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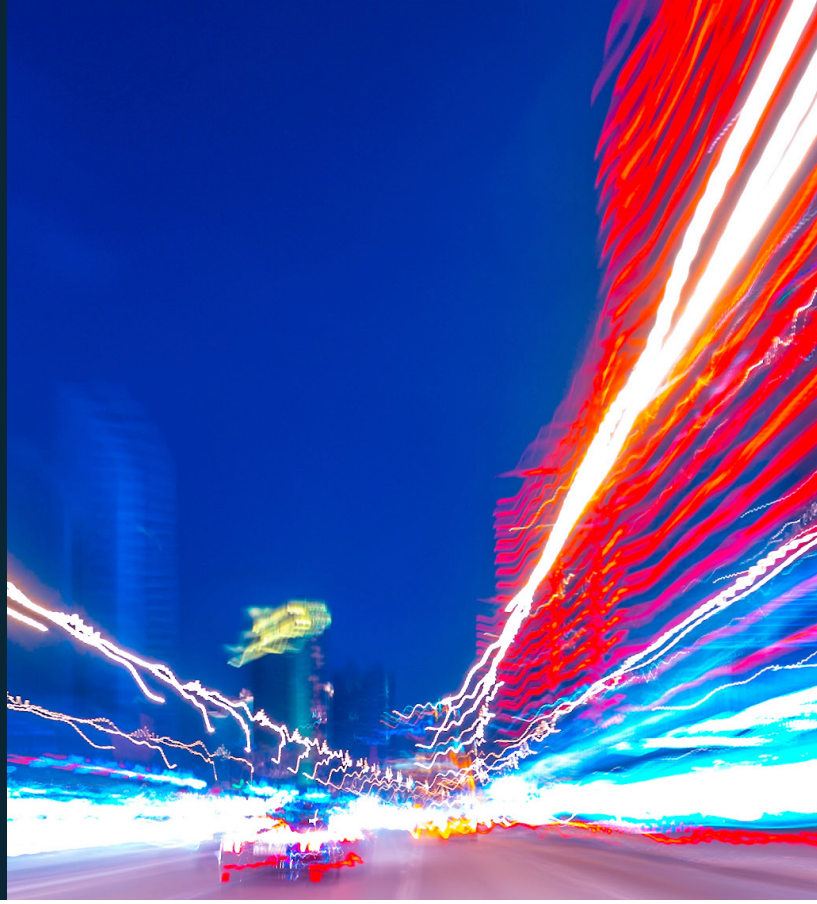

Analyzing the E-UTRAN

Course Description

This course builds on the information provided in LTE System Engineering in order to equip you with a concise knowledge of the LTE E-UTRAN. In particular the detailed operation of S1AP, X2AP, RRC and NAS is examined in context with a variety of key LTE procedures such as network attach, bearer establishment and mobility (both Intra and Inter LTE mobility). Finally, QoS, SON and Relays are also explored as part of the overall E-UTRAN architecture.

Prerequisites: LTE System Engineering

3	18	
Days (LiveOnsite, LiveOnline)	**CPD Learning Credits**	**Level: 3 (Advanced)**

This course will contain the following sections:

1. E-UTRAN

Topic areas covered include:

- What is the E-UTRAN?
  - User Equipment.
  - E-UTRAN.
  - EPC.
  - Femto Cells.
- LTE Interfaces and Protocols:
  - E-UTRAN Interfaces:
    - S1-MME, S1-U, X2, Uu.
  - EPC Interfaces.
- Network Identities:
  - UE Identities.
  - E-UTRAN and EPC Identities.

Activity: Using NetX map to discover the E-UTRAN interfaces and protocols.

2. LTE Procedures

Topic areas covered include:

- E-UTRA Signalling:
  - Stratums:
    - NAS and AS.
  - NAS Messages.
  - LTE States.
- The E-UTRA Protocols:
  - Radio Resource Control.
- Initial Procedures:
  - Cell Search.
  - Cell Selection.
  - PLMN Selection.

LTE Procedures (cont.)

  - Cell Selection.
  - Random Access.
  - RRC Connection.
  - LTE Bearers.
  - Initial Attach.
- Paging.
- System Information:
  - Acquisition of SI Messages:
    - MIB, SIB1. SI Messages.
- Discontinuous Reception.
- Power Control:
  - Downlink Power Control.
  - Uplink Power Control.
- UE Receiver Sensitivity:
  - Other Measurements.
- Radio Link Monitoring:
  - RLF.
- MIMO Modes:
  - SU-MIMO and MU-MIMO.
- Automatic Neighbour Relation:
  - ANR Procedure.
  - Possible ANR Architecture.

Activity: NetX based analysis of LTE Procedures.

3
Days
(LiveOnsite, LiveOnline)

18
CPD Learning Credits

LiveOnsite, LiveOnline

3. QoS Session Management

Topic areas covered include:

- QoS in Packet Switched Networks.
- QoS in LTE:
  - Policy.
  - Bearers and Bearer Managers.
  - EPS Radio and Access Bearer.
  - The Default Bearer.
  - Bearer Identities and Templates.
- L3 Packet Classification:
  - Packet Classification (DiffServ) - IPV4.
  - Packet Classification (DiffServ) - IPv6.
  - L2 Packet Classification.

4. S1 Interface and Procedures

Topic areas covered include:

- The E-UTRAN Interfaces.
- The E-UTRAN Control Plane:
  - E-UTRAN Protocol Specifications.
- The E-UTRAN S1 Application Protocol.
- S1 Application Protocol Elementary Procedures.
- S1 Functions and Procedures.
- Example S1 Procedures:
  - NAS Transport.
  - Initial Context Setup.
  - E-RAB Establishment.
  - S1 Setup.
  - eNB and MME Configuration Update.
  - Handover.
  - Path Switch.
  - Status Transfer.
  - UE Context Release.
  - Reset.
  - S1 Trace Procedures.
  - Location Reporting Control.
  - Overload.
  - Paging.

Activity: NetX based analysis of S1 Interface and Procedures.

5. GTP Protocol

Topic areas covered include:

- GPRS Tunnelling Protocol.
- GTPv1-U Header:
  - Optional Fields.
  - Extension Header.
- GTPv1-U Procedures:
  - Path Management.
  - UDP Header and Port Numbers.
- Summary of GTPv2-C:
  - GTP Messages.
  - GTP Procedures.

Activity: NetX based analysis of the GTP Protocol.

6. LTE PDCP, RLC and MAC

Topic areas covered include:

- The E-UTRA Protocol Stack.
- Packet Data Convergence Protocol:
  - PDCP Services.
  - PDCP Profiles.
  - PDCP Headers.
- Radio Link Control:
  - Transparent Mode.
  - Unacknowledged Mode.
  - Acknowledged Mode.
  - RLC PDUs.
- Medium Access Control:
  - Services Expected from Physical Layer.
  - LTE Logical and Transport Channels.
  - RNTI Identities:
    - C-RNTI, SI-RNTI, P-RNTI, RA-RNTI.
  - MAC Headers.
  - Random Access Process.
    - RAR and Timing.

Activity: NetX based analysis of LTE PDCP, RLC and MAC.

7. LTE Physical Layer

Topic areas covered include:

- Frequency Bands and Channels:
  - Carrier Frequency and EARFCN.
  - Channel Bandwidths.
  - Channel Bandwidths per Operating Band.
  - Default UE Tx-Rx Frequency Separation.
- Resource Grid and Resource Blocks:
  - Downlink PRB Parameters.
  - Uplink PRB Parameters.
  - Virtual Resource Blocks.
- The LTE Downlink Physical Channels:
  - Downlink Channel for Initial Access.
  - Downlink Synchronization Signals (FDD).
- Downlink Reference Signals:
  - Cell Specific Reference Signals.
  - UE Specific Reference Signals.
  - Broadcast Information.
  - PCFICH.
  - PDCCH.
  - PHICH.
  - PDSCH.
- The LTE Uplink Physical Channels:
  - Multiplexing of Control Signalling and UL-SCH Data.
  - Uplink Data Transmission.
  - PUCCH (Physical Uplink Control Channel).
- Uplink Reference Signals:
  - Demodulation Reference Signal.
  - Sounding Reference Signal.
  - PRACH.
- Hybrid ARQ:
  - HARQ Techniques in LTE.
- Channel Coding.

8. E-UTRAN Mobility

Topic areas covered include:

- LTE Mobility:
  - LTE Cell Planning.
- Mobility Functional Architecture:
  - eNB.
  - MME.
  - Tracking Area.

E-UTRAN Mobility (cont.)

- Mobility in the LTE Active State.
- Measurements:
  - Gap Configuration.
  - Timing.
- Handover Process:
  - X2 Handover Request and Response.
  - RRC Connection Reconfiguration.
  - Random Access.
  - SN Status Transfer and Status.
- Data Forwarding:
  - RLC-AM DRBs.
  - RLC-UM DRBs.
  - SRB Handling.
- S1 Based Handover (Relocation).

Activity: NetX based analysis of E-UTRAN Mobility procedures.

9. X2 Interface and Procedures

Topic areas covered include:

- The X2 Interface.
- Architecture of the X2 Application Protocol:
  - Functions of the X2 Application Protocol.
- X2 Elementary Procedures:
  - X2 Basic Mobility Procedures - Handover Preparation.
  - Handover Request.
  - Handover Request Acknowledge.
  - Handover Preparation Failure.
  - SN Status Transfer.
  - UE Context Release.
  - Handover Cancel.
  - X2 Load Indication.
  - X2 Resource Status Reporting.
  - X2 Setup.
  - X2 eNB Configuration.

Activity: NetX based analysis of X2 procedures.

10. E-UTRAN Interworking

Topic areas covered include:

- E-UTRAN Interworking:
  - 3GPP Interworking.
- E-UTRAN to UTRAN/GERAN RAU Procedure:
  - E-UTRAN to UTRAN/GERAN Handover Procedure.
  - Inter-RAT Cell Reselection or Cell Change Order to E-UTRAN.
- UTRAN to E-UTRAN Handover Procedure.