Training Portfolio

INTERMEDIATE

ADVANCED

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Vendor: .ılSPLOTY	System: 5G
Level: **Intermediate**	Duration: **4 days**
Course Title: **5G System Overview**	

Description:

This training is an excellent choice for engineers who have already gained experience with previous generations of mobile technology and begun to work with the new 5G system. Training maintains an appropriate balance between the topics related to 5G CN, NG-RAN (radio part) and 5G based teleservices, giving the opportunity to understand the system as a whole. This training also provides required background knowledge needed to fully participate in more advanced training sessions focused on particular subsystem or network element issues.

Target audience:

The course is intended for 5G system technical staff and their management.

Contents:

Introduction

3GPP mobile network evolution, 5G system performance, technical/business use cases

Architecture

5GS service based and reference point architecture, UDM, UDR, UDSF, 5G-EIR, AMF, SMF, UPF, multiple Packet Session Anchors, Session and Service Continuity, SMS over NAS, PCF, AF, IMS/VoLTE support, interworking with LTE/EPC, NEF, NWDAF, AUSF, N3IWF, NRF, LADN, international roaming, GTPv1-U tunnelling, protocol stacks; identifiers: SUPI/IMSI, SUCI, PEI/IMEI, 5G-GUTI, GPSI/MSISDN/external identifier, Internal-Group Identifier, External Group Identifier, DNN, DNAI ,

PDU sessions & QoS

PDU Session types, QoS Flows, QoS Rules & PDRs, QoS profile: 5QI, non-GBR, GBR and delay critical GBR characteristics; ARP, RQA, notification control, UE-AMBR, Session-AMBR, UPF traffic processing, Forwarding Action Rules, QoS Enforcement Rules, Usage Reporting Rules, Support for Edge Computing,

Network Slicing

Network slicing concept, UE's multiple network slices, S-NSSAI and NSSAI, network slice instances, subscription parameters, UE Configuration, AMF selection, PDU session establishment and SMF selection, Network Function Virtualisation (NFV), TNL associations, RAN virtualisation,

Traffic Cases

RM states: RM-REGISTERED and RM-DEREGISTERED states, TA/TA list management, CM states: CM-CONNECTED with RRC-CONNECTED state, CM-CONNECTED with RRC-INACTIVE state, CM-IDLE, selective (de)activation of U-plane connections, UE reachability in CM-CONNECTED, RAN-based Notification Area (RNA) and paging, MICO mode, procedures: Registration, UE Triggered Service Request, Network Triggered Service Request, AN Release, PDU Session Establishment, SMS, Xn-based Handover, N2-based Handover, N26-based 5GS to EPS handover,

Security

User identity confidentiality; Authentication and Key Agreement (AKA); NAS, RRC and user data ciphering and integrity protection, mobile equipment identification,

NG-RAN

Separation of gNB-CU and gNB-DU, Separation of gNB-CU-CP and gNB-CU-UP, F1 and E1 interfaces, fronthaul options (CPRI, eCPRI, nFAPI), F1/E1 procedures: F1 startup and cells activation, gNB-CU-UP E1 Setup, UE Initial Access, Inter-gNB-DU Mobility, RRC-CONNECTED to RRC-INACTIVE state transition, RRC-INACTIVE to other RRC states transition,

NR

Frequency bands (FR1/FR2), Carrier Aggregation(CA) & Supplementary Uplink (SUL), OFDMA, multiple numerologies, channel bandwidth, FDD/TDD, dynamic TDD, frame structure, Resource Element (RE) & Resource Block (RB), Bandwidth Part (BWP), ARFCN, cell search, SSB blocks, reference signals, MIMO, digital and analogue beamforming, beam sweeping, resource allocation methods,

DSS

Spectrum sharing alternatives (static sharing, re-farming, dynamic spectrum sharing), DSS support in 3GPP standards, deployment alternatives (MBSFN, mini-slot, rate matching), SSB transmission in DSS (non-MBSFN and MBSFN scenario), 3GPP features required for DSS, impact on System Information (SI), capacity considerations (PDCCH capacity, PDSCH capacity), cell resource coordination, DSS deployment phases,

Multi-RAT Dual Connectivity

MR-DC types: NR-DC, EN-DC, NGEN-DC, NE-DC, bearer types, traffic cases.

Prerequisites:

The participants should have general technical telecommunications/computer science knowledge on a degree level. Knowledge about LTE is very useful.

Training method:

Lectures and multimedia presentations.

Vendor: SPLOTY	System: 5G
Level: **Intermediate**	Duration: **2 days**
Course Title: **5G Radio Planning**	

Description:

This training is an excellent choice for engineers responsible for the radio access network planning. Contrary to previous generations, 5G for the first time utilizes very high frequencies reaching 60GHz also called mmWave bands. These high frequency bands offer a wide spectrum that is vital for the improvement of the network performance. However, this comes at a cost. Free space propagation loss increases significantly for the high frequency bands. As a consequence cell radius is much smaller compared to former technologies. This network densification has a significant impact on the radio planning. New propagation models and planning techniques are required. Also other aspects like energy efficiency have to be taken into consideration. This course presents the latest developments in cell planning focused on 5G system.

Target audience:

The course is intended for 5G system technical responsible for radio network planning, design and optimisation.

Contents:

Introduction

3GPP mobile network evolution, 5G system performance, Standalone (SA) and Non-Standalone (NSA) implementation,

Architecture

5GS service based and reference point architecture, UDM, UDR, UDSF, 5G-EIR, AMF, SMF, UPF, multiple Packet Session Anchors, Session and Service Continuity, SMS over NAS, PCF, AF, IMS/VoLTE support, interworking with LTE/EPC, NEF, NWDAF, AUSF, N3IWF, NRF, LADN, international roaming, GTPv1-U tunnelling, protocol stacks; identifiers: SUPI/IMSI, SUCI, PEI/IMEI, 5G-GUTI, GPSI/MSISDN/external identifier, Internal-Group Identifier, External Group Identifier, DNN, DNAI,

NG-RAN

Separation of gNB-CU and gNB-DU, Separation of gNB-CU-CP and gNB-CU-UP, F1 and E1 interfaces, fronthaul options (CPRI, eCPRI, nFAPI), F1/E1 procedures: F1 startup and cells activation, gNB-CU-UP E1 Setup, UE Initial Access, Inter-gNB-DU Mobility, RRC-CONNECTED to RRC-INACTIVE state transition, RRC-INACTIVE to other RRC states transition, TNL associations, RAN virtualisation,

NR

Frequency bands (FR1/FR2), mmWave characteristics, propagation losses (free space loss, atmospheric attenuation, foliage losses, body losses, penetration losses), link budget, mobility related problems (Doppler shift and Doppler spread),

5G Cell Planning

Cell planning fundamentals (planning objectives, inputs and outputs to the planning process), Green Planning (energy metrics and throughput efficiency, optimum base station location for minimum energy consumption), planning of mmWave frequency bands, new propagation models for high frequencies (free space propagation loss including rain and foliage attenuation, Alpha-Beta-Gamma model), algorithms for optimum base station selection (elimination algorithm, evolutionary strategy-based algorithm), detailed analysis of 5G network coverage planning aspects, designing and antenna array (reducing grating lobes and side lobe's power), RF link budget analysis, SINR and signal strength simulations, higher order sectorisation, antenna downtilt optimisation, planning of cloud RAN (optimisation of the number of virtual Baseband Units – vBBUs), Automated Cell Planning (geographic information system, 3D building model), cell planning case studies discussion.

Prerequisites:

The participants should have general technical telecommunications/computer science knowledge on a degree level. Knowledge about radio planning methods for previous mobile technologies is very useful.

Training method:

Lectures and multimedia presentations.

Vendor: .ISPLOTY	System: LTE
Level: **Intermediate**	Duration: **3 days**

Course Title:

EPS/LTE System Overview

Description:

This training is an excellent choice for engineers who have already gained experience with previous generations of mobile technology and begun to work with the new EPS/LTE system. Training maintains an appropriate balance between the topics related to E-UTRAN (radio part), EPC (CN part) and LTE™ based teleservices, giving the opportunity to understand the system as a whole. This training also provides required background knowledge needed to fully participate in more advanced training sessions focused on particular subsystem or network element issues.

Target audience:

The course is intended for EPS/LTE technical staff and their management.

Contents:

Introduction

3GPP mobile network evolution, LTE performance,

Network architecture

EPC: MME, S-GW, P-GW, HSS, EIR, PCRF, interfaces; E-UTRAN: eNB, S1 and X2 interfaces; interworking with GERAN/UTRAN: SGSN, S3, S4 and S12 interfaces; HPLMN routed traffic and local breakout international roaming scenarios; geographical network structure, identity numbers,

OFDMA and SC-FDMA

overview of multiple access technics used in 3GPP RANs, OFDMA fundamentals, OFDMA transmitter/receiver, OFDMA advantages/disadvantages, SC-FDMA fundamentals, OFDMA and SC-FDMA comparison,

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E-UTRAN

FDD/TDD, Inter-Cell Interference, basic transmission structures and parameters, MIMO, channels, transmission process, air interface protocol stack,

EPC

MME in pool, signalling transport - SIGTRAN, user data transport – GTP, database communication – Diameter, default and dedicated EPS bearer, QoS,

PCC

Policy and Charging Control, PCRF in LTE, interworking between EPS/LTE and IMS/VoLTE/RCS via PCRF,

Traffic Cases

EPS attach, TA update, service request, connection release, dedicated bearer activation, UE requested bearer resource allocation, intra-LTE handover, inter-RAT handover, ISR,

Security

Authentication & Key Agreement, key hierarchy, ciphering, integrity protection, key chaining,

SON

Self Organising/Optimising Network – procedure examples: eNB self configuration, interference avoidance, handover optimisation, load optimisation,

CSFB &SMSoSGs

SGs interface, combined EPS/IMSI attach and TA/LA update, CSFB MT/MO call, SMS MT/MO,

IMS services

VoLTE and RCS service profile, LTE – VoLTE interworking, IMS architecture and principles, IMS registration, ASs examples, VoLTE call, SMS, SR-VCC, chat.

A-LTE overview

CA, MIMO, CoMP, eICIC and HetNet, Relay Node.

Prerequisites:

The participants should have general technical telecommunications/computer science knowledge on a degree level. Knowledge about GSM/UMTS GPRS services is very useful.

Training method:

Lectures and multimedia presentations.

Vendor: .ilSPLOTY	System: LTE, IMS
Level: Intermediate	Duration: 2 days
Course Title:	

VoLTE Overview

Description:

VoLTE Overview is an intermediate level of technical training focused on GSMA IR.92 IMS Profile for Voice and SMS over LTE™. VoLTE is presented in the broad context of existing multi-RAT mobile system. Hence, the training explains not only IMS architecture and procedures, but also integration of VoLTE with the existing network infrastructure and services (including CSFB and SMSoSGs).

Target audience:

This training is an excellent choice for engineers and managers who are already familiar with LTE and begin to introduce VoLTE in their network. Participants representing different departments are welcome on the same training session. Mixed groups result in much more interesting discussions and hence a better understanding of the subject among participants. Moreover, mixed groups also result in better inter-department personal relations that are especially important during initial VoLTE troubleshooting.

Contents:

Introduction

LTE, IMS, MMTel, VoLTE, SR-VCC, CSFB & SMSoSGs, RCS, standardisation bodies,

LTE overview

IP-CAN concept, network structure, PCC architecture, attach procedure including PCRF interactions, default and dedicated bearer, PCRF usage including PCEF initiated bearer establishment, QoS parameters (bearer related and bearer unrelated), subscriber data in HSS, mobility (handover and Tracking Area update), service continuity, fast signalling,

VoLTE efficient handling

- mandatory and optional features,
- DRX,

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- ROHC,
- AMR-NB and AMR-WB speech codecs,
- link adaptation,
- EVS codec,
- Dynamic Scheduling and Semi-Persistent Scheduling (SPS),
- DTX,
- HARQ fast re-transmissions,
- Frequency Hopping (FH),
- VoLTE Performance,

IMS basics

IMS architecture components, USIM vs ISIM, IMPI, IMPU, IMS subscription data in HSS, P-CSCF discovery, Application Servers, addressing and routing principles, IMS registration, third-party registration, Initial Filter Criteria (iFC), DNS/ENUM, IPX, security, number portability,

VoLTE voice call

- mobile-to-mobile call,
- SIP and SDP,
- PCC (PCRF) interworking,
- interworking with CS system – calls between VoLTE and CS terminals,
- coexistence of VoLTE and CSFB – T-ADS,

SMS

- SMSoIP service architecture,
- SMSoIP registration,
- SMS transfer,
- integration with SMS Router,

Supplementary services

MMTel and VoLTE supplementary services, synchronization of subscriber profile between CS and IMS domains, examples of supplementary service procedures (Communication Hold – HOLD, Conference – CONF, Communication Diversion – CDIV, Message Waiting Indication – MWI, DTMF),

SRVCC

- SRVCC service architecture,
- SRVCC related identities,
- SRVCC registration,
- SRVCC handover from LTE to 2G/3G CS network,

- SRVCC enhanced with ATCS,
- registration using ATCS enhancements,

CSFB and SMSoSGs

- traditional CS services in LTE without VoLTE support, CSFB and SMSoSGs as the intermediate solution for roaming subscribers and emergency calls,
- CSFB and SMSoSGs architecture,
- CSFB – MO and MT calls,
- SMSoSGs – MO and MT SMS,
- UE domain selection,
- VoLTE migration path,

Security

3GPP & IMS Authentication and Key Agreement, Security Association setup, Ciphering, Generic Authentication Architecture, Generic Bootstrapping Architecture,

Interworking and Roaming

- inter-IMS interworking (IBCF, TrGW),
- PS/CS interworking (BGCF, MGCF),
- international roaming (Local Breakout – LBO, roaming support in PCC – V-PCRF and H-PCRF),

Emergency calls

IMS architecture for emergency calls, emergency service categories, sources for emergency numbers, emergency call initiation, emergency registration to EPS, emergency registration to IMS, geographical positioning, domain selection for emergency call set-up,

Charging & Accounting

charging architecture, offline and online charging, charging data correlation.

Prerequisites:

The participants should be familiar with basic aspects of mobile network architecture and services. Background knowledge of LTE is highly recommended.

Training method:

Lectures, multimedia presentations and practical exercises.

Vendor: .ılSPLOTY	System: LTE LTE-Advanced
Level: **Advanced**	Duration: **1 day**

Course Title:

E-UTRAN Standard Counters & KPIs (R8-R12)

Description:

The training presents standard R8-R12 E-UTRAN counters and KPIs that are comparable across all vendors' implementations. Each counter is described in the system-wide context of procedures and configuration parameters impacting its value.

Please note that only standard counters and KPIs are covered. This training should not be considered as an alternative to similarly titled trainings offered by equipment vendors, since standard counters are just a small fraction of the total number of counters available in real equipment. The counters covered in this training can, however, be used for benchmarking of E-UTRAN areas served by eNBs from different manufacturers.

Target audience:

This training is an excellent choice for engineers and managers who have already been familiar with LTE™/EPS and require knowledge about the most fundamental E-UTRAN counters and KPIs that should be available in every vendor implementation. This knowledge can be a basis for further self or instructor lead studies on E-UTRAN performance management. At the same time it should be sufficient for engineers who are not directly responsible for E-UTRAN but for some reason need an overview of E-UTRAN measurements (e.g. EPC/CN, IMS/VoLTE/RCS engineers).

Contents:

Introduction:

management system architecture, measurement result generation (Cumulative Counter, Status Inspection, Gauge, Discrete Event Registration), measurement definition structure, measurement reporting, performance alarms.

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Counters related to:

- RRC connection,
- UE Context Management,
- E-RAB management,
- Intra-RAT Handovers,
- Cell level QoS measurements,
- Radio resource utilisation,
- UE-associated logical S1-connection,
- Paging,
- LAs of overlapping RAT's (CSFB),
- Measurements related to equipment resources,
- RF measurements,
- SCell scheduling related measurements in CA,
- Measurements related to Relay Node,
- Measurements related Measurement Report,
- UE Rx-Tx time difference and AOA related measurements.

Key Performance Indicators (KPIs):

- Accessibility,
- Retainability,
- Integrity,
- Availability.

Prerequisites:

The participants should be familiar with basic aspects of mobile network architecture and services. Background knowledge of LTE is highly recommended.

Training method:

Lecture and multimedia presentation.

Vendor: .ISPLOTY	System: LTE
Level: **Advanced**	Duration: **4 days**

Course Title:

E-UTRAN/LTE Signalling

Description:

The course contains in-depth description of all interfaces, protocols and procedures within LTE™ RAN - E-UTRAN. The description of each protocol begins with theoretical instructor-led presentation closely followed by set of relevant practical exercises boosting students' attention and involvement. The vast majority of the exercises are based on real network traces presenting both fully successful procedures as well as some selected problematic cases. The training also contains an overview of the LTE/EPS architecture and functionality which is necessary to show E-UTRAN operation within the context of the entire system and to fully cover all aspects of E-UTRAN – EPC interworking.

Target audience:

Experienced network engineers, network planning, management and tuning staff, protocol stack developers and testers, as well as anyone with network experience who needs deep technical knowledge of E-UTRAN.

Contents:

Introduction

EPS Architecture, CSFB, SR-VCC, SON, EPS bearers, QoS, MME in pool, MOCN/MORAN, TA concept, identity numbers, OFDMA/SC-FDMA, MIMO, channels,

Traffic Cases

protocol states, attach and TA update, paging, service request, connection release, bearer activation, intra-LTE and inter-RAT handovers, ISR, CSFB call and SMS, SR-VCC PS to CS handover,

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Security

HSS/AuC and USIM functionality, authentication and key agreement, key hierarchy, ciphering and integrity protection, KSN and local authentication, re-keying and key change, inter-RAT mobility,

NAS EPS Mobility Management (EMM)

signalling connection establishment, routing of initial NAS messages, signalling connection release, GUTI reallocation, authentication, security mode control, identification, information procedure, attach, detach, TA update, service request, extended service request, paging, SMS,

NAS EPS Session Management (ESM)

default and dedicated bearer activation, IP address allocation, bearer modification, bearer deactivation, UE requested PDN connectivity/disconnect, UE requested bearer resource allocation/modification, information request procedure,

Radio Resource Control (RRC)

protocol states, signalling and data radio bearers, system information, paging, connection establishment, reconfiguration, reestablishment, intra-LTE mobility, "forward and backward" handover, inter-RAT mobility, measurements and event reporting, connection release, idle mode mobility,

Packet Data Convergence Protocol (PDCP)

sequence control and duplicate detection, integrity protection, ciphering, status reporting, data retransmission during handover and reestablishment,

Radio Link Control (RLC)

RLC transmission modes: TM, UM and AM, error correction, concatenation, segmentation and reassembly of SDUs, re-segmentation and reordering of PDUs,

Medium Access Control (MAC)

contention based and non-contention based random access procedure, RNTIs, time alignment, DL/UL-SCH data transfer, HARQ operation, TTI bundling, adaptive and non-adaptive retransmissions, multiplexing and assembly of logical channels, QoS, SR, BSR and PHR reporting, DRX, SPS, VoLTE traffic handling,

Physical Layer – Downlink (PHY DL)

OFDM system model, CP length, radio frames, subframes and slots, resource grid, physical channel processing, scrambling, synchronisation and cell search, SCH channel, reference signals & channel estimation, PBCH, PCFICH, PHICH, PDCCH & REGs, DCI formats, resource allocation types, physical and virtual RBs, localised and distributed

virtual RBs, PDSCH, MIMO, spatial layers, transmission rank, codewords, precoding matrix, transmission modes and schemes, channel coding, link adaptation, (a)periodic CQI/PMI reporting, measurements, UE capabilities,

Physical Layer – Uplink (PHY UL)

SC-FDMA system model, localised and distributed transmission, spectrum allocation, radio frames, subframes and slots, resource grid, physical channels, demodulation and sounding reference signals, PUSCH, resource allocation, inter / intra subframe hopping, PUCCH, resource allocations, UCI formats, PRACH & preamble formats, power control,

Stream Control Transmission Protocol (SCTP)

SCTP packet, chunk structure, multihoming, association establishment, transmission of data, retransmission, stream concept, shutdown and abort procedures,

GPRS Tunnelling Protocol – User Plane (GTP-U)

user data tunnelling, handling of sequence numbers, header format, path management messages,

S1 Application Part (S1AP)

SCTP as S1AP bearer, E-RAB setup/modification/release, NAS transport, initial context setup, context modification/release; intra-LTE, inter-RAT and SRVCC handover, path switch, paging, management procedures, UE capability info indication, trace procedures, location reporting,

X2 Application Part (X2AP)

SCTP as X2AP bearer, handover, path switch, data forwarding, load indication, error indication, X2 setup, reset, eNB configuration update, resource status reporting, mobility settings change, radio link failure indication, handover report.

Prerequisites:

General knowledge of EPS/LTE system architecture and functionality is required. Knowledge about GSM/UMTS GPRS services is very useful.

Completion of *EPS/LTE System Overview* course (or equivalent) is highly recommended.

Training method:

Lectures, multimedia presentations and practical exercises.

Vendor: .ISPLOTY	System: LTE
Level: **Advanced**	Duration: **4 days**
Course Title: **EPC/LTE Signalling**	

Description:

This training contains detailed description of all protocols and interfaces used in the EPC – Core Network part of EPS/LTE™ system. Every protocol is described together with exemplary signalling procedures to enhance understanding its functionalities. During the training students have also opportunity to analyse protocol traces from real-life networks. Practical exercises are designed to give attendees additional confidence when working with protocols in live networks.

Target audience:

Experienced network engineers, support engineers, protocol stack developers and testers, as well as anyone with network experience who needs deep technical knowledge of EPC.

Contents:

Introduction

EPS Architecture, EPS interfaces and protocols, identity numbers, MME in pool and GUTI, tunnelling, EPS bearers – bearer establishment and QoS parameters,

Traffic Cases

EPS Mobility Management (EMM) and EPS Connection Management (ECM) states, attach and TA update, service request, S1 release, bearer activation, intra-LTE and inter-system handovers, Idle state Signalling Reduction (ISR), SR-VCC PS to CS handover, CSFB, SMS over SGs, Roaming Retry,

Security

HSS/AuC and USIM functionality, authentication and key agreement, key hierarchy, ciphering and integrity protection, KSN and local authentication, re-keying and key change, inter-RAT mobility,

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NAS EPS Mobility Management (EMM)

signalling connection establishment, routing of initial NAS messages, signalling connection release, GUTI reallocation, authentication, security mode control, identification, information procedure, attach, detach, TA update, service request, extended service request, paging, SMS,

NAS EPS Session Management (ESM)

default and dedicated bearer activation, IP address allocation, bearer modification, bearer deactivation, UE requested PDN connectivity/disconnect, UE requested bearer resource allocation/modification, information request procedure,

Stream Control Transmission Protocol (SCTP)

SCTP vs TCP, multihoming, SCTP packet format, chunk types, SCTP association establishment, acknowledgements and retransmission, stream concept,

GPRS Tunnelling Protocol – User Plane (GTP-U)

GTP-U based interfaces, protocol stack, tunnels, GTP-U messages,

S1-MME interface

S1 interface functions, protocol stack, E-RAB setup, modification and release procedures, UE S1AP IDs, downlink and uplink NAS transport, UE context setup, modification and release procedures, handovers and transparent container IEs, tunnel setup (direct and indirect forwarding), S1 setup, eNB and MME configuration updates,

Diameter Base Protocol

Diameter Base Protocol functionality, Diameter components, transactions and sessions, Diameter agents (Relay, Proxy, Redirect, Translation) and their usage examples, Diameter command structure, Diameter based routing, vendor and application IDs,

S6a and S13 interfaces

interface locations, Update Location procedure and related parameters, Cancel Location, Purge UE, Insert Subscriber Data, Terminating Access Domain Selection, Delete Subscriber Data, Authentication Information Retrieval, ME Identity Check,

GTPv2-C interfaces

GTPv2-C based interfaces, C-plane and U-plane tunnels, tunnel establishment sequences during initial attach, TA Update, Service Request, S1 release and Bearer Activation procedures,

CSFB and SMS

SGs interface location and protocol stack, Location Update, IMSI Detach, Paging, Service Request/Abort procedures over SGs, HSS/MME/VLR failure related procedures, MO/MT CSFB calls,

Sv interface

Sv interface position, SR-VCC registration, SRVCC from E-UTRAN to UTRAN/GERAN.

Prerequisites:

General knowledge of EPS/LTE system architecture and functionality is required. Knowledge about GSM/UMTS GPRS services is very useful.

Completion of *EPS/LTE System Overview* course (or equivalent) is highly recommended.

Training method:

Lectures and practical exercises.

Vendor: .ISPLOTY	System: LTE ADVANCED
Level: **Advanced**	Duration: **2 days**

Course Title:

LTE-Advanced (R10-R11)

Description:

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 along with their various implementation scenarios.

"LTE-Advanced (R10-R11)" course presents operating principles of key LTE-Advanced features. This essential new LTE-Advanced concepts combined with students' technical experience should allow them to form their own opinions about usefulness and applicability of specific features in the existing environment of their network and local mobile market.

Target audience:

The course is intended for experienced network engineers and E-UTRAN developers who are planning or have already worked on introducing LTE-Advanced features.

Contents:

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,

Carrier Aggregation (CA) R10-R11

Intra-band contiguous/non-contiguous and inter-band CA, CA operating bands and bandwidth classes, UE categories, Primary & 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,

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MIMO enhancements R10-R11

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,

Coordinated Multi-Point transmission (CoMP) R11

Distributed and centralized 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,

eNB Relay (RN) R10-R11

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 and Phase II: Attach for RN operation, RRC RN Reconfiguration procedure, Uu/Un interface time multiplexing FDD & TDD, R-PDCCH channel, RN versus repeater,

Heterogeneous Network (HetNet) R10-R11

Various HetNet implementation scenarios utilizing CA, RN, MIMO and CoMP, HetNet micro cell range extension, interference problems, network synchronization, Enhanced Inter-Cell Interference Control (eICIC), Almost Blank Subframes (ABS),

Machine-to-Machine (M2M) R11

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 optimization, invalid USIM state reset, UE Power Saving Mode (PSM), RRC UE assistance for RRM and UE power optimisation,

Minimization of Drive Test (MDT) R11

MDT in connected/idle mode – Immediate/Logged MDT, MDT measurements MDT: 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 signaling based MDT, trace collection,

SON enhancement overview R9-R11

RLF and other failures, RLF report, connection re-establishment, RACH optimisation, Mobility Robustness Optimisation (MRO), Mobility Load Balancing (MLB), Automatic Neighbour Relation (ANR), energy saving,

SR-VCC enhancements R10-R11

Reversed SR-VCC (rSR-VCC), voice and video SR-VCC (vSR-VCC), enhanced SR-VCC (eSR-VCC),

EPDCCH R11

Need for control channel capacity increase, EPDCCH transmission resources, EPDCCH sets, distributed and localized transmission, EPDCCH in MIMO, HetNet and CoMP environment.

Prerequisites:

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

Training method:

Lectures and multimedia presentations.

Vendor:		System:	
Level:	**Advanced**	Duration:	**3 days**
Course Title:			

LTE-Advanced (R10-R12)

Description:

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.

"LTE-Advanced (R10-R12)" course presents operating principles of key LTE-Advanced features. This essential new LTE-Advanced concepts combined with students' technical experience should allow them to form their own opinions about usefulness and applicability of specific features in the existing environment of their network and local mobile market.

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

Target audience:

The course is intended for experienced network engineers and E-UTRAN developers who are planning or have already worked on introducing LTE-Advanced features.

Contents:

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,

Carrier Aggregation (CA) R10-R12

intra-band contiguous/non-contiguous and inter-band CA, CA operating bands and bandwidth classes, UE categories, Primary & Secondary Cell / Component Carrier, implementation scenarios, L1/L2 protocol impact, SCell addition / modification /

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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,

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,

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,

Coordinated Multi-Point transmission (CoMP) R11-R12

Distributed and centralized 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,

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 and Phase II: Attach for RN operation, RRC RN Reconfiguration procedure, Uu/Un interface time multiplexing FDD & TDD, R-PDCCH channel, RN versus repeater,

Small cells enhancements R12

256 QAM, shared HeNB, X2 Gateway,

Heterogeneous Network (HetNet) R10-R12

Various HetNet implementation scenarios utilizing 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),

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 optimization, invalid USIM state reset, UE Power Saving Mode (PSM), RRC UE assistance for RRM and UE power optimisations,

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,

Minimization of Drive Test (MDT) R11-R12

MDT in connected/idle mode – Immediate/Logged MDT, MDT measurements MDT: 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,

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,

SR-VCC enhancements R10-R11

Reversed SR-VCC (rSR-VCC), voice and video SR-VCC (vSR-VCC), enhanced SR-VCC (eSR-VCC),

Enhanced Interference Management and Traffic Adaptation (eIMTA) R12

Dynamic adaptation of UL/DL TDD configuration,

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),

EPDCCH R11-R12

Need for control channel capacity increase, EPDCCH transmission resources, EPDCCH sets, distributed and localized transmission, EPDCCH in MIMO, HetNet and CoMP environment.

Prerequisites:

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

Training method:

Lectures and multimedia presentations.

Vendor:	System:
Level: **Advanced**	Duration: **3 days**

Course Title:

LTE Cellular IoT (R10-R14)

Description:

The course contains in-depth description of Cellular Internet of Things (CIoT) / Machine-Type Communications (MTC) features introduced gradually by 3GPP in LTE Releases 10-14.

Currently many MTC UE's are targeting low-end applications that can be handled adequately by GSM/GPRS. Owing to the low-cost of these devices and good coverage of GSM/GPRS, there is very little motivation for MTC UE suppliers to use modules supporting the LTE radio interface. As more and more MTC UE's are deployed in the field, this naturally increases the reliance on GSM/GPRS networks. This will cost operators not only in terms of maintaining multiple RATs, but it will also prevent operators from reaping the maximum benefit out of their spectrum Given the likely high number of MTC UE's, the overall resource they will need for service provision may be correspondingly significant, and inefficiently assigned.

The LTE CIoT/MTC features aim at overcoming all of the problems outlined above by making LTE an attractive and effective network for handling IoT/MTC traffic for all interested parties, i.e.: operators, MTC UE suppliers and application owners.

Target audience:

The course is intended for E-UTRAN developers and experienced network engineers who are planning or have already worked on introducing Cellular Internet of Things (CIoT).

Contents:

Introduction

IoT requirements and traffic characteristic, overview of LTE CIoT features, terminal categories, comparison with non-3GPP IoT solutions

Architecture

Service Capability Exposure Function (SCEF), MTC Interworking Function (MTC-IWF), Services Capability Server (SCS), Packet Flow Description Function (PFDF), RAN Congestion Awareness Function (RCAF), HSS, GGSN/P-GW/S-GW, SGSN/MME, SMS-

SC, MTC-AAA, new CIoT related interfaces, addressing and identification: IMSI/GUTI, MSISDN, External Identifier, IMSI-Group Identifier, External Group Identifier, Application Port ID, PDP/IP addressing, Non-IP Data Delivery (NIDD)

USIM, Access Control, Load Control

Conventional and embedded USIM/UICC cards, USIM/UICC power saving, IoT related USIM parameters, Access Baring (AB), Extended Access Barring (EAB), Exceptional Data Reporting (EDR), usage of low priority indications, overload protection, backoff timers, Service Gap Control (SGC)

Basic Features

Low complexity UEs, Power Saving Mode (PSM), extended DRX (eDRX), UE assistance for power optimisation, data inactivity monitoring, monitoring events, device triggering, high latency communication, CN assisted eNB parameters tuning, RAN U-plane congestion mitigation, network status notification, background data transfer, PS-only service provision, SMS in MME

CIoT EPS Optimisations

U-plane and C-plane CIoT EPS optimisations, UE and network capabilities, Connection Suspend/Resume procedure, mobility in Suspended state, MO/MT/SMS data transfer over C-plane, bearer establishment during data transfer over C-plane, NAS/RRC/S1AP interactions, C-plane optimisation reliability: NAS (Non)-Delivery Indication & Reliable Data Service (RDS) protocol, C-plane optimisation rate control: serving PLMN rate control, APN rate control, Inter-UE QoS for NB-IoT UEs

Category M (CatM)

Terminal capabilities, half-duplex operation; Enhanced Coverage / Coverage Extension (CE): CE mode A/B, concept of repetitions, cell (re)selection, Random Access and CE levels, paging optimisation, CE restrictions; narrowbands and widebands; frequency hopping, physical signals: PBCH & system information, PUCCH, MPDCCH; scheduling

NB-IoT

Inband, guard and stand-alone operation mode; channel raster; multi-carrier operation: anchor carrier, non-anchor carrier, random access and paging on non-anchor carriers; frequency bands, terminal capabilities, half-duplex operation, DL/UL subcarrier spacing, slot and subframe structures, resource/schedulable units, multiple DL antennas, UL physical channels and signals: NB DM-RS, NPUSCH format 1&2, NPRACH, Enhanced Coverage/Coverage Extension (CE): CE levels and random access, concept of repetitions, CE restrictions, paging; DL physical channels and signals: NRS, NSS, NPBCH, NPDSCH and transmission gaps, NPDCCH and scheduling;

system information, cell (re)selection, RRC connection control: connection establishment, connection control, SRB1, SRB1bis, DRB(s), RRC connection re-establishment, Buffer Status Reporting (BSR), Data Volume and Power Headroom Reporting (DPR), NRSRP, NRSRQ and CQI reporting

Prerequisites:

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

Training method:

Lectures, multimedia presentations and practical exercises.