v 1.010

Quality of Service (QoS)
Issues & their Resolution in evolved 3G and Next Generation Networks

Course Duration:

- 3 days.

Course Description:

- This course is a must for everybody who needs to setup, engineer, upgrade or operate packet-switched networks supporting both, real-time and best effort traffic.
- In the beginning of the course we pinpoint to typical issues with QoS-definition and perception, depending on organizational association and service orientation.
- This part ends with a very important practical exercise and discussion about the basic question: Problem resolution through network engineering or over-provisioning?
- The following part reviews important QoS-profiles and attributes steming from 3GPP, IETF, WIMAX-Forum and from the ITU-T. We also define a generic QoS-profile with mandatory attributes and we assign value ranges to these attributes suiting specific applications.
- Special focus is on the determination of necessary bandwidth resources for different traffic types like voice, video or combinations. We point out the pros and cons of header compression and silence suppression.
- The course continues with the elaboration of important QoS-techniques like admission control, traffic conditioning, policing and policy enforcement. Different approaches and their pros and cons are discussed and jointly elaborated.
- In the next part we review important IP-related QoS-architectures and their specifics, namely DiffServ, IntServ and MPLS. This part concludes with the presentation and review of layer 2 related QoS-tags like ATM-based VCI/VPI or the priority pointers as defined in IEEE 802. 1p.
- Almost the entire next chapter is dedicated to the detailed presentation and discussion of all messages of an example scenario, based on the IMS, which provides e2e QoS between two peers, applying two different access network types and intermediate backbone networks.
- The final chapter is dedicated to the clarification of how QoS is physically provided within the lower layers 2 and 1, specifically.
- At last we elaborate that QoS to a large degree is nothing else but intelligent scheduling, irrespective of whether it is applied in landline or wireless networks. However, we also point out the specific issues of QoS in mobile networks e.g. using HSDPA or HSUPA.

Prerequisites:

- Participants need to be already familiar with typical QoS-issues and the history of QoS. This should stem from previous exposure to design, troubleshooting or operations jobs in telecommunication networks.
- Advanced IP-skills are required. If necessary we recommend to participate to our basic and advanced IP-courses.
- Advanced skills of either WIMAX- or GPRS/UMTS-mobile networking are required.

Course Target:

- The course enables the students to identify the essentials to setup QoS in their specific environment, in their specific networks.
- The student will be able to align the various proprietary and sometimes vendor-specific QoS-architectures and techniques with a generic and independent QoS-architecture.

Some of your Questions that will be answered:

- Why is it so difficult to achieve and provide QoS in packet-switched networks?
- Why is sophisticated packet network engineering becoming more and more important nowadays and in the future?
- How do all these QoS-terms like QoS-profile, QoS-attribute and QoS-class or traffic class relate to each other?
- Which QoS-attributes are required in a QoS-Profile?
- How do VoIP compare to legacy voice services, considering resource consumption and requirements? What can we do to optimize our network accordingly?
- What are the settings of these QoS-attributes to provide suitable performance for different service types?
- How do QoS-related functions like policing, admission control and traffic shaping relate to each other?
- What are the differences between the QoS-architectures DiffServ, IntServ and MPLS and how do they operate in detail?
- Which parameters are used in different layer 1 / layer 2 environments like for instance WIMAX- or UTRA-networks to tag certain QoS-levels?
- How do these layer 1 / layer 2 environments interact with other protocols that need to simultaneously operate e.g. for session setup or user data transfer?

- How does an end-to-end scenario look with full QoS-provisioning?
- Is it possible that a DSL-modem / WLAN-router at home provides QoS? If yes, how does this work?
- How is QoS provided on the lowest layer, on the link?
- That makes QoS-provision in mobile access networks such a challenge and how is it different from QoS in landline networks?
- How is the distinction of different QoS-levels physically realized in landline routers, GPRS access networks, UMTS access networks and WIMAX access networks?

Who should attend this Course:

- The course is mainly targeted at network operator staff who need to upgrade today's networks to become QoS-aware.
- However, the course is also a must for everybody on the vendor side who involved in one section of the overall network to design QoS-aware equipment.

Table of Content:

QoS and the related Issues

- **Our Playground / Scope of this Course**

  ⇒ The QoS-Hierarchy
  Services, Traffic Classes, QoS-Profiles and Parameters, QoS-Parameter Settings, Physical Processing Rules

  ⇒ End-to-End View

- **Differences in the Perception of QoS**

  ⇒ Standard Organization specific Differences

  ⇒ Some Definitions of QoS

- **Operational QoS-Issues**

  ⇒ Mismatch between E2E- and Network-related QoS

  ⇒ Mismatch between offered QoS-Profiles
  Example 1: Requirements exceed maximum or minimum offered Parameter Values, Example 2: Required Parameter is not considered at all

  ⇒ Transport Network Convergence

- **Practical Exercise and Open Discussion: Different Approaches to achieve the desired Quality**
  Over-Provisioning within LAN, Cost, Performance, Control, Future-Proof, Over-Provisioning within WAN and Mobile Access Networks, Cost, Performance, Control, Future-Proof, Traffic and Network Engineering within LAN, Cost, Performance, Control, Future-Proof, Traffic and Network Engineering within WAN and Mobile Access Networks, Cost, Performance, Control, Future-Proof

QoS-Profiles and QoS-Framework

- **Generic QoS-Profile Definition**

  ⇒ Classification and Description of the Parameters
  Guaranteed Bitrate and Peak Bitrate, Latency and Jitter, Latency, Processing Delay and Propagation Delay, The Importance of Propagation Delay, Bit Error Rate (BER) and Block Error Rate (BLER), Block Loss Rate, Other QoS-Parameters, In-Sequence Delivery, Fixed / Variable Packet Size, Minimum Packet Size, Maximum Packet Size

  ⇒ Mapping Services to the generic QoS-Profile
  How to determine the necessary Bandwidth, Example: AMR-Codec 12.2 kbit/s, Conversational Voice and Video Traffic, Audio / Video Streaming Traffic (VoD), Web Browsing, Upload / Download Traffic

- **Mapping proprietary QoS-Profiles to our generic QoS-Profile**

  ⇒ The QoS-Profile of 3GPP
  Parameter Overview, 3GPP-Traffic Classes, Conversational Class, Streaming Class, Interactive Class, Background Class, Guaranteed Bitrate, Peak Bitrate, Latency, Jitter, Bit Error Rate, Block Error Rate & Block Loss Rate, In-Sequence Delivery

  ⇒ The QoS-Profile within ITU-T Y.1541
  Parameter Overview, IPTD, IPDV, IPLR, IPER, ITU-T-Traffic Classes, Class 0, Class 1, Class 2, Class 3,

Class 4, Class 5, Guaranteed Bitrate, Peak Bitrate, Latency, Jitter, Bit Error Rate, Block Error Rate & Block Loss Rate, In-Sequence Delivery

⇒ The QoS-Profile of WIMAX / IEEE 802.16e
Parameter Overview, WIMAX-Traffic Classes, UGS, RT-VR, NRT-VR, BE, ERT-VR (Extended

⇒ Perspective of the User Device
Bearer Service Manager, Issues and Problems

- **QoS-related Traffic Administration**

⇒ Traffic Administration in Operation
Admission Control, Packet Classification, Traffic Conditioning

⇒ Details of Policy Enforcement
Details of the Media Authorization Token, General Information, Address of PDF, Session Identification, Source and Destination Address Identification, Resource Description, Authentication Data

⇒ Traffic Policing and Traffic Shaping
Details of Traffic Policing, Details of Traffic Shaping, How to determine Excess Traffic

- **IP-related Technologies for QoS-Target Definition**

⇒ Overview
DiffServ, IntServ, MPLS

⇒ Details of Diffserv
Operation Principles, PHB vs. PDB, Description of Important PHB's, Overview, DF, CS, Details of the AF(X,Y) PHB (Assured Forwarding), Details of the EF PHB (Expedite Forwarding), Description of Important PDB's, BE, LE, AR , VW, Example: PDB's of the GRX

⇒ Details of IntServ
Introduction and Overview, Controlled Load Services, Guaranteed Services (RFC 2212), Microflow Setup through RSVP, Situation at the Original Transmitter, Situation at Intermediate Routers, Building an Resv-Message at the Receiver, Reception of Resv-Message by the Original Transmitter / Flow Established

⇒ Details of MPLS
Operation of MPLS-enabled Networks, MPLS-Labels and their Format

- **Layer 2 Means for QoS-Target Identification**

⇒ Overview
IEEE 802.1p, ATM, UMTS, WIMAX, IP-Tunneling in IP

⇒ IEEE 802.1P

⇒ GPRS and UMTS
Practical Exercise: Adding Protocols to Bearer Services

End-to-End and Step-by-Step QoS

- **End-to-End View (Architecture and Signaling)**

⇒ The involved Protocol Types

⇒ Scenario Overview

⇒ Scenario Overview (continued)

⇒ Scenario Overview (continued)

⇒ Scenario Overview (continued)

⇒ Scenario Overview (continued)

- **Detailed View at this Scenario**

⇒ SIP-Request Message: INVITE (Msg No 1 and 2)

⇒ DIAMETER: AAR-Message (Msg No 3)

⇒ DIAMETER: AAA-Message (Msg No 4)

⇒ SIP-Request Message: INVITE (Msg No 5)

⇒ SIP-Response Message: 183-Session Progress (Msg No 6 and 7)

⇒ DIAMETER: AAR-Message (Msg No 8)

⇒ DIAMETER: AAA-Message (Msg No 9)

⇒ SIP-Response Message: 183-Session Progress to Peer (Msg No 10)

⇒ SM: ACT_PDP_CT_REQ-Message to SGSN as Access Router (Msg No 11)

⇒ GTP: CT_PDP_CTX_REQ-Message to GGSN as Edge Router (Msg No 12)

⇒ COPS: REQ-Message from Edge Router (PEP) to PDF (Msg No 13)

⇒ COPS: DEC-Message from PDF to Edge Router (PEP) (Msg No 14)

⇒ GTP: CT_PDP_CTX_RSP-Message to SGSN (Msg No 15)

⇒ SM: ACT_SEC_PDP_CT_ACC-Message to Peer (Msg No 16)

⇒ SIP-Request Message: UPDATE (Msg No 17, 18 and 19)

⇒ RSVP: PATH-Message (Msg No 20, 21, 22, 23 and 24)

⇒ RSVP: RESV-Message (Msg No 25 and 26)

⇒ COPS: REQ-Message from Edge Router (PEP) to PDF (Msg No 27)

⇒ COPS: DEC-Message from PDF to Edge Router (PEP) (Msg No 28)

⇒ RSVP: RESV-Message (Msg No 29)

⇒ RSVP: RESV-Message (Msg No 30)

⇒ RSVP: RESV-Message (Msg No 31)

⇒ RSVP: PATH-Message (Msg No 32 and 33)

⇒ COPS: REQ-Message from Edge Router (PEP) to PDF (Msg No 34)

⇒ COPS: DEC-Message from PDF to Edge Router (PEP) (Msg No 35)

⇒ RSVP: PATH-Message (Msg No 36, 37 and 38)

⇒ RSVP: RESV-Message (Msg No 39)

⇒ RSVP: RESV-Message (Msg No 40)

⇒ RSVP: RESV-Message (Msg No 41, 42 and 43)

⇒ SIP-Response Message: 183-Session Progress (Msg No 44, 45 and 46)

How to provide the requested QoS physically

- **Generic View / Important Rules**
  Mapping and Conversion Function, Scheduler Function (Layer 2 / Layer 3)

  ⇒ Practical Exercise: Relating the Generic View to Real-Life Network Nodes
  Device with Layer 1, 2, 3 and Application Layers, Device with Layer 1, 2 and 3, Device with Layer 1 and 2
- **QoS in Landline Networks**
  Scheduling Behavior and Issues, No Traffic in the High Priority Queue, Queue Depth
- **Practical Exercise: QoS in a GPRS Access Network**
- **QoS on the UMTS Air Interface**

  ⇒ HSDPA

  ⇒ HSUPA
- **Core Network Portion: TFT-based QoS-Definition (applies to both GPRS and UMTS)**
- **QoS in a WIMAX-Access Network**

  ⇒ Protocol Stack

  ⇒ QoS on the WIMAX Air Interface
  Overview, Downlink Direction, Uplink Direction