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LTE/EPC
LTE Basics (TK410)

Prerequisites
Participants should have basic knowledge of mobile telecommunication network and technologies, especially in GSM, GPRS and UMTS. For background knowledge, we recommend mainly the TEKonsult course UMTS Network Technology Overview.

Target groups
Technical and non-technical personal that needs a general understanding of the LTE technology

Duration
3.0 days

Course Content

LTE-EPS Introduction
- Mobile Technologies Comparison
- Network Architecture steps towards LTE
- LTE Requirements and Targets

Long Term Evolution architecture
- LTE Network Elements and Functionalities
- LTE Interfaces and Protocol Stacks
- LTE Roaming Cases

LTE Mobility management
- Session Establishment
- LTE Mobility States
- LTE Procedures

LTE Air interface Technology Basics
- OFDM Technology Overview
- SC-FDMA and OFDMA Technology
- MIMO Technology
- LTE frame, subcarriers and modulation
LTE Air Interface (TK411)

Prerequisites
Participants should have basic knowledge of GSM, GPRS and UMTS. Participants should have attended the TEKonsult course LTE Basics.

Target groups
Personnel requiring a detailed understanding of LTE Air interface operation such as Radio network planning/optimization/performance engineers with experience in the fields of 2G/3G.

Duration
3.0 days

Course Content

LTE Air Interface Protocols
- LTE Protocol Architecture
- RRC and MAC Functionalities

OFDM and Modulation Technologies
- Modulation Basics
- DL OFDMA
- UL SC-FDMA

LTE Radio Channels
- Logical Channels
- Transport Channels
- Physical Channels
- Channels Multiplexing

Physical Channels Mapping
- TDD and FDD Frames
- Physical Layer Procedures
- DL Physical Channels
- UL Physical Channels
LTE Radio Resource Management

- Overview of UE Mobility Activities
- RRM Functionalities (Admission Control, Handover Control, Power Control)

MIMO Technology Overview

- Fundamentals of Multiple Antennas Theory
- Physical-Layer MIMO Performance
Prerequisites
Participants must have advanced knowledge of LTE Air Interface and LTE/EPC Network. For background knowledge, we recommend the TEKonsult course LTE Air Interface.

Target groups
Participant from all areas who wish to get an overview of the advanced LTE network
- Telecom engineers and technicians
- Project Managers
- Customer Managers
- Sales Managers

Duration
3.0 days

Course content

Standardization History
- LTE/LTE-A standardization
- The IMT Advanced process
- IMT Advanced Performance Requirements

LTE Release 8/9
- LTE Channel Architecture
- OFDM basics
- LTE Radio Frames
- DL/UL Radio Channels
- DL/UL Transmission Procedures

Enhanced MIMO Support
- Transmission Mode 8 (Dual Layer Beamforming)
- Transmission Mode 9
- Non-Codebook Based Precoding
- New Reference Signals (DM-RS & CSI-RS)
- Uplink MIMO Transmission
- Other UL Features (SORTD, multi-cluster allocation)
Carrier Aggregation (CA)

- CA Concept and Options
- Carrier Combinations and Bandwidth Classes
- Primary and Secondary Serving Cells
- Impact of CA on Control Channel Usage
- New PDCCH/PUCCH Formats
- Cross-carrier Scheduling
- New UE categories for R10 and R11

Relay Architecture

- Network elements for relay operation (Relay Node, Donor eNB, embedded SGW/PGW)
- S1 and X2-Interface Proxying via D-eNB
- Mapping and multiplexing of UP bearers
- Tx/Rx timing between Relay and Donor eNB (Scheduling, HARQ and use of MBSFN Subframes)
- New control channel: the R-PDCCH
- Start up and configuration of the Relay Node

Heterogeneous Networks (HetNet)

- HetNet Deployment Scenarios
- Problems in a HetNet Deployment Scenario
- Inter-cell Interference Coordination (ICIC, R8)
- Enhanced ICIC- Frequency Domain Solution
- Enhanced ICIC- Time Domain Solution
- X2-Interface Signaling Supporting Hetnet

Coordinated Multipoint (CoMP)

- CoMP Concept
- Joint Processing
- Coordinated Scheduling/Beamforming
- New Control Channel: the E-PDCCH
- CSI Reporting for Multi-Cell Operation
- Summary of 3GPP Simulation Results for CoMP
Planning the LTE Radio Network (TK413)

Prerequisites

Participants must have advanced knowledge of the LTE/EPS network and the LTE radio parameters. For background knowledge, we recommend the TEKonsult courses LTE Basics and LTE Air Interface.

Target groups

Deep technical course designed for telecom professionals getting into LTE radio network planning, dimensioning and testing, including RF engineers, network engineers, operations personnel, integrators, regulators, manufactures and managers.

Duration

4.0 days

Course Content

LTE/EPC Generalities

- LTE Requirements and Targets
- EPS Network Elements and Functionalities
- EPS Interfaces and Protocol Stacks

LTE Air Interface

- LTE Air Interface Protocols
- OFDMA and SC-FDMA Key Parameters
- LTE Radio channels
- Physical Channel Overhead Calculation
- MIMO and Diversity Techniques
- Radio Resource Management Overview
- LTE Radio Measurements

Radio Planning Process

- Main Steps of the Radio Planning Process
- Basic parameters in the dimensioning phase
- Nominal Planning and pre-launch optimization
- Available tools
Radio Propagation Properties

- LTE spectrum allocations and regulatory requirements
- Radio propagation in LOS and NLOS environments
- Delay spread, Inter-Symbol Interference (ISI) and cyclic-prefix (CP)
- Doppler shift and Inter-Carrier Interference (ICI)
- Peak-to-Average Power Ratio (PAPR)
- Propagation Models and Calibration

LTE Link Budget

- Cell EDGE throughput calculations
- LTE SINR and sensitivity requirements
- Interference power estimation
- Slow fading model
- LTE Max Allowable Path Loss (MAPL) for different bands and operating modes
- Influence of cyclic prefix (CP) length
- Impact of Power Control, Link Adaptation and MIMO
- Differences to GSM and UMTS link budgets

Coverage Planning – Cell Range Calculation

- Calculation of the cell range with main Propagation Models
- Comparison with other technologies

Capacity Planning

- Capacity Dimensioning Process overview
- LTE cell average throughput
- Factors impacting on the Cell Capacity
- QoS profiles, Services and Oversubscription

LTE Performance Simulation

- Evaluation of spectral efficiency, data rates, latency and cell range
- Comparison with the Performance of other technologies
- LTE TDD Performance Analysis
- LTE Link Level Simulation
- LTE Reuse factor 1 vs. LTE Reuse factor 3 comparison
LTE Deployment Solution

- Macrocells and Microcells
- Indoor planning
- Neighbor planning
- Planning of PCI, CID and TAI
- Self-Organized Networks (SON) concept
- Voice and Data Continuity between LTE and WCDMA
- Voice Continuity between LTE and GSM

Initial Parameter Planning

- Concept of Channel Configuration Parameters
- PRACH configuration parameters
- PCI configuration parameters
- UL DM & RS configuration parameters
- PDCCH capacity and respective parameters
- PUCCH capacity and respective parameters
LTE Parameters (TK414)

Prerequisites

Participants must have advanced knowledge and experience of the LTE Air Interface. For background knowledge, we recommend the TEKonsult courses “LTE Air Interface” and “Planning the LTE Radio Network”.

Target groups

Participants should be Network Planning/Performance engineers and Network Engineering and Optimization personnel.

Duration

4.0 days

Course Content

LTE Functionalities and Features Overview

- LTE Radio Network Architecture and its interfaces
- RRM Process
- Overview of main LTE features

Parameter Structure & SIBs

- Physical Radio Resources
- System Information Broadcast in LTE
- SIB Content

Physical Channel Configuration & Random Access

- Physical Channels Overview
- Physical Signals and Channels Structure and Contents
- Random Access Process and Methods
- PRACH Configuration Options and Parameters

Bearer Control/UE State Handling

- UE states: Parameters and Procedures
- DRX/DTX Configuration
- Different State Transitions
- Radio Bearer Overview
- Performance and Optimization Aspects
Admission Control
- RACin LTE
- Default and Dedicated Bearers
- LTE QoS Profiles

Power Control Setting and AMC
- Explain the basics of LTE PC
- Describe UL open loop PC part
- Discuss UL open loop PC part
- Identify DL power settings
- Analyze PSD
- PC impact on network performance and related parameters

MIMO Mode Control
- Multi-Antenna Techniques
- Multi Antenna Modes in LTE
- Single Antenna Port Transmission
- Receive Diversity
- Basics of MIMO Parameters
- Spatial Multiplex vs. Tx diversity
- Beamforming
- RRM impacts

Mobility Management
- Radio Measurements in LTE
- Idle Mode Mobility Management Parameters
- Connected Mode Mobility Management Parameters

UL/DL Scheduler
- UL and DL Scheduler Principle
- Outer Loop Quality Control
- UL and DL Adaptive Modulation and Coding (AMC) Parameters
- Outer Loop Link Adaptation (OLLA)
- Adaptive Transmission Bandwidth (ATB)
EPC Fundamentals (TK420)

Prerequisites

Participants must have basic knowledge of mobile telecommunication network and technologies, especially in CS and PS core of the GSM/GPRS and UMTS/HSPA networks.

Target groups

Participant from all areas who wish to get an overview of the EPC network: Telecom engineers and technicians, general managers, project managers, customer managers.

Duration

4.0 days

Course Content

EPS Overview

- Evolution history of the 2G and 3G networks
- Standardization regarding LTE
- EPS network architecture and nodes
- FDD and TD-LTE Air Interface basics
- LTE Advanced in 3GPP Rel.10

EPC the Evolved Core Network

- Core Network Architecture and its Evolution
- EPC Network Nodes
- Pool concept for MME and S-GW
- EPC Network Interfaces
- EPC Protocols
- Roaming Architecture

Mobility and Connection Management in EPS

- Mobility Areas
- LTE-UE Identifications
- Terminologies for Mobility and Connection Management
- Mobility and Connection states
- The EPS bearer concept
- EPS Procedures and signaling
- EPS Authentication and Key Agreement
Interworking with other Radio Access Technologies

- Interworking with 3GPP Access Networks
- Interface for interworking between E-UTRAN and GERAN/UTRAN
- CS Domain interworking – Voice Call Continuity and CS Fallback
- Interworking with Non-3GPP access

IP Multimedia Subsystem (IMS)

- Multimedia over IP using SIP
- IMS architecture and basic traffic cases
- IMS relation to EPS

Policy and Charging Control (PCC)

- What is Policy and Charging Control?
- PCC architecture
- The PCRF and PCEF
EPC Signaling (TK421)

Prerequisites
Participants must have advanced knowledge of mobile Core Network especially in the Packet Core. For background knowledge, we recommend the TEKonsult course “EPC System Overview”.

Target groups
Participant who are working on the operation, troubleshooting, planning and optimizing the EPC networks.

Duration
5.0 days

Course Content

EPC Introduction
- Evolution of the 2G and 3G Core Networks
- EPS network architecture and nodes
- Pool concept for MME and S-GW
- EPC Network Interfaces and protocols
- EPS Security Mechanisms: Authentication, Key Agreement and IPsec

Mobility, Connection and Session Management in EPS
- Mobility Areas
- LTE-UE Identifications
- Terminologies for Mobility and Connection Management
- Mobility and Connection states
- Pool concept for MME and SGW
- The EPS bearer concept

S1 Interface and Protocols
- S1 Interface Overview
- S1-U Interface
- The S1-MME Interface
- S1AP main procedures
EPS Session Management
- EPS Bearer overview
- EPS Bearer QoS Profile
- GTP-C Protocol and main Procedures
- EPS Session Management Procedures

S6a Interface and Procedures
- S6a Interface and protocol stack
- Diameter overview
- Authentication procedures in EPS
- Location Update Procedures
- Subscriber Handling Procedures

Multimedia over IP and IMS Basic Procedures
- Basic SIP concepts
- Control plane: SIP and SDP
- User plane: RTP and RTCP
- The IMS Architecture
- Registration and Session Initiation

Interworking with Radio Access Network and Roaming Scenario
- Mobility principles between E-UTRAN and GERAN/UTRAN
- Selected traffic cases for interworking between E-UTRAN and GERAN/UTRAN
- CS Domain interworking – Voice Call Continuity and CS Fallback
- Trusted and non-trusted non-3GPP access networks
- Mobility Mechanisms using Mobile IP
- Roaming Scenario

PCC – Policy and Charging Control
- Purpose of Policy and Charging Control
- The PCC architecture
- The PCRF and PCEF
- AF and SPR
- PCC Rules
The Evolution of Mobile Networks (TK110)

Prerequisites
Participants must have an experience in the mobile network environment.

Target groups
Participant from all areas who wish to get an overview of the evolution of mobile networks from GSM to LTE Advanced: General Managers, Project Managers. Customer Managers, Sales Managers, Human Resource Managers.

Duration
3.0 days

Course Content

The Mobile Networks and its Evolution
- Introduction
- The Standardization
- GSM Systems and the Evolution to GPRS and EDGE
- UMTS Networks and HSPA
- LTE and EPC Systems
- Charging and Accounting
- Future of Mobile Networks

The Evolution of Mobile Services
- Introduction
- Service Layer Overview
- Terminal Technologies
- Service Enablers
- Service Categories
- Voice in LTE

The Evolution of Mobile Telecommunication Market
- Introduction
- Trends and Drivers and Market View
UMTS Network Technology Overview (TK310)

Prerequisites

Participants must have basic knowledge of mobile telecommunication network and technologies, especially in GSM and / or GPRS.

Target groups

Participant from all areas who wish to get an overview of the UMTS network
- Telecom engineers and technicians
- General Managers
- Project Managers
- Customer Managers
- Sales Managers

Duration

2.0 days

Course Content

UMTS Generalities
- Overview of UMTS Technologies
- UMTS System Architecture
- Transmission Solution in UMTS
- Mobility Management

UMTS Radio Access Network
- Radio Access Network Architecture and Interfaces
- Radio Access Network Protocol Stack
- WCDMA Basics
- Radio Access Network Procedures
- High Speed Packet Access in Radio Access System

Service Architectures and Applications in UMTS
- Virtual Home Environment
- Open Service Architecture
- Services and mobile applications in UMTS
- The voice service in UMTS
ATM and IP over ATM Basics (TK320)

Prerequisites

Participants must have basic knowledge about mobile networks and the basic networking concepts are recommended. For background knowledge, we recommend the TEKonsult courses Introduction to IP network and UMTS Network Technology.

Target groups

The target group should be from all areas who wish to learn the ATM technologies and its implementation in UMTS Network.

Duration

2.0 days

Course Content

ATM BASICS

- Network Transfer Mode
- ATM cell
- The ATM cell header
- ATM connections
- ATM as a transport network
- Statistical multiplexing

ATM Traffic and Resource Management

- ATM traffic management function
- Traffic Contracts
- ATM Service Categories
- Resource management in ATM network
- Routing and Digit Analysis

ATM Protocols and Signaling

- ATM protocol
- Physical Layer
- ATM Adaptation Layer
- Switching in ATM network
- Signaling in 3G mobile network
- ATM as a transport network in 3G network
IP over ATM

- The challenges of IP over ATM
- Models of IP over ATM
- IP QoS over ATM
Prerequisites
Participants should have basic knowledge of UMTS Technology and architecture. For background knowledge, we recommend the TEKonsult course “UMTS Network Technology Overview”.

Target groups
Personnel who operate and maintain 3G RAN network.

Duration
3.0 days

Course Content

Introduction to WCDMA
- Main Technologies in WCDMA
- Spreading and Despreading
- Multipath Radio Channels and Rake Reception
- Radio Resource Management

Physical Layer
- Transport Channels multiplexing
- Spreading and Scrambling Principles
- User Data Transmission
- Air Interface Signaling
- Physical Layer Procedures
- Terminal Radio Access Capabilities

High-Speed Packet Access
- Release ’99 WCDMA Packet Data Capabilities
- Spectral Efficiency, Code Efficiency and Dynamic Range
- High Speed Downlink Packet Access (HSDPA)
- High Speed Uplink Packet Access (HSUPA)
UTRAN Signaling (TK312)

Prerequisites
Participants should have advanced knowledge of GSM, GPRS and UMTS. Participants should have attended the TEKonsult course “UMTS Network Technology Overview” and/or “WCDMA for UMTS”.

Target groups
Personnel who operate and maintain RAN network.

Duration
3.0 days

Course Content

UMTS Interfaces and Protocols
- UTRAN Architecture
- UMTS interfaces overview
- Protocol Stacks in UMTS Network

CS Call Setup
- RRC Connection Setup
- Service Request Setup
- Radio Access Bearer Setup
- Transport plane Setup
- Iu-CS call Setup Procedure

PS Call Setup
- Attach and Detach
- PDP Context activation and deactivation
- Iu-PS Call Setup Procedure

HSDPA Call Setup
- HSDPA Overview
- HSDPA Iub Resource Reservation
- Description of HSDPA call setup
HSUPA Call Setup

- HSUPA Overview
- HSUPA Iub Resource Reservation
- Description of HSUPA call setup

Handover Procedures

- Intra Frequency Handover Procedure
- Inter Frequency Handover Procedure
Planning the UMTS Radio Network (TK313)

Prerequisites

Participants must have advanced knowledge of UMTS network and technologies. For background knowledge, we recommend the TEKonsult courses “WCDMA in UMTS” and “UTRAN Signaling”.

Target groups

Deep technical course designed for telecom professionals getting into UMTS radio network planning, dimensioning and testing, including RF engineers, network engineers, operations personnel, integrators, regulators, manufactures and managers.

Duration

4.0 days

Course Content

WCDMA Fundamentals

- Introduction to WCDMA Air Interface
- WCDMA Physical Channels
- HSPA Principles
- HSPA Physical Channels
- RRM Functions

Radio Planning Fundamentals

- Radio Propagation Mechanisms
- Fading Phenomena
- Free Space Loss
- NodeB and UE Performance

Radio Network planning process

- Radio Network Planning Process
- Main Steps in Dimensioning Process
Coverage Dimensioning

- Link Budget for Different Services
- Link Budgets and Parameters
- Planning Margins
- Planning Thresholds
- Cell Range Calculation

Capacity Dimensioning

- Basic Traffic Modeling
- Calculation of Air Interface Capacity and Load

Coverage and Capacity Planning and Improvements

- Different Planning Approaches
- Coverage and Capacity Improvement

Initial Tuning

- Scrambling Code Planning
- Neighbor List Planning
- Location, Routing and UTRAN Registration Area Planning
GSM Network Elements (TK210)

Prerequisites
Participants should have some basics and technical knowledge in telecommunications.

Target groups
Personnel, technicians or engineers, working on GSM equipment

Duration
2.0 Days

Course content

Mobile Station
- Mobile Equipment
  - Mobile Equipment Types
  - Functionality
- Subscriber Identity Module
  - The SIM as a Database
  - Advantage for the Subscriber

Radio Network Subsystem
- Base Transceiver Station
  - Architecture and Functionality of BTS
  - BTS Configurations
  - Connection types BSC-BTS
- Base Station Controller
- Transcoder

Core Network Subsystem
- Home Location Register
- Authentication Center
- Visitor Location Center
- Mobile-Services Switching Center
- Equipment Identity Register
GSM Basic Features

- Cell Selection/Reselection
- Handover
- Power Control
- Adaptive Multi-Rate
- GPRS/EDGE Overview
- Location Services
- Other Features
GSM Signaling (TK212)

Prerequisites

General knowledge about the architecture, terminology and modes of operation of GSM is recommended. For required background knowledge, GSM network element course is recommended.

Target groups

Personnel requiring an in depth radio Network Signaling explanation. This course provides an in-depth description of protocols and signaling procedures used in the 2G networks.

Duration

5.0 days

Course content

OSI Reference Model

Air Interface

- The Structure of the Air Interface in GSM
- Physical and Logical Channels
- Logical Channel Configuration
- Interleaving
- Signaling on the Air Interface
- LAPDm
  - LAPDm Structure
  - LAPDm Message Types
- Air Interface Messages

Abis Interface

- Channel Configuration
- Signaling on Abis Interface
- Dimensioning over Abis interface
- LAPD
  - LAPD Structure
  - LAPD Message Types
- Abis Interface Messages
A Interface

- Signaling System Number 7
  - Message Transfer Part
  - Signaling Connection Control Part
  - User Parts: TCAP, MAP, BSSMAP...
  - SS7 Message types
  - Addressing and Routing

- A Interface Signaling
- Dimensioning over A interface
- A Interface Messages
GSM Planning (TK213)

Prerequisites

Participant should have advanced knowledge about GSM network design and functions. GSM network elements course is highly recommended.

Target groups

Personnel involved in planning and building a GSM network.

Duration

4.0 days

Course content

Planning process

- Preparing a planning project
- Planning targets
- Planning steps

Coverage planning

- Basics of radio wave propagation
- Diversity
- Environments Types
- Free space propagation model
- Okumura-Hata Model
- Walfish–Ikegami Model
- Knife-edge Model
- COST 231 Walfish–Ikegami Model
- COST 231 Okumura-Hata Model
- Link Budget Calculation
- Fading
- Pathloss
- Location probability
- Increasing coverage
Capacity planning

- Introducing traffic theory
- Quality and grade of service
- Erlang-B model
- Erlang-C model
- Calculating the traffic volume
- SDCCH planning
- TCH planning
- Increasing capacity

Frequency planning

- Cellular concept in GSM network
- Frequency plan in GSM network (FDD/FDMA/TDMA)
- Interference and adjacencies
- Frequency reuse and reuse pattern
- Frequency hopping

Optimizing

- Drive test
- Key performance indicator
- Power control
- Discontinuous transmission and voice activity detection
- Codec planning
- Antenna tilt
- Sectorization of the cell
- Hierarchical cell structure
GSM Parameters (TK214)

Prerequisites

Participants must have qualified knowledge of GSM network architecture and functions. GSM signaling course is recommended.

Target groups

Radio Planning Expert and Performance Management Expert

Duration

4.0 days

Course content

GSM Overview

- GSM Air interface concept
- GSM interfaces
- Protocol stack

Cell selection and reselection

- Cell Selection
- Cell Reselection
  - Cell reselection Mobile phase 1 and 2
  - Cell reselection 2G <-> 3G
  - Cell reselection causes
  - NACC
  - NCCR

Handover

- Handover concept and causes
- Handover measurements
- Handover types
- Preemption
- Queuing
- Wireless priority service
- Target cell list generation
- Basic Handover signaling
- Timers related to handover
Channel configuration

- Overview of logical channels for GSM
- BCCH and system information
- RACH Channel
- PCH and AGCH channel
- SDCCH channel
- SACCH Configuration, timers and counters
- FACCH
- Traffic channel TCH
GSM KPI (TK215)

Prerequisites

Participants must have good knowledge of GSM network architecture and Functions.

Target groups

Performance Management Expert

Duration

4.0 days

Course content

Introduction to GSM performance evaluation

- Goals of performance evaluation
- Performance measurement and data collection
  - Measurement reporting
  - Measurement job
  - Measurement granularity
  - Scheduling measurement
- Analyzing measurement
- Traffic theory

GSM Signaling

- Air interface structure and Logical channels
- Protocol stack on air interface
- Protocol stack on Abis
- Protocol stack on A
- Location update
- Immediate assignment procedure
- Assignment procedure
- Handover
- Mobile originating and terminating call
- Paging
- Timers
Key performance indicators

- Introduction to KPI
- TCH KPI
- SDCCH KPI
- Handover KPI
- Traffic KPI
- TCH drop analysis
- SDCCH drop analysis
- Handover Drop analysis
MOBILE CORE NETWORK
Introduction to Signaling in 2G/3G Rel 4 (TK610)

Prerequisites
Participants must have some technical knowledge in telecommunications, and some basic knowledge of 2G/3G networks.

Target groups
Personal, technician and engineers who operate and maintain RAN network.

Duration
5.0 days

Course content

Introduction
- Release 4 concept
- Core network protocols in 2G/3G Rel4 network
- Protocol stacks and interfaces

MTP: Message Transfer Part
- Functionality of the three MTP layers
- MTP message structure
- MTP procedures

SAAL: Signaling ATM Adaptation Layer and MTP3-b
- Function and message structure of SAAL and MTP3-b
- Important SAAL messages and their parameters
- MTP/SAAL functional procedures

SIGTRAN, SS7overIP
- Function and structure of SCTP messages
- Important SCTP messages and their parameters
- Function and structure of M3UA messages
- Important M3UA messages and their parameters
SCCP
- Functions of SCCP in a CCS7 protocol stack
- Structure of a SCCP messages
- Important SCCP messages and their parameters
- SCCP services: connection oriented, connectionless

RANAP
- Transport of RANAP messages on the Iu-CS interface
- Functions of the RANAP signaling protocol on the Iu-CS interface
- Important RANAP messages and their parameters
- RANAP location update procedure on the Iu-CS interface
- RANAP call setup procedure on the Iu-CS interface

TCAP & MAP
- Transport of TCAP and MAP messages on various interfaces
- Structure of a TCAP/MAP message
- Functions of TCAP transaction portion, dialog portion and component portion
- TCAP support for exchange of messages from higher layer protocols
- MAP application context and its application
- MAP functionalities and procedures

AAL Type 2 Signaling
- Transport of AAL2 signaling messages on the IuCS and Nb interface
- Purpose of AAL2 signaling
- AAL2 signaling procedures
- Important AAL2 signaling messages and their parameters

MEGACO
- Transport of MEGACO messages on the Mc interface
- MEGACO protocol concepts: Context, Terminations, Signals
- MEGACO message structure
- Important MEGACO messages and their parameters

ISUP: ISDN User Part
- Function and message structure of ISUP
- Call- and maintenance related ISUP procedures
- Important ISUP messages and their parameters
BICC
- Call setup procedures with BICC
- Transport of BICC messages on the Nc interface
- Important BICC messages and their parameters
- Application transport mechanism inside BICC messages
- Transfer of IPBCP signaling inside BICC messages

SIP
- Transport of SIP messages
- SIP addresses SIP-URI and TEL-URI
- Structure of a SIP dialog for call control on the Nc interface
- SIP requests and responses
- Transport of bearer information inside SIP messages
GPRS Basics (TK611)

Prerequisites
General understanding of telecommunications

Target groups
Personnel needing an overview of GPRS

Duration
3.0 Days

Course content

Introduction to 2G
- Mobile networks evolution
- Data transmission rates in 2G mobile networks

GSM & GPRS Overview
- GSM Subsystems
- GSM Radio Interface Concept
- GPRS benefit
- GPRS applications

EDGE Overview
- EDGE description
- Enhanced GPRS description

TCP/IP Introduction
- Internet Protocols and OSI model
- IP routing
- IP networks components

GPRS Architecture
- GPRS specific network elements
- Open interfaces in the GPRS network
- Packet transfer between GSNs
GPRS Air Interface and Protocols

- Layers protocols
- Physical and logical GPRS channels
- Coding schemes

GPRS Traffic Management

- Mobility management
- Session management
- IP addressing in GPRS
PaCo Signaling (TK612)

Prerequisites
Participants should have knowledge of 3G SGSN and GGSN Fundamentals. They should also have practical O&M experience in the PCN area to optimally benefit from his course.

Target groups
System Level Experts in Packet Core

Duration
4.0 Days

Course content

SIGTRAN
- Protocol stacks
- Messages

Iu-PS Interface
- Protocol layers
- Control plane messages and information elements

Gr interface
- SGSN and HLR interaction
- Procedures and messages

Domain Name Service in Packet Core
- DNS concepts and messages
- Messages

Gn interface
- Gn interface description.
- Control plane messages and information elements
MM/SM Procedures
- MM/SM procedures description
- Examples of procedure

Roaming Messages
- Inter system roaming
- Intra system roaming
IMS Fundamentals (TK630)

Prerequisites
Participants should have advanced knowledge of IP networks and routing and also SIP and Diameter protocols. For knowledge background we recommend the TEKonsult course SIP and Introduction to IP Networks.

Target groups
Personnel who operate and maintain IMS network

Duration
3.0 days

Course Content

3GPP IMS Network Architecture
- Call session control function CSCF
- Architecture of the 3GPP IMS Network
- CSCF interfaces and functions
- Protocol stack
- IMS specific Identifiers

TISPAN Next Generation Network Architecture
- TISPAN NGN Overall Architecture
- 3GPP/TISPAN Next Generation Network Overview

Application servers
- External and internal application server
- Application server scenarios

Basic Signaling Flows
- SIP Basics
- Basic 3GPP IMS Signaling Flows
- Basic TISPAN NGN Signaling Flows
SIP Signaling (TK631)

Prerequisites
Participants should have:
- Basic knowledge of telecommunications
- Profound knowledge of TCP/IP and Voice over IP

Target groups
Service specialists or System engineers

Duration
2.0 days

Course Content

SIP OVERVIEW
- Fundamentals of how SIP works
- Session description protocol (SDP)
- Security considerations
- HTTP and SMTP, SIP
- SIP extended features and services
- Interworking with PSTN
- Service creation issues
- Basic call features
- Quality of Service issues

SIP SYSTEM OPERATIONS
- SIP Parameters
- Protocols
- User Agents
- Call Processors
- Customer Status
- Address Tracking
- Call Forwarding
SIP PROTOCOL OPERATION

- Client/Server transactions
- Proxy servers
- SIP messages
- Transport layer
- Session Description Protocol (SDP)
- SDP packets

SIP ENTITIES

- SIP Clients
- SIP as a peer-to-peer protocol
- User Agents (UAs) as the peers in a session
- User agent client (UAC)
- User agent server (UAS)
- SIP Servers

SIP MESSAGES

- Message Types
- Message Parts
- Message Samples
- Requests
- Responses
- Header Fields
- Bodies
IMS Signaling (TK632)

Prerequisites

Participants should have advanced knowledge of TCP/IP and Voice over IP and also good knowledge on SIP and Diameter protocols. Participants should have attended the TEKonsult course SIP signaling, Introduction to IP Networks and IMS Network Introduction.

Target groups

Participants from all areas who wish to get an advanced knowledge of IMS:
- Service specialists
- System engineers
- Personnel responsible for troubleshooting IMS
- Personnel who operate and maintain IMS

Duration

4.0 days

Course Content

IP Multimedia Subsystem

- Introduction of IMS into the 3GPP Architecture
- IMS by TISPAN
- IMS Standardization Overview

Session Initiation Protocol (SIP)

- SIP functions and protocol stack
- Basic SIP flows
- SIP message routing principles
- SIP message body - session description protocol
- SIP extensions

DIAMETER Base Protocol and Cx/Dx/Sh DIAMETER Applications

- Diameter Functions and Tasks on Cx Interface
- Diameter Messages and Parameters
- Diameter Procedures on Cx, Dx and Sh Interfaces
e2/e4 Interface - DIAMETER Protocol
- Diameter Functions and Tasks on the e2 Interface
- Diameter Functions and Tasks on the e4 Interface

Gq' Interface - DIAMETER Protocol
- Bearer Authorization, Policy Enforcement and Decision
- Gq' Diameter Application
- Gq' Diameter Messages and Parameters

H.248 - MEGACO
- H.248 tasks and architecture
- H.248 Connection Model: Terminations and Contexts
- H.248 Commands
- Non-Call Related Transactions
- Overview on the Ia Interface

Voice over IP - Real Time Transport Protocol
- Real Time Transport Protocol
- Real Time Transport Control Protocol
IP
Introduction to IP Networks (TK710)

Prerequisites

Participants should have basic knowledge of telecommunication.

Target groups

Participants who wish to get a technically oriented overview of the technology, applications and internetworking of IP based Local Area Networks (LAN).

Duration

3.0 days

Course Content

OSI Model Review

- Layer definitions

LAN Technologies

- Ethernet (Frame format, VLAN)
- Point-to-Point Protocol (PPP)

Network Layer

- Introduction to IP
- IP header
- IP Addressing
- The ARP Protocol Family
- ICMP
- IP Routing
- Routing Protocols (RIP, OSPF, BGP)

Transport Layer

- Transmission Control Protocol (TCP)
- User Datagram Protocol (UDP)
- Stream Control Transmission Protocol (SCTP)
Multiservice Networks

- Qos Basics
- VoIP Concept

NAT and IPv6

- NAT
- IPv6
IPv6 (TK711)

Prerequisites
Participants should have basic knowledge of TCP/IP network and especially the IPv4 addressing and technology. For knowledge background, we recommend the TEKonsult course Introduction to IP Network.

Target groups
Participants who wish to get a technically oriented overview of the technology, applications and internetworking of IPv6.

Duration
3.0 days

Course Content

Introduction to IPv6
- Why IPv6
- IPv4 and IPv6 Comparison

IPv6 Addressing
- Binary Number Representation
- IPv6 Addressing

IPv6 Header Information
- IPv4 Protocol Stack
- Ipv6 Protocol Stack
- IPv6 Dual Stack
- New Header Format
- IPV6 Extension Headers
ICMPv6 Network Operation

- ICMPv6 Message Types
- ICMPv6 Ping Operation
- Neighbor Solicitation
- Neighbor Advertisement
- Router Solicitation
- Router Advertisement
- DHCPv6 Overview
- ICMPv6 Redirect
- ICMPv6 Multicast Messages
- ICMPv6 Time Exceeded Destination Unreachable
- ICMPv6 MTU Path Discovery

Routing Services and Protocols

- Routing Protocols Supported by IPv6
- RIPng protocol
- OSPFv3 Protocol
- BGP Protocol

IPv6 Security

- IPSec Tunneling
- IPv6 IPSec Overview
- IPSec Framework
QOS in IP Networks (TK712)

Prerequisites

Participants should have basic knowledge of TCP/IP network and technology. Participant should have attended the courses Introduction to IP network and IP routing.

Target groups

Participants who wish to acquire in-depth knowledge of QoS enabled IP.

Duration

3.0 days

Course Content

The need for QoS

- QoS from an application perspective
  - Delay profiling applications
  - VOIP
  - Video
  - Interactive applications
  - Bulk transfer applications
  - Non delay apps
- QoS from a network perspective
  - Bandwidth Vs QoS
  - Burst management

Different approaches to QoS

- Traffic Engineering
- Packet Classification
QoS Mechanisms

- Diffserv
- Rate Limiting and Policing
- Queuing and scheduling methods
- Discard mechanisms
- WRED
- Graceful discarding
- Layer 2 frame prioritization
- Special considerations for VOIP
  - Packet discard strategy
  - Matching telephone GOS to QoS

Network Monitoring Tools

- QoS Monitoring and Measurement Criteria
  - Drop rate
  - Round trip delay
  - Jitter
  - Uptime
- Sources of QoS performance data
MPLS (TK713)

Prerequisites

Participants should have basic knowledge of telecommunication and IP knowledge is strongly recommended. For background knowledge, we recommend the TEKonsult courses introduction to IP Network and QOS IP.

Target groups

Participants who wish to acquire in-depth knowledge of MPLS.

Duration

2.0 days

Course Content

MPLS Basics

- MPLS Services
- Label Switched Routers
- Ingress and Egress Label Edge Routers
- Forward Equivalent Classes
- Label Switched Paths
- Selecting the Label headers appropriate to the technology
- Distributing Labels with Label Distribution Protocol (LDP)
- Comparing traffic patterns in routed and MPLS switched networks

Stacking Labels for Service Discrimination

- Multi-Service Provisioning
- Mechanisms used in ATM networks and their problems
- Deploying Label Stacking for identification of Services
- Tunneling VPN services
- Delivering Transit Networks Services

Pseudo Wire Services

- Label Stacking
- Virtual Private Wire Service (VPWS)
- Virtual Private LAN Service (VPLS)
- Resilience
Quality of Service Options in MPLS Networks

- Defining the objectives of QoS
- QoS Options
- Selecting Between Multiple QoS Paths
- Deploying QoS using Class of Service and Experimental bits
- Explicitly Routed LSP
- RSVP for QoS
- Constraint Based Label Switched Paths

Deploying QoS and Differentiated Services

- Delivering QoS using Differentiated Services Code Points within IP
- Forwarding Models for DiffServ Label Switched Routers
- Preconfigured Explicit Label Switched Paths
- RSVP Extensions for DiffServ support
- Intserv Service types

Delivering Reliability

- Fault Tolerance objectives for MPLS
- Establishing a Fault Tolerant Session with LDP
- Recovering Failed LDP Sessions
- Check-pointing and graceful termination
- Fast rerouting Alternatives
- Security Considerations
- Implementation Issues
Prerequisites

Participants should have basic knowledge of telecommunication and IP knowledge is strongly recommended. For background knowledge, we recommend the TEKonsult course Introduction to IP Network.

Target groups

Participants who wish to acquire in-depth knowledge of IP Routing.

Duration

2.0 days

Course Content

IP Addressing

- IP Addressing structure
- Subnetting

Routing Overview

- Static routing
- Dynamic routing

Routing Information Protocol (RIP)

- Overview of RIP
- Characteristics of RIPv1
- Characteristics of RIPv2

Open Shortest Path First (OSPF)

- OSPF routing protocols, Link State Routing, Route calculation process
- OSPF areas, router types, inter-area calculation, communication with external AS

Border Gateway Protocol (BGP)

- BGP characteristics
- Format of BGP messages,
- BGP path attributes, BGP route selection
Multicast Routing

- Introduction to multicast and multicast addressing
- Multicast groups, IGMPv1 and IGMPv2 comparison
TCP/IP in the Mobile Packet Core (TK715)

Prerequisites
Participants should have basic knowledge and experience of telecommunication.

Target groups
Participants who need to have a good knowledge of TCP/IP for GPRS and 3G networks

Duration
4.0 days

Course Content

Network Layer
- OSI Model Review
- Introduction to IP
- The ARP Protocol Family
- ICMP
- IPSec

IP Routing
- Routing Information Protocol (RIP)
- Open Shortest Path First (OSPF)
- Border Gateway Protocol (BGP)
- Multicast Routing

Transport Layer
- Transmission Control Protocol (TCP)
- User Datagram Protocol (UDP)
- Stream Control Transmission Protocol (SCTP)

IP in GPRS/UMTS/EPS
- Tunneling
- PDP Context Activation
- Default Bearer set-up
- User profile, APN and IP connectivity of a UE
Quality of service

- Definition of QoS in UMTS and LTE/EPS
- QoS implementation, Packet Marking, Packet Dropping, etc
- QoS provisioning: Diffserv and MPLS

DNS

- DNS resolution
- DNS within MPC

NAT and IPv6

- NAT
- IPv6
Fiber Optics Technologies (TK810)

Prerequisites
Participants should have basic telecommunication knowledge.

Target groups
Optical Transmission network engineers and technicians

Duration
2.0 days

Course content

Optical Fiber
- Types
- Transmission modes
- Connectors

SDH
- Introduction
- SDH Frame structure
- Signal multiplexing

WDM
- Introduction
- Signal Multiplexing
- OTN (Optical Transport Network)

FTTx
- Concept and principal
- PON
- GPON
PDH/SDH/OTH Technologies (TK811)

Prerequisites
Participants must have some technical knowledge in telecommunications, and some basic knowledge in PDH & SDH.

Target groups
All personnel starting a sequence of SDH training, from Planning and Engineering to Management Experts and Service should attend.

Duration
2.0 days

Course content

PDH Technology
- ANSI/CEPT standards
- Description of the Frame structure
- Principles of PDH Multiplexing

SDH Technology
- ITU-T Recommendations for Synchronous Digital Hierarchy
- Description of the STM-1 Frame structure
- Multiplexing of SDH Signals
- Synchronization of STM-1 Frames
- STM-1 Signal: basic elements

Mapping of PDH/ATM over SDH
- Mapping of PDH signals over SDH
- Mapping of ATM Cells over SDH
- Concatenation of Payloads

Pointer
- Principle and Functions
- Types and structure
Description of the Overhead and its functions

- Overhead Functions
- Section Overhead: MSOH & RSOH
- Path Overhead

Monitoring of the SDH signal

- Bit Interleaved Parity
- Remote error Indication and Remote defect Indication
- Alarm Indication signal
OTN: Optical Transport Network (TK812)

Prerequisites

Participants must have some technical knowledge in telecommunications, and some basic knowledge in optical transmission principles. Fiber optics basics course is recommended.

Target groups

All personnel starting a sequence of DWDM training, from Planning and Engineering to Management Experts and Service should attend.

Duration

2.0 days

Course content

Introduction to OTN

Multiplexing and mapping principles

- Multiplexing
- Mapping
- Insertion of client signals

Overhead description

- OTS OH description
- OMS OH description
- OCh OH description
- OTUk OH description
- ODUk OH description
- OPUk OH description

Maintenance signals

- OTS maintenance signals
- OMS maintenance signals
- OCh maintenance signals
- OTUk maintenance signals
- ODUk maintenance signals
- Client maintenance signal
DWDM Overview (TK813)

Prerequisites

Participants must have some technical knowledge in telecommunications, and some basic knowledge in optical transmission principles. Fiber optics basics and OTN basics courses are recommended.

Target groups

All personnel starting a sequence of DWDM training, from Planning and Engineering to Management Experts and Service should attend.

Duration

2.0 days

Course content

Introduction

- DWDM principle
- description of the Optical Network Elements

Optical technology

- Attenuation
- Dispersion Effects
- Polarization Mode Dispersion
- Effects of Nonlinear Optics
- Components of the Optical Network Elements
- Optical Fibers
- Optical Multiplexers and Demultiplexers
- Optical Amplifiers
- Lasers types
- Photodetectors
- Types of Connectors

Basics of DWDM Link Planning

Measurements

- Reflectometers
- Polarization Mode Dispersion
- Power measurement and optical Spectrum
WIMAX (TK850)

Prerequisites
Participants must have some technical knowledge in telecommunications.

Target groups
Technician and engineers working in the access field.

Duration
3.0 days

Course content

Overview on WiMax

802.16 Family and RF design
- An overview
- An insight into IEEE 802.16 WiMAX

Wimax air interface
- Introduction
- Physical Layer
- MAC Layer
- QoS

Introduction on OFDMA
- OFDMA System Architecture
- OFDMA System Properties
- Coverage and Capacity

Wimax Applications

Wimax security
- Security in WiMAX
- Privacy Key Management (PKM) Protocol
Voip over Wimax

- Voice over Ethernet via IEEE 802.16
- QoS Strategy for VoIP Services over IEEE 802.16
- Conclusions

Current trend with wimax

802.16 QoS architecture

- QoS Components and Architectures
Access network technologies and concepts (TK851)

Prerequisites
Participants must have some technical knowledge in telecommunications.

Target groups
Technician and engineers who are working in the access field. All Personnel that want to have an idea about technologies used in the access network.

Duration
3.0 days

Course content

Bandwidth demand
- DATA Services
- Voice services
- Problem of the copper wire

xDSL
- Concept and Principles
- Symmetrical technologies
- Asymmetrical technologies
- DSLAM concepts

FTTx Networks
- FTTx concept
- FTTx applications
- Network design and Implementation

Ethernet in the first Mile

Passive Optical Networks
- Passive Optical components
- APON/BPON Characteristics
- EPON Characteristics
- GPON Characteristics
Linux Level 1 (TK010)

Prerequisites

No required prerequisite. This course is for users of Linux who want to start building skills in systems administration on Red Hat Linux.

Target groups

End-users, programmers or integrators who are new to the Linux environment

Duration

2.0 days

Course Content

Linux Presentation

- Introduction
- System Architecture (Kernel, Processes, Memory handling)
- Linux Users

Linux files

- Directories
- File Types
- Access Rights
- Super User

Linux basic commands

- Shell
- Environment Variables
- File handling Commands
- Input/output Redirection
- Redirection from/to files
- Redirection to Pipes
- Task Managing
- Scripts and Commands
Linux Utilities

- vi
- Text Filters
- Process Handling
- File system Handling

Processes

- Definition
- Process Creation
- Process Supervision
Linux Level 2 (TK011)

Prerequisites

Participants should have attended the TEKonsult course Linux Level 1.

Target groups

The course is designed for end-users, programmers or integrators who are working in the Linux environment and users of Linux who want to start building skills in systems administration on Red Hat Linux.

Duration

2.0 days

Course Content

Directory Tree Overview

- /etc
- /var
- /proc
- /usr
- /dev

File System Administration

- File system Details
- Mke2fs
- Ext2, Ext3 File Systems
- fsck
- File System Attributes
- Commands and Files

Linux Networking

- IP Connectivity
- Ethernet
- Bridging
- IP Routing
Memory Management

- Virtual Memory
- Swap Space Creation
- Using Swap Space
- Allocating Swap Space
- Buffer Cache

User Administration

- User Accounts
- Creating Users
- Managing Users Properties
- Removing Users