

## LTE System Overview – 3 days

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The LTE System Overview course offers a comprehensive – yet easily understandable – overview of the functionality of LTE or 4G. LTE, or strictly speaking the Evolved Packet System (EPS), consists of the evolved Radio Access Network (E-UTRAN) and the Evolved Packet Core (EPC) as defined in 3GPP technical specifications. The course focuses on the network architecture, nodes and mode of operation of the entire LTE System. It accounts for interfaces, protocols and services provided by LTE, including Mobile Broadband, VoLTE and IoT. Message-level traffic cases are used throughout the course to demonstrate important functions and concepts.

### PREREQUISITES

General knowledge about the architecture, terminology and modes of operation of the GSM/UMTS networks is recommended. Basic knowledge of the Internet Protocol (IP) family is useful. For required background knowledge, the Apis course *3GPP Mobile Systems Overview* is recommended.

### 3GPP System Overview

- 2G and 3G networks and their relation to LTE/4G
- LTE network architecture and nodes, overall mode of operation
- Basic concepts: UE identities, PDN Connection, EPS Bearers, Quality of Service, etc.
- Traffic case: Network Attach and PDN Connection Setup

### IP Introduction

- The IP protocol stack: application / transport / network / L2 & L1
- IP networking: routers, switches, DNS, DHCP, NAT
- Protocol Headers
- Relation to LTE

### E-UTRAN – the LTE RAN

- OFDM basics
- E-UTRAN characteristics, nodes and mode of operation
- E-UTRAN interfaces
- NAS – Non-Access Stratum protocols
- RRC – Radio Resources Control
- Layer 2: PDCP, RLC and MAC functions
- Traffic case: Handover
- E-UTRAN channel architecture: Logical Channels, Transport Channels and Physical Channels
- UE states: Idle and Connected

### Evolved Packet Core - EPC

- Core Network architecture and interfaces
- EPC nodes – MME, SGW, PGW, PCRF and HSS
- Control and User Plane Separation - CUPS
- LTE Security
- Context storage and context transfer
- Bearers, tunnelling and Quality of Service (QoS)
- EPC Protocols: S1AP, GTP, Diameter and PFCP
- Cloud and Network Function Virtualization (NFV)

## **PDN Connection Setup and Data Transfer (Mobile Broadband)**

- Networks Attach and PDN Connection Setup
- GTP-U Tunnels
- Access Point Name (APN)
- User Plane data transfer from end-to-end

## **SIP – Session Initiation Protocol**

- SIP nodes and network architecture
- User Agent, Proxy Server, Registrar and Location Service
- SIP Identities
- SIP Methods – requests and responses
- SDP, RTP and RTCP
- SIP Traffic Case

## **IMS – the IP Multimedia Subsystem and VoLTE**

- Multimedia over IP using SIP
- IMS nodes and architecture
- IP-CAN, CSCF (Call Session Control Function), HSS and AS
- IMS subscriber identities – IMPI and IMPU
- Basic IMS traffic cases; Registration and Invitation

## **PCC – Policy and Charging Control**

- What is Policy and Charging Control?
- PCC architecture
- The PCRF and the PCEF
- Handling of user data / traffic using PCC

## **IoT in 4G**

- NB-IoT and LTE-M
- IoT device behavior and traffic characteristics
- Communication options for IoT traffic
- SCEF and MTC-IWF

## **A quick look at 5G**

- Non-Stand Alone (NSA) NR and the en-gNB
- Stand-Alone (SA) NR
- NG-RAN and the 5GC
- Three main 5G use cases: eMBB, mMTC and URLLC