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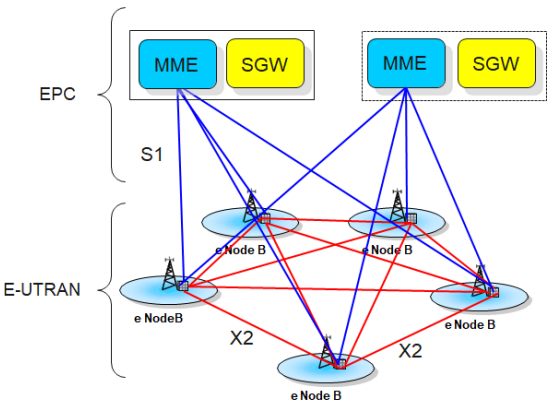
भारत सरकार, रेल मंत्रालय
GOVERNMENT OF INDIA, MINISTRY OF RAILWAYS

# एलटीई एवं एलटीई – आर पर प्रश्न बैंक

# Question Bank on LTE & LTE-R

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अमृत RDSO रेल अग्रदूत Transforming Railways

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### Q.1 What is LTE?

Long Term Evolution (LTE) is the latest family of mobile communication standards developed by 3rd Generation Partnership Project (3GPP) in order to cope with the needs and demands of future networks as they evolve and expand.

### Q.2 What are the goals of the LTE standards?

The goals set out for the LTE standards are to lower overall costs, improve quality of service and higher data, increase spectral efficiency, and create better integration with other open standards.

### Q.3 Is LTE a 4G Protocol?

The networking industry recognizes LTE a 4G technology along with WiMax and HSPA+. None of these qualified as 4G based on the original definition of the International Telecommunications Union (ITU) standards group, but in December 2010 the ITU redefined 4G to include them.
While some marketing professionals and press have labeled LTE-Advanced as 5G, no widely-approved definition of 5G exists to justify the claim.

### Q.4 What is LTE Advanced?

LTE Advanced is a mobile system that goes beyond LTE in several ways. In addition to best-in-class performance in terms of peak and sustained data rates and corresponding spectral efficiencies, capacity, latency, and overall network complexity and QoS (Quality of Service) management, LTE Advanced networks target peak data rates of 100 Mbps for high mobility and up to 1Gbps for low mobility.

### Q.5 What is the difference between LTE and LTE Advanced?

The main difference between them is carrier aggregation which is introduced in LTE advanced. Number of antennas supported by MIMO has been increased to 8 in LTE advanced.

### Q.6 Is LTE Better Than Wi-Fi?

LTE and Wi-Fi serve different purposes. Wi-Fi works best for servicing wireless local area networks while LTE works well for long-distance communications and roaming.

### Q.7 What is OFDM?

OFDM, also known as Orthogonal Frequency Division Multiplexing, is a method of encoding digital data on multiple carrier frequencies, and is used in LTE and other advanced wireless systems. This is where a significant number of closely spaced orthogonal sub-carrier signals are used to carry data streams. In OFDM a high-rate bit stream is multiplexed into a number of narrow band subcarriers and transmitted over parallel subcarriers which do not interfere with any other subcarrier in the cell. The orthogonality of subcarriers prevents crosstalk between them.

### Q.8 What is MIMO (Multiple Input Multiple Output) and why is it important to LTE?

The purpose of MIMO (Multiple Input Multiple Output) is to increase data rates over the air by utilizing a multiple antenna technique where spatial multiplexing is used in proportion to the number of antennas used. In MIMO, multiple transmitting antennas carry bit streams running parallel to one another, thus creating multiple channels. The receiver uses multiple antennas to extract each stream by cancelling the interference from other antennas when certain pre-determined conditions are satisfied.

### Q.9 What is the advantage of using SC-FDMA in LTE uplink?

The main advantage of SC-FDMA is low PAPR (Peak-To-Average Power Ratio) due to its single carrier structure compared to OFDMA which is used in LTE downlink. This increases the efficiency of power amplifier and hence increases the battery life.

### Q.10 What is Link Adaptation?

Link Adaptation is a technique used by the eNodeB to select appropriate modulation and coding rate based on the channel quality information feedback by the UE to maximize the throughput.

### Q.11 How does Intra E-UTRAN handover is performed?

Intra E-UTRAN Handover is used to hand over a UE from a source eNodeB to a target eNodeB using X2 when the MME is unchanged. In the scenario described here Serving GW is also unchanged. The presence of IP connectivity between the Serving GW and the source eNodeB, as well as between the Serving GW and the target eNodeB is assumed.

### Q.12 What is Resource Block in LTE?

LTE frame is divided based on time slots on time axis and frequency subcarrier on frequency axis. Resource block is the smallest unit of resource allocation in LTE system. It is of about 0.5ms duration and composed of 12 subcarriers in 1 OFDM symbol. One time slot is equal to 7 OFDM symbols in normal cyclic prefix and 6 OFDM symbols in extended cyclic prefix. One full resource block is equal to 12 subcarriers by 7 symbols in normal CP. Hence it consists of total 84 time/frequency elements referred as resource elements in LTE network.

### Q.13 What is the difference between Reference Signal (RS) and Synchronization Signal (SS) in LTE? What are the types of RS and SS?

Reference signal (RS) is used as pilot subcarrier in LTE similar to other broadband wireless technologies such as WLAN, WIMAX etc. RS is used for channel estimation and tracking. Synchronization signal (SS) is used as preamble sequence in LTE for synchronization purpose.

RS are of two types viz.

- Demodulation RS (DRS)
- Sounding RS (SRS)

DRS is used for sync and channel estimation purpose. SRS is used for channel quality estimation purpose. DRS is used in both the uplink and downlink, while SRS is used only in the uplink.

SS are of two types viz.

- P-SS
- S-SS

P-SS is used for initial synchronization. S-SS is used for frame boundary determination.

### Q.14 What is Home Subscriber Server (HSS)?

The HSS (for Home Subscriber Server) is a database that contains user-related and subscriber-related information. It also provides support functions in mobility management, call and session setup, user authentication and access authorization.
A Home Network may contain one or several HSSs: it depends on the number of mobile subscribers, on the capacity of the equipment and on the organisation of the network.

### Q.15 What is Policy and Charging Rules Function (PCRF)?

The Policy and Charging Rules Function (PCRF), is a combination of the Charging Rules Function (CRF) and the Policy Decision Function (PDF). PCRF brings together and enhances capabilities from earlier 3GPP releases to deliver dynamic control of policy and charging on a per subscriber and per IP flow basis. It is responsible for policy control decision-making, as well as for controlling the flow-based charging functionalities in the Policy Control Enforcement Function (PCEF), which resides in the P-GW. The PCRF provides the QoS (Quality of Service) authorization that decides how a certain data flow will be treated in the PCEF and ensures that this is in accordance with the user's subscription profile.

### Q.16 What is LTE for Railways (LTE-R)?

LTE-R is a next-gen communications network dedicated for railway services, enabling high-speed wireless voice and data communications inside trains, from the train to the ground and from train to train. LTE-R can also support passenger information applications, CCTV, traffic management, ticketing and other services on a single network.

The LTE-R systems are compatible with modern train automation systems like European Train Control System (ETCS) or similar and also interoperable with other legacy mobile communication systems such as GSM and UMTS.

### Q.17 Which frequency band has been allotted to Indian Railways for implementing LTE?

5 MHz (paired) Spectrum in 700 MHz band (703-748 MHz Uplink & 758-803 MHz Downlink, also specified as Band 28 in 3GPP/ETSI standards) has been allocated to Indian Railways for implementing LTE services.

### Q.18 What are Mission Critical Services (MCX) through LTE?

Mission Critical Services includes:

- Mission Critical Push to Talk (MCPTT)
- Mission Critical Data (MCData)
- Mission Critical Video (MCVideo)

**Q.19 What is FRMCS?**

Future Railway Mobile Communication System (FRMCS) is the future worldwide telecommunication system designed by International Union of Railways (UIC), in close cooperation with the different stakeholders from the rail sector, as the successor of GSM-R but also as a key enabler for rail transport digitalisation.
FRMCS is set to become the global standard for railway communications. This mobile broadband-ready technology enables to improve safety and operational efficiency, support innovative passenger services and accelerate digital transformation.

**Q.20 What are the main applications planned to be implemented on LTE in Indian Railways?**

The following main applications/solutions are to be implemented on LTE in Indian Railways:-

1. Indian Railway Automatic Train Protection System (IRATP) through Train Collision Avoidance System (TCAS) or any other similar systems as specified by Indian Railways
2. Mission Critical Services (MCX) as per FRMCS standards
3. Video Surveillance System in locomotives for Level Crossing Gate/ Tunnels/ Bridges
4. Onboard Passenger Information System (PIS) consisting of passenger information display and passenger announcement system
5. Internet of Things (IoT) based Asset reliability monitoring
6. Onboard Video Surveillance System (VSS) for Passenger Security
7. Broadband Internet on Running Train (Onboard Wi-Fi facility through LTE).

**Q.21 How LTE is going to be implemented in Indian Railways?**

Initially, LTE shall be implemented on Indian Railways with two EPCs at two different geographic locations (Northern and Southern). Later on, two more EPCs (Western and Eastern) may be provided based on increase of traffic capacity. The EPCs shall be redundant and virtualized.

The Northern EPC (at Delhi) and Southern EPC (at Secunderabad) shall work in redundant mode with 1:1 redundancy. The Northern/Southern EPC should be planned to work on full capacity of designated Zonal Railways.

The same capacity shall be kept as redundant in Southern/Northern EPC. At each location EPC shall support local redundancy on Server/port/connectivity level.

MME, HSS & PCRF components of Evolved packet core can be centralized and shall be geo-redundant. Application servers shall also be centralized and situated along with the core.

In order to reduce the latency over the transport network Serving Gateway (S- GW) and Packet Data Network Gateway (P-GW) may be deployed at all Zonal Railway locations.

### Q.22 What are the requirements of EPC for deployment in IR?

- EPC shall support high availability and geo-redundancy with uptime of 99.999%.
- It should be expandable to cater higher capacities as per the Railways future network requirements.
- EPC shall be interoperable with any LTE-RAN vendor and vice versa.

### Q.23 What is International Mobile Subscriber Identity (IMSI)?

The IMSI is a number that uniquely identifies every user of a cellular network. It is also used for acquiring other details of the mobile in the home location register (HLR) or as locally copied in the visitor location register.
The IMSI is a string of decimal digits, up to a maximum length of 15 digits, which identifies a unique subscription.

The IMSI consists of three fields: the mobile country code (MCC), the mobile network code (MNC), and the mobile subscription identification number (MSIN).

**Q.24 What is Mobile Subscriber International Subscriber Directory Number (MS ISDN)?**

Mobile Station/Subscriber International Subscriber Directory Number (MSISDN) is a number (Mobile Phone Number) used to identify a mobile phone number internationally.

It is the mapping of the telephone number to the subscriber identity module in a mobile or cellular phone.



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