

LTE Physical Layer – 3 days

CONTENTS

The course describes the physical layer (layer 1) aspects of the LTE (E-UTRA) radio interface. Downlink and uplink control channels for synchronization, scheduling, hybrid-ARQ operation and feedback signalling are described in detail. The full processing chain "from IP-packet to radio wave" is covered (including also layer 2 functions). Physical layer procedures such as cell search, random access, scheduling and hybrid-ARQ are described.

The course also includes a chapter on the evolution of the LTE physical layer standard (Release-10 to Release-13) for features such as carrier aggregation, enhanced MIMO and dual connectivity. Note: the course does not cover the TDD option for LTE.

PREREQUISITES

Basic knowledge regarding the architecture, terminology and modes of operation of the LTE radio access network is highly recommended. Knowledge about UMTS High Speed Packet Access concepts is useful but not mandatory.

LTE Overview

- Evolved Packet System network architecture
- Summary of radio techniques used in LTE
- Current status of the LTE/LTE-A standard

LTE Protocol Architecture

- Logical, transport and physical channels and their relation to the radio interface protocol stack
- Overview of RRC signalling and layer 2 functions relevant for proper layer 1 operation

OFDM & MIMO in LTE

- Overview of OFDM transmission: subcarriers, OFDM symbols, cyclic prefix, DFT processing
- LTE resource definitions: Resource Elements, RE Groups, Control Channel Elements, Resource Blocks
- Multi-antenna transmission basics
- LTE transmission modes
- LTE radio frame and subframe structure (mapping of control channels, data and reference signals)

Layer 1 Information Processing

- Channel coding and rate matching
- Scrambling and modulation
- Layer mapping, precoding and antenna mapping

Synchronization & Network Access

- P-SS, S-SS and the Physical Cell Id.
- Generation of pseudo-random sequences
- PBCH and system information
- RACH and the Random Access procedure
- Coding and mapping of the PRACH

Downlink Transmission Procedures

- Downlink control procedures on PCFICH and PDCCH
- Coding and mapping of the PCFICH and PDCCH
- Blind decoding of control channels in the UE: search spaces, aggregation levels and PDCCH formats
- Usage of different DCI contents
- Resource allocation type 0, 1 and 2
- Determination of MCS and TB size

Uplink Transmission Procedures

- Time-frequency mapping of the PUCCH region(s)
- Control signalling procedures on PUCCH
- Usage of different PUCCH/UCI formats
- Multiplexing UCI on PUSCH
- Coding and mapping of the PUCCH & PHICH

Hybrid-ARQ and Scheduling

- HARQ processes, timing, redundancy versions
- CQI and PMI/RI reporting options
- Scheduling request procedure

LTE Evolution

- Overview of LTE release 10 to release 15
- Transmission Mode 9
- Non-codebook based precoding
- New DM-RS reference signal mapping
- New CSI-RS reference signal mapping
- Carrier aggregation: basic concept
- Carrier aggregation: impact on control channels
- Dual connectivity: basic concept
- Dual connectivity: user plane options