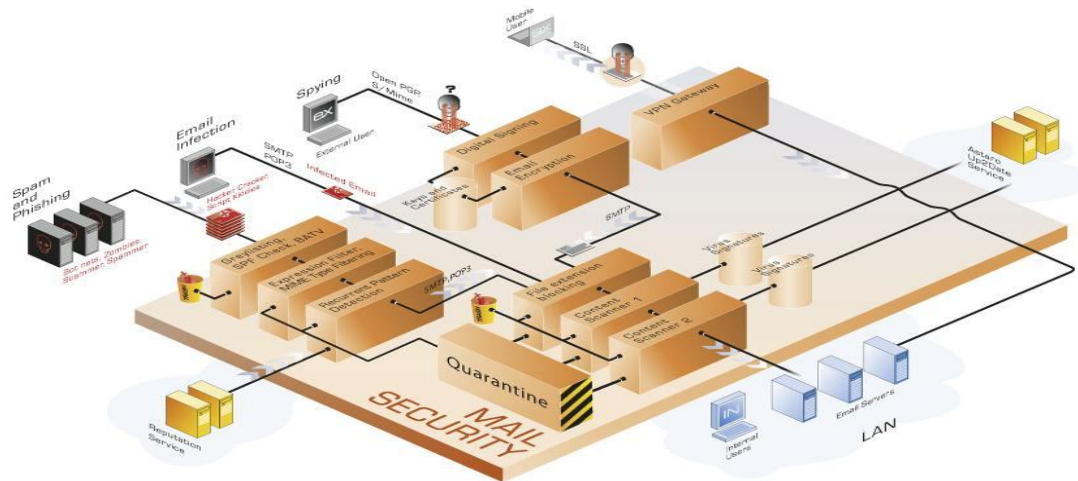


Fig-5: SECURITY OF THE WIRED NETWORK THROUGH WHICH THE DATA

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D. Services Provided By 4G

4G will likely become a unification of different wireless networks, including wireless LAN technologies public cellular networks (2.5G, 3G), and even personal area networks. Under this umbrella, 4G needs to support a wide range of mobile devices that can roam across different types of networks. These devices would have to support Different networks, meaning that one device would have to have the capability of working on different networks. One solution to this “multi-network functional device” is a software defined radio. QoS assurance is important for real time traffics like Voice over IP (VoIP), online gaming, IP TV and video streaming etc. QoS enables network administrators to avoid network congestion and manage the network resources efficiently. The goal of the 4G is to provide the users the facility of Always Best Connected (ABC concept). Fourth generation of networks is a combination of different networks.

It gives a platform for various technologies to be accessed. To provide QoS in 4G is not simple and easy job as one has to deal with different parameters in different technologies. Like if a user is moving and changing his coverage network, so to provide service under QoS framework is challenging. While a mobile user is moving from one network to another network his communication session needs to be maintained seamlessly irrelevant of the coverage network. Similar is the case with video conferencing and video streaming, the users like to receive the services seamlessly.

There are some protocols designed to maintain the seamless communication of the users while moving or in other words to minimize the latency and packet loss of the ongoing communication session. The mobility protocols are Mobile IPv6, Hierarchical MIPv6, Fast MIPv6 and some more (details of all these protocols are given in chapter Handovers). These protocols can help in improving the mobility management of mobile users. In order to provide QoS to the mobile users we propose a combination of mobility protocol Seamless Mobile IPv6 (SMIPv6) and Session Imitation Protocol (SIP). There are two types of losses when a mobile user switches network, one is called segment packet loss and the other is called edge packet loss.

Segment packet loss is because of the undeterministic nature of the handoff while the edge packet loss is between the Mobility Anchor Point (MAP) and the MN. To minimize these losses different approaches are used, to minimize edge packet loss the MN is moved as close to the MAP as possible, while for the segmented packet loss two approaches are used one is synchronized packet simulcast (SPS) and hybrid simulcast mechanism are used. In SPS the packets are sent to both the current network as well the potential network the MN is approaching [14]. While hybrid simulcast mean that the mobile node informs the network about the handoff to be taken into effect but it is decided by the network to which AR the MN shall attach.

This way the packet loss is minimized (the detailed mechanism is given in chapter of handover). Session Initiation Protocol (SIP) is used to manage mobility of different entities such as session, terminal, service and personal mobility. It facilitates mobility and maintains the real time multimedia sessions. SIP is an application layer protocol therefore it can work both in IPv4 and IPv6. SIP work along with other protocols Such as Real Time Transport Protocol (RTP).

IV. CONCLUSION

In this paper we are describing about the various wireless mobile technologies, and various applications of 4G mobile communication as well as the LTE (Long Term Evolution). And also we describe about various networks we are used in 4G, such as MIMO and OFDMA Evolution, in that we discuss about FDMA, CDMA, as well as TDMA. And also describes the Security, Quality of Service in 4G. We present the challenges that 4G faces and their up-to-date solutions. To improve the QoS in 4G we propose our own scheme of combining mobility protocol SMIP and application layer protocol SIP. With this scheme the QoS level in 4G can be improved because both the protocols provide support in handovers. Together they can decrease the packet loss and can improve security during the handover process. We can make sure the resource allocation during the handover process by combining the two protocols and mobility management can be optimized.

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