

## Certification Program in Long Term Evolution (LTE)



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#### Program Introduction:

LTE Training program provides understanding of next Long Term Evolution (LTE) Networks. Participants gain an overview on the evolution, architecture, protocols, services and application of these networks. Also the comparative analysis between other 4G technologies is covered in telecom training course.

Candidates undergoing this program should have basic understanding of mobile telecom network technologies like GSM, CDMA and WCDMA.

#### After Completing LTE Telecom Training you shall be able to:

- Define the evolution path of LTE networks with application areas
- Explain and relate LTE Technology to Network Elements
- Define the LTE network Architecture, interfaces and applications
- Understand LTE Air Interface, Modulation schemes, Messages and Radio Resource Management.
- Understand the traffic concepts of LTE Networks to manage & operate the Networks.
- Explain the Mobility and session management principles.
- Understand the functionality of LTE Packet core network elements.

#### Module 1: Long Term Evolution Network Architecture

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| <ul style="list-style-type: none"> <li>• LTE v/s 3G v/s 2G Networks</li> <li>• LTE/SAE Network Elements             <ul style="list-style-type: none"> <li>○ eNodeB</li> <li>○ Mobility Management Entity (MME)</li> <li>○ Serving SAE Gateway</li> <li>○ Packet Data Network (PDN) SAE Gateway</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• LTE Interfaces             <ul style="list-style-type: none"> <li>○ X2 Interface</li> <li>○ S1-U</li> <li>○ S1-MME</li> <li>○ S6a</li> <li>○ S11</li> <li>○ S5/S8</li> <li>○ S7</li> <li>○ SGI</li> <li>○ RX+</li> </ul> </li> </ul> |
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**Module Duration : 60 Mins**

#### Module 2: LTE Air Interface (Part 1)

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| <ul style="list-style-type: none"> <li>• Principle of OFDM</li> <li>• OFDM Operation</li> <li>• Multipath Propagation and Inter Symbol Interference (ISI)</li> <li>• Cyclic Prefix</li> <li>• SCyclic Prefix – Types</li> <li>• Multi-carrier Modulation</li> </ul> | <ul style="list-style-type: none"> <li>• OFDMA Symbol</li> <li>• Peak-to-Average Power Ratio in OFDMA</li> <li>• SC-FDMA Signal &amp; Limitations of Single Carrier</li> <li>• Comparison of OFDMA and SC-FDMA</li> <li>• OFDMA Parameters</li> <li>• OFDMA Sub-carrier Types</li> </ul> |
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**Module Duration : 60 Mins**

#### Module 3: LTE Air Interface (Part 2)

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| <ul style="list-style-type: none"> <li>• Importance of Data Protection</li> <li>• Concept of Channel Coding</li> <li>• Coding Algorithm (Block Codes, Conventional Codes)</li> <li>• Channel Coding Techniques:             <ul style="list-style-type: none"> <li>○ Automatic Repeat Request (ARQ)</li> <li>○ Forward Error Correction (FEC)</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• Different Methods of FEC:             <ul style="list-style-type: none"> <li>○ Convolutional Codes</li> <li>○ Interleaving</li> <li>○ Turbo Coding</li> </ul> </li> <li>• Error Correction Technique::             <ul style="list-style-type: none"> <li>○ ARQ</li> <li>○ HARQ</li> </ul> </li> </ul> |
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**Module Duration : 60 Mins**

#### Module 4: Signalling in LTE Network

- S1 and X2 interfaces
- LTE Radio Interface LTE states
- Downlink Physical signal and channels
- Uplink Physical signal and channels
- Protocol Structure of S1-C or S1-MME
- Protocol Structure of S1-U
- S1 Interface Functions (Initial Context Setup, NAS Node Selection, Bearer Setup, Modification & Release, Paging, Mobility, Load Balancing)
- X2 User Plane & Control Plane Protocol Structure
- X2 Interface Functions
- All Possible NAS and AS States in LTE
- EMM (EPS Mobility Management) States
- ECM (EPS Connection Mobility) States
- RRC (Radio Resource Control) States
- UE states in LTE
- LTE Channels and Signals: Downlink
- Modulation Schemes Used in LTE

**Module Duration : 60 Mins**

#### Module 5: LTE Power Control and MIMO

- Introduction of Random Access
- Random Access Procedure
- Cases where Random Access Procedure is required:
  - Initial Access
  - RRC Connected
  - Handover
- Types of Random Access Procedure:
  - Contention Based Random Access (CBRA)
  - Contention Free Random Access (CFRA)
  - Handover
- Contention Based Random Access (CBRA) Procedure steps
- Contention Free Random Access (CFRA) Procedure steps
- Power Control in LTE
- Types of Power Control:
  - Closed Loop Power Control
  - Open Loop Power Control
- Closed Loop Power Control process
- Open Loop Power Control process
- Multiple Inputs Multiple Outputs (MIMO)
- Basic terminologies used in MIMO:
  - Transmission Layer
  - Spatial Multiplexing
  - Transmission Layer
  - Rank
  - PMI Pre-coding Matrix Indicator
  - Beamforming
- LTE Transmission Modes

**Module Duration : 60 Mins**

#### Module 6: Radio Resource Management

- Introduction of RRC
- RRC Protocol Model
- RRC Functions and Procedures
- Important RRC Messages (MIBs & SIB)
- Introduction of Paging
- Various cases where paging is required
- Paging Occasion (PO) and Paging Frame (PF)
- Paging Procedure
- Cell Search Procedure
- Various situations where a UE needs to go through the Cell Search Procedure

**Module Duration : 60 Mins**

#### Module 7: Mobility Management

- Scheduling
- Types of scheduling (Dynamic, Persistent, Semi-persistent)
- Bearers
- Types of bearer:
  - Default bearer
  - Dedicated bearer (GBR and Non-GBR)
- Aggregate Maximum Bit Rate (AMBR)
- Allocation and Retention Priority (ARP)
- Quality of Service (QoS)
- QoS Class Identifier (QCI)
- Mobility in LTE:
  - Mobility in LTE IDLE mode:
    - Cell selection procedure
    - Cell re-selection procedure
  - LTE Measurement reports (Events)
  - Mobility in LTE connected mode:
    - X2-based Handover
    - S1-based Handover
    - Inter-RAT handover

**Module Duration : 60 Mins**

#### Final Certification Exam

The students are required to undergo the final certification exam after going through all the modules. The certification exam is of 1 hour duration and would contain 50 questions. The students need to score atleast 50% marks to clear the certification. The students will have unlimited attempts to clear this certification exam.