ENG-514 - Advanced Mobile Networks: QoS, QoE & Technical Aspects

Description

The increasing uptake of Internet of Things (IoT), Big data and cloud-based services introduces a new set of requirements for network performance. Furthermore, the evolution of mobile networks towards an all-IP 4G LTE, VoLTE and 5G introduces new challenges for traditional voice and data services. It is critical for operators to guarantee minimum levels of performance. Therefore, operators need to understand and manage both quality and performance of the services to fulfill on the technical quality of service (QoS) as well as on the quality of experience (QoE) level. Regulators also need to understand the technical aspects of QoS and QoE in order to evaluate and measure operator performance from a regulatory perspective.

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This 5-day Training Course equips participants with the technical competencies required to successfully perform technical tasks related to evaluating and measuring QoS and QoE in advanced mobile networks from a regulator and operator point of view.

Topics

The Training Course covers the following topics:

The Role of the Regulator in QoE and QoS

- What is customer satisfaction and QoE?
- Characteristics of QoE
  - Subjective
  - Objective
  - Indirect: market share, CHURN rate, complaint rate, etc.
- Characteristics of QoS
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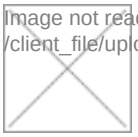
Relationship between QoE and QoS Roles of the regulator affecting QoS and QoE
- Role of the regulator in evaluating and monitoring QoS and QoE

Defining, Understanding and Measuring QoS and QoE

- What is QoS (inward looking, network oriented) and QoE (outward looking, customer focussed)
- Measuring QoS and QoE in Mobile Networks
- QoS is based on technical and lower layer parameters in RF, signalling, and IP
- QoE more often uses events on application layer or above
- QoS parameters allow users to efficiently spot technical problems and bottlenecks in the network.
- QoE is providing an end-to-end view and is often based on perceptual feedback given by a user.

QoS Mapping



QoE Mapping

LTE Overview Release 8/9

- LTE channel architecture
- OFDM basics (subcarriers, IFFT, cyclic prefix, etc.)
- LTE radio frames (subframes, RE mapping, etc.)
- Contents and mapping of DL/UL control channels
- DL/UL transmission procedures (scheduling & HARQ)

LTE System Architecture

- LTE Network Architecture
- Network Elements – eNB, aGW (MME/UPE)
- LTE Interfaces - S1-MME, S1-U, S3, S4, S5, S6a, Gx, S8 – 13 etc
- System Architecture Evolution (SAE)
- Evolved Packet Core (EPC)
- E-UTRAN Architecture

The LTE Air Interface

- Physical layer
- LTE Frame Structure
- LTE Logical and Transport Channels
- Layer 2 Procedures
- OFDM
- SC-FDMA
- Multiple Antenna Techniques

LTE QoS Framework and tying it to QoE

- QoS and QoE features in LTE to support VoLTE
- E-UTRAN architecture and interfaces
- EPS Bearer and PDN Connectivity options and operations
- User plane connection concepts, packet flows, SDFs and Traffic Flow Aggregates
- LTE QoS parameters, QCI, ARP
- QoS parameter representation in LTE signalling protocols
- QoS Management – TFTs and packet filters
- LTE PCC (Policy and Charging Control) mechanisms
- PCC Rules, function and structure for supporying QoS and QoE
- Interaction between PCC elements and internal and external network nodes
- Mapping LTE QoS to legacy network schemes
- Measuring QoS and tying it to QoE
- QoS influence on LTE handovers

LTE-Advanced: Rel. 10 and Beyond Overview

- IMT-2000 compliant 4G standards="HTTP:>
- Definition of LTE-Advanced
- Difference between LTE and LTE Advanced
- LTE Advanced E-UTRAN Architecture – Relays and HeNBs
- 3GPP Specifications for LTE-Advanced
- Requirements and targets for LTE-Advanced
    - Peak Data Rate
    - Latency – User Plane and Control Plane
    - Spectrum Efficiency
    - Cell Edge User Throughput
    - Mobility
    - Spectrum Flexibility
- Summary of Self Evaluation Results
- QoS and QoE features in LTE-Advanced to support VoLTE

Advancements in LTE Advanced

- Multi-hop transmission (Relay)
- Multi-cell cooperation (CoMP: Cooperative Multipoint Tx/Rx)
- Interference management in heterogeneous cell overlay
- Bandwidth/spectrum aggregation
- MIMO enhancement
- Hybrid multiple access scheme for UL
- DL/UL Inter-cell Interference Management
- Self-Organizing Network (SON)
- Relay
- CoMP
- Heterogeneous Cell Overlay

LTE-A Carrier Aggregation

- Type of Carrier Aggregation
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Deployment strategies

- E-UTRA CA bands notation
- UE bandwidth class
- Channel bandwidths per operating band for CA
- E-UTRAN aspects
- Impact of Carrier Aggregation on signaling aspects
- Transport (MAC) layer aspects
- Carrier activation/deactivation and discontinuous reception DRX
- Physical layer aspects
- Downlink channel quality
- Uplink control signaling
- Uplink channel quality
- Uplink transmit power control
- Downlink radio link monitoring
- Timing and synchronization
- Cross-carrier scheduling
- Radio Resource Control (RRC) aspects
- RRC UE capability transfer procedure
- Scell addition and removal
- Handover

EPS Signaling – Interfaces, Protocols & Contexts

- Protocol Stacks for EPS
- Radio Protocols
- The RRC Protocol
- EPC Protocols
- The S1 Application Protocol
- The NAS Protocols (EMM and ESM)
- The GTP Protocol
- Encapsulation & Tunneling
- The SGs interface
- Allocated Resources
- Dedicated Bearer Activation
- GERAN/UTRAN/E-UTRAN Coverage
- Idle & Connected Mode
- Contexts

IMS
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- The scope of IMS
- IMS Architecture
- Registration & Invitation
- Protocol stack in PGW
- SIP Invitation, non IMS user
- Public and Private IMS Identities: IMPI & IMPU
- IMS Service Profile
- Traffic Case: IMS Invitation
- Protocol Stack IMS Profile for voice in EPS
- IMS Profile for voice
- IMS Registration & De-registration

VoLTE Call Procedures

- VoLTE Signaling
- High Level SIP Signaling Flow: Understanding the IMS Signaling Flow
- Overview of VoIP protocols: SIP, SDP, RTP, RTCP and RTSP
- Introduction of Circuit Switched Fall Back (CSFB) (including handover between a VoLTE-IP-call and a non-IP-call (circuit switched call))
- VoLTE to VoLTE Call Establishment
- Similarities and Differences between Circuit-Switched Fallback (CSFB), Single Radio Voice Call Continuity (SRVCC) and Voice over IMS
- Introduction of Single Radio Voice Call Continuity (SRVCC)
- Delivering the SDP Offer
    - SIP INVITE Composition
    - Media Anchoring (Calling Party)
    - Application Servers (Calling Party)
    - Routing the SIP Signalling to the Called Party
    - Application Servers (Called Party)
    - Media Anchoring (Called Party)
- Delivering the SDP Answer
    - Session Progress
    - Dedicated Bearer Establishment
    - Bidirectional Media
- PRACK, Preconditions and Acceptance
    - Provisional Response Acknowledgement
    - Meeting Preconditions
    - Alerting and Call Acceptance
    - Session Timers
- VoLTE Call Termination
    - Media Path Removal
    - Dedicated EPS Bearer Deletion
- Activity: NetX based detailed analysis of a VoLTE to VoLTE call flow.

QoS and QoE Measurement in VoLTE Procedures

- VoLTE Accessibility
- Accessibility Failure Signatures
- Accessibility Failure KPIs and Protocols
- VoLTE QoS
- Random Access Procedure
- Initial Attach and IMS Registration
- E-RAB Setup Details
- Service Request
- VoLTE Dedicated EPS Bearer Establishment and Release

- VoLTE Retainability
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    - VoLTE Retainability
    - Synchronization

    - Maximum RLC Retransmissions
    - Drop Scenarios
    - Connection Release Causes
    - TTI Bundling and RLC Segmentation
    - Retainability Failures
- VoLTE Mobility
    - Idle Mode Mobility
    - Connected Mode Mobility
    - Measurements Events
    - Handover Measurements
    - Handover Preparation
    - Handover Execution
    - VoLTE-to-UMTS Handover
    - LTE Measurement Procedure
- VoLTE Capacity and Coverage Overview
    - VoLTE Capacity
    - Resources Management
    - AMR
    - Semi-Persistent Scheduling
    - PDCCH Dimensioning
    - VoLTE UL Link Budget
    - UL Link Budget for VoLTE with TTI Bundling

5G Architecture

- Objective of the architecture
- Architecture of 5G
- Different from LTE
- Master Core Technology
- Flexible frame structure & design
- 5G Design principles
    - Flexibility
    - Reliability
- Various components and functions
- Network Softwarization and Programmability
- Impact on Mobile technologies
- Impact on Service & Infrastructure Management and Orchestration
- Key differences between 5G & previous Cellular technologies

5G QoS and Advancement

- 5G Radio
    - 5G Performance requirements
    - 5G Spectrum; Multi spectrum scenario
    - Air Interface Overview
    - Radio Network Virtualization (Cloud RAN)
- Migration to 5G

    - Challenges for migration
    - Options
- Advanced Features details
- How Operator can move smoothly to 5G
- 5G use cases
    - Mobile Broadband
    - Automotive
    - Smart Society
    - Smart Grids
    - Health
    - Industrial
    - Logistic/ freight tracking
- 5G & IoT framework compatibility
- 5G fundamental role in IoT

Learning Outcomes

At the end of the course, participants will be able to:

- Explain the importance and the role of the regulator in measuring and monitoring QoS and QoE in advanced mobile networks
- Recognize LTE and LTE-A system architecture, infrastructure, QoS framework and its relationship to QoE
- Discuss LTE-A carrier aggregation, EPS and IMS
- Utilize tools to define and measure QoS and QoE in 4G networks and in VoLTE call procedures
- Understand 5G requirements, migration options, use cases, its role in IoT and 5G advanced features

Target audience

- Managers and personnel working for regulators who need to understand, measure and monitor advanced networks and QoS/QoE measurements
- Technical managers and personnel working for network operators with advanced mobile networks (LTE and LTE Advanced)

Methodology

A combination of engaging activities and dynamic presentations to stimulate and maximize participants' learning.

Methodology

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Location

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4802 de Verdun St, Office #1, Montreal, QC, H4G 1N1 Canada
Tel: +1 514 281 1211 Fax: +1 514 281 2005
info@neotelis.com