18ECE220T - Advance Mobile Communication System

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Assignment-1

1) How is the data rate calculated in fixed WiMax Based on OFDM Phy Layer?

The data rate in fixed WiMax Based on the OFDM PHY layer is determined by several factors, such as channel Bandwidth, modulation scheme, coding rate, and the no. of subcarriers used.

The data rate can be calculated using the formula.

$$R_{data} = N_{data} \times \frac{\text{bits per subscriber}}{T_{system}} \times R$$

- N_{data} is the no. of data subscribers
- "bits per subcarrier" depends on the modulation scheme
- T_{sym} is the symbol duration.
- R is the coding rate.

$$T_{sys} = T_u + T_g \quad ; \quad T_u = \frac{N}{BW} \quad ; \quad T_g = T_u \times \text{guard interval}$$

2) State the reason for using Packet fragmentation or Packet packing?

Packet fragmentation and packet packing are technique used in network communication to manage the size of data packages for efficient transmission over a network. It helps handle large data packet, ensures compatibility with different network segments, manage error in high error environments and optimizes data flow by reducing latency. It can also be more efficient in fitting size constraints of network segment, reducing latency

3) Give the difference between WiMax System and LTE

WiMax System

- WiMax, developed by the IEEE, initially aimed at providing wireless BroadBand over the long distances.
- It uses OFDMA (Orthogonal Frequency Division Multiple Access) for downlink and uplink.
- WiMax operates in various licensed and unlicensed freq Bands
- It offers theoretical peak data rates up to 40Mbps for Mobile wimax and upto 1 Gbps for fixed connections.
- It initially targeted broadband access in underserved or rural area.
- It has smaller Ecosystem with extensive support from device and vendors
- It has been overshadowed by LTE and its adoption has declined.

LTE System

- LTE, developed by 3GPP, aimed to provide high-speed Mobile services and enhances existing cellular network.
- It uses OFDMA for the Downlink and SC-FDMA for the uplink.
- It operates in a wider range of licensed frequency bands.
- It offers theoretical peak data rates up to 300Mbps for Downlink and 75Mbps for uplink in Early LTE.
- LTE widely adopted as the standard for 4G mobile networks globally
- LTE has a larger Ecosystem with extensive support from device manufactures, chipset vendors and network equipment providers.
- LTE continues to evolve with advancements like LTE-Advanced Pro and the transition to 5G.

What are LTE protocols & specifications?

LTE Protocols and specifications overview

Physical Layer

- OFDM (Orthogonal Frequency Division Multiplexing) for Downlink
- SC-FDMA (Single carrier frequency Division Multiple Access) for uplink
- MIMO (Multiple input Multiple output) for enhanced data throughput and spectral efficiency.

Medium Access Control (MAC) layer

- Scheduling: Manages resources allocation to different users.
- HARQ (Hybrid Automatic Repeat Request) for error detection and error correction.
- QoS (Quality of service): Prioritizes different types of traffic

Radio Link Control (RLC) Layer

- Segmentation and Reassembly: Splits data packet into small segments for transmission.
- Error Correction: Ensures data integrity through technique

Packet Data Convergence Protocol (PDCP) Layer

- Head Compression: Reduces IP header overhead.
- Security: Provides ciphering and integrity protection for Data.

Radio Resource Control (RRC) layer

- Connection Management: Handle establishement, maintence, and release of RRC connections.
- Mobility Management: Supports handover and cell reselection
- Broadcasting: Disseminates system information to all users.

Network layer

- IP (Internet Protocol): fundamental protocol for Data transmision.
- NAS (NON Access Stratum): Form Highest control between user equipment and MME.
- Establish and Maintain IP connectivity between UE and PDN.

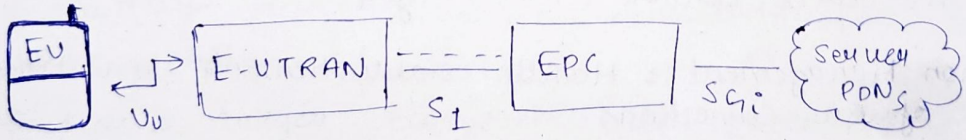
5) How does lawful Interception works in LTE Evolved System?

Lawful Interception (LI) in the LTE Evolved Packet System (EPS) involves the authorized surveillance of communication by law enforcement agencies. This process is facilitated by integrating interception functions into network elements like the Mobility Management Entity (MME), Serving Gateway (SGW) and Packet Data Network Gateway (PGW). When a lawful interception request is received, these elements duplicate the targeted user's communication Data including signal and securely transmit it to Law Enforcement Monitoring facility. This process is conducted transparently to the user and in compliance with legal and regulatory requirement to ensure privacy and security are maintained for non-targeted users.

6) Explain LTE network architecture and Various Interface.

LTE network architecture consists of three main components

- The user Equipment (UE)
- The Evolved UMTS Terrestial Radio Access Network (E-UTRAN)
- The Evolved Packed Core (EPC)



The Evolved packet core communicates with packet data networks in the outside would such as the internet, Private corporate network or the IP Multimedia Subsystem. The interface between the different parts of the system are denoted by Uu, S1 and SGi.

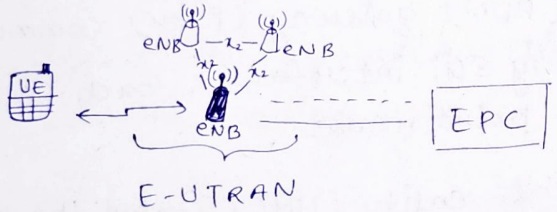
The User Equipment (UE)

The internal Equi Architecture of the user equipment for LTE is identical to the one used by UMTS and GSM which is actually a Mobile Equipment. The mobile equipment comprised of the following important modules:

- Mobile Termination (MT) – Handle all the communication function.
- Terminal Equipment (TE) – Terminates the data stream.
- Universal Integrated circuit Card (UICC) – It RUNs (USIM)

* The E-UTRAN (The access network)

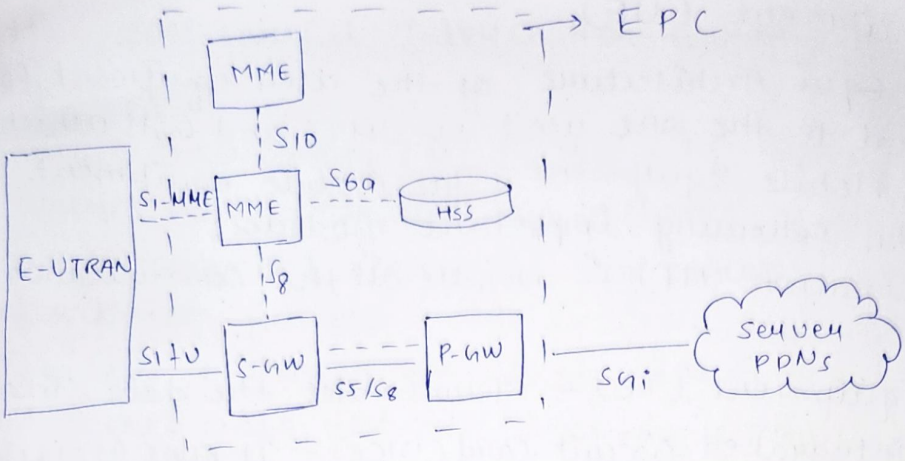
The E-UTRAN handles the radio communications between the mobile and the evolved packet core and just had one component, the evolved Base station called eNodeB or eNB. Each eNB is a Base station that controls the mobile in one or more cells. The Base station that is communicating with a mobile is known as its serving eNB.



- The eBN sends and receives radio transmission to all the mobile using the analogue and digital signal processing functions of LTE air interface.
- The eNB controls the low-level operation of all its mobile, by sending the signalling messages such as handover command.

* The Evolved Packet Core (EPC)

The architecture of Evolved Packed core (EPC) has been below. There are few more components which have not been shown in diagram to keep it simple. These components like the Earthquake and Tsunami warning System (ETWS), The Equipment Identify Register (EIR) and policy control, and charging Rules function



- The Home Subscriber Server (HSS) component has been carried forward from UMTS and GSM and is a central database that contains information about all the network operator's subscribers.
- The Serving gateway (S-GW) act as a router, and forwards data between the Base Station and the PDN gateway.
- Packet Data Network (PDN) gateway (P-GW) communicate with outside would, using SGi interface. Each PDN is identified by an access point name.
- The mobility management entity (MME) control the high-level operation of the mobile by means of signalling messages and HSS
- The interfacing between the serving and PDN gateways is known as S5/S8. This has two slightly different implementations, namely S5 if the two device in same network and S8 if they are in different network.