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From LTE to LTE-Advanced
Comprehensive Overview for Technical Managers

Course Duration:

- 1 day

Course Description:

- This course addresses the needs of technical managers, engineers and technicians who are involved in the design, consideration and development of LTE and other 3GPP cellular standards and in particular the evolution from LTE to LTE Advanced. The course focuses on both sides, UE/Mobile as well as network.
- The course starts with a roadmap overview of the 3GPP standardization from 2G technologies (GSM) up to 4G technologies (LTE-Advanced).
- An overview of the network architecture with the introduction of LTE and LTE-Advanced will be provided mapping it to the content of the standards of 3GPP releases 8, 9, 10 and beyond as well as an indication of the current implementation status in Europe and North America.
- We will then review the core technologies of LTE, such as OFDMA, SC-FDMA, Antenna technologies and the channel structures and resource allocations on the shared channels.
- We will then review different interworking options, such as I-WLAN, WISPr, tunneling through GAN / UMAN / VoLGA or as non-trusted, non 3GPP access network connecting to LTE infrastructure with DSMIP or PMIP as well as reviewing voice call setups with and without IMS support.
- We will discuss in detail the changes and enhancements that will be introduced with LTE-Advanced, such as the increase in throughput, Spectral Efficiency, the relationship with LTE, Carrier Aggregation, Coordinated Multipoint Transmission and the use of Relay Nodes.
- The course will conclude with other enhancements introduced with LTE Advanced as well as possibly still lacking Enhancements.

Prerequisites:

- The student should possess good knowledge in wireless and/or cellular communication technology before coming to the course.
- We would recommend our webinars or web based training courses on LTE to be taken as course preparation.

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Course Target:

- The student is enabled to understand the LTE technologies and the evolution towards LTE advanced with 3GPP release 10 ff.

Some of your Questions that will be answered:

- What are the technologies behind the various specification evolutions from 2G to 4G and what is the current status of LTE implementations?
- How does a voice call setup work with LTE , what are the options and what are the benefits of using VoLGA or IMS?
- How is authentication of the terminal being done in case of a roaming through WiFi or any other access technology instead of a LTE access?
- What are the main improvements with LTE-Advanced to achieve the target throughput rates and efficiency?
- How does Intra-and Inter-Band Carrier Aggregation work to obtain the required system bandwidth?
- What is Coordinated Multipoint Transmission and how does it work?

Who should attend this Course:

- The course is particular useful to technical managers and other staff who need to develop a clear understanding of the evolution and impact of the migration from LTE towards LTE-Advanced.

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Table of Content:

Introduction

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Technology of LTE

- **Generic Assessment of Smart Antenna Techniques**

  ⇒ Terminology & Introduction
  SISO, SIMO, MISO, MIMO, Physical Basics of the Multipath Dimension, Signal Fading and Alteration between Tx and Rx, Scattering, Refraction, Reflection, Diffraction, Consequences for the different Signal Paths, Macro-Diversity vs Micro-Diversity

  ⇒ MIMO
  Specifics of MIMO, How MIMO basically works ..., Single User- vs Multi User-MIMO

  ⇒ STBC and SFBC

  ⇒ Transmit Beamforming

  ⇒ Smart Antenna Techniques in LTE
  Overview, Receive Diversity, SFBC, SU-MIMO, MU-MIMO, Transmit Beamforming, Processing Chain and Terminology, The Term: "Codeword", The Term: "Layer", The Term: "Precoding", The Term: "Antenna Port"

- **Introduction to OFDM/OFDMA Technology**

  ⇒ Impact of Orthogonality in the Frequency Domain – 3 Steps

  ⇒ Practical Exercise: Physical Basics of OFDM / OFDMA

  ⇒ OFDM / OFDMA and IFFT
  Considering the Discrete Oscillator Array Option, Details of the IFFT Option, Why is it called F a s t Fourier Transformation?

  ⇒ Modulation Scheme Overview

  ⇒ Using different Modulation Schemes on Different Subcarriers

  ⇒ Tackling Inter-Symbol Interference (ISI)
  Introduction, Delay Spread, Cyclic Prefix, Variable Duration and other Assets of the Cyclic Prefix, Cyclic Prefix in OFDMA in LTE

  ⇒ From generic OFDM/OFDMA to the LTE-Implementation
  The OFDM-"Brickwall", Time / Frequency View on OFDM: The "Grid", Subcarrier Spacing in LTE, Transmission Bandwidth in LTE, Definition of Radio Frame, Sub-Frame and Slot in LTE, Cyclic Prefix Options in LTE, Definition of Slot, Subframe and Radio Frame, Resource Blocks and TTI in LTE, Virtual vs Physical Resource Blocks, System Bandwidth and Resource Blocks, Number of RB's, FFT-Size and Bandwidth

  ⇒ SC-FDMA
  Why SC-FDMA?, PAPR of Single-Carrier vs. Multi-Carrier Systems, The Processing Chain of SC-FDMA, Example: Processing Data through SC-FDMA, Step 1 : Converting Binary Information into Sub-Symbols, Duration of a single Sub-Symbol, Step 2: Preparation of DFT / Number Conversion, Step 3: Introducing the Formula of DFT, Step 4: Execution of M-Point DFT, Step 4: Final Result of the DFT: The 4 Subcarriers, Step 5: Shifting the Subcarriers to the Correct Frequency, Step 6: Execution of IFFT on Subcarrier x[0..3]

  ⇒ Introducing CAZAC-Sequences
  Reviewing Autocorrelation Properties, Zadoff-Chu Sequence Generation

- **Channels in E-UTRAN**

  ⇒ Logical, Transport and Physical Channels

  ⇒ Mapping Channels to the OFDMA-Grid
  Problem Description, Important Constraints for Permutation Rules, Mapping of Downlink Channels and

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Signals, Primary & Secondary Synchronization Signals and PBCH, Content and Meaning of PSC and SSC, Content and Meaning of the PBCH, Downlink Reference Signals, PCFICH, PHICH

- **Resource Allocation in LTE**
  - ⇒ Relationship between PDCCH and PDSCH
  - ⇒ Transmission Mode and DCI
  - ⇒ Example for Downlink Resource Allocation: DCI-Format 1 / Resource Allocation Type 0
  - ⇒ UL Resource Allocation
    Example for Uplink Resource Allocation: DCI-Format 0 / Resource Allocation Type 2
- **Mapping of Uplink Channels and Signals**
  - ⇒ Time-Frequency Grid for SC-FDMA
- **Protocol Stacks**
  - ⇒ Control Plane / E-UTRAN - EPC
  - ⇒ User Plane E-UTRAN – EPC (S5/S8 GTP-based)
  - ⇒ User Plane E-UTRAN – EPC (S5/S8 PMIPv6/GRE-based)
  - ⇒ Some Look at RRC...

Operation & Applications of LTE

- **The NAS (Non-Access Stratum)**
  - ⇒ EPS Mobility Management (EMM)
    Important EMM-Procedures, Common Procedures, Specific Procedures, Connection Management Procedures, State Machine, Relationship between EMM and ECM
  - ⇒ EPS Session Management (ESM)
    Important ESM-Procedures, MME-initiated, UE-initiated, State Machine
- **Attachment and Default Bearer Setup**
- **Voice Services over LTE**
  - ⇒ Overview
  - ⇒ Architecture in case of IMS-based Voice Services
    SRVCC, Signaling Procedure (SIP, SDP, DIAMETER), LTE and the need for IMS
  - ⇒ Architecture in case of circuit-switched Fallback
    Procedure Description, Signaling Procedure for MOC
  - ⇒ Architecture in case of VoLGA
- **E-UTRAN Measurements**
  - ⇒ Overview

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⇒ Measurements and their Constraints in E-UTRAN

⇒ Measurement Events in E-UTRAN

- **Idle Mode Procedures – Neighbor Cell Monitoring & Cell Reselection**

⇒ Priority-Based Cell Reselection of Multi-RAT UE's
SPID - Subscriber Profile ID for RAT/Frequency priority, E-UTRAN priority-based Cell Reselection Details, UTRAN priority-based Cell Reselection Details, GERAN priority-based Cell Reselection Details

Changes & Enhancements with LTE-Advanced

- **Targets of IMT-Advanced**

⇒ Overview

⇒ Relationship between LTE and LTE-Advanced

⇒ Overview of Features of LTE-Advanced

- **Carrier Aggregation / Use of Component Carriers**
Contiguous Intra-Band, Non-Contiguous Intra-Band, Non-Contiguous Inter-Band

⇒ Initially Investigated Deployment Scenarios

- **Introduction of Relay Nodes => Coverage Extension**
Overview, The Un-Interface, Operation

Solutions for Practical Exercises

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