4G TECHNOLOGY AND COMMUNICATIONS

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Abstract- 4G is the fourth generation of cellular wireless standards. It is a successor to the 3G and 2G families of standards. With increasing end user demands for wider service due to the rapid growth and variety of IT (information technology) industry, the service with the data rate of 30 Mbps cannot accommodate the future mobile multimedia environment. Therefore, worldwide radio and mobile communication institutes and companies started the R & D of 4G mobile communications system. The approaching 4G (fourth generation) mobile communication systems are projected to solve still-remaining problems of 3G. 4G seems to be the solution for the growing user requirements of wireless broadband access and the limitations of the existing wireless communication. The goal of this generation is to produce specifications for a new radio-access technology geared to higher data rates, low latency and greater spectral efficiency. This paper is provides technological features of an existing 4G communication technology and its architecture to integrate the social networking process. It also presents an overall vision of the 4G framework, and integration of communication. A special consideration has been given to the security concerns of 4G by discussing a security threat analysis model proposed by International Telecommunication Union (ITU). By applying this model, a detailed analysis of threats to 4G and the corresponding measures to counter them can be performed.

I. INTRODUCTION

Mobile systems focus on seamlessly integrating the existing wireless technologies including GSM, wireless LAN, and Bluetooth. 4G systems supports comprehensive and personalized services, providing stable system performance and quality service. 4G is a Mobile multimedia, anytime anywhere, Global mobility support, integrated wireless solution, and customized personal service network system. 4G is used broadly to include several types of broadband wireless access communication systems along with cellular telephone systems. Also mobile communications and wireless networks are developing at an astounding speed, with evidences of significant growth in the areas of mobile subscribers and terminals, mobile and wireless access networks, and mobile services and applications. The present time is just right to start the research of 4G mobile communications because of:

Possibility: According to the historical indication of a generation revolution once a decade, and now we are near the end of 3G standardization phases and the beginning of 3G deployment.

Necessity: According to 3G goals, 3G is necessary but not sufficient to the mobile communication strategy, in which many problems are only partly solved and there are still many problems left to be solved in the next generation, i.e. 4G.

II. EVOLUTION OF 4TH GENERATION

The history and evolution of the mobile services from the first generation to 4th generation are discussed in this section. As the second generation was the total replacement of the first generation and the third generation was the total replacement of the second generation networks and handsets, so the fourth generation cannot be just an incremental evolution of the 3G technologies.
### III. ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AMPS</td>
<td>Advanced mobile phone service</td>
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<tr>
<td>CDMA</td>
<td>Code division multiple access</td>
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<tr>
<td>FDMA</td>
<td>Frequency division multiple access</td>
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<tr>
<td>GPRS</td>
<td>General packet radio system</td>
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<td>GSM</td>
<td>Global system for mobile</td>
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<td>NMT</td>
<td>Nordic mobile telephone</td>
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<tr>
<td>PDC</td>
<td>Personal digital cellular</td>
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<td>PSTN</td>
<td>Public switched telephone network</td>
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<td>TACS</td>
<td>Total access communications system</td>
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<tr>
<td>TDMA</td>
<td>Time division multiple access</td>
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### IV. FEATURES OF 4G

- A spectrally efficient system
- High network capacity i.e. more simultaneous users per cell
- A nominal data rate of 100 Mbps while the client physically moves at high speed relative to station, and 1Gbps while client and station are in relatively fixed positions as defined by ITU
- Smooth handoff across heterogeneous networks, seamless connectivity and global roaming across multiple networks
- High quality of service for next generation multimedia support (real time audio, high speed data, HDTV video content, mobile TV, etc.)
- Global mobile access (terminal and personal mobility)
- High quality of service (full coverage, intelligibility, no drop, and no/lower call blocking and latency)
- Easy and simple access to multimedia voice, data, message, video, Worldwide Web, Global Positioning System (GPS), etc.
- Power efficiency- 100 MOPS/mW and more.
- OFDMA (Orthogonal Frequency Division Multiple Access) modulation
- Implementation of MIMO (multiple inputs, multiple outputs)
- Smart antenna enhancements
- SDR (Software-Defined Radio)
- IPv6 and IP mobility

### Principle Technology Used and Working of 4G

The infrastructure and the terminals of 4G will have almost all the standards from 2G to 4G implemented. The infrastructure for 4G will be only packet-based (all-IP). But there is suggestion to have an open Internet platform. The 4G technology en suite with 802.16e mobile version of WiMax (also known as WiBro), and HC-SDMA, Adaptive Modulation and coding (AMC), Adaptive Hybrid ARQ, MIMO AND OFDM and Open distributed Ad- Hoc Wireless Network.

**OFDM (Orthogonal Frequency Division Multiplexing):** OFDM increases bandwidth by splitting a data-bearing radio signal into smaller signal sets and modulating each onto a different subcarrier, transmitting them simultaneously at different frequencies. The subcarriers are spaced orthogonally and thus large numbers can be packed closely together with minimal interference. To maintain orthogonality among the tones, a cyclic prefix is added, the length of which is greater than the expected delay spread. With proper coding and interleaving across frequencies, multipath becomes...
an OFDM system advantage by yielding frequency diversity. OFDM can be implemented efficiently by using fast Fourier transforms (FFTs) at the transmitter and receiver.

MIMO (Multiple Input-Multiple Outputs):- MIMO is a spatial diversity technique that increases coverage or data capacity by either transmitting the same data on different antennas or different data on different antennas. A high-performance 4G broadband wireless mobile service requires multiple antennas be used at both the base station and subscriber ends. Multiple antenna technologies enable high capacities suited for internet and multimedia services and also dramatically increase range and reliability. Multiple antennas at the transmitter and receiver provide diversity in a fading environment. By employing multiple antennas, multiple spatial channels are created, making it unlikely that all channels fade simultaneously. With MIMO, the channel response becomes a matrix. Because each narrow band carrier can be equalized independently, the complexity of space-time equalizers is avoided.

AMC (Adaptive Modulation Coding):- The principle of AMC is to change the modulation and coding format (transport format) in accordance with instantaneous variations in channel conditions. AMC extends the system’s ability to adapt to good channel conditions. Channel conditions should be estimated based on feedback from the receiver. AMC allows different data rates to be assigned to different users, depending on their channel conditions. Since channel conditions vary over time, the receiver collects a set of channel statistics, such as modulation and coding, signal bandwidth, signal power, training period, channel estimation filters, and automatic gain control, which are used by both the transmitter and the receiver to optimize system parameters.

ADAPTIVE HYBRID (ARQ): A successful broadband wireless system must have an efficient co-designed medium access control (MAC) layer for reliable link performance over the lousy wireless channel. The corresponding MAC is designed so that the TCP/IP layer sees a high-quality link it expects. This is achieved by an automatic retransmission and fragmentation mechanism called automatic Repeat Request (ARQ), wherein the transmitter breaks up packets received from higher layers into smaller sub packets, which are transmitted sequentially. If a sub packet is received incorrectly, the transmitter is requested to retransmit it. ARQ can be seen as a mechanism for introducing time diversity into the system due to its capability to recover from noise, interference, and fades. It will retain the quality of service in terms of data transmission.

OPEN DISTRIBUTED AD-HOC WIRELESS NETWORK: Routing infrastructure, including handsets, utilize intelligent routing capabilities to determine the best path for each transmission. Routing for the best path must be defined for least power. That is, network nodes must be able to calculate and update routing tables to send data packets through the paths with minimal power requirements. This is different than network nodes associating with the physically closest available infrastructure. The 4G mobile system based on open wireless platform architecture will become the next wave in wireless communications. The technology leads to integrate the computing network for human needs. At the same time, these technologies and the existing and upcoming 4G used to create the human network via computing devices. The social networking and it ecological issues are discussed below.

V. ADVANTAGES OF 4G
- Quickly download files over a wireless network.
- Extremely high voice quality.
- Easily access Internet, IM, Social Networks, streaming media, video calling, etc.
- Higher bandwidth.
- WiMAX, LTE, and HSPA+ are all versions of 4G, WiMAX is used by Sprint, LTE is used by Verizon and AT&T, HSPA+ is used by AT&T and T Mobile.
- 4G is 10 times faster than 3G.

VI. DISADVANTAGES OF 4G
- New frequencies means new components in cell towers.
- Higher data prices for consumers.
- Consumer is forced to buy a new device to support the 4G.
• It is impossible to make your current equipment compatible with the 4G network.
• 4G is only currently available in certain cities of the world.

VII. APPLICATION OF 4G TECHNOLOGY

To achieve the goals of true broadband service, the systems need to make the leap to a fourth-generation (4G) network. This is where Global Wireless Communications (GWC) enters the fray and excels at it. GWC will provide high speed, high capacity, low cost-per-bit IP-based services, fibre optic wireless connections and a truly global wireless communications system operating in frequency ranges that surpass all other telecommunication companies on planet Earth. 4G will consist of a hierarchy of quality/bandwidth modes, organized somewhat like this:

• Voice, low-to-medium resolution images, moderate data rates.

• High quality audio, images with good quality on small screens (handset, PDA, laptop PC). This can be achieved with WiMax, cable, satellite and DSL in supporting roles.

• Wide coverage with HDTV quality images, hundreds of Mbps data rates. Broadcast HDTV, digital cable, satellite and next generations of WiMax/WiBro support this level of quality.

• Local distribution of HDTV quality images, hundreds of Mbps data rates. UWB, 60 GHz systems, and other developing technologies can address this application area.

Some of the other applications of 4G are given as follows:

• Virtual Presence: This means that the 4G provides user services at all times, even if the user is off-site.

• Virtual navigation: 4G provides users with virtual navigation through which a user can access a database of a street, building, etc.

• Tele-geoprocessing application: This is a combination of GIS (Geographical Information System) and GPS (Global Positioning System) in which a user can get the location by querying.

• Tele-Medicine and Education: 4G will support remote health monitoring of patients. For people who are interested in lifelong education, 4G provides a good opportunity.

VIII. NEW CHALLENGES IN 4G COMMUNICATION

• Security and Privacy: In the development of 4G Networks, security measures must be established that enable data transmission to be as safe as possible. Specifically, “The 4G core addresses mobility, security, and QoS through reuse of existing mechanisms while still trying to work on some mobility and handover issues”. Therefore, it is necessary for the organization to develop an effective series of tools that support maximum 4G security measures as a means of protecting data that is transmitted across the network from hackers and other security violations. Because of the nature of the 4G network, there is an increased likelihood of security attacks, and therefore, multiple levels of security, including increased requirements for authentication, will be necessary to protect data and information that is transmitted across the network.

• Expedition: One of the main goals of G4 networks is to blanket very wide geographic area with seamless service. Obviously, smaller local area networks will run different operating systems. The heterogeneity of these wireless networks exchanging different types of data complicates the security and privacy issues. Furthermore, the encryption and decryption methods being used for 3G
networks are not appropriate for 4G networks as new devices and services are introduced for the first time in 4G networks. To overcome these security and privacy issues, two approaches can be followed. The first is to modify the existing security and privacy methods so that they will be applicable to heterogeneous 4G networks. Another approach is to develop new dynamic reconfigurable, adaptive, and lightweight mechanisms whenever the currently utilized methods cannot be adapted to 4G networks.

- **Quality of Service**: 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, as in the case of Ericsson’s 4G Network for TeliaSonera. The company promises that “The new 4G network will do for broadband what mobile telephony did for voice. With real-time performance, and about 10 times higher data rates compared to today’s mobile broadband networks, consumers can always be connected, even on the move. As a result, it is important for providers to develop an effective approach to the 4G Network that will enhance quality, provide effective security measures, and will ensure that all users are provided with extensive alternatives for downloading video, music, and picture files without delays. 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. Consequently, integrating the mechanisms of providing services to both non-IP-based as well as IP-based devices is one of key challenges that 4G networks have to address complex architecture.

IX. CONCLUSION

4G seems to be a very promising generation of wireless communication that will change the people’s life to wireless world. There are many striking attractive features proposed for 4G which ensures a very high data rate, global roaming etc. New ideas are being introduced by researchers throughout the world, but new ideas introduce new challenges. There are several issues yet to be solved like incorporating the mobile world to the IP based core network, efficient billing system, smooth hand off mechanisms etc. Someday 4G networks may replace all existing 2.5G and 3G networks, perhaps even before a full deployment of 3G multiple 3G standards and springing up that would make it difficult for 3G devices to be truly global.

REFERENCES

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