Course ID
LTE-CT
Course Duration
3 days

Course Title
LTE: A Comprehensive Tutorial

Related Courses

- Principles of OFDM and MIMO (OM, 3 days)
- LTE: Technology, Business, and Competitive Landscape (LTE-BIZ, 2 days)
- LTE: A Comprehensive Three Day Course (LTE-C3DC, 3 days)
- LTE Air Interface Techniques (LTEAI, 3 days)
- LTE Air Interface Techniques: A Comprehensive Course (LTEAI4D, 4 days)
- LTE Signaling and Functionality (LTESIG, 3 days)
- LTE Planning Considerations (LTEPLAN, 4 days)
- LTE Advanced System Techniques (LTE-ADV, 4 days)
- LTE/SAE: A Technology Overview (LTE-TECH, 3 days)
- LTE RF Network Planning Workshop (LTEWK, 5 days)
- LTE/4G: The Next Generation Mobile Networks (LTE4G, 2 days)
- LTE/4G: A Comprehensive Look at the Next Generation Mobile Networks (LTE4, 4 days)
- LTE Air Interface: An Advanced Course for Hardware/Software Developers (LTEHSW, 5-10 days)
- HSDPA: Network Architecture, Operation, and Design (HSDPA, 2 days)
- HSUPA: Network Architecture, Operation, and Design (HSUPA, 2 days)

Aimed At

This course is aimed at technical professionals who are familiar with 2G and/or 3G wireless technologies and desire an overview of the LTE technology.

Group Size

5-25

Prerequisites

Familiarity with 2G and/or 3G wireless technologies.

Course in a Nutshell

The course begins with a review of the RF/wireless basics, 3GPP standards evolution, and a discussion of the key 4G-enabling technologies such as OFDM, MIMO, and HARQ. This is followed by a comprehensive discussion of the physical layer for both the uplink and the downlink, antennas employed with LTE, and spectrum management issues. The course concludes with a look at the state-of-the-art of LTE deployment as well as the future of LTE technology evolution.

Customize It!

We can customize this course to suit the needs of audiences such as hardware designers, application developers, service designers, sales engineers, marketing/sales personnel, radio planners, and persons involved in defense and homeland security.

Course Outline

Part 1: Cellular Systems Design and Components

- **Introduction**
  - The cellular concept and objectives
- **Radio signal propagation**
  - Basic channel modeling
  - Signal strength vs distance
  - Impediments to propagation
- **Interference**
  - Co-channel interference
  - Carrier-to-interference ratio
  - Adjacent channel interference
- **Frequency reuse and planning**
  - Cellular hexagonal grid concept
  - Distance to reuse
  - Handoff strategies

Part 2: 3GPP Standards Evolution

- **3GPP standardization process**
  - The need for standardization
  - 3GPP structure and operation
- **Motives behind 3G evolution**
  - Driving forces
  - Radio access evolution
  - Core network evolution
- **Summary of 3GPP standards**
  - Summary of GSM operations
  - Summary of GPRS/EDGE operations
  - Summary of UMTS/WCDMA operations
  - Summary of HSPA operations
  - New technologies for LTE

Part 3: 3G Technology Development

- **The challenge of high data rates in mobile communications**
  - Fundamental constraints
  - Higher order modulation for limited bandwidth applications
  - Wider bandwidth and multicarrier operation
- **Orthogonal frequency division multiplexing (OFDM)**
  - Principles of OFDM

  - OFDM implementation methods
  - Cyclic prefix
  - Channel estimation
  - Frequency diversity
  - Selection of OFDM parameters
  - OFDM as a multiple-access scheme
- **Wideband single carrier transmission**
  - Equalization against frequency selective fading
  - Discrete Fourier transform (DFT) spread OFDM
- **Multiple input multiple output (MIMO) methods**
  - Benefits of MIMO
  - Multiple receive antennas
  - Multiple transmit antennas
  - Spatial multiplexing
- **Scheduling, link adaptation, and hybrid automatic repeat request (HARQ)**
  - Power and data rate control
  - Channel dependent scheduling
  - Advanced retransmission schemes using HARQ

(Day 2)

Part 4: Physical Layer for Downlink

- **Orthogonal frequency division multiple access (OFDMA)**
  - OFDM signal structure in LTE
  - OFDM performance
  - OFDMA methods for LTE
- **Synchronization and cell search**
  - Synchronization sequences and cell search in LTE
  - Coherent and non-coherent detection
- **Reference signals (RS) and channel estimation**
  - LTE RS design
  - Frequency domain channel modeling and estimation
  - Time domain channel modeling and estimation
- **Downlink physical data and control channels**
  - Downlink data transporting channels
  - Downlink control channels
- **Channel coding and link adaptation**
  - Link adaptation and feedback

- Channel coding for data and control channels

- **Multiple access**
  - Multiple antennas
  - Multiple-input multiple-output (MIMO) in LTE
- **Multi-user scheduling and interference mitigation**
  - Resource allocation strategies
  - Scheduling algorithms
  - Interference coordination and frequency reuse in LTE
- **Radio resource management**
  - User equipment (UE) mobility activities
  - Cell search
  - Measurements when connected to the LTE system
  - Neighbor cell monitoring and cell reselection
  - Handover techniques
- **Broadcast operations**
  - Broadcast modes
  - Multimedia broadcast and multicast service (MBMS) in LTE
  - UE capabilities for MBMS reception and processing
  - Mobile broadcast modes

Part 5: Physical Layer for Uplink

- **Single-carrier frequency-division multiple-access (SC-FDMA)**
  - SC-FDMA signal structure for LTE
  - SC-FDMA signal generation
  - Transmit processing for LTE
- **Uplink reference signals (RS)**
  - RS sequence generation
  - Sequence group hopping and planning
  - Demodulation reference signals
  - Uplink sounding reference signals
- **Uplink physical channel structure**
  - Uplink data channels
  - Uplink control channels
  - Multiplexing of control signaling
  - Multiple access techniques
- **Uplink capacity and coverage**
  - Factors affecting capacity and their evaluation
  - LTE uplink coverage and link budget

- **Random access on the uplink**
  - Random access procedures
  - Random access channel design and implementation
  - Time division duplex (TDD) random access channel
- **Uplink transmission procedures**
  - Uplink timing control
  - Uplink power control

(Day 3)

Part 6: Antennas for LTE

- **Basic antenna characteristics**
  - Effective isotropic radiated power
  - Polarization
  - Directivity and gain
- **Antenna types and selection**
  - Transmit and receive antennas
  - Downtilt
  - Sectoring antennas
- **Advanced antennas for base stations**
  - Receive and transmit diversity
  - Beamtilt
  - Modular high-gain antennas
  - Higher order sectorization
  - Fixed and steerable array antennas
- **Performance assessment factors**
  - Capacity, coverage, and quality-of-service
  - Cell count estimation and simulation
  - Directional antennas and signal interception

Part 7: Spectrum Management

- **Spectrum allocation for 3G technologies**
  - Bandwidths and channel spacing
- **Duplex modes**
  - TDD, FDD, and HD-FDD
- **Interference in unpaired spectrum**
  - Adjacent carrier interference
- **Half-duplex system design**

- Transmit/receive switching
- Coexistence with other systems
- HD-FDD operations

- **Reciprocity**
  - Conditions for reciprocity
  - Applications of reciprocity

Part 8: LTE Today and Tomorrow

- **Status of LTE Deployments**
  - Technology comparison with WiMAX
  - Status of major carrier commitments
- **Overview of LTE-Advanced**
  - Fundamental requirements
  - Technical components
- **Course Wrap-up: Recap and Discussion**

How You Will Learn

- A highly qualified engineer/instructor, well-versed in a number of 4G and 3G wireless technologies, will present this course in an interactive lecture format.
- Along with the lecture, we employ discussion, group activities, and case studies to help you understand the key points.
- If you already know something about 3G/4G technologies, we will build on that knowledge base. We'll compare and contrast what's already known to you with what's new, making the new material easier to learn.
- If your background is less technical, we will use appropriate examples and analogies to convey the complex subject matter in terms that make sense.
- You will receive a printed Participant Handbook which will help you remember and retain what you learned in class and use it on the job.

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