LTE/E-UTRAN Signalling

Who Should Attend?
This course is intended for E-UTRAN protocol stack developers, experienced network engineers, network tuning staff, and anyone with network experience who needs deep technical knowledge of the functionality of E-UTRAN.

Course Content

1. Introduction: EPS/LTE network structure, identity numbers, interfaces and protocol stacks, geographical network structure, OFDMA and SC-FDMA, interference avoidance, MIMO, channels, EPS bearers and QoS, MME in pool.
2. Traffic Cases: EMM, ECM and RRC states, attach procedure, TA update, UE/network triggered service request, S1 release procedure, dedicated bearer activation, UE requested bearer resource allocation, handover, intersystem handover, Idle mode Signalling Reduction - ISR, Circuit Switched Fallback - CSFB, SMSoSGs.
3. Security: user identity confidentiality, entity authentication, ciphering & integrity protection, key-change-on-the-fly, periodic local authentication, E-UTRAN - UTRAN/GERAN interworking including SRVCC.
4. NAS Signalling:
   - EPS Mobility Management (EMM): coordination between EMM and GMM, coordination between EMM and MM, establishment of the NAS signalling connection, routing of initial NAS messages, release of the NAS signalling connection, GUTI reallocation, authentication, security mode control, identification, EMM information procedure, attach for EPS services, combined attach for EPS and non-EPS services, detach, normal and periodic TA updating, combined TA/LA updating, service request, extended service request, paging, transport of NAS messages, generic transport of NAS messages.
   - EPS Session Management (ESM): coordination between ESM and SM, ESM and EMM coordination for ISR, IP address allocation, address handling for ESM procedures, default EPS bearer context activation, dedicated EPS bearer context activation, EPS bearer context modification, EPS bearer context deactivation, UE requested PDN connectivity, UE requested PDN disconnect, UE requested bearer resource allocation, UE requested bearer resource modification, ESM information request procedure, notification procedure.
5. Radio Resource Control (RRC): UE states and state transitions, signalling radio bearers, message format, system information, paging, connection establishment, reconfiguration, re-establishment and release, initial security activation, counter check, handover to E-UTRAN, mobility from E-UTRAN, Inter-RAT CCO to E-UTRAN, mobility from E-UTRA, measurements and event reporting, DL/UL upper layer protocols information transfer.
6. Packet Data Convergence Protocol (PDCP): sequence control and duplicate detection, integrity protection, ciphering, data discard, status report, packet format.
7. Radio Link Control (RLC): transparent, unacknowledged and acknowledged mode, error correction, concatenation, segmentation and reassembly of RLC SDUs, re-segmentation and reordering of RLC data PDUs, duplicate detection.
8. Medium Access Control (MAC): contention based and non-contention based random access procedure, RNTI types, maintenance of time alignment, DL/UL-SCH data transfer, HARQ operation, TTI bundling, adaptive and non-adaptive retransmissions, multiplexing

and assembly, logical channel prioritisation, scheduling request, buffer status reporting, power headroom reporting, discontinuous reception, PCH reception, semi-persistent scheduling, PDU formats and parameters, MAC control elements.

9. Physical Layer:
   - Downlink: OFDM system model, modulation mapper, cyclic prefix length, subcarrier spacing, FFT size, sampling rate, spectrum allocation, radio frames, subframes and slots, resource grid, physical channel processing, scrambling, synchronisation and cell search, SCH channel, channel estimation, reference signals, PBCH channel, PDSCH channel, REG, PCFICH channel, PHICH channel, Walsh codes, PDCCH channel, PDCCH formats, DCI formats, resource allocation types, physical and virtual RBs, localised and distributed virtual RBs, PDCCH processing, multiple antenna techniques, spatial layers, transmission rank, codeword, precoding matrix, transmission modes and schemes, channel coding, link adaptation, (a)periodic CQI/PMI reporting, wideband / higher layer configured sub-band / UE selected sub-band feedback, measurements, measurement gaps, UE capabilities,
   - Uplink: SC-FDMA system model, localised and distributed transmission, spectrum allocation, radio frames, subframes and slots, resource grid, physical channels, demodulation and sounding reference signals, PUSCH channel, resource allocation, inter / intra subframe hopping, PUCCH channel, PUCCH resource allocations, PUCCH formats, PRACH channel, preamble formats, multiple antenna techniques, power control.
10. Stream Control Transmission Protocol (SCTP): SCTP packet, chunk structure, security, multihoming, association establishment, transmission of data, cumulative and selective acknowledgement, retransmission, stream concept, sequence control, shutdown and abort procedures.
11. GPRS Tunnelling Protocol - User Plane (GTP-U): tunneling, handling of sequence numbers, header format, path management messages.
12. S1 Application Part (S1AP): SCTP as S1AP bearer, E-RAB setup/modification/release, NAS transport, initial context setup, context modification/release; intra LTE, inter RAT and SRVCC handover: signaling sequences, transparent containers, direct/indirect forwarding, resource allocation, handover notification, path switch, handover cancellation, eNB status transfer; paging; management procedures: reset, error indication, S1 setup, eNB/MME configuration update, overload; UE capability info indication, trace procedures, location reporting procedures.
13. X2 Application Part (X2AP): SCTP as X2AP bearer; handover: signaling sequences, path switch, data forwarding, status transfer, UE context release, handover cancellation; load indication, error indication, X2 setup, reset, eNB configuration update, resource status reporting, mobility settings change, radio link failure indication, handover report.
14. Idle mode: PLMN selection, cell selection, cell reselection.

Course Objectives

This course focuses on signalling between EPS/LTE nodes within E-UTRAN. During the course all protocols and signalling procedures on all interfaces (i.e. Uu, X2 and S1) within E-UTRAN are presented in detail. The course also describes overview of EPS architecture and system wide signalling procedures, including EPC - E-UTRAN interworking.

Prerequisites
The participants should have basic knowledge of LTE technology.

Training structure
Four-day training divided into logical sessions.

Methodology
Lectures and theoretical exercises.