JAHANGIRNAGAR UNIVERSITY

Institute of Information Technology (IIT)

ASSIGNMENT 1
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1. Distinguish between 2nd, 3rd, 4th, 5th Generation Cellular Networks

Comparison	2G	3G	4G	5G
Year Introduced	1993	2001	2009	2018
Technology	GSM	WCDMA	LTE, WiMAX	MIMO, mm Waves
Access System	TDMA, CDMA	CDMA	CDMA	OFDM, BDMA
Bandwidth	25 MHz	25 MHz	100 MHz	30 GHz to 300 GHz
Internet Service	Narrowband	Broadband	Ultra Broadband	Wireless World Wide Web
Switching Type	Circuit for voice & Packet for data	Packet except air interference	Packet	Packet
Advantage	Multimedia Message (MMS, SMS), Internet access	Roaming, High Security	High speed internet, Global mobility	Extremely high speed, Low latency
Applications	Voice calls, Short messages	Mobile TV, Video Conference, GPS	High speed internet browsing, Mobile TV	HD video stream, remote control of vehicles

2. GSM architecture overview

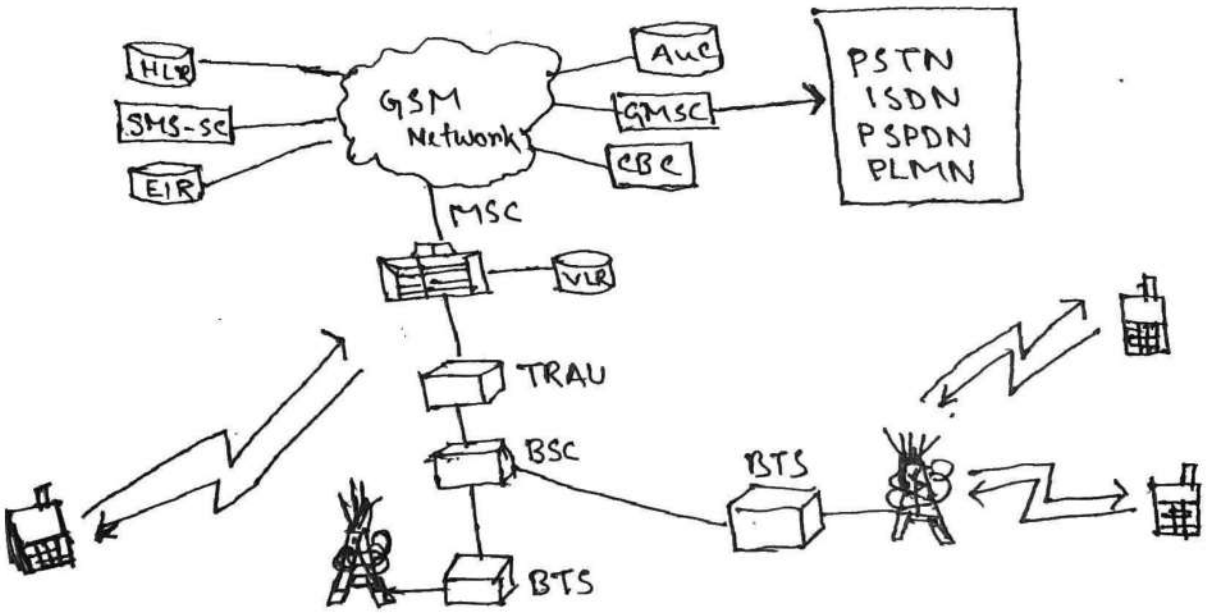


Fig: GSM architecture

3. The authentication and ciphering functions in GSM showing the detail steps of procedures

The authentication center keeps authentication algorithms. The authentication center (AuC) chooses a subscriber-specific authentication key Ki based on the IMSI sent in the authentication request. Additionally, a random-number generator provides a set of random-number parameters RAND, which are utilized, along with the key Ki, to provide each RAND parameter with a checking parameter SRES using the authentication method A3. The authentication center normally sends these RAND/SRES parameters to the visitor location register VLR, together with a calculated cipher key Kc, to be stored.

When the VLR needs to authenticate a subscriber, it chooses a RAND value for the parameter from a RAND/SRES database relating to the current subscriber and sends it to the mobile station, where it is then passed on to the SIM operation. The authentication key Ki and authentication algorithm A3 employed by the authentication center are included in the SIM. The SIM uses the received RAND parameter and the key Ki to calculate the SRES parameter, which is the authentication response, using A3 method. The VLR means visitor location register receives the SRES parameter from the mobile station. The VLR compares the SRES value transmitted by the mobile station to an earlier stored SRES value, and if they match, the authentication is successful. When a mobile station is registered in the GSM network, the network can request authentication at any time. Authentication can be done. As example, when a mobile station joins a network.

Ciphering is a technique used in many telecommunication systems for preventing unauthorized access to data being delivered. For example, with the GSM system, it is possible to use difficult-to-crack data transmission ciphering, in which speech and data transferred to digital form are ciphered at the mobile station before being broadcast over the radio route. Also, in the GSM network, ciphered data is decoded into plain speech and data. Ciphering can refer to either ciphering or decoding of traffic in the context of this operation. Ciphering and user authentication rely on cipher keys and algorithms that are only available to the transmission and reception equipment.

4. GSM Speech Processing describing all steps like First and second level of interleaving

The modules that voice will pass through before being broadcast over the radio make up the GSM physical layer. These modules include speech coding, channel coding, interleaving, ciphering, burst assembly, and modulation. The voice coding block RELP 13kbps is employed (Residually Excited Linear Predictive coder). With a constraint length of 5, rate 1/2 convolution coding is used in the channel coding block. The interleaving block executes diagonal interleaving after the 456 encoded bits in 20ms are separated into 57 bits' sub-blocks. In total, there will be roughly 8 57-bit sub blocks. The ciphering block employs the A3 and A5 encryption algorithms. Each call's encryption is tweaked to improve privacy. The burst assembly block frames the burst as needed by the GSM frame structure. A Gaussian filter is used to modulate and filter the same. To lower the occupied Bandwidth, the modulation block employs GMSK modulation with a Bit rate of 0.3.

5. Overview of GSM Timing Structures.

To deliver the transmitted data the needed structure and time, the GSM data structure is separated into slots, frames, multi frames, super frames, and hyper frames. The frame is the most basic component of the GSM frame structure. This is made up of the 8 slots in the TDMA system, each of which is used for a separate user. The slots for transmission and reception for a given mobile are offset in time. For this reason, the mobile does not transmit and receive at the same time. The basic GSM frame establishes the foundation on which all GSM messaging and signaling timing and structure is based. The fundamental unit of time is the burst period, which lasts around 0.577 milliseconds (15/26 milliseconds). A TDMA frame is formed by grouping eight of these burst periods together. This is the basic unit for the definition of logical channels, lasting roughly 4.615 milliseconds (120/26 milliseconds). Each TDMA frame has one physical channel, which is one burst period.

The base station transmits two types of channels, namely traffic and control, in a nutshell. As a result, the channel structure is divided into two types of frames: one for traffic on the main carrier frequency and another for control on the beacon frequency.

6. UMTS Network Architecture

The emphasis for the systems shifted from mobile voice communications to mobile data and general connection with the transition from 2G to 3G.

When GSM was established, the groundwork for the UMTS network had already been laid. The basic access elements, as well as circuit switched voice, were provided by this. With GPRS, the inclusion of packet data necessitated the establishment of more network entities. The 3G UMTS network architecture was built on the basis of the merging of these two network parts.

The radio access network underwent significant changes as a fully new radio interface based on CDMA was implemented. The handset's name was also changed to user equipment, signifying that it was no longer simply a voice phone but also a data set, which might have been a phone, PDA, or laptop, with many computers requiring a 3G dongle to link into a USB port.

The UMTS network architecture can be divided into the following 3 elements:

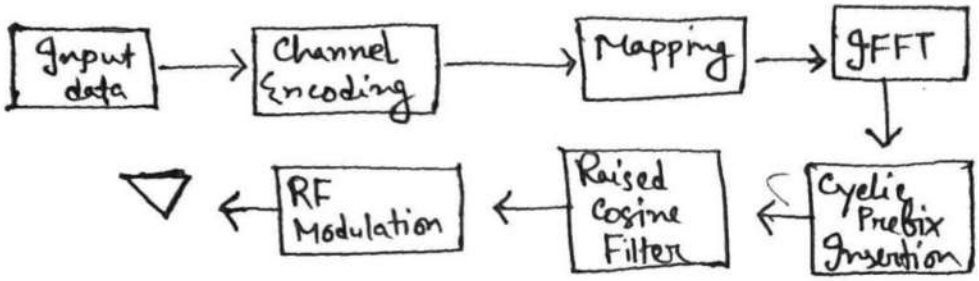
a. User Equipment: The User Equipment or shortly known as UE is the name given to what was previous termed the mobile, or cellphone. The new name was chosen because the considerably greater functionality that the UE could have. It could also be anything between a mobile phone used for talking to a data terminal attached to a computer with no voice capability.
b. Radio Network System: Shortly it is known as RNS or (UMTS Radio Access Network) UTRAN, is the equivalent of the previous Base Station Subsystem (BSS) in GSM. It provides and manages the air interface for the overall network.
c. Core Network: The core network provides all the central processing and management for the system. It is the equivalent of the GSM Network Switching Subsystem (NSS).

7. OFDMA Based WiMAX Network

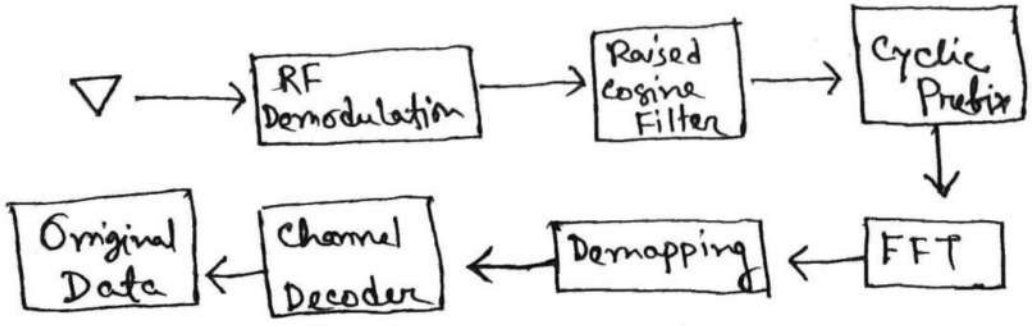
WiMAX is a collection of wireless broadband communication technologies. It is based on the IEEE 802.16 standards that includes physical layer (PHY) and media access control (MAC) choices. A multi-user orthogonal frequency-division multiple access (OFDMA) digital modulation technology is a typical orthogonal frequency-division multiplexing (OFDM) digital modulation technique. Multiple access is achieved with OFDMA by distributing sections of subcarriers to certain users. This allows multiple users to communicate low data rate data at once. Low data rate data at the same time.

Transmission: The i/p serial data turns into a parallel data stream after being formatted into the requisite word size for transmission, For example: 2 bits/word for QPSK. For each value, a single subcarrier frequency is assigned for data transmission. Based on the modulation mechanism, the data on each symbol is subsequently transferred to a phase angle. After determining the requisite spectra, an IIFT transform is performed to determine the associated time waveform. To ensure orthogonality, CP was added to the beginning of each symbol.

Receiving: The reception component of the WiMAX-based OFDM system operates completely opposite to the transmitter side of the system in that the CP is eliminated and the FFT of each symbol is used to determine the original broadcast spectrum.



ⓐ Fig for Transmission



ⓑ Fig for Receiving

8. Architecture of LTE, 4G Mobile Communications (WiMAX and LTE)

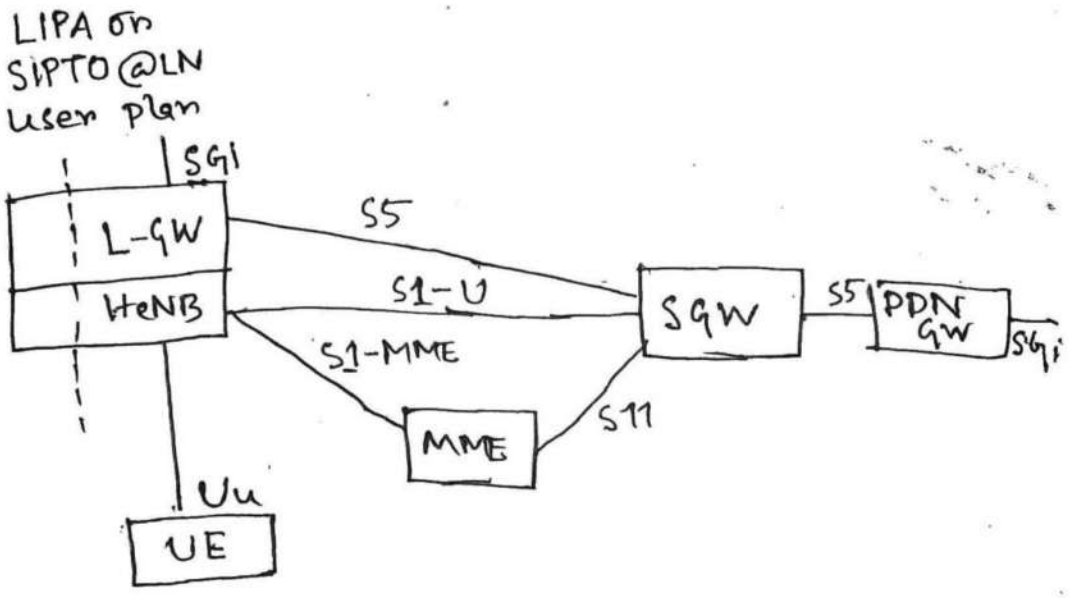


Fig: 4G LTE Network Architecture

9. Some important features of WiMAX, and LTE

WiMAX means Worldwide Interoperability for Microwave Access. It is a point-to-multipoint wireless networking standard based on IEEE 802.16. It describes how different wireless devices connect over the air/network in a large region.

2 types of WiMAX specification:

a. Fixed wireless WiMAX: Accesses the Internet from a desktop computer at home or other permanent location.
b. Mobile wireless WiMAX: Accesses the WiMAX network with mobile computers and mobile devices such as smart phones.

LTE means Long Term Evolution. It is the path taken to obtain 4G speed. It is a wireless data transmission standard, which means it is the technology that underpins 4G, the global standard for data transport via cellular networks. As a result, quicker data transfer is possible, for example, as compared to earlier 3G technology, downloading preferred music, websites, and videos is now considerably faster. It is the final step toward 4th Generation. It provides cellular mobile communication systems with a high-performance air interface. So, by the time and evaluation there was 2G, followed by 3G, and now there is LTE, which is known as 4G.

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