enki

Training and Consultancy

Catalogue 2017

ENKI
Training and Consultancy

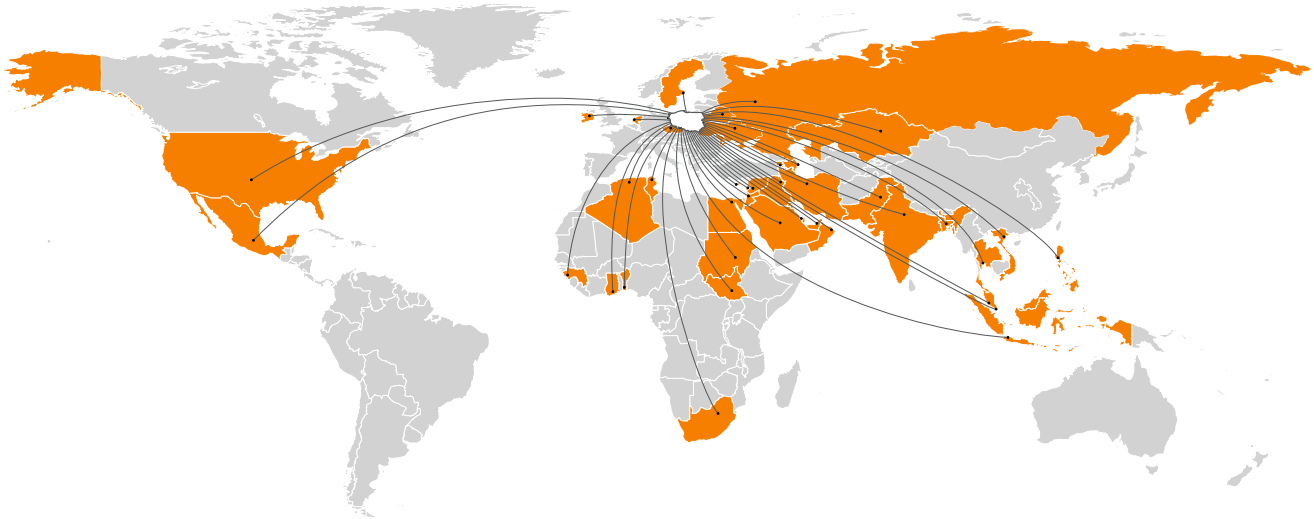
About ENKI

ENKI is a worldwide provider of mobile telecommunications training services. Based on research of the latest 3GPP, ETSI and IETF standards we develop easy-to-understand advanced technical training programs in 2G (GSM), 3G (WCDMA) and 4G (LTE) to deliver telecom courses to mobile operators, equipment suppliers and service providers.

We transfer complex technical knowledge and share our experience in an easy-to-understand way, therefore your time dedicated for training with us is efficient used.

Our ultimate goal is to provide the customer with the highest quality services in a reliable and timely manner. Therefore development and delivery of our courses follow the ISO 9001:2008 quality management standard.

We offer public schedule courses in Poland as well as trainings at customer premises. Since 2001 broad competences of our team and quality of our trainings has took us to 40 countries on 4 continents*.



*Algeria, Armenia, Azerbaidjan, Bahrain, Bangladesh, Benin, Bialorus, Cyprus, Czech Republic, Egypt, Ghana, Guinea, India, Indonesia, Iran, Iraq, Ireland, Jordan, Kazakhstan, Lebanon, Malaysia, Mexico, Netherlands, Oman, Pakistan, Philippines, Russia, Saudi Arabia, Singapore, South Africa, Sudan, South Sudan, Sweden, Syria, Thailand, Tunisia, Ukraine, United Arab Emirates, United States of America, Vietnam.

Why ENKI courses?

Continuous technology progress transforms our world and business. ENKI *telecommunications trainings* let you follow in an easy way the technology progress and discover essential changes, which a new technology brings. ENKI courses are based on telecommunications standards (3GPP, ETSI and IETF) and directed to engineers, managers and all staff engaged in maintenance of the 2G (GSM), 3G (WCDMA) and 4G (LTE) networks.

Our teaching skills, telecommunications and computer science knowledge, researches of the 3GPP, ETSI and IETF standards and long-term experience related to Ericsson and other vendors equipment result in unforgettable trainings. Moreover, our instructors exactly know *what the learning is* and possess pedagogical skills to make a training an exciting journey of telecommunications discovery.

Learning is a complex process where you associate a new fact with knowledge that you already have. And when you discover the next new fact you try to match it with the previous one. Learning is about building a net of associations between facts. We have developed a training methodology which perfectly supports the learning process.

Experience

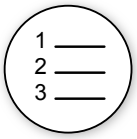
We embrace telecom. From GSM to LTE Advanced. From radio network through core network to IMS. Our instructors have been conducting telecom trainings since 1999.

Recognised quality

Your long-term satisfaction is our target. A number of customers have trusted us. We have conducted courses in 40 countries on 4 continents.

Structured information

Carefully selection of contents and well structured information. The logical sequence of topics supported by exercises, case studies and tests makes our trainings *easy-to-understand*. You never get lost.



Colours bring associations

To quicker grasp new knowledge your brain needs pictures and colours. In most books pictures are coloured to make them look pretty. We spend hundreds of hours to elaborate pictures, where colours bring associations to make even difficult subjects *easy-to-understand*.

We systematically develop new courses and build consistent training flows. Recently we have developed Long Term Evolution (LTE) training flows dedicated to technical staff engaged in LTE radio network design and LTE network optimisation.

Our student books are created in LaTeX typesetting system, which is very suitable to produce technical documents of high typographical quality. Pictures are drawn in Inkscape with use of ENKI elaborated colour scheme to support our "Colours bring associations" approach.

Our team

Adam Girycki

The founder of ENKI Training and Consultancy. Graduated Technical Physics (1994) from the Silesian University of Technology in Gliwice, Poland. Completed PhD studies in Electronic and Telecommunications (1998) at the Silesian University of Technology in Gliwice. Expert in the field of the GSM/EGPRS and LTE radio network signalling, planning and optimisation. Engaged in the telecom training since 1999.

Privately, passionate of running with the personal record at 2015 Paris Marathon.

Estera Bul

Training Coordinator. Graduated Management (2012) and Project Management and Innovation (2015) from the Silesian University of Technology in Zabrze.

Helpful and happy to get in touch with you. Eager to present our training offer and answer to all your queries and training requests.

Aleksander Simon

Graduated Technical Physics (1983) from the Silesian University of Technology in Gliwice, Poland. PhD degree (1990) from Institute of Fundamental Technological Research Polish Academy of Sciences. Associate professor at the Academy of Computer Science and Management in Bielsko-Biala, Poland (since 2003). Expert in the field of mobile telecommunications signalling and security. Engaged in telecom training since 1997.

Janusz Uszko

Graduated Computer Science (1995) from Jagiellonian University in Cracow, Poland. Completed PhD studies in Computer Mechanics (1999) at the University of Technology in Cracow. Expert in the field of WCDMA and LTE radio network design and optimisation. Engaged in the telecom training since 1998.

Marcin Kuczera

Graduated Electronics and Telecommunication (2000) from Silesian University of Technology in Gliwice, Poland. Specialist in the field of IP networking, network configuration, planning and optimisation. His area of competence includes IP in packet networks of mobile operators, BSS/OSS systems, SGSN and GGSN nodes, IP core network devices as well as commercial application of open source operating systems (Linux, xBSD). He is also running own company delivering internet access, transmission services and telephony solutions.

Mirosław Waśniowski

Over 16 years of professional experience in mobile communication and data transmission. Graduated Electronic and Telecommunication (1999) as well as Management and Marketing (2001) from the AGH University of Science and Technology in Krakow, Poland. His main area of professional interest covers transmission and transport technologies such as MPLS and IP, as well as signalling, concepts with the focus on core networks used in 2G and 3G mobile networks. He is also involved in knowledge transfer activities in the field of planning and optimisation of Core Network in various generations of mobile systems.

In parallel he has been involved in preparation and management of research and development projects (2004-2015) sponsored by the European Union under the 7th Framework Programme and more recently in Horizon 2020. He advises innovative companies, prepares winning proposals in the ICT domain and supports businesses in running R&D projects. The successfully managed projects demonstrated his knowledge and managerial skills. Personal interests in developing product and process innovations associated with the focus on knowledge management encouraged him to undertake the MBA Program, which he completed with the distinction degree from the Oxford Brookes University (2008).

Nayan Abdullah

Graduated in Electrical and Electronics Engineering from Bangladesh University of Engineering and Technology, Bangladesh. Expert in the field of GSM/EGPRS, UMTS and LTE radio network planning and optimisation. His professional experience includes planning and optimisation projects for Huawei and Ericsson equipment for operators in Bangladesh. Engaged in telecom training since 2007.

Paweł Iwan

Graduated Computer Science (Software Engineering faculty, Computer Networks faculty) from Jagiellonian University (2010) in Krakow, Poland. Specialist in a field of WCDMA, LTE, Core Networks (PS, EPS) and Charging Systems. Engaged in telecom training since 2008.

In parallel, involved in consulting, preparation and management of several research and development projects financed from UE 7th Framework Programme and Horizon 2020.

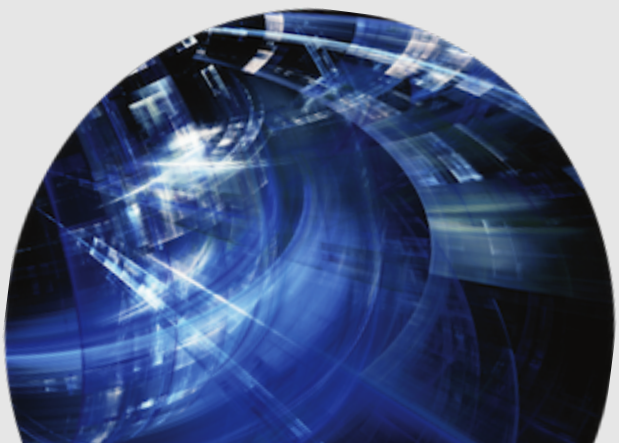
Privately, passionate of music and organiser of concerts, festivals and events.

Piotr Gruszczyński

Graduated Computer Science and Telecommunication (1997) from the French-Polish School of New Communication Technologies. Involved in GSM technology from 1997. Expert in the field of GERAN optimisation, 2G/3G Core and EPC core networks signalling, planning and troubleshooting. Broad knowledge of IP technology with transport solutions (Ethernet flavours, MPLS) as well as services, especially emerging solutions with telecom: SIGTRAN, VoIP/IMS, TMN. Telecom instructor since 1999.

Tomasz Głowacki

Graduated Automatic Control, Electronics and Telecommunication, Computer Science (2011) with master degree from Silesian University of Technology in Gliwice, Poland. He specialises in LTE, WCDMA and IP in mobile networks with a focus on IMS. Engaged in the telecom training since 2010.



Training difficulty level

★ A course which introduces a technology or activity. Usually without specified prerequisites.

★★ A course that describes a technology or activity. In the case of technical courses the ability to understand technical subjects or adequate technical background would be a prerequisite.

★★★ A course that presents certain aspects of a technology. General knowledge of the technology's principles is the necessary prerequisite.

★★★★ An advanced course which deals with details and applications of the technology or activity. Typically a broad knowledge and experiences are required prior to attending such a course.

★★★★★ A course prepared and provided on a special request. Commonly it relates to designated aspects of a given concept or technology.

Telecom training

GSM/GPRS

UMTS

LTE & WiMAX

DATACOM & NETWORKING

IMS

SAP BusinessObjects

GSM Cell Planning Flow

ELP 0104 ★★★

The GSM Cell Planning Flow describes the GSM/GPRS radio network design process, which is focused on fulfilling operator desired coverage, capacity and quality requirements. Coverage: both theoretical and semi-empirical coverage propagation models are presented and the signal strength design concept. Capacity: the concept of congestion and Erlang formula are presented and used for traffic and control channels capacity dimensioning. Quality: co-channel and adjacent channel interference and frequency reuse pattern concepts are presented and used for channel and BSIC planning. Impact of GPRS on the GSM network planning is also discussed. The training includes radio network design case study. The course also presents the in-building cell planning process and the selected radio network procedures essential for the cell planner.

Target audience – Who should attend and benefit

It is recommended for radio network planning and optimisation engineers.

Prerequisites – What you are supposed to know prior to the course

General knowledge in GSM is recommended before attending the course.

Course content – What you will learn

- GSM/GPRS system description
  - GSM system architecture
  - GPRS system architecture
  - Network identity numbers
  - GSM air interface
  - GPRS air interface
- Cell planning introduction
  - Cell planning process
  - Cell planning prerequisites
  - Nominal cell plan
  - Site survey
  - System design
  - System implementation
  - System tuning
- Radio wave propagation
  - Wireless transmission
  - Generation of radio waves
  - Radio wave propagation in free space
  - Transmission problems
  - Cell type
  - Semi-empirical models
- Coverage predictions
  - Cell coverage definition
  - Power budget
  - Signal strength required
  - Signal strength design
  - Cell range
- Traffic
  - Traffic concept
  - Grade of Service (GoS)
  - Erlang B-table
  - Traffic distribution
  - SDCCH GoS
  - Channel utilization
  - GPRS capacity
- Frequency planning
  - Capacity goes with the carrier
  - Channel reuse pattern
  - Frequency allocation
  - BSIC planning
  - Cell planning aspects of GPRS
- SDCCH dimensioning
  - Introduction
  - SDCCH configurations
  - Actual SDCCH traffic to TCH traffic ration
  - Immediate assignment on TCH not used
  - Immediate assignment on TCH used
  - Half rate
- Location area dimensioning
  - Introduction
  - BTS paging capacity
  - BSC paging capacity
  - Location Area dimensioning strategy
- Radio network dimensioning
  - Introduction
  - Site survey instruments
  - Radio network survey
  - Survey report
- In-building cell planning
  - Work flow
  - Capacity dimensioning
  - Choice of BTS and antenna
  - RF design
  - Frequency planning
  - Traffic control
- Traffic cases
  - Traffic cases categories
  - Location updating
  - Calls
  - Handovers
- Introduction to system tuning
  - Quality of service
  - Optimisation process
  - Categories of optimisation tools
- GSM radio network parameters and procedures
  - GSM idle mode cell selection algorithm
  - Paging
  - GSM active mode cell selection algorithm
  - GPRS Mobility Management functionality
  - Frequency hopping
  - MS power control
  - GPRS MS power control
  - Discontinuous Transmission

Duration – How long it takes

5 days which is equivalent to 30 hours of lecture.

Planning Digital Microwave Point-to-Point Systems

ELP 0110 ★★

The training presents the design process of digital microwave point-to-point systems. Such systems are widely used by fixed and mobile telephony operators as well as for military purposes. During this course attendees obtain necessary theory and study detailed aspects of planning process. The most important parts of the course cover the following subjects: radio wave propagation theory, types of fading, parameters and configuration of radio equipment (antennas, waveguides, modems), frequency planning, interference conditions and link budget. Finally, the course also presents a detailed case-study example which summarises the knowledge provided.

Target audience – Who should attend and benefit

This course is addressed to individuals responsible for planning, engineering, operating and maintaining digital microwave point-to-point radio systems. Practical and theoretical knowledge would be valuable for both technical professionals and engineers.

Prerequisites – What you are supposed to know prior to the course

Ability to understand technical subjects. Some familiarity with basic algebra would be helpful. Technical background in telecommunications would also be an advantage when attending this course. A scientific handheld calculator or a laptop is recommended due to some practical exercises.

Course content – What you will learn

- Introduction to Digital Microwave Systems
  - Frequencies
  - System components
  - Applications
- Transmission Methods
  - Digital modulation techniques
  - Error detection and error correction
- Microwave propagation
  - Free space propagation
  - Atmospheric effects on propagation
  - Attenuation due to atmospheric gases
  - Refraction in troposphere
  - Diffraction due to obstacles
- Types of fading
  - Rain fading
  - Multipath fading
- Radio Equipment
  - Types and parameters of antennas
  - Waveguide characteristics
  - Transmitter and receiver characteristics
- Equipment configurations
  - Indoor/outdoor mounting
  - Diversity and branching schemes
- Frequency planning
  - Frequency bands assigned to point-to-point radio links
  - Interferences
  - Frequency coordination
  - Frequency re-use
- Reliability and quality standards
- Radio path planning
  - Network topologies
  - Line-of-Sight (LOS) requirements
  - Path profiles
  - Path and site surveys
- Link design
  - Choosing antenna heights (including reflection point calculations)
  - Power budget and fade margin
  - Outage predictions (due to rain and multipath fading)
- Tutorial example

Duration – How long it takes

2 days which is equivalent to 12 hours of lecture.

GSM Advanced Signalling

ELP 0406 ★★★★

The course focuses on functional aspects of the most important GSM network nodes and the signalling exchanged among them. The GSM signalling model is introduced and explained step by step, following the main interfaces on the so-called "connection path" (Um, A-bis, A). The various signalling protocols are discussed, with stress on the specific traffic cases (location updating, call connection, handover).

The course is based on the GSM Technical Specifications and hence is vendor-independent.

Target audience – Who should attend and benefit

The course is addressed to network engineers, network planning and tuning personnel, as well as any technical stuff requiring deeper knowledge of the system signalling.

Prerequisites – What you are supposed to know prior to the course

An understanding of the principles of the GSM systems and basic knowledge on architecture of cellular network is essential.

Course content – What you will learn

- GSM architecture overview
  - Nodes
  - Interfaces
  - Traffic and Signalling
  - Protocols
- Network identity numbers
  - Mobile Station International ISDN Number (MSISDN)
  - International Mobile Subscriber Identity (IMSI)
  - Temporary Mobile Subscriber Identity (TMSI)
  - International Mobile Equipment Identity (IMEI)
  - Location Area Identity (LAI)
  - Cell Global Identity (CGI)
  - Base Station Identity Code (BSIC)
  - Mobile Station Roaming Number (MSRN)
- Air interface characteristics
  - Frequency bands
  - Physical channels
  - Cell allocation
  - GSM logical channels
  - Frame structure
  - Burst formats
  - GSM channel combinations
  - Mapping of logical channels onto physical channels
- Traffic cases
  - Location updating
  - Calls
  - Handovers
- System Information
  - Idle mode System Information
  - Active mode System Information
- Signaling on the MS-BTS (Um) interface
  - General description
  - Layer 3 protocols
  - Layer 3 message format
  - Network signalling vs. user signalling (SMS)
  - LAPDm signalling (Layer 2)
  - Layer 1 functions
- Signalling on the BTS-BSC (A-bis) interface
  - Traffic
  - Transcoding and rate adaptation
  - DTX functions and in-band signalling
  - TRX signalling
  - Layer 1
  - Layer 2 (LAPD)
  - Layer 3
- Signalling in SS7
  - Signalling methods
  - Signalling System No. 7
  - Signalling network
  - MTP signalling
  - SCCP signalling
- Signalling on the BSC-MSC (A) interface
  - BSSAP signalling
  - Direct Transfer Application Part (DTAP)
  - BSS Management Application Part (BSSMAP)
  - Initial MS messages
  - MS Classmark information
  - Message format on the A interface
- Switching System signalling
  - Mobile Application Part (MAP)
  - Transaction Capability Application Part (TCAP)
  - ISDN User Part (ISUP)
- Signalling procedures between MS and MSC
  - Mobile terminating call
  - Call disconnection and release of resources
  - Location updating
  - Signalling diagrams
- GPRS signalling overview
  - System architecture
  - Aire interface
  - System information
  - Mobility Management functionality

Duration – How long it takes

4 days (equivalent to 24 hours of lecture) for the Base Station System part plus 1 day (equivalent to 6 hours of lecture) for the Switching System part.

GPRS Advanced Signalling

ELP 0408 ★★★★

The course focuses on functional aspects of the GPRS bearer service, with stress on signalling exchanged among the main GPRS entities. The GPRS signalling model is introduced and explained step by step, both in transmission and signalling planes. The various signalling protocols are discussed, with stress on the specific traffic cases (GPRS attach, PDP context activation, location updates).

The course is based on the GSM Technical Specifications and hence is vendor-independent.

Target audience – Who should attend and benefit

The course is addressed to network engineers, network planning and tuning personnel, as well as any technical stuff requiring deeper knowledge of the GPRS network.

Prerequisites – What you are supposed to know prior to the course

An understanding of the principles of the GPRS bearer service and basic knowledge on architecture of the GPRS network is essential. Participation in the GSM Advanced Signalling (ELP 0406) courses is recommended.

Course content – What you will learn

- GPRS system overview
  - Introduction
  - Interfaces
  - Traffic and signalling
- GPRS protocols
  - Layered protocol structure
  - Transmission plane
  - Signalling plane
- GPRS traffic management
  - GPRS traffic management functions
  - Mobility states of an MS
  - Mobility Management procedures
  - Quality of Service
  - Session Management procedures
- GPRS air interface
  - GPRS Radio Resources
  - Protocol stack
  - Subnetwork Dependent Convergence Protocol (SNDCP) layer
  - Logical Link Control (LLC) layer
  - Radio Link Control (RLC)/ Medium Access Control (MAC) layer
  - GSM Radio Frequency (GSM RF) layer
- Gb interface
  - BSS architecture
  - Gb interface protocol stack
  - Identification of logical connections
  - BSS GPRS Protocol (BSSGP)
  - Network Service (NS)
  - Frame Relay (FR)
  - Physical layer (L1bis)
- Core network
  - Interfaces and protocols in the GPRS backbone network
  - SS7 interfaces
  - Gs interfaces (BSSAP+)
  - IP interface
  - IP connectivity and addressing
  - GPRS backbone network
  - GPRS Tunnelling Protocol (GTP)
- Signalling procedures
  - Common security functions
  - MS attach
  - MS detach
  - PDP context activation
  - PDP context deactivation
  - Cell update
  - Types of SGSN RA update
  - Intra-SGSN RA update
  - Inter-SGSN RA update
  - Combined Inter-SGSN RA/LA update
  - Suspension of GPRS services

Duration – How long it takes

3 days which is equivalent to 18 hours of lecture.

GSM/GPRS Radio Network Optimisation

ELP 0202 ★★★★

The GSM/GPRS Radio Network Optimisation starts from describing the Quality of Service concept and optimisation process. Next the course discusses in details algorithms with their parameters which control various aspects of the Mobile Station (MS) in the radio network and which change impacts the Quality of Service.

The training also presents tools which are used in radio network optimisation. From the tools on the MS side the course included TEMS Investigation log-files analysis and report generation. From the tools on the network side the radio network statistics of accessibility, retainability and service integrity are analysed.

Target audience – Who should attend and benefit

It is recommended for those who are involved in tuning activities of the GSM/GPRS network.

Prerequisites – What you are supposed to know prior to the course

Participation in the GSM Cell Planning Flow (ELP 0104) course is recommended or equivalent knowledge of the cell planning process is required.

Course Content – What you will learn

- GSM and GPRS system description
  - GSM system architecture
  - GPRS system architecture
  - Network identity numbers
  - GSM air interface
  - GPRS air interface
- Managing the quality
  - Quality of service
  - Optimisation process
  - Optimisation tools
- Coverage planning
  - Power budget
  - Signal strength required
  - Signal strength design
  - Cell range
- Traffic cases and Layer 3 messages
  - Location updating
  - Calls (mobile originating call establishment, mobile terminating call establishment, call disconnection)
  - Handovers
  - Synchronization channel information
  - Measurement report
- Radio network procedures
  - GSM idle mode cell selection algorithm
  - Paging
  - GSM active mode cell selection algorithm
  - GPRS Mobility Management (MM) functionality
  - Frequency hopping
  - MS power control
  - GPRS MS power control
  - Discontinuous Transmission (DTX)
- System Information
  - Idle mode System Information
  - Active mode System Information
  - GPRS System Information
- SDCCH dimensioning
  - Introduction
  - SDCCH configurations
  - Actual SDCCH traffic to TCH traffic ratio
  - Immediate assignment on TCH not used
  - Immediate assignment on TCH used
  - Half rate
- Location Area dimensioning
  - Introduction
  - BTS paging capacity
  - BSC paging capacity
  - Location Area dimensioning strategy
- TEMS Investigation
  - Introduction
  - Line Chart
  - Serving + Neighbours
  - Radio Parameters
  - Current Channel
  - Map Chart
  - Layer 3 Messages
- Radio network statistics
  - Radio Network Performance Analysis
  - Accessibility
  - Retainability
  - Service integrity
  - GPRS user formulas

Duration – How long it takes

4 days which is equivalent to 24 hours of lecture.

UMTS/WCDMA Advanced Overview

ELP 0606 ★★★

The course presents an overview on the architecture, functionality and services of UMTS. The focus is put on the new, characteristic features of UMTS/WCDMA differentiating the system from GSM. The course provides a detailed survey through WCDMA air interface including spreading operation, fast power control, soft handover, rake receiver as well as some aspects of radio network planning. It describes the UMTS Terrestrial Radio Access Network as well as the Core Network elements and functions. A brief introduction to protocols and procedures in UMTS is given. The course provides the participants with the overview on UMTS service concepts as well as presents some major security issues in UMTS. The course is based on the 3GPP Technical Specifications and hence is vendor-independent.

Target audience – Who should attend and benefit

The course is addressed to network engineers and consultants who will work with UMTS system, as well as any technical staff requiring deeper appreciation of UMTS.

Prerequisites – What you are supposed to know prior to the course

Ability to understand technical subjects. Technical background in mobile telecommunications is required.

Course content – What you will learn

- UMTS system introduction
  - Migration from GSM to UMTS
  - UMTS as a 3G mobile system
- 3G standardization
  - IMT-2000
  - Spectrum allocation
- System architecture
  - Introduction
  - Radio Access Network
  - Core Network
  - User Equipment
  - External networks
  - Network geographical structure
  - Identity numbers
- Introduction to WCDMA
  - Radio access methods
  - Spectrum spreading
- WCDMA air interface
  - Channelization and scrambling
  - Modulation
  - Bandwidth on demand
  - Power control
  - Handover
  - Multipath radio channels and RAKE receiver
  - WCDMA channel concept
  - WCDMA physical layer procedures
- Data processing in WCDMA transmitter
  - Source coding
  - Channel coding
  - Error detection coding (CRC attachment)
  - Transport block concatenation and code block segmentation
  - Error correction coding
  - Radio frame size equalization
  - Interleaving
- Introduction to radio network planning
  - Introduction
  - Radio network dimensioning
  - Planning requirements
  - Link budget
  - Capacity
  - Capacity limitations
  - Capacity improvements
  - Coverage
  - GSM co-planning
  - GSM and WCDMA coverage comparison
  - Planning tools
  - Network optimization
- UTRAN
  - Introduction
  - UTRAN logical architecture
  - UTRAN interfaces
  - UTRAN functions
  - Synchronization
  - Implementation issues
  - UTRAN improvements
- Core Network
  - Introduction
  - CN nodes, interfaces and their functions
  - CN evolution
  - CN transmission
- Introduction to protocols and procedures
  - Protocol reference architecture
- Security
  - Security features in UMTS
  - 3G Security threats
  - UTRAN security
  - CN security
  - User domain security
  - Security of services and applications
  - Lawful interception
  - UMTS versus GSM security model
- Services
  - Introduction
  - UMTS service categories
  - UMTS service architecture
  - Quality of Service (QoS) in UMTS

Duration – How long it takes

5 days which is equivalent to 30 hours of lecture.

WCDMA Radio Network Planning

ELP 0161 ★★★★

WCDMA Radio Network Planning introduces the principles of the WCDMA air interface. First, the course presents spread spectrum technology, physical layer of the radio interface and network planning aspects. Next special attention is put on the description of WCDMA radio network planning process including coverage and capacity planning, interference analysis and network optimisation. Also the effect of the propagation environment, base station solutions and GSM co-planning are discussed as well as the new UMTS service architecture and Quality of Service (QoS).

Target audience – Who should attend and benefit

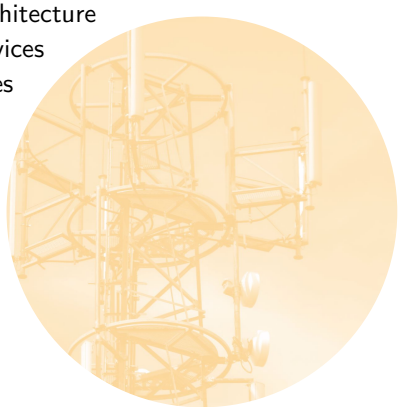
It is recommended for those who are involved in the cell planning and optimisation process.

Prerequisites – What you are supposed to know prior to the course

Ability to understand technical subjects is required. General knowledge in GSM and UMTS is recommended before attending the course. Participation in the GSM Cell Planning Flow (ELP 0104) or equivalent knowledge is beneficial.

Course content – What you will learn

- Introduction to WCDMA system
  - Why WCDMA?
  - UMTS standardisation
  - WCDMA air interface requirements
  - UMTS architecture
- Air interface
  - Spectrum allocation
  - Radio access methods
  - Spreading
  - Bandwidth on demand
  - Power control
  - Handover
  - Multipath radio channels
  - Rake receiver
- RAN architecture
  - Node B
  - Radio Network Controller
  - Radio Network Subsystems
  - UTRAN interfaces
  - UTRAN functions
- Channel concept
  - Logical channels
  - Transport channels
  - Physical channels
  - Packet data transmission
  - Transport channels for packet data (common, dedicated and shared transport channels)
- WCDMA radio network planning process
  - Radio network dimensioning
  - Planning requirements
  - Link budget
  - Planning tools
  - Network optimisation
- Coverage predictions
  - Uplink coverage (bit rate, AMR speech codec, multipath diversity, macro diversity, receiver antenna diversity, base station baseband algorithm, coverage calculations, example)
  - Downlink coverage
  - Coverage improvements
- Capacity predictions
  - Uplink capacity
  - Downlink capacity
  - Capacity versus coverage simulations
  - Capacity limitations
  - Capacity improvements
  - Network growth
- Adjacent channel interference
  - Interference scenario
  - UTRA FDD and TDD mode interference
  - Network planning solutions
- GSM co-planning
  - GSM coverage calculations
  - GSM and WCDMA coverage comparison
- UMTS services
  - UMTS service architecture
  - UMTS bearer services
  - UMTS QoS classes
  - QoS attributes



Duration – How long it takes

3 days which is equivalent to 18 hours of lecture.

UMTS Advanced Signalling

ELP 0605 ★★★★

The course offers a complete understanding of all signalling protocols implemented in the Universal Mobile Telecommunications System. It introduces the general architecture of the UMTS network, defines interfaces and protocol stacks, and presents their description through functions and services they provide. Specific stress is placed on WCDMA Radio Access Network signalling, although Core Network signalling is also treated extensively. Most important network procedures, such as signalling connection establishment, UMTS attach, service request and soft handover are discussed and presented on signalling diagrams. The course is based on the 3GPP Technical Specifications and hence is vendor-independent.

Target audience – Who should attend and benefit

The course is addressed to network engineers and consultants who will work with UMTS system, as well as any technical staff requiring deeper appreciation of UMTS signalling.

Prerequisites – What you are supposed to know prior to the course

Ability to understand technical subjects. Technical background in mobile telecommunications is required. Basic knowledge of signalling and protocols is of advantage.

Course content – What you will learn

- General UMTS network architecture
  - Introduction
  - UTRAN
  - Core Network
  - User Equipment
- UMTS protocol architecture
  - Introduction
  - UMTS layers and planes
  - UMTS strata
  - UMTS bearers and QoS
  - UMTS signalling models
- WCDMA radio interface
  - WCDMA as a spread-spectrum radio system
  - Bandwidth on demand
  - Channelization and scrambling
  - Modulation
  - WCDMA channel concept
- UTRAN
  - The general purpose of UTRAN
  - UTRAN protocol model
  - UTRAN functions
  - Performance of Node B
  - Performance of RNC
  - Radio Resource Management (RRM)
- Signalling on Uu interface
  - Layer 3 control plane – Radio Resource Control (RRC) protocol
  - Layer 2 protocols common to control and user planes
  - Layer 2 protocols specific to user plane
  - Layer 1 – physical layer
- Signalling on Iub interface
  - Protocol model for Iub
  - Node-B Application Part (NBAP)
  - Iub frame protocols
- Signalling on Iur interface
  - Iur signalling procedures
  - Protocol model for Iur
  - Radio Network Subsystem Application Part (RNSAP)
  - Iur frame protocols
- Signalling on Iu interface
  - General description of Iu interface
  - Protocol model for Iu-CS
  - Protocol model for Iu-PS
  - Radio Access Network Application Part (RANAP)
  - Iu user plane protocols (frame protocols)
- Core Network
  - The Core Network protocol model
  - Non-Access Stratum protocols
  - Network control signalling protocols
  - Packet data backbone network protocol
  - Transit network control protocols
  - Service control protocols
- Transport network protocols
  - Introduction
  - TDM
  - ATM and its Adaptation Layers (AAL2, AAL5)
  - SAAL and MTB-3b
  - IP
  - SCCP
- Basic and advanced traffic cases
  - Basic model of a UMTS transaction
  - Mobility Management (MM) procedures
  - Radio Resource Management (RRM) procedures
  - Calls

Duration – How long it takes

5 days which equivalent to 30 hours of lecture.

WCDMA Radio Network Optimisation

ELP 0607 ★★★★

The success of optimisation process depends a lot on the understanding of the coverage and capacity requirements, the use of different functionalities as well as a clear understanding of KPIs to evaluate network performance. The course discusses important WCDMA functionalities with emphasis on relevant parameters. The course also discusses counters and KPIs used in the network performance analysis. To support general troubleshooting, the course also presents important parameter setting and typical optimisation cases.

Target audience – Who should attend and benefit

The course is addressed to network engineers involved in optimisation process.

Prerequisites – What you are supposed to know prior to the course

Participants are recommended to have prior knowledge on existing 2G and 3G systems. The course does not discuss WCDMA network basics.

Course content – What you will learn

- UMTS network architecture
- Performance management
  - Quality of Service (QoS)
  - Optimisation process
- Coverage predictions
  - Uplink coverage
  - Downlink coverage
  - Coverage improvements
- Capacity predictions
  - Uplink capacity
  - Downlink capacity
  - Capacity vs coverage
  - Capacity limitations
  - Capacity improvements
  - Network growth
- Idle mode and common channels behaviour
  - RRC states and state transitions
  - Service types in idle and connected mode
  - Idle mode procedures (PLMN selection, cell selection and reselection, location area and routing area updating, paging, system information)
- Admission control
  - QoS based admission control
  - Load based admission control
  - Other possibilities
- Congestion control
  - Trigger of congestion control
  - Impact of congestion control
  - Congestion control algorithm
  - Setting of congestion control parameters
- Measurements handling
  - Physical layer measurements
  - Layer 3 filtering
  - UE measurements
  - UTRAN measurements
  - Compressed mode
- Handover
  - Handover procedure
  - Soft/softer handover
  - Inter-Frequency handover
  - Inter Radio Access Technology (inter-RAT) handover
- Power control
  - Power control mechanisms
  - Open-loop power control
  - Power control in downlink common channels
  - Closed loop power control
  - Inner loop power control
  - Outer loop power control
- Radio bearer control
  - Radio bearer control procedures
  - Radio bearer control configuration
  - Transport channel reconfiguration
  - Physical channel reconfiguration
  - Transport Format Combination (TFC) control
  - Dynamic Resource Allocation Control (DRAC) of uplink DCHs
  - Variable rate transmission of uplink DCHs
- Traffic management
  - Traffic distribution
  - Inter Radio Access Technology (inter-RAT) handover and cell change
  - Inter-Frequency handover
  - Hierarchical Cell Structure
- Performance measurements and KPIs
  - Performance management functionalities and requirements
  - Measurement administration
  - RAB management
  - Signalling connection establishment
  - RRC connection establishment
  - RRC connection release
  - RLC connection
  - Soft handover
  - Hard handover
  - CS and PS inter-RAT handover
  - Iu connection release
  - Paging performance
  - KPIs
- WCDMA RAN parameters setting and optimisation
  - Parameter setting guideline
  - Improving important KPIs
  - Conclusion

Duration – How long it takes

5 days which is equivalent to 30 hours of lecture.

LTE/SAE Overview

ELP 4002 ★★★

The LTE/SAE Overview course presents the Long Term Evolution (LTE) and System Architecture Evolution (SAE) technology. A general characteristic of the technology is presented, with stress on its advantages and disadvantages. The course overviews the packet core, the radio network and the multimedia technology, which uses the former two to provide users with high bandwidth services.

Target audience – Who should attend and benefit

The course is addressed to managerial staff and network engineers involved in decision process of network development, as well as to anybody who wishes to understand the principles of the LTE technology.

Prerequisites – What you are supposed to know prior to the course

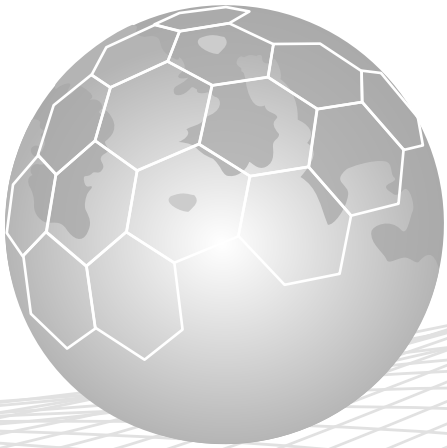
A good understanding of existing 2G and 3G mobile systems will be beneficial.

Course content – What you will learn

- OFDMA principles
  - Two way communication (FDD and TDD)
  - Access network evolution overview (FDMA, TDMA, WCDMA, OFDMA)
  - Complex numbers
  - Fourier analysis
  - Orthogonal Frequency Division Multiplexing (OFDM) concept
  - OFDM transmitter
  - Modulation
- EPS architecture
  - LTE requirements
  - EPS architectural principles (EPC and E-UTRAN)
  - EPC functions
  - LTE functions
  - Strata (NAS and AS)
  - EPS bearers and QoS
  - Integration with 2G and 3G
  - Interfaces overview
- IMS overview
  - What is the IMS?
  - Why IMS?
  - IMS standardisation
  - IMS architecture
  - Standardised applications
  - IMS and LTE integration
  - Example of IMS service
- LTE signalling
  - User plane
  - Control plane
  - Protocols (RRC, PDCP, RLC, MAC)
  - Radio interface structure
- LTE air interface introduction
  - Channel structure (logical channels, transport channels and physical channels)
  - Time domain structure for FDD and TDD
  - Frequency domain structure
  - Scheduling Block
  - System spectral efficiency
  - Downlink transmission technique
  - Uplink transmission technique
  - Multiple Input Multiple Output (MIMO)

Duration – How long it takes

2 days which is equivalent to 12 hours of lecture.



WiMAX Introduction

ELP 4001 ★★

The WiMAX Introduction course presents the WiMAX technology that is designated to support 4G mobile networks. General characteristics of the technology is presented, with stress on its advantages and disadvantages as well as market analysis of implementation success.

Target audience – Who should attend and benefit

The course is addressed to managerial staff and network engineers involved in decision process of network development, as well as to anybody who wishes to understand how networks will evolve to 4G.

Prerequisites – What you are supposed to know prior to the course

A good understanding of existing 2G and 3G mobile systems will be beneficial.

Course content – What you will learn

- WiMAX network architecture
  - General architectural principles
  - Network reference model
  - Reference points
  - Functionalities, design and decomposition
  - Network entry discovery and selection/reselection
  - IP addressing
  - Authentication and security architecture
  - Quality of Service
  - Radio resource management
  - Paging and idle mode operation
- Protocol layering across WiMAX network
  - Data plane
  - Control plane
- Enabling concepts and technologies
  - OFDM
  - Coding and modulation
  - Link layer retransmissions (Hybrid ARQ)
  - Quality of Service
  - IP based QoS techniques
  - Robust security
  - 802.16 security sublayer
  - Authentication and access control
- IP based architecture in WiMAX
  - Reliability
  - Resource availability
- Layered model of WiMAX
  - Physical layer
  - MAC layer
- Mobility in WiMAX
  - Mobility management procedures
  - Mobility management architectural aspects
- Evolution of WiMAX- 802.16m
  - Short term perspective
  - Long term evolution of WiMAX
- WiMAX or LTE/SAE
  - Standardization of mobile systems
  - WiMAX versus LTE/SAE
  - Market analysis of implementation success
  - 4G and beyond

Duration – How long it takes

1 day which is equivalent to 6 hours of lecture.

GPRS/UMTS/LTE Workshop

ELP 4008 ★★

The GPRS/UMTS/LTE Workshop course presents architecture and details of the air interface of the 2G, 3G and 4G packet switch systems. Participants are first introduced with the GPRS/EGPRS system and discover the needs for 3G system. Next details of the 3G system are presented including the air interface, packet switched core network, Quality of Service (QoS) handling, security aspects and service provisioning. Finally participants become familiar with the advantages of the LTE and details of LTE architecture, air interface and service provisioning in LTE by IMS. The training provides brief and excellent overview and comparison of the GPRS, UMTS and LTE systems.

Target audience – Who should attend and benefit

The training is addressed to both managerial and technical staff who require an overview and comparison of the 2G, 3G and 4G systems.

Prerequisites – What you are supposed to know prior to the course

No specific requirements, however general knowledge in GSM, UMTS and LTE is beneficial.

Course content – What you will learn

- Generations of mobile telecommunications
  - CS vs. PS mobile data
  - FDD and TDD
  - Opportunity Driven Multiple Access (ODMA)
  - Access network evolution overview (1G, 2G, 3G and 4G)
- GPRS architecture
  - Adding packet data to GSM
  - GSM and GPRS nodes
  - GPRS interface
  - Traffic and signalling
- GPRS air interface
  - GPRS channel concept
  - GPRS protocols
  - SNDCP layer
  - LLC layer
  - RLC/MAC layer
  - GSM RF layer
  - EGPRS
- The need for 3rd generation system
  - Migration from GSM to UMTS
  - UMTS as a 3G mobile system
  - IMT-2000
  - Spectrum allocation
- UMTS architecture
  - Overall UMTS architecture
  - UTRAN
  - Core Network
  - User Equipment
- WCDMA air interface
  - WCDMA as a spread-spectrum radio system
  - Bandwidth on demand
  - Channelization and scrambling
  - Modulation
  - WCDMA channel concept
  - Rake receiver
- UTRAN
  - The general purpose of UTRAN
  - UTRAN protocol model
  - UTRAN functions
  - RRC states
  - Performance of Node B
  - Performance of RNC
  - Radio Resource Management (RRM)
- CN protocols for GPRS and UMTS
  - CN evolution
  - The Core Network protocol model
  - Non-Access Stratum (NAS) protocols
  - Packet data backbone network protocol
  - CN transmission (ATM and IP)
- UMTS services and applications
  - Service provisioning
  - UMTS service categories
  - UMTS service architecture
  - Quality of Service (QoS) in UMTS
  - Security
  - Requirements of the user equipment
- EPS architecture
  - LTE requirements
  - EPS architectural principles
  - Strata
  - EPS Bearer and QoS
  - Integration with 2G and 3G
  - Interfaces overview
  - EPC functions
  - LTE functions
- LTE air interface
  - User plane
  - Control plane
  - Protocols
  - Radio interface structure
  - Channel structure
  - Time domain structure
  - Frequency domain structure
  - Scheduling Block
  - System spectral efficiency
  - MIMO
  - Evolution options for LTE
- Service provisioning in LTE
  - IMS (What is the IMS?, Why IMS?, IMS standardisation, IMS architecture, standardised applications, IMS and LTE integration, example of IMS service)
  - CS fallback

Duration – How long it takes

3 days which is equivalent to 18 hours of lecture.

LTE Air Interface

ELP 4003 ★★★

The LTE Air Interface course offers a complete understanding of the radio interface in Long Term Evolution (LTE) technology. A general characteristic of LTE is presented with stress on its advantages and disadvantages. The course focuses on the physical channels structure and their processing in both FDD and TDD mode of LTE. The course also presents procedures of power control, link adaptation and HARQ related to downlink and uplink scheduling. The concept of MIMO in LTE, idle mode behaviour and handover process are also discussed. The course is based on the 3GPP Technical Specifications and hence is equipment vendor independent.

Target audience – Who should attend and benefit

The course is addressed to managerial staff and network engineers involved in the radio network planning and optimization process, as well as to anybody who requires detailed knowledge on the LTE radio interface structure and function.

Prerequisites – What you are supposed to know prior to the course

Ability to understand technical subjects is required. A good understanding of existing 2G and 3G mobile systems will be beneficial.

Course content – What you will learn

- OFDMA principles
  - Two way communication
  - Access network evolution overview
  - Complex numbers
  - Fourier analysis
  - Orthogonal Frequency Division Multiplexing (OFDM) concept
  - OFDM transmitter
  - Modulation
- EPS architecture
  - LTE requirements
  - EPS architectural principles
  - EPC functions
  - LTE functions
  - Strata (NAS and AS)
  - EPS Bearer and QoS
  - Integration with 2G and 3G
  - Interfaces overview
- LTE signalling
  - User plane
  - Control plane
  - Protocols (RRC, PDCP, RLC, MAC)
  - Radio interface structure
- LTE radio interface introduction
  - Channel structure (logical channels, transport channels and physical channels)
  - Time domain structure for FDD and TDD
  - Frequency domain structure
  - Scheduling Block
  - Virtual Resource Block (localized and distributed type)
  - System spectral efficiency
- LTE downlink physical channels
  - Cell search
  - P-SS
  - S-SS
  - RS
  - PBCH (MIB and SIB)
  - PCFICH
  - PDCCH (usage, mapping, format, processing, blind decoding)
  - PDSCH (CRC attachment, code block segmentation, channel coding, rate matching, code block concatenation, scrambling, modulation mapper, layer mapper, precoding, resource element mapping)
  - PHICH
  - PMCH
  - Downlink physical channels modulation summary
- LTE uplink physical channels
  - PUSCH
  - Uplink reference signals (RS, SRS)
  - PUCCH
  - PRACH
- Physical layer procedures
  - Timing advance (uplink-downlink frame timing, timing advance range, random access, other cases, maintenance of uplink time alignment)
  - Random Access (RA)
  - Resource allocation (type 0, 1 and 2)
  - MIMO (spatial multiplexing, transmit diversity, transmission modes, MIMO antennas)
  - UE reporting (CQI definition, aperiodic CQI/PMI/RI reporting using PUSCH, periodic CQI/PMI/RI reporting using PUCCH)
  - Modulation order and transport block size determination
  - UL power control (PUSCH power control, PUSCH power control example)
- LTE mobility
  - Idle mode mobility (PLMN selection, cell selection, cell reselection)
  - Connected mode mobility (X2 handover, event triggered reporting, A3 event)

Duration – How long it takes

3 days which is equivalent to 18 hours of lecture.

LTE Signalling

ELP 4004 ★★★★

The course offers a complete understanding of all signalling protocols implemented in the Long Term Evolution (LTE) /System Architecture Evolution (SAE) technology. The course presents the LTE/SAE architecture with its nodes, interfaces and protocol stacks and describes protocols through functions and and services they provide. The course focuses on the details of the radio access network (LTE) signalling, however the most important aspects of the core network (SAE) signalling are also covered. Most important network procedures, such as signalling connection establishment, attach, service request and handover are discussed and presented on signalling diagrams. The course is based on the 3GPP Technical Specifications and hence is equipment vendor independent.

Target audience – Who should attend and benefit

The course is addressed to network optimisers and technical staff requiring deeper understanding of LTE signalling.

Prerequisites – What you are supposed to know prior to the course

Successful completion of the LTE Air Interface is required.

Course content – What you will learn

- LTE/SAE architecture
- LTE protocol architecture
  - Introduction
  - LTE protocol layer
  - Strata
  - User plane
  - Control plane
  - EPS bearer and QoS
  - Radio interface structure
  - 3GPP Technical Specification (3GPP TS) for LTE
- Non-Access Stratum (NAS)
  - NAS protocol architecture
  - NAS functions
  - NAS procedures
  - UE mode of operation
  - EMM
  - ESM elementary procedures
- Radio Resource Control (RRC)
  - Introduction
  - Radio interface architecture
  - RRC states
  - RRC procedures and messages
  - System Information
  - Mobility in idle mode
  - Connection control
  - Measurement control
  - Connected mode mobility management
  - RRC timers and constants
- S1 Application Protocol (S1AP)
  - S1 protocol architecture
  - S1AP functions
  - S1AP elementary procedures
  - E-RAB management procedures
  - Context management procedures
  - Handover signalling
  - Paging
  - NAS transport
  - Management procedures
  - Other procedures
- X2 Application Protocol (X2AP)
  - X2 protocol architecture
  - X2AP services
  - X2AP functions
  - X2AP elementary procedures
  - Basic mobility procedures
  - Global procedures
- GPRS Tunneling Protocol -Control (GTP-C)
  - GTP-C protocol architecture
  - GTP-C procedures
  - Mobility management
  - CSFB
  - Non-3GPP related access
- LTE security
  - Threats in LTE network
  - EPS security features
  - EPS key hierarchy
  - Authentication and Key agreement
  - EPS protection for signalling and user data
- Packet Data Convergence Protocol (PDCP)
  - PDCP protocol architecture
  - PDCP services
  - PDCP functions
  - PDCP procedures
  - PDU format
- Radio Link Control (RLC)
  - RLC protocol architecture
  - RLC services
  - RLC functions
  - RLC procedures
  - RLC transmission example
  - PDU formats
- Medium Access Control (MAC)
  - MAC protocol architecture
  - MAC services
  - MAC functions
  - MAC procedures
  - PDU formats

Duration – How long it takes

3 day which is equivalent to 18 hours of lecture.

LTE Advanced

ELP 4010 ★★★

Participants attending this course will discover key features of LTE Advanced technology. First the course briefly presents the LTE of Release 9. Next the course provides detailed explanation on functions added in 3GPP Releases 10 and 11, such as Carrier Aggregation, Enhanced MIMO, Relaying, Collaborative Multipoint and Heterogeneous Networks.

At the end of the training participants will learn about the upcoming new ideas in mobile telecommunications.

Target audience – Who should attend and benefit

The training is addressed to network engineers, consultants and managing staff who will participate in the LTE Advanced deployment in currently operating LTE networks.

Prerequisites – What you are supposed to know prior to the course

Participants are required to have basic knowledge of LTE technology. For background knowledge participation in ELP 4003 LTE Air Interface is recommended.

Course content – What you will learn

- Introduction
  - Motivations and goals for LTE Advanced
  - Standardization history from Release 8 to Release 11
- LTE revision
  - OFDMA principles
  - Physical layer procedures
- Carrier Aggregation (CA)
  - CA types
  - CA configuration
  - Deployment scenarios
  - Serving cell types
  - Control channels
  - Uplink transmission scheme
  - Mobility
- Enhanced MIMO
  - Antenna port
  - Downlink physical channel processing
  - Reference signals in LTE Advanced (LTE-A)
  - UE CSI reporting
  - Downlink MIMO
  - Uplink MIMO
- Relaying
  - Introduction
  - Enhancements of Release 10 and 11
  - Relay classification
  - Relay architecture
  - Relay processes and procedures
  - Relay evolution
- Coordinated Multipoint (CoMP)
  - CoMP technology basis
  - Joint Processing (JP)
  - UL CoMP
  - CoMP scenarios
  - Backhaul requirements
  - EPDCCH
  - Reference signals
  - CSI-IM
  - Virtual CellID
- Heterogeneous Networks (HetNet)
  - Introduction
  - HetNet deployment scenarios
  - Interference handling in HetNets
  - HetNet benefits
- Beyond Release 12
  - New features

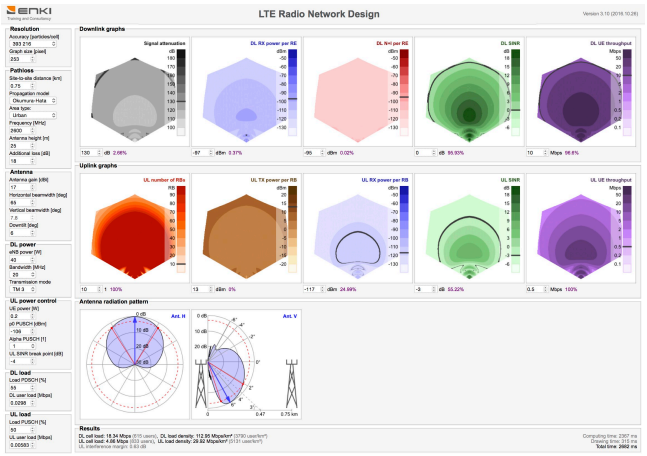
Duration – How long it takes

2 days which is equivalent to 12 hours of lecture.

LTE Radio Network Design Workshop

ELP 4015 ★★★★

The LTE Radio Network Design Workshop training presents the complete workflow of the LTE radio network dimensioning to meet operator's coverage and capacity requirements. Coverage and capacity calculations and their results are carried out and visualised with use the LTE RND software tool developed by ENKI®.



The training explains the LTE design requirements and system characteristic particularly important from radio network design perspective, including channel bandwidth, physical layer bit rate, signalling overhead, maximum user throughput, MIMO, link adaptation, scheduling, UE categories and eNB hardware. Next, the design inputs, e.g. frequency, antenna radiation pattern, downtilt, cell load and UE power control parameters are explained together with their impact on the network coverage and capacity.

Step-by-step, each calculation is explained in details with an example exercise. The results of each exercise are illustrated by a dimensioning graph of the LTE RND tool. Each participant uses the LTE RND tool to design an LTE network with characteristic, coverage and capacity requirements of her/his interest. The course also explains the techniques of physical channels dimensioning and important design parameters dimensioning including PCI and tracking area dimensioning.

Target audience – Who should attend and benefit

The course is addressed to Service Planning Engineer, Service Design Engineer, Network Design Engineer.

Prerequisites – What you are supposed to know prior to the course

Successful completion of the LTE Air Interface is required.

Course content – What you will learn

- LTE design introduction?
  - LTE RND tasks
  - LTE characteristic
  - LTE traffic
- LTE RND inputs
  - Accuracy [particle/cell]
  - Site-to-site distance [km]
  - Graph size [pixel]
  - Propagation model
  - Area type
  - Frequency [MHz]
  - Antenna height [m]
  - Additional loss [dB]
  - Antenna gain [dBi]
  - Horizontal beamwidth [deg]
  - Vertical beamwidth [deg]
  - Downtilt [deg]
  - eNB power [W]
  - Bandwidth [MHz]
  - Transmission mode
  - UE power [W]
  - p0 PUSCH [dBm]
  - Alpha PUSCH [1]
  - UL SINR break point [dB]
  - Load PDSCH [
  - DL average user load [Mbps]
  - Load PUSCH [
  - UL average user load [Mbps]
- LTE downlink coverage and capacity dimensioning.
  - Signal attenuation
  - DL RX power per RE
  - DL N+I per RE
  - DL SINR
  - DL UE throughput
  - DL cell load
- LTE uplink coverage and capacity dimensioning
  - UL number of RBs
  - UL TX power per RB
  - UL RX power per RB
  - UL interference margin
  - UL SINR
  - UL UE throughput
  - UL cell load
- Case study: Design the LTE radio network
  - Define LTE RND requirements
  - DL and UL coverage and capacity dimensioning
  - Project summary
- LTE physical channels and design parameters dimensioning
  - PCI planning
  - RACH root sequence planning
  - PDCCH dimensioning
  - Paging capacity dimensioning
  - TA dimensioning
  - PUCCH dimensioning

Duration – How long it takes

3 day which is equivalent to 18 hours of lecture.

LTE Optimisation Workshop

ELP 4017 ★★★★

The LTE Optimisation Workshop training gives understanding of how the Evolved UTRAN (E-UTRAN) performance is monitored by 3GPP specific Key Performance Indicators (KPIs) and how to optimise the E-UTRAN performance by use of Long Term Evolution (LTE) parameters.

First, the Evolved Packet System (EPS) architecture is presented together with the EPS nodes functions. Also the LTE protocols architecture is explained with the distinction between transport and signalling protocols, Access Stratum (AS) and Non-Access Stratum (NAS), User Plane (UP) and Control Plane (CP). The EPS UP and CP protocol stacks are presented with emphasis on the radio interface. Next, the fundamental concept of the EPS bearer and Quality of Service (QoS) is explained. The default and dedicated EPS bearer setup process and its interworking with Home Subscriber Server (HSS) and Policy and Charging Rules Function (PCRF) nodes is shown.

The training also explains the concept, range and usage of RSPR, RSRQ and SINR for coverage verification, signal strength and signal quality analysis.

The essential part of the training contains the definition of the KPIs for Accessibility, Retainability, Integrity, Availability and Mobility together with the Performance Measurement (PM) counters used in the KPIs as defined by the 3GPP. The counters are illustrated in the flow graphs. For better understating of the KPI formulas, they are calculated with use of an Excel spreadsheet for a sample cell. The training focuses on explanation of the LTE procedures, functions and parameters, which are used to improve the KPI performance. Also live network log-files are analysed for in depth understanding of the parameters structure and usage.

Target audience – Who should attend and benefit

The course is addressed to network engineers involved in the optimisation process.

Prerequisites – What you are supposed to know prior to the course

Successful completion of the LTE Air Interface and LTE Signalling is required.

Course content – What you will learn

- EPS architecture
  - EPC (MME, P-GW and S-GW)
  - E-UTRAN (eNB)
  - EPS interfaces
- LTE protocol architecture
  - Introduction (protocols, SAPs, OSI model)
  - LTE protocol layer
  - Strata (NAS, AS)
  - User plane
  - Control plane
  - Radio interface structure and DL data flow
  - 3GPP TS for LTE
- EPS bearer and QoS
  - EPS bearer
  - Quality of Service
  - Default and dedicated EPS bearer setup
- Drive test coverage analysis
  - RSPR (definition and plot)
  - RSRQ (definition and plot)
  - CINR (definition and plot)
- Accessibility
  - Accessibility KPIs
  - Accessibility procedures (RRC connection establishment, S1 signalling connection establishment, E-RAB establishment, idle mode behaviour, cell selection and reselection, paging, TA update, random access)
  - Accessibility optimisation (log-file analysis, system information, RACH parameters, RRC establishment failure, admission control parameters, traffic distribution)
- Retainability
  - Retainability KPIs
  - Retainability procedures (E-RAB release, UE context release, radio link failure)
  - Retainability optimisation (T310, T311, RRC connection reestablishment, power control)
- Integrity
  - Integrity KPIs
  - Integrity procedures (scheduling, link adaptation, frequency selective scheduling, power control, MIMO with RI)
  - Integrity optimisation (log-file transport protocols parameters analysis, CQI analysis, HARQ and BLER analysis, ARQ, P0 and Alpha, MIMO transmission mode, PDCCH dimensioning)
- Availability
  - E-UTRAN cell availability KPI
- Mobility
  - Mobility KPIs
  - Mobility procedures (X2, S1 and IRAT handover, CSFB, event triggered reporting)
  - Mobility optimisation (handover log-file analysis, A2 and A3 event parameters analysis)

Duration – How long it takes

4 days which is equivalent to 24 hours of lecture.

IP in Mobile Networks' Backbone

ELP 0306 ★★

The course presents Internet Protocol from the perspective of mobile operators. Generic knowledge is explained as well as specific functionality used in mobile backbone networks. The IP, its main protocols such as TCP and ICMP are presented.

The course is based on the IETF RFCs and GSM Technical Specifications and hence is vendor-independent.

Target audience – Who should attend and benefit

The course is addressed to core network engineers, as well as any technical staff requiring knowledge of the Internet Protocol based networks.

Prerequisites – What you are supposed to know prior to the course

An understanding of the principles of the telecommunication will be an advantage for participation in this course.

Course content – What you will learn

- Mobile IP network overview
  - 2G mobile backbone network
  - 3G core network
- Internet Protocol version 4
  - IPv4 header
  - Addressing, sub-netting and super-netting
  - IPv4 protocols
  - IP options
  - QoS for IPv4
- Internet Protocol version 6
  - IPv6 header
  - Addressing
  - IPv6 protocols
  - IPv6 options
  - QoS for IPv6
- Main IP protocols and their functions
  - ICMP
  - TCP
  - UDP
- Routing in IP
  - Static routing
  - IGP routing: RIP, OSPF
  - EGP routing: BGP
  - Source based routing
- Domain handling in IP
  - DNS resolution
  - DNS information structure
  - Implementation of gprs. domains (including roaming case)
- SNMP
  - Functions
  - MIBs
- IP tunnelling
  - IP-in-IP and GRE
  - IPSec
  - GTP
- Security in IP
  - Possible exploits (DoS, sniffing, spoofing)
  - IPSec concepts
  - Interconnection of different mobile backbones
  - External connections to backbone network nodes
- Transmission networks in mobile backbone networks
  - ATM
  - MPLS/GMPLS
  - Ethernet
- Mobile IP – impact on backbone networks

Duration – How long it takes

4 days which is equivalent to 24 hours of lecture.

SIGTRAN – Signalling Transfer using IP Networks

ELP 0307 ★★★★

Modern telecommunications networks tend to produce more and more SS7 signalling in order to support an increasing number of new information services, made available to a huge subscriber base. It therefore becomes essential for a network operator to provide speed and efficiency in transmission of signalling. Narrowband systems (such as traditional SS7 implementations, basing on TDM), are being successively replaced by broadband signalling, which uses speedy, bandwidth efficient transport networks such as ATM and IP. SIGTRAN is a broadband implementation of the Signalling System No.7 in IP networks. It takes the advantage of high transmission bit rates and low latency, provided by IP transport mechanisms.

The course offers a complete description of the SIGTRAN protocol stack, with stress on functionality of Stream Control Transmission Protocol (SCTP), which replaces the traditional Transmission Control Protocol (TCP) used in IP networks, and MTP3 User Adaptation (M3UA), which replaces Level 3 of the narrowband Message Transfer Part implementation.

The course is based on the ITU and IETF specifications and hence is vendor-independent.

Target Audience – Who should attend and benefit

The course is addressed to experienced network engineers and consultants who will work with SIGTRAN, as well as any technical staff requiring deeper understanding of SS7 signalling over IP.

Prerequisites – What you are supposed to know prior to the course

Ability to understand technical subjects. Basic knowledge of signalling and protocols is mandatory. Technical background in SS7 and IP will be an advantage.

Course content – What you sill learn

- Introduction
  - Signalling in telecommunication networks
  - Overview of modern signalling transport systems
- The SIGTRAN signalling model
  - SIGTRAN concepts
  - SIGTRAN protocol architecture
  - SIGTRAN adaptation protocols
- Stream Control Transmission Protocol (SCTP)
  - The need for SCTP
  - SCTP versus TCP
  - SCTP functions
  - SCTP packet structure
  - Establishment of an SCTP association
  - Transmission of user data
  - SCTP service primitives
  - Other SCTP mechanisms
- MTP3 User Adaptation (M3UA)
  - M3UA concepts
  - M3UA message format
  - Establishment of M3UA connection
  - Transfer of User Data
  - Protocol Data Parameter
  - Other M3UA mechanisms
- Traffic cases

Duration – How long it takes

2 days which is equivalent to 12 hours of lecture.

SS7 and SIGTRAN in Mobile Networks

ELP 0309 ★★★★

The introduction of horizontal architecture in telecommunication was dominated by the vision to migrate all traffic generated in a network to packet switched transport protocol. With the introduction of SIGTRAN, the same IP backbone can be used for speech, circuit switched data and GPRS as well as for signalling. This training discusses the essential concepts and new terminologies. The SIGTRAN protocol stack and basic signalling flows are explained.

Target audience – Who should attend and benefit

The target audience for this course is Core Network engineers, service planning engineers, service design engineers and anyone who is interested to have an understand of underlying protocols in the core network nodes.

Prerequisites – What you are supposed to know prior to the course

The participants are expected to be familiar with SS7 signalling and general understanding of any telecommunication network.

Course content – What you will learn

- Signalling in telecom networks
  - Access signalling
  - Inter-exchange signalling
  - OSI reference model
  - Signalling System 7 (SS7)
  - OSI model and SS7
  - Signalling network components
  - Signalling link types
- Signalling System 7 Message Transfer Part
  - Signalling data link
  - Signalling link
  - Signalling network
  - MTP functionality overview
- Users of Message Transfer Parts
  - ISDN User Part (ISUP)
  - Signalling Connection Control Part (SCCP)
  - Transaction Capability Application Part (TCAP)
  - Mobile Application Part (MAP)
- IP networks and TCP/IP suite
  - Protocol stack for Internet
  - IP transport
  - TCP, UDP and SCTP
- GSM-GPRS/UMTS core network architecture and protocols
  - Core Network nodes, interfaces and functions
  - CN evolution
  - GSM and UMTS call control and bearer control protocol
- Signalling transport in split network architecture
  - ATM
  - IP transport
- SS7 over IP-SIGTRAN
  - Why SIGTRAN
  - SIGTRAN concepts
  - SIGTRAN protocol architecture
  - SIGTRAN adaptation protocols
- Stream Control Transmission Protocol
  - SCTP vs TCP
  - SCTP functions, packet format and interface primitives
  - Other SCTP mechanisms
- MTP3 User Adaptation
  - M3UA protocol architecture
  - M3UA implementation examples
  - Services provided by M3UA
  - M3UA protocol elements
  - Establishment of M3UA connection
- MTP2 User Adaptation
  - Protocol architecture
  - Services provided by M2UA adaptation layer
  - Functions provided by M2UA layer
  - Protocol elements
  - Message flow examples
- MTP2 Peer Adaptation
  - Signalling transport architecture
  - Services provided by M2PA
  - Functions provided by M2PA
  - Protocol elements
  - Message flow examples
  - M2PA differences and other user adaptations
  - M2PA vs M2UA
- SCCP User Adaptation
  - Signalling transport architecture
  - Services provided by SUA layer
  - Internal function in SUA layer
  - Protocol elements
  - Message flow examples
  - M3UA and SUA comparison
- Traffic cases
  - Mobile to mobile speech call setup, same UMTS network
  - Mobile originating call setup to ISDN/PSTN
  - Mobile terminating call setup from ISDN/PSTN
  - UMTS to GSM inter-MSC handover
  - GSM to UMTS inter-MSC handover
  - Inter- MSC location update, type normal
- SIGTRAN and future networks
  - Advantage of SS7
  - Motivation to migrate to IP
  - Alternatives of SIGTRAN
  - Long Term Evolution
  - Beyond LTE

Duration – How long it takes

5 days which is equivalent to 30 hours of lecture.

IMS and SIP Signalling with EPS and UMTS Access

ELP 4005 ★★★★

The course provides comprehensive understanding of the IMS architecture and presents interfaces and protocol stacks with their detailed description through functions and services they provide. The course contains analysis of several extensive examples of IMS signalling flows taken from a real network. The most important IMS procedures, such as registration and session initiation, are also discussed and presented on signalling diagrams. Each IMS service enabler (e.g. PoC, MMTel or Presence) is presented separately with its general description and from the perspective of SIP usage. The course also provides the explanation of basic concepts related to security, authentication, charging, Quality of Service and service provisioning. In addition the interworking between IMS, packed switched and circuit switched networks as well as cooperation of different IP versions is presented.

Target audience – Who should attend and benefit

The course is addressed to telecom professionals working with technical project management, product management, hardware and software design, system engineering, testing and verification, network planning, operations and maintenance and technical sales of IMS systems, products and services.

Prerequisites – What you are supposed to know prior to the course

General knowledge about mobile networks and networking concepts is recommended. For background knowledge participation in ELP 0306 IP in Mobile Backbone Network, ELP 0606 UMTS/WCDMA Advanced Overview and ELP 4002 LTE/SAE Overview is recommended.

Course contents – What you will learn

- Network overview
  - Brief introduction to the evolution of mobile networks as well as the addresses and protocols used throughout the years
  - IMS voice codecs
- Introduction to Voice over IP
  - Control plane protocols: SIP and SDP
  - User plane protocols: RTP and RTCP
  - Basic SIP concepts and nodes
  - CS breakout nodes: the MGC, MGW and BGCF
- IMS architecture and basic concepts
  - From CS to PS networks
  - Architectural requirements
  - IMS layered architecture: service control layer, connectivity layer and service/application layer
  - Description of IMS entities and reference points
  - Identities, including ISIM, IMPI and IMPU
  - Usage of GRUU
  - Usage of SIP URI and tel URI
  - Basic SIP signalling flows: Registration and Session Initiation
- SIP extensions used in IMS
  - Extending basic SIP – new methods and messages, e.g. P-Headers, 100rel, path, precondition, compression, privacy, sec-agree and preferences
  - DNS usage in SIP: SRV, NAPTR records and ENUM use
  - 3GPP extensions in use: IMS Register and IMS Invite signalling flows
- DIAMETER
  - The Diameter base protocol
  - Authentication and authorization in IMS
  - Service provisioning
- IMS security
  - The IMS security architecture (SEG and NDS)
  - Overview of IMS authentication methods (NBA, GIBA, AKA, HTTP digest)
  - User privacy in IMS
- Interworking
  - IMS - PSTN/CS interworking
  - IMS - IP/PS interworking and the concept of B2BUA
  - IPv6 and IPv4 interworking
  - The support for NAT in IMS
- Policy and Charging Control
  - Charging architecture
  - Offline and online charging
  - Flow based charging
- Quality of Service
  - The UMTS and EPS bearers and QoS
  - Mapping between QCI and QoS classes
  - Policy and Charging Control usage for QoS handling
- Introduction to IMS services
  - Service provisioning architecture in IMS: the SIP methods Refer and Publish
  - Routing Public Service Identity
  - Voice Call Continuity
- SIP usage in IMS services
  - Presence
  - Push to talk over Cellular
  - Messaging
  - Conferencing
  - Multimedia Telephony
  - Combinational Services

Duration – How long it takes

3 days which is equivalent to 18 hours of lecture.

IMS Architecture and Services

ELP 4006 ★★★★

The training gives detailed understanding of IMS architecture and its services as specified by 3GPP and OMA. Before any specific IMS description is held, a brief introduction to mobile networks and IP suite protocols and functions is given. In the next step participants are familiarised on how the multimedia, like voice and video, are transmitted over the IP networks maintaining the adequate quality. The discussion about IMS begins with the analysis of the basic architectural requirements and continues with the detailed description of each network node and the most important reference points. With this knowledge, the basic concepts related to IMS, such as IMS identification, PCC, service provisioning and the interaction between circuit-switched and packet-switched domains are explained.

The training covers the IMS service enablers as specified by 3GPP and OMA. Each service is explained with the emphasis on its architecture, protocols in use as well as its troubleshooting and optimisation parameters. In order to facilitate the assimilation of knowledge, the presented IMS services and procedures are complemented by examples of SIP messages exchanged in live networks.

Target audience – Who should attend and benefit

The training is addressed to telecom professionals working with technical project management, product management, hardware and software design, system engineering, testing and verification, network planning, operations and maintenance and technical sales of IMS systems, products and services.

Prerequisites – What you are supposed to know prior to the course

General knowledge about mobile networks and networking concepts is recommended. For background knowledge participation in IP in Mobile Backbone Network (ELP 0306) is recommended.

Course content – What you will learn

- Introduction
  - Mobile networks architecture
  - LTE/SAE overview
  - What is the IP Multimedia Subsystem (IMS)?
  - Fixed and mobile convergence
  - Transition to all-IP solution
  - Example of IMS services
- TCP/IP protocol suite
  - IPv4 and IPv6 addressing and routing
  - Transport layer protocols: UDP, TCP and SCTP
  - Applications in TCP/IP Suite
- Multimedia over IP with SIP
  - IMS codecs and codecs characteristics
  - SIP methods, headers and responses
  - SDP attributes with QoS
  - RTP and RTCP functions and characteristics
- IMS architecture
  - From CS to PS networks
  - IMS requirements
  - IMS-related entities and functionalities
  - IMS reference points
- IMS concepts
  - IMS protocols: SIP, SDP and DIAMETER
  - IMS procedures: Registration and Session Initiation
  - Identification in IMS
  - Service provisioning
  - Policy and Charging Control
  - Mechanisms for controlling bearer resources
  - IMS Centralized Services and Service Continuity
- Presence
  - What is Presence?
  - Publishing/subscribing Presence
  - Presence Authorization Rules
  - Presence enhanced services
- Group Management
  - What is Group Management?
  - XML Configuration Access Protocol (XCAP)
  - Common policy
  - XCAP in resource lists
  - Group Management by OMA
  - MMTel and service management
- Push to Talk Over Cellular (PoC)
  - PoC architecture
  - PoC features
  - PoC user plane
- Messaging
  - Messaging in IMS
  - Session-based messaging
  - Messaging interworking
  - Instant Messaging by OMA
- Conferencing
  - Architecture and principals of IMS Conferencing
  - IMS Conferencing procedures
- Media Telephony (MMTel)
  - MMTel communication
  - Supplementary services

Duration – How long it takes

3 days which is equivalent to 18 hours of lecture.

SAP BusinessObjects

ELP 2005 ★★★

Proper data analysis has became one of the major requirements for sustainable business development. Timely knowledge about the company s state indicators, such as resource utilisation or customers satisfaction, provide means for increasing the final product quality and, as a result, boost the overall income.

Mobile operators are one of many examples, where time of reaction to product (mobile network) shortages plays a crucial role. Every day thousands of counters are collected from many nodes in the operator s network and only their proper representation guaranties that adequate steps will be taken in the reasonable time.

SAP BusinessObjects XI is one of the best applications delivering tools for performing data analysis on huge data sets when using multiple data sources. It allows for designing and analysing custom reports either online (InfoView) or offline (Rich Client).

This training aims at providing a comprehensive knowledge about BusinessObjects XI basic features. The emphasis is mainly put on report design as well as its analysis. Definitions of terminology, such as measure, universe, drill down, slice or dice is provided together with multitude of real life examples.

During this training you will gain knowledge on how to create Web Intelligence documents for your reporting needs, to retrieve data by building queries using BusinessObjects universes and to use Web Intelligence to enhance documents for easier analysis.

At the end of the course you will also be able to efficiently and effectively manage personal and corporate documents, having the access to all the information whenever and wherever you need it.

The content of the training is fully customisable and may be changed according to your needs.

Target audience – Who should attend and benefit

The SAP BusinessObjects XI 3.1 Report designer training has been designed for telecom professionals working with report design and analysis.

Prerequisites – What you are supposed to know prior to the course

General knowledge about Microsoft Excel and basic computer skills are sufficient for this training.

Course contents – What you will learn

- Introduction
  - Data analysis introduction
  - What is BusinessObjects XI?
  - Basic concepts and terms
  - Web Intelligence Rich Client basic operations
  - Web Intelligence Thin Client (Infoview) basic operations
  - Document properties
- Creating first report
  - Accessing universe – your data provider
  - Creating simple query
  - Exploring workspace
  - Editing report structure
- Report development
  - Selecting and filtering data
  - Tables
  - Charts
  - Working with report tabs
  - Advanced functions and variables
  - Styles
- Data analysis
  - Sorting
  - Grouping
  - Calculations
  - Breaks
  - Ranking
  - Slice and Dice
  - Drill Through
- Publishing documents

Duration – How long it takes

2 days which is equivalent to 12 hours of lecture.

Contact information

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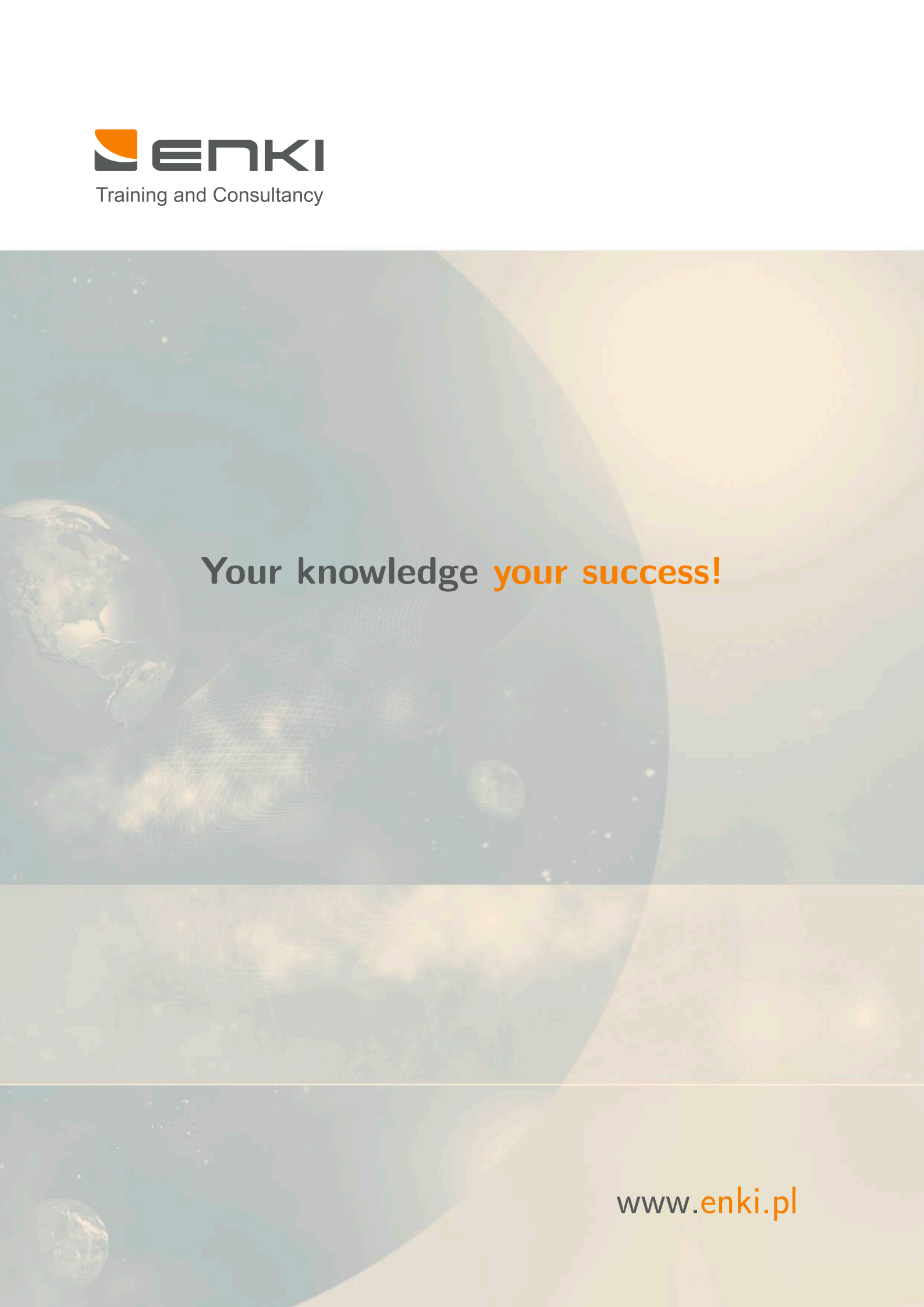
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