Training
Catalogue

LELIWA

" You see, wire telegraph is a kind of a very, very long cat. You pull his tail in New York and his head is meowing in Los Angeles. Do you understand this? And radio operates exactly the same way: you send signals here, they receive them there. The only difference is that there is no cat."

Albert Einstein, when asked to describe radio

About us

Leliwa Company has been providing the highest quality training services since 1996. The company has cooperated with many telecom equipment vendors such as Ericsson, Nokia, Alcatel, Siemens, NSN, Samsung and cellular operators such as Vodafone, T-Mobile, Orange. Our offer includes a wide range of training courses in the following areas: telecommunication, GSM, GPRS, UMTS, HSPA, LTE, IMS and others. Our competencies and flexibility allow us to deliver over 1000 course days per year world-wide. For detailed information about our offer please visit Leliwa website: **www.leliwa.com**

As a part of our daily efforts to support customers with the highest quality level, we continuously follow the state-of-the-art technologies appearing in the mobile networks industry and include them in Leliwa training portfolio. Leliwa instructors is a team of highly skilled professionals focused on helping you maximize the value from your telecommunication investments. We provide you with expertise and experience to: help your business grow, reduce your overall costs and simplify your environment.

Should you have any questions or require further information about our offer, please feel free to contact us by choosing the most convenient method:

Direct e-mail address: **training@leliwa.com**
Direct phone number to our office: **+48 32 376 63 05** Ext 1

For your convenience and future use, you can scan the QR-code to save our contact details directly on your mobile device.

Table of Contents

■□□ - basic ■■□ - intermediate ■■■ - advanced

GSM/UMTS/LTE Basics

The "GSM/UMTS/LTE Basics" course presents in a concise form all the issues connected with modern cellular network, where GSM including GPRS/EDGE and UMTS including HSDPA/HSUPA services are commonly used and implementation of LTE together with IMS is a challenge of the following years. During the training, all the radio access technologies i.e. GSM, UMTS and LTE and all types of services i.e. traditional telephony, packet transmission and IMS services are presented with the equal stress, since in the modern cellular network, all of them are run or will be run simultaneously in the near future. Instead of presenting the topics in the traditional form, describing one technology after another, this course rather concentrates on common radio and network problems and on how this common problems are solved by GSM, UMTS and LTE, Thanks to, such form of the training, it becomes clear for the participants, that within 3GPP, there are no technologies that are fundamentally better or worsen then the others; each of them is optimized towards a certain environments and services; and all of them interwork with each other, creating one common, constantly evolving network. With the "GSM/UMTS/LTE Basics" course participants may begin their cellular network education. Further, there are more advanced courses, which present aspects of GSM, UMTS and LTE technologies in greater detail.

Level: basic

Duration: 2 or 3 days

Training method

Lectures, multimedia presentation (diagrams, animated diagrams, acoustic effects used as an analogy to radio signals) and theoretical exercises.

Target audience

The course is intended for anyone who needs an introduction to aspects of GSM/UMTS/LTE architecture and functionality on a basic level. The detailed description of technical solutions is not included in the course.

Prerequisites:

There are no prerequisites to attend the course.

Training contents

- **Introduction**
  - **Cellular concept**
    cellular and non-cellular mobile systems, cell definition, cell and antenna types, frequency reuse patterns, relation between capacity and quality, increase of capacity,
  - **Analogue and digital signals**
    analogue-to-digital conversion, sampling, quantisation, coding, digital transmission advantages,
  - **Speech compression**
    types and properties of speech coders,
  - **Transmission systems basics**
    E1/PCM link, transmission media: electrical cable, optical cable, microwave link,
  - **Switching**
    circuit switching, packet switching, CSD & GPRS services.
- **Radio transmission**
  - **Transmission problems**
    path loss, attenuation, shadowing, interferences, multipath propagation, time alignment,
  - **Solutions to transmission problems**
    power control, channel coding, interleaving, antenna diversity, frequency hopping, adaptive equalization, timing advance,
  - **Duplex mode**
    Frequency Division Duplex – FDD and Time Division Duplex – TDD,
  - **Multiple access**
    Frequency Division Multiple Access – TDMA, Time Division Multiple Access – TDMA, Code Division Multiple Access – CDMA, Orthogonal Frequency Division Multiple Access – OFDMA,
  - **Modulation**
    basic binary modulations, quadrature modulations, other high order modulations, relation between binary through-put and interference sensitivity, overview of modulations used in cellular systems: GMSK, QPSK, 8PSK, 16QAM, 32QAM, 64QAM, relation between symbol rate and channel width,
  - **Radio link adaptation**
    codec rate, modulation type and power level selection based on terminal and base station measurements reports,
  - **Multiple antennas systems**
    multiple antennas system types, reception diversity, transmission diversity, Multiple Input Multiple Output – MIMO, advantages and disadvantages of multiple antennas systems, multiple antennas systems in cellular networks.
- **Radio Access Networks - RANs**
  - **Architecture**
    GSM/EDGE Radio Access Network – GERAN: BTS and BSC, UMTS Terrestrial Access Network – UTRAN: NB and RNC, Evolved UTRAN - E-UTRAN: eNB,
  - **Radio and physical channels**
    GERAN: frequency bands, radio channel, TDMA and physical channel, cell's radio resources, UTRAN: frequency bands, radio channel, signal spreading, CDMA and physical channel, orthogonal codes, Walsh tree, cell's radio resources; E-UTRAN: frequency bands, cell's radio resources,
  - **Logical channels**
    traffic and control channels; broadcast, common and dedicated channels,
  - **Resource allocation**
    resource/channel allocation for speech connection in GERAN and UTRAN, resource/channel allocation for packet connection in GERAN, UTRAN and E-UTRAN
  - **Handover**
    hard and soft handover, advantages and disadvantages off hard and soft handover, handover between GERAN cells, handover types in cellular systems.
- **Core Network - CN**
  - **Circuit Switched (CS) CN domain**
    R99- architecture: MSC/VLR, GMSC, HLR, EIR, AuC, routing of mobile terminated and mobile originated call, mobile-to-mobile call, subscriber profile transfer bewteen HLR and VLRs;

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

R4 architecture: MSC/GMSC Server, CS-MGW, IP/ATM transport network, advantages and disadvantages of R4 architecture; zalety i wady sieci o architekturze R4; R5 architecture: HSS; identyfication numbers: IMSI, MSISDN, MSRN, TMSI/P-TMSI/GUTI, IMEI,

- **Packet Switched (PS) CN domain**
  SGSN, GGSN, IP transport network, GTP tunnels, APN, packet session establishment,
- **Evolved Packet Core (EPC) for LTE**
  MME, S-GW, P-GW, PCRF, default and dedicated session establishment, cooperation between external servers and EPS access network, advantages of LTE/EPS CN in compari son to tradicional CN,
- **Location update and paging**
  location/paging areas: LA, RA and TA, location update and paging procedure, advantages of location update procedure in LTE/EPS in comparison to traditional solutions,
- **Security**
  Auc and SIM, authentication, ciphering, equipment check, security procedures in cellular systems,
- **International roaming**
  international roaming for CS and PS services,
- **SMS**
  mobile originated and mobile terminated SMS, SMS Cell Broadcast – SMS CB,
- **Charging**
  charging for CS and PS services,
- **Intelligent Network – IN / CAMEL**
  IN concept, basic IN services, architecture: gsmSSF, gsmSCF, SDP, SRF; IN parameters in HLR and VLR, IN service triggering, VPN service – example of IN service provisioning.

• IP Multimedia Subsystem - IMS

- **IMS concept**
- **Architecture**
  P-CSCF, S-CSCF, I-CSCF, HSS, AS, MGCF, IM-MGW, BGCF, MRFC, MRFP,
- **Identification and addressing parameters**
  private and public user identity, ISIM card, ENUM translation,
- **Traffic cases**
  Quality of Service – QoS, protocols, IMS discovery, registration, security procedures, mobile-to-mobile call, mobile-to-PSTN,
- **Other services**
  presence service, push-to-talk over cellular, instant messaging, session based messaging, SMS, whiteboard communication.

„The trainer really knew what he was talking about, very confident.“

15-27.11.2008 Kiev, Ukraine

SS7 over IP (SIGTRAN)

"SS7 over IP (SIGTRAN)" course gives a detailed description of the structure and functions of the SIGTRAN that can be used to carry SS7 messages over the IP connection. During the course all SIGTRAN protocols are discussed. However the stress is put on two of them: SCTP and M3UA, as the first is mandatory for any SIGTRAN system and the second is chosen by major GSM/UMTS equipment vendors to be implemented in their products.

Level: advanced

Duration: 2 days

Training method

Instructor-led training and exercises.

Target audience

The course is intended for network engineers and anyone who needs technical knowledge on functionality of SIGTRAN and possibilities of SS7 messages transmission over IP network.

Prerequisites:

The participants should have attended the following course "Signalling System No. 7 in GSM" or should have the equivalent knowledge.

Training contents

- **Introduction**
  IP networks, Signalling System No.7, GSM/UMTS Core Network, VoIP, IMS,
  - **Stream Control Transmission Protocol – SCTP**
  - **SCTP introduction**
    the need for the new transport protocol, design process of the new transport protocol,
  - **SCTP packets**
    common header, interaction between SCTP and ICMP and ICMPv6, MTU discovery, ICMP messages and attacks to SCTP,
  - **Chunk structure**
    chunk type, chunk flags, chunk length, fixed fields, parameters, error cause, padding,
  - **Chunk types**
    INIT, INIT ACK, COOKIE ECHO, COOKIE ACK, DATA, SACK, HEARTBEAT, HEARTBEAT ACK, ABORT, SHUTDOWN, SHUTDOWN ACK, SHUTDOWN COMPLETE, ERROR,
  - **Association establishment**
    the evolution of the association establishment, comparison of the TCP and SCTP association establishment, cookie mechanism, SCTP and DoS attacks, SCTP and NAT interaction, parameters – addresses, streams and flow/buffer control,
  - **Transmission of data**
    basic data transmission – TSN, cumulative TSN, gap acknowledge blocks, selective retransmissions, flow control – congestion in the network, congestion in the receiver buffer, slow start, fast retransmission,
  - **Stream concept**
    streams as a solution to a HOL problem, mapping of upper layer data to streams, new sequential numbers – SSN.
  - **Errors**
  - **Shutdown and abort procedures**
- **SCTP exercise**
  analysis of the printout from protocol analyser,
- **SCTP Adaptation Layers**
  IUA, V5UA, M2UA, M2PA, M3UA, SUA,
- **MTP3 User Adaptation Layer - M3UA**
  IP networks, Signalling System No.7, GSM/UMTS Core Network, VoIP, IMS,
  - **Introduction**
    M3UA network architecture – AS, ASP, IPSP, SG, SGP, ASP states, ASP traffic modes, AS redundancy,
  - **Services provided by the M3UA layer**
    transport of MTP3 user data, native management functions, Interworking with MTP3 network management, SCTP stream mapping,
  - **Protocol stack**
    ISUP message transport, SCCP transport between IPSPs, SCCP layer in SG, examples of the messages transfer paths via SG,
  - **Routing**
    SPC representation, routing contexts and routing keys, message distribution at the SGP, message distribution at the ASP,
  - **Protocol elements**
    common message header, variable length parameter, common parameters, M3UA specific parameters,
  - **Transfer messages**
    DATA,
  - **SS7 Signalling Network Management Messages SSNM**
    DUNA, DRST, DAVA, DAUD, SCON, DUPU,
  - **ASP State Maintenance Messages ASPSM**
    ASPUP, ASPUP ACK, ASPDN, ASPDN ACK, BEAT, BEAT ACK,
  - **Routing Key Management Messages RKM**
    REG REQ, REG RSP, DEREG REQ, DEREG RSP,
  - **ASP Traffic Maintenance Messages ASPTM**
    ASPAC, ASPAC ACK, ASPIA, ASPIA ACK,
  - **Management Messages MGMT**
    ERR, NTFY.
- **M3UA exercise**
  analysis of the printout from protocol analyser,
- **SCCP User Adaptation Layer - SUA**
  services provided by the SUA layer, protocol stack, routing and address translation, protocol elements, messages and procedures,
- **ISDN Q.921-User Adaptation Layer - IUA**
  services provided by the IUA layer, protocol stack, protocol elements, messages and procedures.

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

NFC Basics

For nearly three decades wireless, non-contact technology applying electromagnetic field has been applied to articles identification and data transfer. This technology is known as Radio Frequency Identification (RFID). Due to its simple architecture, RFID has been widely employed in many areas (animal identification, biometric passport, electronic payment etc.). In the meantime, the extensive penetration of smartphones into the market, gave rise to a new set of standards adapting such contactless data transfer for mobile devices. These standards specified a new technology – Near Field Communication (NFC). The "NFC Basics" course presents in a concise form the architecture, functionality and security of NFC system. Furthermore, the projects implementing this technology are presented (payment by cell phones, e-ticket etc.).

Level:
basic

Duration:
1 day

Training method

Lectures with multimedia presentation.

Target audience

The course is intended for anyone who needs an introduction to NFC system at the basic level. The detailed description of technical solutions is not included in the course.

Prerequisites:

There are no prerequisites for attendance.

Training contents

- **Introduction:**
  - **Radio Frequency Identification (RFID) evolution towards the NFC technology,**
  - **NFC standardization bodies**
    NFC Forum, ISO, GSMA, 3GPP,
- **NFC Technology**
  - **Principles of data exchange through Near Field Communication**
    tag/card, reader,
  - **Modes of operation**
    active, passive,
  - **Communication modes**
    read/write, peer-to-peer, NFC card emulation,
  - **Architecture of mobile devices (smartphones) supporting NFC**
  - **Radio transmission**
    frequency, bandwidth, throughput, coding and modulation methods,
- **Protocols and signalling procedures**
  - **Connection setup**
  - **Protocol stack for NFC communication modes**
    read/write (NFC Data Exchange Format – NDEF
    peer-to-peer (Logical Link Control Protocol – LLCP,
    NFC card emulation.
- **Security**
  - **Forms of possible attacks**
  - **Security procedures**
- **Implementations**
  - **Payment,**
  - **E-tickets (public transport, sport events, cinema)**
  - **Loyalty cards**
  - **ID cards**
  - **NFC Smart Poster,**
  - **NFC City.**

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

Policy and Charging Control (PCC) Basics

"Policy and Charging Control Basics" course describes the new policy control and charging functions added recently to mobile networks. The PCC architecture discussed during the lecture enables a precise control of packet traffic and accurate charging of individual services accessed by the users. The training presents historical background and subsequent evolution of the PCC system. Functionality of PCC components is discussed. New features available in each PCC release are presented. Required modification in the infrastructure and resulting benefits for the operator are investigated. Examples of service offerings available due to implementation of the PCC system are presented. For better understanding of the PCC functions, basic traffic cases are analysed.

Level: basic

Duration: 1 day

Training method

Theoretical lectures.

Target audience

The course is intended for participants with no experience with PCC architecture. It is dedicated to technical as well as non-technical staff. The content should help the representatives of marketing and VAS departments to understand the multitude of new service offerings and charging models available thanks to the PCC system. It should be also interesting for the engineers working with the core network and charging, but not familiar with this new system.

Prerequisites:

Basic telecommunications knowledge.

Training contents

- **Introduction**
  evolution of charging in mobile networks, post-paid charging, pre-paid charging, difference between circuit-switched and packet-switched traffic, evolution of policy and charging control from independent solutions towards combined PCC system
- **Basic Concepts**
  explanation of basic mechanisms – how to: control access to the services, ensure the desired QoS for services, precisely control charging on a service level, detect specific services applying sophisticated packet filtering criteria
- **Architecture Evolution**
  functionality of PCC components, and interaction among them, new components added in each release of the system
- **Operator Benefits and Opportunities**
  Benefits for the operator resulting from new functionalities introduced in each PCC release, examples how those services may be used to create new marketing offerings:
  - **tailor-made flat rate plans, personalized for subscriber individual needs,**
  - **platinum, gold, silver, bronze categories with different transmission speed and quotas,**
  - **application-based add-on packages like music, social media, news, based on subscriber preferences,**
  - **sharing of resources among many users – ideal offers for families and small businesses,**
  - **blocking of content – utilised in parental control service,**
  - **sponsored content – advertisements,**
  - **Qos control – prioritisation of premium-rate content, business subscribers ready to pay more for faster internet access,**
  - **time-based differentiation – cheaper rate during off-peak hours, short-time access for travellers,**
  - **pay-as-you-go, multitude of service bundles offering faster speed, extra volume, or free services.**
- **Basic Traffic Cases**
  interaction among PCC components in different traffic cases

„The instructor is a master in his domain."

17.03.2013 Algiers, Algeria

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

Policy and Charging Control (PCC) Technology

"Policy and Charging Control Technology" course focuses on a new architecture that enables a precise control of packet traffic and charging based on individual services accessed by the users. During the course all components of the PCC solution are presented. Detailed functionality of each element is discussed. Protocols and signalling procedures on all interfaces (i.e. Gy, Gz, Gx, Gxx, Rx, Ud, Sy, Sp, Sd) within PCC system are presented in details. The course also describes overview of PCC architecture and system wide signalling procedures, including home and roaming scenarios.

Level: advanced

Duration: 2 days

Training method

Lectures and theoretical exercises.

Target audience

The course is intended for experienced network engineers, especially working in PS core network and charging domains, PCC protocol stack developers, and anyone with network experience, who needs deep technical knowledge on functionality of PCC.

Prerequisites:

The participants should have attended "GPRS Technology", "UMTS Technology" and "LTE/EPS Technology" course or should have the equivalent knowledge.

Training contents

- **Introduction**
  evolution of charging in mobile networks, post-paid charging, pre-paid charging, difference between circuit-switched and packet-switched traffic, evolution of policy and charging control from independent solutions towards combined PCC system,
- **Architecture Evolution**
  PCC architecture changes since release R7 until R11, home network and roaming interworking, new elements added to the PCC system: BBERF, UDR, TDF, ADC ,
- **Basic Concepts and General Requirements**
  explanation of basic concepts: policy control, QoS control, charging control, PCC rule, QoS rule, charging key, ADC rule, binding, Service Data Flow and others, general requirements put on PCC system and others,
- **Detailed Functionality of Particular PCC Components**
  detailed functional description of PCC elements: PCRF, PCEF, SPR, AF, OFCS, OCS, BBERF, UDR, detailed description of PCC functions: binding mechanism, reporting, credit management, event triggers, policy control, SDF prioritization and conflict handling, and others,
- **Traffic Cases**
  IP-CAN session establishment, termination, modification, update of the subscription information in the PCRF, discovery and selection of the PCRF, gateway control session procedures,
- **Interfaces in details**
  - **Gx reference point**
    Gx model, PCC rules, IP flow mobility routing rules, Application Detection and Control Rules, PCC procedures over Gx interface, ADC procedures over Gx reference point, initialization, maintenance and termination of connection and session, Gx specific AVPs, Gx re-used AVPs, Gx specific Experimental-Result-Code AVP values, Gx Messages,
  - **Gxx reference point**
    Gxx model, PCC procedures over Gxx interfaces, Gxx specific AVPs, Gxx re-used AVPs, Gxx specific Experimental-Result-Code AVP values, Gxx Messages,
  - **S9 reference point**
    S9 model, PCC, QoS, IP flow mobility routing Rules and ADC Rules, PCC procedures over S9 Reference Point, Home-Routed access, Visited access, IMS Emergency services, S9 specific AVPs, S9 re-used AVPs, S9 Messages, S9 specific Experimental-Result-Code AVP values,
  - **Sy reference point**
    Sy model, Subscriber Spending Limits, Spending Limits procedures over Sy reference point, Sy specific AVPs, Sy re-used AVPs, Sy specific Experimental-Result-Code AVP values, Sy Messages.
- **Detailed signaling flows Gx, Gxx, Rx, Sd, Sy and S9 interfaces**
  IP-CAN Session Establishment, IP-CAN Session Termination UE or PCRF initiated HPLMN or VPLMN, IP-CAN Session Modification, Gateway Control Session Procedures, Multiple BBERF Signaling Flows, Application Detection and Enforcement Procedures, Spending limits Procedures over Sy reference point,
- **QoS Parameters mapping**
  QoS parameter mapping Functions at AF, QoS parameter mapping Functions at PCRF, QoS parameter mapping Functions at PCEF, QoS parameter mapping Functions at UE for a UE-initiated GPRS PDP Context, PCRF addressing.

CAMEL Operations & Parameters

"CAMEL Operations & Parameters" is an advanced technical course covering details of signalling procedures related to Customized Customised Applications for Mobile network Enhanced Logic (CAMEL) based Mobile Intelligent Network (MIN) services. In practice CAMEL Phase 2, sometimes enhanced with a limited support of Phase 3 GPRS Pre-Paid Service (PPS) is absolutely dominating standard MIN solution in existing networks. Most probably, the existing MINs are never going to be upgraded towards higher CAMEL Phases due to the common trend towards alternative solutions based on SIP IMS Application Servers and Diameter based On line and Off-line Charging System (OCS/OFCS). Hence to better the course effectiveness the course is not going beyond the set of operations available in CAMEL Phase2 and CAMEL Phase 3 limited to GPRS PPS.

Level: advanced

Duration: 2 days

Training method

Lectures and exercises with various real CAMEL traces analysis. Additional traces submitted by the client before the training or provided in-real time on site are welcome.

Target audience

The training presents the knowledge useful for those who in their everyday work operate, maintain and/or supervise CAMEL based Mobile Intelligent Network (MIN) services in a GSM/UMTS CS network.

Prerequisites:

Practical experience in GSM/UMTS is recommended.

Training contents

- **Introduction**
  CAMEL Phases, 3GPP and GSMA/IREG reference documents, service examples,
- **Architecture and subscriber data**
  mobile-to-mobile call scenario with international roaming and with/without optional routing, functional entities: HLR, GMSC, MSC/VLR, gsmSCF, gsmSSF, gsmSRF, CAP and MAP based interfaces, MAP operations supporting CAMEL subscriber data management and USSD, detection points, CAMEL subscription data: O-CSI, T-CSI, U/UG-CSI, SS-CSI, TIF-CSI, Basic Call State Model: O-BCSM, T-BCSM, BCSM modelling of call scenarios,
- **Overview of SS7 transport services for CAP and MAP**
  classical SS7, routing on MTP3 and SCCP level, SS7 over IP – SIGTRAN, routing on M3UA level, load sharing, sequence control, TCAP dialogues,
- **Mobile Originated Call**
  location update and O-CSI, BCSM, triggering detection points and service triggering, Initial DP operation and parameters,
- **Mobile Terminated Call**
  HLR interrogation and T-CSI, BCSM, triggering detection points and service triggering, Initial DP operation and parameters),
- **Call Handling**
  Connect, Continue, Release Call operations and parameters, usage examples,
- **Monitoring of calls**
  arming, disarming and reporting event BCSM detection points, Request Report BCSM Event, Event Report BCSM, Call Information Request, Call Information Report operations and parameters, usage examples,
- **CS charging**
  Apply Charging, Apply Charging Report, Furnish Charging Information, Send Charging Information operations and parameters, usage examples,
- **SRF interactions - announcements and user dialogues**
  Connect to Resource, Play Announcement, Prompt and Collect User Information, Assist Request Instructions, Specialised Resource Report, Establish Temporary Connection, Disconnect Forward Connection operations and parameters, usage examples,
- **GPRS charging (optional)**
  Initial DP GPRS, Connect GPRS, Continue GPRS, Apply Charging GPRS, Apply Charging Report GPRS, Event Report GPRS, Cancel GPRS, Entity Released GPRS, Furnish Charging Information GPRS, Release GPRS operations and parameters, usage examples.

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

GSM Technology

"GSM Technology" is an intermediate technical course covering all aspects of GSM architecture and functionality. It presents the knowledge useful for those who in their everyday work operate, maintain and supervise the GSM network. The knowledge gained during this course can be furthermore extended during specific courses and consultations covering issues like operation, structure and configuration of specific network nodes as well as courses on signalling within Base Station System and Switching System.

Level: intermediate

Duration: 2 days

Training method

Lectures, presentation of services and theoretical exercises.

Target audience

The course is intended for GSM technical staff and their management.

Prerequisites:

The participants should have general technical telecommunications /electronics/computer science knowledge on a degree level.

Training contents

- **Introduction**
  cellular concept, omni-directional and sector cells, frequency reuse and clusters, cell split,
- **Architecture**
  MSC, GMSC, HLR, VLR, AUC, EIR, BSC, BTS, SMS nodes, IWF for fax and data calls, MIN nodes, identity numbers,
- **Air interface**
  frequency bands, FDMA and radio channels, TDMA and physical channels, hopping physical channels, logical channels, channel mapping, burst structure,
- **Radio transmission**
  transmission problems: path loss, attenuation, shadowing, interferences, multipath fading; time alignment, solutions to transmission problems: dynamic power regulation, channel coding, interleaving, antenna diversity, frequency hopping, adaptive equalization, timing advance; speech coding, modulation,
- **Traffic cases**
  radio connection establishment, location updating, IMSI detach, mobile originating call, mobile terminating call, handover, SMS, international roaming, charging,
- **Security**
  AUC functions, authentication, ciphering, equipment check,
- **Base Transceiver Station**
  functions, BTS classification, hardware build-up, antenna system, transmission network topology.

„The instructor could answer all questions asked in the class, good examples and easy to engage."

22-26.03.2013 Gaborone, Botswana

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

Signalling in GSM BSS

"Signalling in GSM BSS" course focuses on signalling between GSM nodes within Base Station System (BSS). During the course all protocols and signalling procedures on all interfaces within BSS are presented in details. The organisation of channels of air interface and cell parameters is also widely covered in the course. The course also describes parts of the Signalling System No. 7 that are relevant for BSS and presents co-operation between Core Network and BSS during procedures like call set-up and location update.

Level: advanced

Duration: 4 days

Training method

Lectures and theoretical exercises.

Target audience

The course is intended for experienced network engineers and network tuning staff and anyone with network experience, who needs deep technical knowledge on functionality of GSM BSS.

Prerequisites:

The participants should have attended "GSM Technology" course or should have the equivalent knowledge. Practical experience in GSM would be recommended.

Training contents

- **Introduction**
  GSM architecture, GSM architecture for SMS, data and fax services, mobile intelligent network, GSM identity numbers, types of signalling, GSM protocol stack,
- **Physical and logical channels**
  GSM frequency bands, FDMA and radio channels, TDMA and physical channels, frequency hopping, logical channels, permitted channel combinations, mapping, timeslot structure,
- **Traffic Cases**
  radio connection establishment, location updating, IMSI detach, MO - Mobile Originating and MT - Mobile Terminating call, handover,
- **Um interface**
  - **Layer 3**
    CM – Connection Management, MM – Mobility Management and RR – Radio Resource Management, CM protocols: CC – Call Control, SS – Supplementary Services and SMS, procedure examples: MO/MT call set-up, call clearing, call mode change, CCBS – Call Completion to Busy Subscriber, call hold/retrieve, call waiting, multiparty call, DTMF, security procedures, location update and IMSI detach, radio link establishment and release, handover,
  - **Layer 2 – LAPDm**
    frame structure, acknowledge/unacknowledged mode, retransmissions, segmentation,
  - **Layer 1 – physical layer**
    channel coding, burst formatting, modulation.
- **Speech processing**
  speech compression, channel coding, DTX - Discontinuous Transmission, VAD - Voice Activity Detection, lost frame substitution, AMR - Adaptive Multi Rate,
- **MS in idle and active state**
  system information messages, PLMN selection, cell selection and reselection, radio link measurements,
- **A-bis interface**
  - **BTSM – BTS Management protocol**
    radio link layer, dedicated channel, common channel and TRX management procedures, message structure.
  - **LAPD**
  - **Physical layer**
- **SS7 overview and SS7 in BSS**
  network components, protocol stack, MTP – Message Transfer Part, SCCP – Signalling Connection Control Part, usage of SCCP connection oriented mode on A interface, BSSAP - Base Station System Application Part: BSSMAP – BSS Management Application Part, handling of non-transparent and initial MS messages, TCH assignment, handover,
- **MSC in pool**
  MSC in pool concept, Network Resource Identification, node selection, NRI based routing, load balancing and redistribution, MM procedures.

„The training helped me to deepen my configuration knowledge."

19–20.07.2012 Niamey, Niger

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

Signalling System No.7 in GSM

"Signalling System No.7 in GSM" course focuses on signalling between GSM Core Network nodes. The course also describes co-operation between Core Network and Base Station System during procedures like call set-up and location update.

Level: advanced

Duration: 3 days

Training method

Lectures and theoretical exercises.

Target audience

The course is intended for experienced network engineers, network tuning staff and anyone with network experience, who needs deep technical knowledge on functionality of GSM Core Network signalling.

Prerequisites:

The participants should have attended "GSM Technology" course or should have the equivalent knowledge. Practical experience in GSM would be recommended.

Training contents

- **Introduction**
  GSM architecture, GSM architecture for SMS, data and fax services, mobile intelligent network components, identity numbers, physical and logical channels, types of signalling, GSM protocol stack,
- **Traffic cases**
  radio connection establishment, location updating, IMSI detach, mobile originating , call, mobile terminating call, handover, security procedures,
- **MTP – Message Transfer Part**
  MTP level 1, MTP level 2, signal units, acknowledgement and retransmissions, alignment procedure, processor outage, flow control, MTP level 3, signalling point codes, routing, load sharing, signalling network management: signalling link changeover and changeback, forced rerouting, controlled rerouting, MTP restart, link inhibiting and uninhibiting, transfer prohibited/allowed/restricted/controlled, user part availability control, signalling link test,
- **ISUP - ISDN User Part**
  message structure, call set-up, unsuccessful call set-up, normal call release, suspend/resume, propagation delay determination, echo control procedure, continuity-check, blocking/unblocking of circuits, reset of circuits, unreasonable messages,
- **SCCP - Signalling Connection Control Part**
  point code, subsystem number and global title addressing, different types of global titles, global title translation, addressing examples for GSM procedures, SCCP classes, connection oriented and connection less mode, usage of connection oriented mode at BSC-MSC interface, management procedures,
- **BSSAP – Base Station System Application Part**
  DTAP – Direct Transfer Application Part and handling of transparent messages, BSSMAP – BSS Management Application Part and handling of non-transparent and initial MS messages, TCH activation, handover and location update, relation between SCCP and BSSAP procedures,
- **TCAP – Transaction Capabilities Application Part**
  dialogues, transactions and components, relation between TCAP and MAP/INAP/CAP procedures),
- **MAP – Mobile Application Part**
  MAP versions, MAP protocol fallback, location update, MS purging, basic and subsequent handover, VLR and HLR restoration, MT call, supplementary services, USSD, SMS),
- **Intelligent Network Overview**
  differences between CAP – CAMEL Application Part and INAP – Intelligent Network Application Part, CAMEL subscription information, triggering of IN services, detection points, BCSM – Basic Call State Model, VPN call set-up),
- **SIGTRAN Overview**
  protocol stack, SCTP – Stream Control Transmission Protocol overview.

GSM Cell Planning

The course discusses in details GSM radio network dimensioning. It focuses on coverage predictions, traffic estimations, frequency planning, outdoor and in-building planning as well as describes the basic radio network parameters and procedures. Since 3G and LTE networks expand worldwide, the inter-working mechanisms between the GSM and these technologies are comprehensively explained.

Level: intermediate

Duration: 3 days

Training method

Lectures and theoretical exercises.

Target audience

The course is intended for those, who already know the GSM network and wish to learn the principles of cellular networks planning. This is particularly intended for engineers who work with planning and optimization of radio network.

Prerequisites:

The participants should have attended the "GSM Technology" course or should have the equivalent knowledge on GSM.

Training contents

- **GSM network structure**
- **Introduction to Cell Planning**
- **Logical and physical Channels**
- **Antennas and another equipment**
- **Radio transmission**
  problems and solutions to those problems,
- **Radio wave propagation**
- **Coverage calculation**
  algorithms of radio signal propagation in different environments,
- **System balance**
- **Capacity**
  traffic dimensioning.
- **Frequency and BSIC planning**
- **Study case 1 - Outdoor Network Planning**
- **Indoor (In-building) Cell Planning**
- **Study case 2 - Indoor Network Planning**
- **Outline of Radio Network Features**
- **GSM-WCDMA and GSM-LTE mobility**

„The training was good. The courses are adapted."

23-26.07.2013 Ivory Coast, Abidjan

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

GPRS/EGPRS Technology

"GPRS/EGPRS Technology" is an intermediate technical course, which covers all aspects of packet-switched data transmission in GSM network. It is useful for those who operate, maintain and develop the GPRS subnetwork.

Level: intermediate

Duration: 2 days

Training method

Lectures, presentation of services and theoretical exercises.

Target audience

The course is intended for technical GSM/GPRS staff and their management.

Prerequisites:

The participants should have attended one of the following courses for better understanding "GSM Technology" or have the equivalent knowledge on GSM networks.

Training contents

- **Data and fax transmission services in GSM network**
- **GSM/GPRS network architecture**
  new GPRS network nodes and changes to the existing GSM nodes,
- **GPRS network interfaces based on IP protocol, SS No. 7 and Frame Relay**
- **Use of GPRS network**
  subscriber's equipment, GPRS attach and PDP context activation procedures,
- **Air interface**
  physical and logical GPRS channels, access to common channels shared by several subscribers, location update procedures.
- **Increased efficiency of GSM as a result of GPRS introduction**
- **Quality of service, charging and international roaming**
- **EDGE/EGPRS technology**

„The training was very helpful, related to my work."

22-26.07.2013 Gaborone, Botswana

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

Signalling in GPRS/EGPRS

"Signalling in GPRS/EGPRS" course focuses on signalling between GPRS nodes. During the course all protocols and signalling procedures on all interfaces within Base Station System and Core Network are presented in details. The organisations of channels of air interface and cell parameters are also widely covered in the course.

Level: advanced

Duration: 4 days

Training method

Lectures and theoretical exercises.

Target audience

The course is intended for experienced network engineers and network tuning staff and anyone with network experience, who needs deep technical knowledge on functionality of GPRS.

Prerequisites:

The participants should have attended "GPRS/EGPRS Technology" course or should have the equivalent knowledge. "Signalling in GSM BSS" or equivalent knowledge is useful but not compulsory. Practical experience in GPRS would be recommended.

Training contents

- **Introduction**
  network architecture - components and interfaces, basic signalling procedures, GPRS mobility management,
- **Um interface – channels**
  GSM channels, PDCH, GPRS logical channels, mapping of logical channels, TA control procedures, logical channels priorities,
- **Um interface - user plane**
  protocols: PDP, SNDCP, LLC, RLC/MAC, GSM RF,
- **Um interface - control plane**
  GMM and SM procedures, cell update,
- **Um interface - MS activities**
  cell reselection, MS power control, measurement reporting, paging and DRX,
- **Um interface - System Information**
  Packet System Information and System Information type 13,
- **Gb interface**
  Gb over Frame Relay, Gb over IP, Network Service, BSSGP, flow control,
- **Gn and Gp interfaces**
  GTP header, GTP messages, PDP context activation, tunnelling, inter SGSN routeing update, international roaming,
- **SS7 interfaces**
  MAP, Gs interface and BSSAP+,
- **Quality of Service**
  service attributes, packet flow management,
- **GPRS and EGPRS – comparison**
  EDGE technical description, standard and protocol improvements,
- **Dual Transfer Mode – DTM**
- **SGSNs in Pool**
  Network Resource Identifier, node selection, load redistribution, GMM procedures, combined MM/GMM procedures.

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

UMTS Technology

"UMTS Technology" course is an intermediate technical course, which covers all aspects of architecture and functionality of third generation cellular networks – UMTS. It presents the knowledge useful for everyone interested in 3G systems.

Level: intermediate

Duration: 2 days

Training method

Lectures and theoretical exercises.

Target audience

The course is intended for technical GSM/GPRS staff and their management who plan to or already work on introducing UMTS.

Prerequisites:

The participants should have attended the following courses for better understanding "GSM Technology", "GPRS/EGPRS Technology" or have the equivalent knowledge on GSM/GPRS.

Training contents

- **Introduction**
  three generations, ITU and IMT-2000, 3GPP and UMTS, 3GPP2 and cdma2000, evolution paths,
- **Network structure**
  GSM evolution, GSM, GSM/GPRS, 3GPP R99/R3 UMTS, 3GPP R4 UMTS and 3GPP R5 network structure, identity numbers, geographical network structure,
- **WCDMA Wideband Code Division Multiple Access**
  multiple access, duplex division, 3G radio spectrum, WCDMA, channels, power control, handover, RAKE receiver, micro and macro diversity,
- **UTRAN UMTS Terrestrial Radio Access Network**
  UTRAN architecture, BTS hardware architecture, packet access, packet scheduling, capacity and coverage considerations, cell breathing, HSDPA & HSUPA,
  - **HSPA +**
    Multiple Input Multiple Output (MIMO), Higher Order Modulation (64 QAM DL, 16 QAM UL), HSPA voice support - VoIP over HSPA and CS Voice over HSPA, HSPA multicarrier operation.
- **Core Network**
  layers, transport layer based on ATM or IP, ATM overview, Voice Telephony over ATM (VToA), IP overview, Voice over IP (VoIP), QoS in IP networks, MPLS overview, SIGTRAN, control layer, signalling protocols, traffic cases,
- **IP Multimedia System – IMS**
  network architecture, identification, QoS, protocols, IMS discovery, registration, security procedures, mobile-to-mobile call, mobile-to-PSTN call, presence service, push-to-talk over cellular, messaging, white board communication, voice call continuity,
- **UMTS Services**
  bearer services, QoS classes, QoS parameters, multimedia call, streaming, MExE, USAT, positioning services, CAMEL, OSA, security.

„The instructor has a good knowledge in 3G. He knows how to explain clearly."

14-21.05.2012 Antananarivo, Madagascar

WCDMA Air Interface

"WCDMA Air Interface" course gives the detailed description of the WCDMA FDD technology and its use in the UMTS network. The training focuses on physical layer operation and procedures and other functions closely related with the physical layer. The training presents functionality related with the use of R99 dedicated channels, as well as, HSPA.

Level: intermediate

Duration: 4 days

Training method

Lectures and theoretical exercises.

Target audience

Radio network planning and design engineers, radio network tuning engineers and access transport network design engineers. It is recommended for personnel who need an understanding of the WCDMA air interface.

Prerequisites:

The participants should have a general technical knowledge about UMTS.

Training contents

- **Introduction**
  network architecture, UMTS R99/R3, UMTS R4, UMTS R5, UMTS R6, UMTS domain architecture, UTRAN, RNC, Node B, UE & USIM, area concept, numbering and identification,
- **WCDMA**
  multiple access, duplex division, 3G radio spectrum, WCDMA overview, main principles, advantages and problems, spreading process, channelisation, scrambling, filtering and modulation,
- **Channels**
  radio channels, physical channels, transport channels, logical channels, channel mapping, channels and protocol layers,
- **Quality of Service**
  QoS architecture, UMTS QoS classes, sources of service attributes, UMTS bearer service attributes, RAB service attributes, radio bearer service attributes, RAN access & CN bearer service attributes,
- **Channel coding**
  source coding, AMR, channel coding, error detection, error correction, interleaving, data flow through layer 1, TFCI and CCTrCH, coding for 12.2 speech, VBR, DTX, BTFD,
- **Power control**
  open-loop power control, inner-loop power control, outer-loop power control, power control in soft handover,
- **Multipath propagation**
  short and long time delay profile, rake receiver, downlink open loop transmit diversity, downlink closed loop transmit diversity,
- **Synchronisation and random access**
  downlink timing, cell search procedure, random access,
- **Idle mode**
  PLMN Selection, cell selection and reselection, system information, mobility management, paging, cell reselection between GERAN and UTRAN,
- **Handover**
  cell sets and measurements, soft/softer handover, events, signalling, time offset, handover between GERAN and UTRAN, hard handover, compressed mode,
- **Introduction**
  packet data access in R99, HSDPA characteristics, HSUPA characteristics,
- **Architecture and protocols**
  radio resource management, protocol architecture, impact on UTRAN interfaces, protocol states,
- **HSDPA channels**
  HS-DSCH, HS-PDSCH, HS-SCCH, HS-DPCCH, associated PDCHs, F-DPCH,
- **HSDPA operation**
  link adaptation, HS-DSCH coding and HARQ, serving HS-DSCH cell change, measurements, compressed mode, terminal capabilities,
- **HSUPA channels**
  E-DCH, E-DPDCH, E-DPCCH, E-HICH, E-RGCH, E-AGCH,
- **HSUPA operation**
  E-DCH channel coding, HARQ, two TTI lengths, measurements, MAC-es and MAC-e, E-TFC selection, HSUPA scheduling, serving E-DCH cell change, compressed mode, terminal capabilities,
- **HSPA +**
  multi-antenna transmission: Multiple Input Multiple Output – MIMO, Higher Order Modulation: 64 QAM DL and 16 QAM UL, Continuous Packet Connectivity – CPC, Enhanced FACH, Enhanced RACH, Fast Dormancy, HSPA voice support: VoIP over HSPA and CS Voice over HSPA, flatter architecture, integrated RNC/Node B, HSPA multicarrier operation, terminal capabilities.

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

HSDPA/HSUPA Technology

HSDPA (High Speed Downlink Packet Access) and HSUPA (High Speed Uplink Packet Access) are the next big steps in upgrading WCDMA/UMTS networks. These two new radio capabilities enable a new set of packet-based services to go wireless in an efficient way. This training concentrates on the differences that HSDPA/HSUPA has brought to WCDMA radio access. The detailed information about WCDMA radio can be obtained from other courses.

Level: intermediate

Duration: 2 days

Training method

Lecture.

Target audience

The course is intended for anyone, who needs detailed technical information on radio transmission based on WCDMA HSDPA/HSUPA.

Prerequisites:

The participants should have attended one of the following courses for better understanding "UMTS Technology" or "WCDMA/UMTS Air Interface", or they should have the equivalent knowledge about WCDMA/UMTS on general intermediate level.

Training contents

- **Introduction**
  - Packet data access in R99
  - HSDPA characteristics
  - HSUPA characteristic
- **Architecture and protocols**
  - Radio resource management
  - Protocol architecture
  - Impact on UTRAN interfaces
  - Protocol states
- **HSDPA channels**
  - High Speed – Downlink Shared Channel (HS-DSCH)
  - High speed – Physical Downlink Shared Channel (HS-PDSCH)
  - High Speed – Shared Control Channel (HS-SCCH)
  - High Speed – Dedicated Physical Control Channel (HS-DPCCH)
  - Associated PDCHs
  - Fractional DPCH (F-DPCH)
- **HSDPA operation**
  - Link adaptation
  - HS-DSCH coding and HARQ
  - Serving HS-DSCH cell change
  - Measurements
  - Compressed mode
  - Terminal capabilities
- **HSUPA channels**
  - Enhanced – Dedicated Channel E-DCH
  - Enhanced – Dedicated Physical Data Channel (E-DPDCH)
  - Enhanced – Dedicated Physical Control Channel (E-DPCCH)
  - E-DCH HARQ Indicator Channel (E-HICH)
  - E-DCH Relative Grant Channel (E-RGCH)
  - E-DCH Access Grant Channel (E-AGCH)
- **HSUPA operation**
  - E-DCH channel coding
  - HARQ
  - Two TTI lengths
  - Measurements
  - MAC-es and MAC-e
  - E-TFC selection
  - HSUPA scheduling
  - Serving E-DCH cell change
  - Compressed mode
  - Terminal capabilities
- **Resource Management**
- **HSPA +**
  - Multi-antenna transmission: Multiple Input Multiple Output (MIMO)
  - Higher Order Modulation (64 QAM DL, 16 QAM UL)
  - Continuous Packet Connectivity (CPC)
  - Enhanced FACH
  - Enhanced RACH
  - Fast Dormancy
  - HSPA voice support (VoIP over HSPA, CS Voice over HSPA)
  - Flatter architecture
  - Integrated RNC/Node B
  - HSPA Multicarrier Operation
  - Terminal capabilities

RCS-e / joyn Basics

For a long time, IP Multimedia Subsystem (IMS) was nothing more than just a revolutionary idea to move all existing teleservices, including telephony to the PS domain of the mobile network and to create a vast variety of brand new teleservices totally based on end-to-end IP connectivity. Today, thanks to Rich Communication Suite-enhanced (RCS-e) initiative, there is a clear path and agreement on how to turn IMS into practice. RCS-e ensures that the same initial subset of IMS services will be introduced by all operators, infrastructure and terminal vendors and will work smoothly also in inter-operator scenarios. The course explains RCS-e services, underpaying IMS architecture and basic procedures and their impact on existing operator infrastructure.

Level:
basic

Duration:
1 day

Training method
Lecture.

Target audience
The course is intended for those who want to extend their knowledge about mobile network with basic aspects of RCS-e services, functionality and architecture. The detailed description of technical solutions is not included in the course.

Prerequisites:
The participants should be familiar with basic aspects of mobile network architecture and services.

Training contents

- **Introduction**
  standardisation: IETF, 3GPP, OMA, GSMA, joyn – a common trade/service mark,
- **RCS-e services**
  RCS R1-R5 services, RCS-e mandatory services, RCS-e optional services,
- **IMS overview**
  basic architecture components, addressing and routing principles, traffic cases, IPX, security.
- **Services (functional description & technical overview)**
  - **Capability discovery, Address Book and Presence Service**
  - **Chat, messaging and file transfer**
  - **Image Share and Video Share**
  - **Telephony**
- **Multi device environment**
- **Auto-configuration and auto provisioning**

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

RCS5 / joyn Basics

Since the first operators are already running RCS-e services, it is time to prepare for the next step in RCS evolution - RCS 5. RCS-e has not introduced any new revolutionary services, all RCS-e's services were available much earlier from Over-The-Top (OTT) providers. The role of the RCS-e, was rather to create basis architecture and interworking procedures, that could be used to keep those services under control of a large number of independent cellular operators. RCS 5 is required to take full advantage of the IMS based system, introduced by the operator due to the launch of RCS-e and/or VoLTE services. At the same time the variety and quality of the RCS 5 services will allow mobile operators RCS5 reach significant advantage over OTT providers. The course explains RCS 5 services, underpaying IMS architecture and basic procedures and their impact on existing operator infrastructure.

Level:
basic

Duration:
1 day

Training method

Lecture.

Target audience

The course is intended for those who want to extend their knowledge about mobile network with basic aspects of RCS 5 services, functionality and architecture. The detailed description of technical solutions is not included in the course.

Prerequisites:

The participants should be familiar with basic aspects of mobile network architecture and services.

Training contents

- **Introduction**
  standardisation: IETF, 3GPP, OMA, GSMA, joyn – a common trade/service mark, RCS 5 versus OTT solutions,
- **RCS services**
  RCS-e and RCS 5 mandatory and optional services,
- **IMS overview**
  basic architecture components, addressing and routing principles, number portability, international roaming, traffic cases, IPX, security,
- **Services (functional description & technical overview)**
  - **Capability discovery, Address Book and Presence Service**
  - **Messaging (OMA CPM, OMA SIMPLE IM, SMS, MMS, 1-to-1 chat, 1-to-many chat, file transfer)**
  - **Content Sharing (Image and Video Share)**
  - **IP Call (Voice Call, Video Call, Supplementary Services, SR-VCC, interworking with CS telephony)**
  - **Geolocation Services (Geolocation Push, Geolocation Pull)**
- **Multi device environment**
- **Auto-configuration and auto provisioning**
- **Integration with VoLTE**

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

IMS/RCS Technology

For a long time, IP Multimedia Subsystem (IMS) was nothing more than just a revolutionary idea to move all existing teleservices, including telephony to the PS domain of the mobile network and to create a vast variety of brand new teleservices totally based on end-to-end IP connectivity.
Today, thanks to GSMA Rich Communication Suite (RCS) initiative, there is a clear path and agreement on how to turn IMS into practice. RCS ensures that the same initial subset of IMS services will be introduced by all operators, infrastructure and terminal vendors and will work smoothly also in inter-operator scenarios. The course explains IMS architecture, addressing, intra- and inter-operator signalling procedures, paying a special attention to the non-voice services selected by the GSMA for RCS-e and RCS5.

Level: intermediate

Duration: 2 days

Training method

Lecture.

Target audience

The course is intended for technical mobile network staff and their management who plan to or already work on introducing IMS/RCS services.

Prerequisites:

The participants should have a general technical knowledge about IP networks and packet bearer services in 3GPP mobile systems.

Training contents

- **Introduction**
  IMS and RCS standardisation, horizontally and vertically integrated networks, RCS-e and RCS R1-R5 services,
- **Architecture**
  basic IMS architecture, RCS R1-R5 architecture, IPX architecture, numbering and addressing, ENUM in IMS, DNS and ENUM in RCS/IPX,
- **Access networks**
  PS bearer services in GSM/GERAN, UMTS/UTRAN, LTE/E-UTRAN, Broadband Access - I WLAN, QoS, Policy Control and Charging – PCC,
- **Signalling procedures**
  SIP & SDP, SIP signalling bearer establishment, media bearer establishment, IMS discovery, registration, subscriber profile, initial filter criteria, mobile-to-mobile call, mobile-to-PSTN call, multi-device environment and SIP forking,
- **Security**
  IMS authentication, SIP confidentiality and integrity, SIP Digest, SIP Digest with TLS, GPRS-IMS-Bundled Authentication - GIBA, Generic Authentication Architecture - GAA,
- **Enhanced address book & Presence service**
  Enhanced address book and Presence service in RCS R1-R5, network address book, address book synchronisation in single and multi-device environment, presence information sharing, service availability/capability discovery, social presence relationship, geo-localisation, VIP contacts, 3GPP IMS Presence service, Presence Server, Resource List Server, OMA XDMS, XCAP, OMA Presence Service, service capability discovery via SIP options in RCS-e,
- **Image Share & Video Share**
  service capability discovery for IS&VS, IS&VS session setup, IS&VS in RCS R1-R5e, multi-device environment,
- **Messaging & File transfer**
  wersje MAP, automatyczne przejście procedury do niższej
  - **3GPP IMS Messaging**
    immediate messaging, session-based messaging, SMS over generic IP-CAN),
  - **OMA Instant Messaging (IM)**
    pager mode, large message mode, session mode, file transfer mode, 1-to-1, peer to peer, 1-to-many chat, predefined and ad-hoc group chat, deferred delivery, history and search, IM baring, final delivery reports,
  - **OMA Converged IP Messaging (CPM)**
    store and forward, common message store, CPM – SMS/MMS interworking,
  - **RCS-e/RCS5 Messaging**
    multi-device environment, 3GPP and OMA messaging services in RCS-e/RCS5),
  - **Geolocation services**
    geolocation PUSH and PULL.
- **IP Voice and IP Video Call overview***
  VoLTE and VoHSPA overview, MMTel architecture, call setup, supplementary services,
- **Auto configuration and provisioning**
  RCS managed objects, first time registration and client configuration provisioning, re-registration, OMA DM, OMA CP.

*** Since the training is focused on non-voice RCS services, this section of the training has an overview character only. In case the full description of those services is required, we recommend combining this training with one of our IMS voice-focused trainings e.g. "VoLTE Basics".**

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

LTE/IMS Basics

LTE/IMS Basics course will make the participants familiar with the new cellular system – Long Time Evolution (LTE) / Evolved Packet System (EPS) – a descent of PS GPRS/HSPA solutions of modern GSM/UMTS networks. LTE network, on its own, does not offer any teleservices (e.g. telephony, video-telephony, messaging) towards the end subscribers, but rather concentrates on packet bearer services (i.e. transmission of IP packets with required quality of services). Teleservices are offered instead by IP Multimedia Subsystem (IMS), that is described in a second part of the training. IMS is offering its teleservices to the end subscribers via IP connectivity provided by the LTE access network. The course also includes section about Circuit Switched Fallback (CSFB) and SMSoSGs which can be used to hand over the connection during setup from LTE to CS GSM/UMTS in order to establish traditional CS call or send traditional SMS via LTE in case the IMS is not present in the network.

Training contents

- **Performance of LTE - throughput, delay**
- **Evolution of radio access technologies from FDMA, through TDMA and CDMA to the latest LTE's OFDMA – presented in an easy way, as analogies between radio and music**
- **Evolution of cellular system architecture from GSM/GPRS/GERAN, through UMTS/HSPA/UTRAN up to EPS/E-UTRAN (gradual simplification of the architecture, reduction of transmission delays)**
- **Evolution of signalling procedures (location update, connection establishment, reduction of transmission gaps and setup delays)**
- **IMS architecture - analogies between tradi tional GSM and IMS**
- **IMS telephony call setup (including interna tional roaming)**
- **Other IMS services (presence service, push-to-talk, whiteboard communication, emergency call, instant messaging, session based messaging, SMS, voice call continuity)**
- **IMS as fixed-mobile convergence solution**
- **Provisioning of telephony and other trditional CS teleservices (SMS, USSD) without IMS (CSFB and SMSoSGs)**

Level: basic

Duration: 1 day

Training method

Lecture supported by multimedia presentation (including music and animation).

Target audience

The course is intended for the staff, who wants to extend their GSM/UMTS knowledge with issues regarding LTE/IMS architecture and functionality on a basic level. The detailed description of technical solutions is not included in the course.

Prerequisites:

The participants should have attended "GSM/UMTS/LTE Basics" course or should have the equivalent knowledge about GSM/UMTS.

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

VoLTE Basics

Unlike previous 3GPP wireless technologies, LTE has no Circuit Switched (CS) bearer to support voice, so carrying voice over LTE requires a migration to a Voice over IP (VoIP) solution. Until this migration occurs, LTE-capable handsets need to revert to 2G or 3G for voice calls, which can reduce quality or even suspend Packed Switched (PS) services. The GSMA's IP Multimedia Subsystem (IMS) Profile for Voice and SMS document, commonly referenced as Voice over LTE (VoLTE), defines the mandatory set of features that the mobile device and network are required to implement in order to guarantee an interoperable, high quality IMS-based telephony service over LTE. The course focuses on VoLTE services, underpaying IMS architecture, basic procedures and their impact on existing operator infrastructure. The intermediate solutions like CSFB and SMSoSGs are also explained as they can be used concurrently with VoLTE to support roaming subscribers and emergency calls as long as the operator is not ready to move those service to VoLTE.

Training contents

- **Introduction**
  standardisation: 3GPP – MMTel, SR-VCC, SCFB and SMSoSGs and GSMA - VoLTE,
- **LTE overview**
  network structure, attach procedure, default and dedicated bearer, PCRF usage, QoS parameters, efficient handling of VoIP in E-UTRAN – SPS, DRX, DTX, fast re-transmissions, AMR-NB and AMR-WB speech coder, fast signalling, service continuity,
- **IMS overview**
  basic architecture components, addressing and routing principles, registration procedures, IPX, security, number portability, international roaming,
- **Call setup and release**
  mobile-to-mobile end-to-end VoLTE call, interworking with CS system for VoLTE originating and terminating calls, Terminating - Access Domain Selection T-ADS, emergency calls,
- **Supplementary services**
  MMTel supplementary services, VoLTE supplementary services, synchronization of supplementary service setting between VoLTE and CS system, SMS, examples of supplementary service procedures,
- **SR-VCC**
  voice call continuity service handover from LTE to 2G/3G CS network, additional network components and upgrades required to support SR-VCC,
- **CSFB and SMSoSGs**
  handling of traditional CS services in LTE without VoLTE, CSFB and SMSoSGs as the intermediate solution for roaming subscribers and emergency calls,
- **Integration with RCS 5 services**
  overview of RCS 5 services, chat – SMS interworking, presence service, multidevice environment.

Level: basic

Duration: 1 day

Training method

Lecture.

Target audience

The course is intended for those who want to extend their knowledge about mobile network with basic aspects of VoLTE services, functionality and architecture. The detailed description of technical solutions is not included in the course.

Prerequisites:

The participants should be familiar with basic aspects of mobile network architecture and services.

„The course will help us to understand the new technology and system, and how it will improve network availability and efficiently."

13.03.2013 Accra, Ghana

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

LTE/EPS Technology

The 3GPP evolution for the 3G mobile system created the new base station system, called Evolved UMTS Terrestrial Radio Access Network (E-UTRAN) and a new core network, called Evolved Packet Core (EPC) as a result of two standardisation projects: Long Term Evolution (LTE) and System Architecture Evolution (SAE). Under these specifications a mobile phone gets access to higher bandwidth with low latency in an improved and more efficient network architecture. The standards define an all-IP network as a base for the E-UTRAN/EPC. The E-UTRAN/EPC does not have a separate PS data traffic and CS voice network, both communicate over the same new Evolved Packet System (EPS) network. LTE/EPS Technology course is an intermediate technical course, which covers all aspects of architecture and functionality of the EPS.

Level: intermediate

Duration: 2 days

Training method

Lecture.

Target audience

The course is intended for technical GSM/UMTS staff and their management who plan to or already work on introducing LTE/EPS network.

Prerequisites:

The participants should have attended the following courses for better understanding: "UMTS Technology" or "WCDMA Air Interface", or have the equivalent knowledge on UMTS.

Training contents

- **Introduction**
  3GPP mobile network evolution, requirements for the LTE system,
- **Network architecture**
  - **EPC – Evolved Packet Core**
    MME -Mobility Management Entity, S-GW – Serving Gateway, P-GW – Packet Data Network Gateway, HSS - Home Subscriber Server, EIR - Equipment Identity Register, PCRF - Policy and Charging Rules Function,
  - **E-UTRAN**
    and E-UTRAN architecture comparison, evolved Node B – eNB, the need for eNB-eNB X2 interface,
  - **Architecture for interworking with GERAN/UTRAN**
    SGSN - Serving GPRS Support Node, interfaces: S3, S4, S12 and one tunnel option,
  - **Architecture for roaming**
    user traffic routed to the HPLMN, local breakout,
  - **Architecture for interworking with non-3GPP IP access (WLAN, WiMax)**
    trusted and untrusted non-3GPP IP access, ePDG - evolved Packet Data Gateway, AAA - Authentication Authorisation and Accounting,
  - **Interfaces and protocol stacks**
  - **Geographical network structure**
    TA - Tracking Area and TA list registration,
  - **Identity numbers**
    IMSI, MSISDN, IMEI, PDP address, GUTI, S-TMSI, M-TMSI.
- **OFDMA and SC-FDMA**
  multiple access technologies, FT - Fourier Transform and DFT - Discrete Fourier Transform , orthogonality of frequencies, channel separation in FDMA and OFDM, transmission example, implementation, advantages and disadvantages of OFDM, OFDMA, SC-FDMA,
- **E-UTRAN**
  - **Duplex mode**
    FDD and TDD,
  - **Frequency bands**
  - **ICI - Inter-Cell Interference**
    ICI randomization, cancellation, co-ordination/avoidance,
  - **Basic time structures and parameters**
    resource grid, resource block, radio frame, reference symbols,
  - **MIMO – Multiple Input Multiple Output**
    multiple antenna systems, reference symbols from multiple antennas, MIMO channels estimation,
  - **Channels**
    radio, physical, transport, logical channels and their characteristics, UTRAN and E UTRAN channel comparison,
  - **Transmission process**
- **Core network**
  - **MME in Pool**
    pool area, MME selection and addressing, load balancing, overload control,
  - **Signalling Transport - SIGTRAN**
    SCTP, multihoming, streams, stream oriented / message oriented protocol – comparison, security, SIGTRAN in GSM/UMTS / SIGTRAN in EPS – comparison,
  - **User data transport**
    tunneling concept, GPRS Tunneling Protocol – GTP, tunnel establishment,
  - **Diameter**
    3GPP Diameter applications, Proxy/Relay agent,
  - **QoS**
    EPS default bearer, EPS dedicated bearer, bearer establishment, QoS parameters, exchange of QoS related parameters between EPS and service network).
- **Policy Control and Charging - PCC**
  PCC in UMTS R5-, R6 and UMTS/EPS R8, Policy Decision Function - PDF, Charging Rules Function – CRF, Policy and Charging Rules Function – PCRF, interaction with services, flow based charging and policy control,
- **Traffic Cases**
  EMM, ECM and RRC states, attach procedure, TA update, UE/network triggered service request, S1 release procedure, dedicated bearer activation, UE requested bearer resource allocation, handover, intersystem handover, Idle mode Signalling Reduction - ISR,

- **Security**
  Authentication & Key Agreement - EPS-AKA, key hierarchy, ciphering, integrity protection,
- **EPS Management**
  Self Organising Network – SON, eNB establishment, optimisation of the neighbourhood list, coverage and capacity optimisation, continuous optimisation due to dynamic changes, handover optimisation,
- **Services**
  IMS – IP Multimedia Subsystem, network architecture, identification, QoS, protocols, IMS discovery, registration, security procedures, mobile-to-mobile call, mobile-to-PSTN call, presence service, push-to-talk over cellular, instant messaging, session based messaging, SMS, VCC - Voice Call Continuity, SR-VCC Single Radio Voice Call Continuity,
- **CS Fallback and SMSoSGs**
  MSC-MME interworking, combined IMSI/EPS Attach, combined LA/TA update, CS call, SMS, other CS services.

„The Instructor goes all about to explain and answer all questions. Even the examples he provides are very relevant, it makes it easier not to forget.“

27–31.01.2012 Johannesburg, South Africa

T +48 32 376 63 05, **F** +48 32 376 63 07
E info@leliwa.com, **W** www.leliwa.com

Signalling in E-UTRAN/LTE

"Signalling in E-UTRAN/LTE" course focuses on signalling between EPS/LTE nodes within E-UTRAN. During the course all protocols and signalling procedures on all interfaces (i.e. Uu, X2 and S1) within E-UTRAN are presented in details. The course also describes overview of EPS architecture and system wide signalling procedures, including EPC - E-UTRAN interworking.

Level: advanced

Duration: 4 days

Training method

Lectures and theoretical exercises.

Target audience

The course is intended for E-UTRAN protocol stack developers, experienced network engineers and network tuning staff and anyone with network experience, who needs deep technical knowledge on functionality of E-UTRAN.

Prerequisites:

The participants should have attended "LTE/EPS Technology" course or should have the equivalent knowledge.

Training contents

- **Introduction**
  EPS/LTE network structure, identity numbers, interfaces and protocol stacks, geographical network structure, OFDMA and SC-FDMA, interference avoidance, MIMO, channels, EPS bearers and QoS, MME in pool,
- **Traffic Cases**
  EMM, ECM and RRC states, attach procedure, TA update, UE/network triggered service request, S1 release procedure, dedicated bearer activation, UE requested bearer resource allocation, handover, intersystem handover, Idle mode Signalling Reduction – ISR,
- **Security**
  user identity confidentiality, entity authentication, ciphering & integrity protection, key-change-on-the-fly, periodic local authentication, E-UTRAN – UTRAN/GERAN interworking including SRVCC,
- **NAS Signalling**
  - **EPS Mobility Management (EMM)**
    coordination between EMM and GMM, coordination between EMM and MM, establishment of the NAS signalling connection, routing of initial NAS messages, release of the NAS signalling connection, GUTI reallocation, authentication, security mode control, identification, EMM information procedure, attach for EPS services, combined attach for EPS and non-EPS services, detach, normal and periodic TA updating, combined TA/LA updating, service request, extended service request, paging, transport of NAS messages, generic transport of NAS messages,
  - **EPS Session Management (ESM)**
    coordination between ESM and SM, ESM and EMM coordination for ISR, IP address allocation, address handling for ESM procedures, default EPS bearer context activation, dedicated EPS bearer context activation, EPS bearer context modification, EPS bearer context deactivation, UE requested PDN connectivity, UE requested PDN disconnect, UE requested bearer resource allocation, UE requested bearer resource modification, ESM information request procedure, notification procedure.
- **Radio Resource Control (RRC)**
  UE states and state transitions, signalling radio bearers, message format, system information, paging, connection establishment, reconfiguration, re establishment and release, initial security activation, counter check, handover to E-UTRAN, mobility from E-UTRAN, Inter-RAT CCO to E-UTRAN, mobility from E-UTRA, measurements and event reporting, DL/UL upper layer protocols information transfer),
- **Packet Data Convergence Protocol (PDCP)**
  sequence control and duplicate detection, integrity protection, ciphering, data discard, status report, packet format,
- **Radio Link Control (RLC)**
  transparent, unacknowledged and acknowledged mode, error correction, concatenation, segmentation and reassembly of RLC SDUs, re-segmentation and reordering of RLC data PDUs, duplicate detection,
- **Medium Access Control (MAC)**
  contention based and non-contention based random access procedure, RNTI types, maintenance of time alignment, DL/UL-SCH data transfer, HARQ operation, TTI bundling, adaptive and non-adaptive retransmissions, multiplexing and assembly, logical channel prioritisation, scheduling request, buffer status reporting, power headroom reporting, discontinuous reception, PCH reception, semi-persistent scheduling, PDU formats and parameters, MAC control elements,
- **Physical Layer**
  - **Downlink**
    OFDM system model, modulation mapper, cyclic prefix length, subcarrier spacing, FFT size, sampling rate, spectrum allocation, radio frames, subframes and slots, resource grid, physical channel processing, scrambling, synchronisation and cell search, SCH channel, channel estimation, reference signals, PBCH channel, PDSCH channel, REG, PCFICH channel, PHICH channel, Walsh codes, PDCCH channel, PDCCH formats, DCI formats, resource allocation types, physical and virtual RBs, localised and distributed virtual RBs, PDCCH processing, multiple antenna

techniques, spatial layers, transmission rank, codeword, precoding matrix, transmission modes and schemes, channel coding, link adaptation, (a)periodic CQI/PMI reporting, wideband / higher layer configured sub-band / UE selected sub-band feedback, measurements, measurement gaps, UE capabilities,

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

- **Stream Control Transmission Protocol (SCTP)**
  SCTP packet, chunk structure, security, multihoming, association establishment, transmission of data, cumulative and selective acknowledgement, retransmission, stream concept, sequence control, shutdown and abort procedures,
- **GPRS Tunnelling Protocol – User Plane (GTP-U)**
  tunneling, handling of sequence numbers, header format, path management messages,
- **S1 Application Part (S1AP)**
  SCTP as S1AP bearer, E-RAB setup/modification/release, NAS transport, initial context setup, context modification/release; intra LTE, inter RAT and SRVCC handover: signaling sequences, transparent containers, direct/indirect forwarding, resource allocation, handover notification, path switch, handover cancellation, eNB status transfer; paging; management procedures: reset, error indication, S1 setup, eNB/MME configuration update, overload; UE capability info indication, trace procedures, location reporting procedures,
- **X2 Application Part (X2AP)**
  SCTP as X2AP bearer; handover: signaling sequences, path switch, data forwarding, status transfer, UE context release, handover cancellation; load indication, error indication, X2 setup, reset, eNB configuration update, resource status reporting, mobility settings change, radio link failure indication, handover report,
- **Cell selection and reselection**

„The trainer was excellent. He did extremely well. Also the training materials were very good and provided additional important information.“

13–16.11.2012 Accra, Ghana

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

LTE Advanced E-UTRAN R10/R11

LTE Advanced E-UTRAN R10/R11 course focuses on differences between E-UTRAN R8/R9 and E UTRAN R10/R11 also known as LTE-Advanced. The training covers a functional description of all major R10/R11 enhancements together with the required signalling protocols modifications.

Level: advanced

Duration: 1 day

Training method

Lecture.

Target audience

The course is intended for E-UTRAN protocol stack developers, experienced network engineers, network tuning staff and anyone with network experience, who needs deep technical knowledge on functionality of E-UTRAN R10/R11.

Prerequisites:

The participants should have attended "Signalling in E-UTRAN/LTE" course or should have the equivalent knowledge.

Training contents

- **Introduction**
  4G/IMT-Advanced requirements, LTE-Advanced requirements, R10/R11 features' overview.
- **Carrier aggregation**
  general concept, backward compatibility, intra-band contiguous, intra-band non-contiguous and inter-band carrier aggregation, operating bands, terminal capabilities, coverage scenarios, primary and secondary component carriers/cells, protocol impact, secondary cell activation/deactivation, multiple timing advance values, regular and cross-carrier scheduling, cross-carrier scheduling in HetNet, periodic and aperiodic SRS, uplink multi-cluster transmission, simultaneous PUCCH and PUSCH transmission, handover scenarios and new reporting events.
- **Multi-antenna solutions**
  R8/R9 and R10/R11 MIMO comparison, beamforming, backward compatibility, protocol impact, DL MIMO: transmission mode 9 and 10, DCI format 2C, Channel State Information Reference Signals – CSI-RSs, UE-specific Reference Signals – URSs, antenna ports mapping to physical antennas, UL MIMO: transmission mode 1 and 2, DCI format 4, Orthogonal Cover Codes – OCC, UL MU-MIMO enhancements.
- **eNB Relay**
  general concept, backward compatibility, inband and outband relay, architecture, S1 and X2 U/C-plane protocol aspects, radio protocol aspects, RN start-up and reconfiguration procedure, E-RAB activation/modification, physical layer modifications, Uu/Un interface time multiplexing, R-PDCCH channel, O&M, relay versus repeater.
- **Enhanced Inter-Cell Interference Control (eICIC)**
  Heterogeneous Network - HetNet, interference problems, Almost Blank Subframes - ABS, X2 load indication procedure, UE measurements.
- **Coordinated Multi-Point transmission (CoMP)**
  evolution of the bases station architecture, Centralised-RAN architecture, fronthaul and backhaul requirements, DL CoMP: Joint Transmission - JT, Dynamic Point Selection - DPS / muting, Coordinated Scheduling/Beamforming - CS/CB, Dynamic Cell Selection - DCS versus handover, UL CoMP: Joint Reception – JR, Coordinated Scheduling and Beamforming - CS/CB, CoMP sets, CSI reporting.
- **SR-VCC enhancements**
  Attach and TAU procedures for SR-VCC, reversed SR-VCC, Single Radio Video Call Continuity – vSR-VCC procedures.

Signalling in EPC/LTE

"Signalling in EPC/LTE" course focuses on signalling between EPS/LTE nodes within GPRS Tunnelling Protocol (GTP) based Evolved Packet Core (EPC)* network. During the course protocols and signalling procedures on S1, S3, S4, S5/S8, S6a, S6c, S9, S10, S11, S12, S13, SGs, SGd, Sv and optionally X2 interfaces are presented in details. The course also describes overview of EPS architecture and system wide signalling procedures, including EPC - E-UTRAN interworking.

Level: advanced

Duration: 4 days

Training method

Lectures and theoretical exercises.

Target audience

The course is intended for experienced network engineers, network tuning staff, EPC protocol stack developers, and anyone with network experience, who needs deep technical knowledge on functionality of EPC.

Prerequisites:

The participants should have attended "LTE/EPS Technology" course or should have the equivalent knowledge.

Training contents*

- **Introduction**
  EPS/LTE network structure, identity numbers, interfaces and protocol stacks, geographical network structure, EPS bearers and QoS, MME in pool,
- **Traffic Cases**
  EMM, ECM and RRC states, attach procedure, TA update, UE/network triggered service request, S1 release procedure, dedicated bearer activation, UE requested bearer resource allocation, handover, intersystem handover, Idle mode Signalling Reduction – ISR, CS FallBack – CSFB, SMSoSGs, SMS in MME,
- **Security**
  user identity confidentiality, entity authentication, ciphering & integrity protection, key-change-on-the-fly, periodic local authentication, E-UTRAN – UTRAN/GERAN interworking including SRVCC,
- **NAS Signalling**
  - **EPS Mobility Management (EMM)**
    coordination between EMM and GMM, coordination between EMM and MM, establishment of the NAS signalling connection, routing of initial NAS messages, release of the NAS signalling connection, GUTI reallocation, authentication, security mode control, identification, EMM information procedure, attach for EPS services, combined attach for EPS and non-EPS services, detach, normal and periodic TA updating, combined TA/LA updating, service request, extended service request, paging, transport of NAS messages, generic transport of NAS messages,
  - **EPS Session Management (ESM)**
    coordination between ESM and SM, ESM and EMM coordination for ISR, IP address allocation, address handling for ESM procedures, default EPS bearer context activation, dedicated EPS bearer context activation, EPS bearer context modification, EPS bearer context deactivation, UE requested PDN connectivity, UE requested PDN disconnect, UE requested bearer resource allocation, UE requested bearer resource modification, ESM information request procedure, notification procedure.
- **Stream Control Transmission Protocol (SCTP)**
  SCTP packet, chunk structure, security, multihoming, association establishment, transmission of data, cumulative and selective acknowledgement, retransmission, stream concept, sequence control, shutdown and abort procedures,
- **GPRS Tunnelling Protocol – User Plane (GTP-U)**
  tunnelling, handling of sequence numbers, header format, path management messages,
- **S1 Application Part (S1AP)**
  SCTP as S1AP bearer, E-RAB setup/modification/release, NAS transport, initial context setup, context modification/release; intra LTE, inter RAT and SRVCC handover: signalling sequences, transparent containers, direct/indirect forwarding, resource allocation, handover notification, path switch, handover cancellation, eNB status transfer; paging; management procedures: reset, error indication, S1 setup, eNB/MME configuration update, overload; UE capability info indication, trace procedures, location reporting procedures,
- **X2 Application Part (X2AP) - optional**
  SCTP as X2AP bearer, handover: signalling sequences, path switch, data forwarding, status transfer, UE context release, handover cancellation; load indication, error indication, X2 setup, reset, eNB configuration update, resource status reporting, mobility settings change, radio link failure indication, handover report,
- **Diameter base protocol**
  Diameter system basic components, transaction and session, Diameter agents, addressing and identification, routing, Diameter peers, message processing, error handling,
- **Diameter based MME interfaces**
  S6a interface procedures: location management, subscriber data handling, authentication, fault recovery, notification procedures, S13 interface procedures: IMEI check, EPC – IMS/VoLTE/RCS interworking - T-ADS procedure,
- **GTPv2-C**
  Initial Attach and UE requested PDN connectivity, P/S-GW selection, PDP type selection and PDN address allocation, TA Update, Handover, UE triggered Service Request, Network triggered Service Request, S1 release procedure, Dedicated bearer activation, interworking with GIBA,
- **(v)SR-VCC**
  EPC – IMS/VoLTE/RCS interworking for SR-VCC handover, Sv interface procedures: PS to CS and CS to PS handover, vSR-VCC,
- **CSFB, SMSoSGs and SMS in MME**
  ESGs, SGd and S6c interfaces, combined EPS/IMSI attach and TA/LA update, EPS/IMSI detach, MM information transfer, TMSI reallocation, CS paging, CS service request, CS service reject, NAS message tunnelling, fault recovery, SMS in MME.

*** The training does not cover PMIP based EPC specific procedures.**

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

GPRS in modern Telemetry

"GPRS in modern Telemetry" is an advanced technical training covering all aspects related to telemetric data transmission applications, utilizing GPRS packet transmission in GSM, UMTS and LTE mobile networks. Since GSM technology has the largest geographical coverage and highest reliability, it is presented as a base solution for telemetric applications. Other mobile technologies – UMTS and LTE are described from the point of view of differences in relation to GSM technology, as they are solutions used to ensure high bitrates or minimize delays. The training covers also other services offered by mobile networks that can be used to transfer telemetric date (SMS, USSD, CSD).

Level: advanced

Duration: 2 days

Training method

Lectures, practical presentation, practical and theoretical exercises.

Target audience

The training is dedicated to developers and users of telemetric GPRS systems

Prerequisites:

General knowledge in the domain of telecommunication/ electronics/informatics at university level.

Training contents

- **Introduction**
  mobile systems standardization, cellular system concept, theoretical and real cell shapes, radio transmission problems and solutions,
- **Network structure**
  nodes and interfaces, addressing and identification, APN,
- **Signalling procedures**
  terminal registration in network, location update, session establishment, IP address allocation, parameters negotiated during signalling procedure affecting delay and battery consumption,
- **GPRS radio transmission**
  physical and logical channels used in packet transmission, static and dynamic GPRS channels configured in cell, channel allocation and release, channels sharing by multiple terminals, difference in behaviour of different standard terminals – from R96 to R9, differences between GPRS and EGPRS/EDGE, physical channel throughput, data and IP header compression)
- **QoS**
  QoS parameters negotiation between terminal and network, sources of QoS parameters, QoS profile parameters in R96 and R99,
- **GPRS terminal**
  telemetric terminal types, multislot classes, power classes and other basic catalogue terminal parameters, communication between GPRS terminal and telemetric application, AT commands,
- **Security procedures**
  authentication, ciphering, integrity control using SIM and USIM parameters, terminal legality verification),
- **Other data transfer services in mobile networks**
  SMS, USSD, CSD, missed call signalling utilization,
- **Outdoor antenna systems**
  cell coverage, radio link budget, logarithmic scale, units used in calculations, types and characteristics of antennas attached to a terminal, directional antenna gain, coaxial cable attenuation, attenuation of different types of objects (walls, ceilings, metal boxes, PVC boxes, windows, practical measurements of signal level,
- **GPRS communication reliability**
  dual SIM, roaming, SGSN in pool, SIM card configuration,
- **Practical presentation of telemetric system**
  practical demonstration of test telemetric system with active cooperation of students.

T +48 32 376 63 05, F +48 32 376 63 07
E info@leliwa.com, W www.leliwa.com

Notes

Notes

Notes

Leliwa Sp. z o.o.
PL-44 100 Gliwice,
Plebiscytowa 1/122, Polska
T +48 32 376 63 05
F +48 32 376 63 07
E info@leliwa.com

LELIWA

Leliwa Sp. z o.o.
PL-44 100 Gliwice,
Plebiscytowa 1/122, Poland
T +48 32 376 63 05
F +48 32 376 63 07
E info@leliwa.com
www.leliwa.com

Leliwa Telecom AB
SE-167 66 Bromma,
Orrspelsvägen 66, Sweden
T +46 707 42 3945
F +48 32 376 63 07
E info@leliwa.com
www.leliwa.com