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VoLTE from A - Z

Course Duration:

- 3 days.

Course Description:

- The course describes the voice over LTE capabilities with a special focus on IMS and the signaling protocol SIP / SDP.

- We will start with an overview on the IMS related architecture with special focus on the LTE Access network and 3GPP interworking with other RATs.

- We will then introduce the bearer concept and QoS architecture in LTE / SAE discussing the signaling for default and dedicated bearer setup, e.g. IMS triggered with the interaction with the policy functions (PCRFs).

- The purpose of the main architecture elements will be explained focusing in a sort of data sheet for each logical element. Other control entities,such as public, private and service identities, their relationsship and use will be explained in detail in order to understand service routing capabilities.

- A central part will be an introduction to the signaling and media stream protocols, such as SIP / SDP, Diameter for policing and RTP / RTCP and their applicability for voice and other media transport in LTE.

- This protocol section will be completed with a review of the softswitch architecture as required by LTE for a roaming environvironment with voice support, introducing the architecture and fucntionality of Media Gateway Controllers and associated Media Gateways.

- We will then discuss in detail the alternatives for voice over LTE – with and without IMS support, such as SRVCC, CS Fallback and also quickly review other solutions such as VoLGA etc.

- Related scenarios and different use case for SRVCC and CS Fallback – including SMS transmission - will then conclude the course.

Pre-Requisites:

- The student must possess a sound understanding of network architectures in 3GPP. There is no particular knowledge required regarding IMS and SIP/SDP.

- We do recommend our webinar or web based training courses on LTE as preparation for the course in order to improve efficiency and comprehension.

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Course Target:

- The student is enabled to understand particular voice requirements for LTE networks and is entitled to maintain and operate such networks.

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Some of your questions that will be answered:

- Why is IMS becoming an important function for LTE deployments supporting roaming voice subscribers?

- What are the main controlling entities for voice support in an IMS / LTE system environment?

- How are voice bearers identified and handled distinct from other services?

- How are sessions initiated and controlled, what is meant by a transaction, a SIP call and a SIP dialog?

- How are SIP transactions and dialogs identified? What are the most important header fields and their purpose?

- Where and for what purpose is Diameter protocol being used in a network deploying voice over LTE?

- Which mandatory codec types have to be supported for the media stream?

- How does a softswitch work and what are its main components and signaling interfaces?

- What is CS Fallback and when and where is it applicable? How is CSFB signaled / triggered?

- What is SRVCC and when and where is that applicable? How is this distinct from CSFB?

- How is SMS handled in an LTE voice environment and what are the alternatives for SMS here?

Who should attend this class?

- Design engineers who need to understand Voice over LTE protocols, features and interfaces.

- Anyone who need to understand the VoLTE terminology, features, interfaces and the applicability in future 3GPP networks.

Table of Contents:

Termination of U-plane packets for paging reasons, Support of UE mobility anchoring by switching U-plane during inter eNB handover, Transport Packet Marking According to QCI, Mobility anchoring for inter-3GPP mobility, Packet routing and forwarding, Charging support, Lawful interception

⇒ Functions of the PDN GW
Termination towards of PDN's, Policy enforcement, Charging support, DHCPv4 and DHCPv6 functions

⇒ Control Plane / E-UTRAN – EPC

⇒ User Plane E-UTRAN – EPC (S5/S8 GTP-based)

⇒ SIP / SDP Transport Details

- **VoLTE Network details in the context of LTE**

  ⇒ VoLTE Terminal

  ⇒ EPS Functions for VoLTE

  ⇒ VoLTE Policing

  ⇒ IMS Functions for VoLTE

  ⇒ VoLTE specific Application Servers

  ⇒ VoLTE Handover Provisions with Rel. 8 - SRVCC

  ⇒ VoLTE Enhancements with Rel. 10 – eSRVCC

- **The Mobile's Way to SIP Registration and SIP-Sessions**

- **Bearer Concept & QoS-Architecture in SAE**

  ⇒ SAE-Bearers, Classification and Policy Enforcement

  ⇒ The QoS-Profile of the SAE-Bearer
  QCI – QoS Class Identifier, GBR – Guaranteed Bit Rate, MBR – Maximum Bitrate, AMBR - Aggregate Maximum Bit Rate (APN-AMBR, UE-AMBR), QCI-Values and their Meanings, Mapping between Rel. 8 QoS and earlier Releases (QCI – QoS Class Identifier,), QCI-Values and IP Transport Layer Mapping

- **IMS in the overall Network Architecture**

- **The IMS in the 3GPP Architecture (Network Perspective)**

  ⇒ And what is inside the IMS?

VoLTE Signaling – SIP and SDP

- **SIP and SDP**

  ⇒ Scope of SIP
  , Session Establishment, Clarification of the Term "Session", Session Modification, Session Release

  ⇒ SIP Messaging between User Agents (UA's)

⇒ Session Setup Example through SIP

⇒ Some SIP-Terminologies
Message Types, SIP-Methods, Response Types

⇒ SIP-Message Format
General Information, Request Messages, , Response Messages

⇒ Selected SIP Header Parameters
Other Private Headers for e.g. INVITE method, Example: SIP Logfile with Header and Routing Info

⇒ Important Header Extensions for VoLTE Applications
The "Contact:" Header Field

⇒ IMS-related Identities

⇒ Public User Identities

⇒ Private User Identities

⇒ Service Identities
Private User Identity (IMPI) / Public User Identity (IMPU) (Overview / the ISIM, Private User Identity (IMPI), Public User Identity (IMPU)), Use of Private and Public User Identities in REGISTER-Msgs. (Home Network Domain Name, Use of Private User Identity, Use of Public User Identity, Use of Temporary Public User Identity), Relationship between Private and Public User Identities (Public Service Identity (PSI), The Private Service Identity)

⇒ Transaction Identification (two UA's / no Proxies)
The Cseq Parameter , The Branch Parameter, Magic Cookie "z9hG4bK", Example: Transaction Identification (Sequence Numbering (CSeq))

⇒ Dialog Identification (two Users / with or w/o Proxies)
Session Identification and Distinction

⇒ VoLTE Specific Signaling Requirements
Reliable Provisional Responses and Supported Feature Indication (Indicating Support or Requirement of acknowledged provisional Responses), Reliability of Provisional Responses (The PRACK Method and SIP Headers RSeq and RAck)

⇒ Session Description Protocol
Part1: Session Description Items , Part 2: Time Description Items , Part 3: Media Description Items

⇒ Important Media and Session Details for VoLTE
The m-line Attribute (Media Type (MIME), Port-Number, Transport, Payload-Type-List, RTP Payload Type List, Media Transport Details, Example: AMR Codec definition), The Bandwidth Modifiers (CT (Conference Total), AS (Application Specific), TIAS (Transport Independent Application Specific), RR (Rtcp bandwidth for data Receiver) and RS (Rtcp bandwidth for data Sender))

⇒ The Offer / Answer Model
VoLTE Requirement: Precondition Framework, Example: SIP Logfile with SDP Parameter Definitions as Payload

VoLTE Operational Details

- **IMS Architecture Review**
  - $\Rightarrow$ Generic SIP-Network Architecture
  - $\Rightarrow$ Server Types (generic)
  - $\Rightarrow$ Special Server Types (generic)

- **IMS – the Detailed View**

- **P-CSCF – Tasks & Functions**
  - $\Rightarrow$ Typical Use Cases
    Security Association Details
  - $\Rightarrow$ P-CSCF Interworking with the TrGw

- **I-CSCF – Tasks & Functions**

- **Typical I-CSCF Use Cases**
  - $\Rightarrow$ I-CSCF Involvement during UA Registration
  - $\Rightarrow$ Topology Hiding through the I-CSCF

- **S-CSCF – Tasks & Functions**

- **Typical Use Cases of the S-CSCF**
  - $\Rightarrow$ Registration Overview
  - $\Rightarrow$ Service Architecture and Routing
  - $\Rightarrow$ Routing Selection with Initial Filter Criteria
    Example: Initial Filter Criteria and Trigger Point Configuration
  - $\Rightarrow$ SIP Routing Principles
    IMS Routing Scenarios (Examples), IMS Routing Scenarios (Examples) (cont'd)

- **Use Case of the BGCF**

- **Typical Use Cases of the MGCF and the IMS-MGW**
  - $\Rightarrow$ Involvement during IMS-MOC towards PSTN or CS-Domain

Other VoLTE related Protocols

- **Introduction to other important VoLTE-related Protocols**
  SIP Use within VoLTE, DIA (DIAMETER)), H.248 / MEGACO, RTP / SRTP (Real-time Transport Protocol / Secure Real-time Transport Protocol)
  - $\Rightarrow$ Introduction to the DIAMETER Protocol

$\Rightarrow$ IMS-specific Amendments to DIAMETER Protocol

$\Rightarrow$ Diameter Architecture Overview

- **SIP Session Setup and Diameter Relation – Principles**

- **Review of RTP / SRTP / RTSP / RTCP**

  $\Rightarrow$ Operational Overview of RTP and RTCP
  SSRC (Synchronization Source / 32 bit), CSRC (Contributing Source / 32 bit), Timestamp Information

  $\Rightarrow$ RTP / RTCP

  $\Rightarrow$ Review of the RTP Header Format
  Version, P-Bit (Padding), Ext-Bit (Header Extension), CSRC-Count, M-Bit (Marker), Timestamp, Synchronization Source (SSRC), Contributing Source (CSRC), Extension Header, Payload Type, Sequence Number

  $\Rightarrow$ IMS Mandatory Media for VoLTE Services – UE View

  $\Rightarrow$ Tasks and Functions of RTCP
  Quality Report Transfer, Session Control, CNAME <=> SSRC Binding

  $\Rightarrow$ Example of an RTCP-Frame (Sender Report)
  Gateway Architecture, Scope of H.248, Example of Media Gateway Operation through H.248

  $\Rightarrow$ DNS-Queries in the IMS-Environment

  $\Rightarrow$ ENUM

  $\Rightarrow$ IPsec in Tunnel Mode
  The IPSec Authentication Header (Next Header (8 bit), Payload Length (8 bit), Reserved (16 bit), Security Parameters Index (SPI) (32 bit), Sequence Number (32 bit), Authentication Data (n bit)), The IPSec Encapsulated Security Payload (ESP) Header (Security Parameters Index (SPI) (32 bit), Sequence Number (32 bit), Payload Data (n bit), Padding (0 – 255 octets), Padding Length (8 bit), Next Header (8 bit), ESP Authentication Data (n bit))

Important Procedures and Scenarios

- **Attachment through E-UTRAN / new MME**

  $\Rightarrow$ VoLTE related Message Details
  UE Capability Indication during Attachment Request
  Network Capabilities and UE Configuration with ATT_ACC
  Information Stored in EPS Entities after Attachment
  LTE Connections and Bearers after Attachment

- **Detailed IMS Registration**
  3rd Party Registration

- **Detailed IMS Registration (continued)**

  $\Rightarrow$ Registration with SRVCC Enhancements (ATCF)

Example: SIP REGISTER – UE to P-CSCF (1st Register), , Example: SIP REGISTER – UE to P-CSCF (2nd Register), Example: SIP REGISTER – P-CSCF to ATCF, Example: SIP REGISTER – ATCF towards S-CSCF (Supported Feature Indications), Example: 200 OK Response (Register) – ATCF towards UE

- **Dedicated EPS Bearer Establishment**

  ⇒ Session Establishment Signaling
    Example: SIP INVITE – UE to P-CSCF, Example: SIP INVITE – P-CSCF to ATCF, Example: SIP INVITE – ATCF towards remote UA (via SCC-AS), Example: SIP 183 Session Progress Response – SCC-AS towards ATCF, Example: SIP 183 Session Progress Response – ATCF to P-CSCF

  ⇒ Network Initiated Bearer Establishment (IMS triggered)
    Initial Conditions, Detailed Description of PDN-GW & PCRF interworking

  ⇒ Example for VoIP-IMS in LTE – S1-MME/UserPlane
    Three EPS Bearers for a Voice Call?, Example for Traffic Flow Template (TFT) – QCI 5, Example for Traffic Flow Template (TFT) – QCI 1

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VoLTE related Services

- **LTE and the Voice Alternatives**

  ⇒ SRVCC

  ⇒ CSFB

  ⇒ SVLTE

  ⇒ VoLGA

  ⇒ Over The Top (OTT)

  ⇒ IMS

  ⇒ The Voice Evolution

- **Architecture in case of IMS-based Voice Services**
    SRVCC)

- **IMS based VoLTE – A Brief Comparison**

- **LTE Voice Architecture with IMS**

- **LTE Voice Architecture with IMS (continued)**

- **IMS Centralized Services**

  ⇒ Architecture for IMS Service Centralization and Continuity
    SCC AS , UE (normal or enhanced for ICS), MSC Server (normal or enhancements for ICS), IMS registration via CS access

- **IMS MMTel Overview**

- **Single Radio Voice Call Continuity (SRVCC)**

  ⇒ SRVCC Evolution (eSRVCC, aSRVCC, rSRVCC, vSRVCC)

- **SRVCC in Release 8**
  Enhanced SRVCC (eSRVCC) – Rel. 10, , Example: SRVCC from eUTRAN to GERAN
  with PS Bearer HO (HO Preparation:, Bearer Splitting:, PS to CS Handover Initiation,
  Relocation of PS Bearers, Session Transfer Initiation, Handover Execution, Session
  Transfer Signaling, CS Handover Completion, Deletion of the old voice bearer, PS
  Handover Completion, Additional Emergency Services Handling)

- **VoLTE – The Service Overview and Summary**

  ⇒ Generic IMS Functionality
  SIP Registration, Authentication, Addressing, Call Establishment and Termination,
  Forking, Tracing of Signals, Use of Signaling Compression

  ⇒ Overview of IMS Supplementary Services
  Overview, Supplementary Service Configuration, Ad Hoc Multi Party Conference,
  Communication waiting, Message Waiting Indication, Originating Identification Restriction,
  Terminating Identification Restriction, Communication Diversion, Communication Barring

  ⇒ Call Setup and SMS over IP Functionality
  Call Setup Features (SIP Preconditions, Loss of PDN Connectivity, Loss of Media Bearer
  and Radio Connection, Voice Media, Multimedia), SMS Over IP

  ⇒ IMS Required Media Support
  Codecs, RTP Profile, SDP Offer, Data Transport, RTCP, DTMF Events

  ⇒ Radio and Packet Core Feature Set
  ROHC Profiles, LTE Radio Bearer Configurations, Bearer Management, P-CSCF
  Discovery

  ⇒ IMS Common Functionality
  IP Version, Emergency Service, Domain Selection

  ⇒ Rich Communication Suite (RCS, RCS-e, Joyn)