# LTE Advanced (R10-R12)

**Who Should Attend?**

The course is intended for experienced network engineers and E-UTRAN developers who are planning or have already started to introduce LTE-Advanced features.

**Course Scope**

1. Introduction:
   - 4G/IMT-Advanced and 3GPP LTE-Advanced requirements,
   - cell spectral efficiency, peak spectral efficiency,
   - cell edge user spectral efficiency,
   - mobility,
   - scalable bandwidth,
   - C/U-plane latency,
   - handover interruption time,
   - VoIP capacity,
   - frequency bands.
2. Carrier Aggregation (CA) R10-R12:
   - intra-band contiguous/non-contiguous and inter-band CA,
   - CA operating bands and bandwidth classes,
   - UE categories,
   - Primary and Secondary Cell / Component Carrier,
   - implementation scenarios,
   - L1/L2 protocol impact,
   - SCell addition / modification / release,
   - SCell activation / deactivation,
   - multiple Timing Advance,
   - enhanced Power Headroom reporting,
   - regular and cross-carrier scheduling,
   - CSI and HARQ-ACK reporting,
   - PUCCH format 1b CS and format 3,
   - (a)periodic SRS reporting,
   - UL multi-cluster transmission,
   - simultaneous PUCCH and PUSCH,
   - handover scenarios,
   - Event A6.
3. Dual Connectivity (DC) R12:
   - multi-site CA versus DC,
   - synchronous/asynchronous DC,
   - architecture – MeNB,
   - SeNB,
   - MCG bearer,
   - split bearer,
   - SCG bearer,

- terminal capabilities,
- operating bands,
- radio protocols,
- PDCP routing and re-ordering,
- X2UP protocol,
- SeNB addition/modification/release procedures,
- security,
- PH reporting,
- power control.

4. MIMO enhancements R10-R12:
- DL R8/R9 MIMO introduction – critical survey of existing TMs and transmission schemes,
- beamforming as the main MIMO solution in LTE-Advanced,
- new resource efficient Reference Signals – CSI-RS and URS for TM9/TM10,
- UL MIMO flexible DM RS sequence allocation (OCC) for MU-MIMO,
- UL TM2.

5. Coordinated Multi-Point transmission (CoMP) R11-R12:
- distributed and centralised RAN,
- backhaul and fronthaul,
- DL CoMP - Joint Transmission (JT),
- Dynamic Point Selection (DPS) / Dynamic Cell Selection (DCS),
- Coordinated Scheduling/Beamforming (CS/CB),
- UL CoMP - Joint Reception (JR),
- Coordinated Scheduling and Beamforming (CS/CB),
- TM 10,
- CSI reporting.

6. eNB Relay (RN) R10-R12:
- E-UTRAN architecture supporting RNs,
- inband (type 1) / outband (type 1b),
- U/C plane protocol stack for supporting S1/X2 over Un interface,
- RN start-up procedure:
  - phase I: Attach for RN preconfiguration
  - phase II: Attach for RN operation,
- RRC RN Reconfiguration procedure,
- Uu/Un interface time multiplexing FDD & TDD,
- R-PDCCH channel,
- RN versus repeater.

7. Small cells enhancements R12:
- 256 QAM,
- shared HeNB,
- X2 Gateway,

8. Heterogeneous Network (HetNet) R10-R12:
- various HetNet implementation scenarios utilising CA, DC, RN, MIMO and CoMP,
- HetNet micro cell range extension,
- interference problems,
- network synchronisation,

- Enhanced Inter-Cell Interference Control (eICIC),
- Almost Blank Subframes (ABS).

9. Machine-to-Machine (M2M) R11-R12:
- UE category 0,
- embedded SIM (eUICC),
- MFF1/MFF2 M2M SIM,
- M2M related USIM parameters – EFnasconfig,
- Extended Access Baring (EAB) and other access control procedures,
- overriding low access priority and EAB,
- overload protection: charging,
- periodic TAU optimisation,
- usage of low priority indicators,
- EMM and ESM back off timers,
- PLMN (re)selection optimisation,
- invalid USIM state reset,
- UE Power Saving Mode (PSM),
- RRC UE assistance for RRM and UE power optimisations.

10. Proximity Services (ProSe) / Device-to-Device communication (D2D) R12:
- use cases and scenarios,
- architecture,
- UE-to-Network Relay,
- ProSe Application Server,
- UE identities,
- direct discovery and direct communication,
- HSS subscription,
- C/U-plane protocol stacks,
- sidelink,
- interferences and power control.

11. Minimisation of Drive Test (MDT) R11-R12:
- MDT in connected/idle mode – Immediate/Logged MDT,
- MDT measurements:
  - RSRP/RSRQ, PH,
  - UL interference,
  - data volume,
  - IP throughput
  - and measurement collection triggers,
- geographical positioning methods:
  - GNSS,
  - E-CID,
  - E-CGI,
- MDT control – area based and signalling based MDT,
- trace collection.

12. SON enhancement overview R9-R12:
- RLF and other failures,
- RLF report,
- connection re-establishment,

- RACH optimisation,
- intra-LTE/inter-RAT Mobility Robustness Optimisation (MRO),
- intra LTE/inter-RAT Mobility Load Balancing (MLB),
- intra-LTE/inter-RAT Automatic Neighbour Relation (ANR),
- energy saving.
13. SR-VCC enhancements R10-R11:
    - reversed SR-VCC (rSR-VCC),
    - voice and video SR-VCC (vSR-VCC),
    - enhanced SR VCC (eSR-VCC).
14. Enhanced Interference Management and Traffic Adaptation (eIMTA) R12:
    - dynamic adaptation of UL/DL TDD configuration.
15. Wi-Fi Interworking R8-R12:
    - access Network Discovery and Selection,
    - Multiple Access PDN Connectivity,
    - IP Flow Mobility,
    - S2a-based Mobility over GTP,
    - Local IP Access (LIPA),
    - Selected IP Traffic Offload (SIPTO).
16. EPDCCH R11-R12:
    - need for control channel capacity increase,
    - EPDCCH transmission resources,
    - EPDCCH sets,
    - distributed and localised transmission,
    - EPDCCH in MIMO,
    - HetNet and CoMP environment.

**Course Objectives**

Unquestionably LTE™ R8/R9 has proved to be a great success. It is now the time for careful examination of all the technological improvements available in R10/R11/R12 along with their various implementation scenarios.

This course presents the operating principles of key LTE-Advanced features. These essential new LTE-Advanced concepts combined with students' technical experience will allow them to form their own opinions about the usefulness and applicability of specific features in the existing environment of their network and local mobile market.

This training contains not only brand new R12 features like Dual Connectivity, Proximity Services, and eIMTA, but also plenty of smaller R12 enhancements of "older" R10/R11 features and a separate section devoted to LTE/UMTS-WiFi integration.

# LTE Advanced (R10-R12)

**Prerequisites**

Knowledge of E-UTRAN/LTE is required. Completion of LTE/E-UTRAN Signalling course (or equivalent) is highly recommended.

**Training Structure**

Three-day training divided into logical sessions.

**Methodology**

Instructor-led training. Lectures and multimedia presentations.