

Understanding

# LTE Air Interface and E-UTRAN

LTE's PHYSical and MAC layers



## Course Description

This course which covers the major area of LTEs (Long Term Evolution) Evolved UMTS Terrestrial Radio Access (E-UTRA). Mainly the Physical layer but the RLC, PDCP and MAC layers and interaction are included.

The new physical layer is key to the level of performance that LTE must deliver and much flexibility has been incorporated to cope with varying allocations of spectrum, as well as the workbook in both printed and searchable electronic formats, attendees receive a specially produced LTE Air Interface acronym list.

While there is a section on MIMO and beamforming antennas, this is a large subject and those requiring in-depth knowledge of this topic are directed towards the separate two day Antennas for LTE course.

## Students Will Learn

- **Understand Spectrum Implications for LTE**
- **Comprehend OFDMA and SC-FDMA and Their Usage**
- **Be Aware of The MIMO Implications and Options**
- **Appreciate The Radio Channels And Resource Allocation**
- **Gain Knowledge of Detailed MAC Operation**
- **Be Aware of the Air Interface Security Operation**
- **And More...**

## Target Audience

Anyone needing an in-depth understanding of the areas of LTEs (Long Term Evolution) Evolved UMTS Terrestrial Radio Access (E-UTRA). Specifically, the Physical and MAC layers are commended to this course. Such attendees would be employed by or contracted to operators, manufacturers, integrators or regulators.

## Prerequisites

The course assumes an understanding of LTE technical concepts and architecture. The core network especially is not described in this course.

## Course Outline

### Module I: The Position and Aim of the E-UTRA

Responsibilities

Architecture

Spectrum Usage & Frequency Bands

### Module II: **The LTE UE and BS**

#### Terminal identities

Tracking Areas

UE Transmitter Characteristics

UE Receiver Characteristics

### Module III: Physical Layer: Moving Antennas On

MIMO Concepts

Space Time Diversity Coding and Spatial Multiplexing

Channel Ranks

Beamforming

Precoding

Feedback

LTE MIMO Options

Module IV: LTE Multiple Access

OFDM, OFDMA and SC-FDMA

Inter Symbol Interference

OFDM Problems

SC-FDMA

Frequency Hopping

Proposed use in LTE

The FEC:- Turbo Coding Refresher

Modulation in LTE

Module V: Physical Channels

Physical, Logical and Transport Channels

Control channels and data channels

Uplink Data Transfer

Downlink Channels

Overview of the Downlink

Physical Multicast Channel

Physical Broadcast Channel

Physical control format indicator channel

•Uplink Channels

Physical Uplink Shared Channel

Physical Uplink Control Channel

Module VI: **Slot Structure and Physical Resource Elements**

Frame Types

Resource Grid

Resource Elements

Resource Blocks

Channels and Reference Signals

TDD Frames and Fields

Downlink Procedures

Uplink Procedures

## Module VII: **Layer 2: MAC Layer: Structure and Operation**

Protocols and Packets

Channels and Processes

RLC Sublayer

PDCP Sublayer

MAC Sublayer

## Module VIII: MAC Procedures

Random Access

DL-SCH data transfer

ARQ and HARQ

UL-SCH data transfer

PCH reception

BCH reception

Discontinuous Reception (DRX)

## Module IX: **MAC PDU Formats**

MAC PDU (DL-SCH and UL-SCH)

MAC Control Elements

MAC Headers

Transport Blocks

#### Module X: Security in the E-UTRA

Security Architecture

Implications

Attack Possibilities

User to Network Security

eNodeB Security

eNodeB Threats

Countermeasures

### **Delivery Method**

Instructor-Led with numerous case-studies and exercises.

### **Equipment Requirements**

**(This apply's to our hands-on courses only)**

BTS always provides equipment to have a very successful Hands-On course. BTS also encourages all attendees to bring their own equipment to the course. This will provide attendees the opportunity to incorporate their own gear into the labs and gain valuable training using their specific equipment.

### **Course Length**

2 Days