Training Course Outline

ITU and National Institute of Telecommunications

Title	QoS Technologies and Regulation for Fixed and Mobile
Modality	Online instructor-led training course
Level	Intermediate
Dates	21 – 28 August 2023
Duration	8 days
Language	English
Region	World or Multi-Regional
Registration type	Application and selection
Registration deadline	11 August 2023
Training fees	150 USD
Description	This course will focus on technical, business and regulatory aspects of QoS for Fixed and Mobile Networks. It includes QoS (Quality of Service) and QoE (Quality of Experience) fundamentals by ITU, as well as traffic and QoS management in Internet and IP networks. Further, it includes QoS for fixed ultra-broadband access, including QoS solutions in metallic and optical networks, carrier grade Ethernet QoS, as well as end-to-end QoS. The course also covers QoS for mobile ultra-broadband access, including 4G and 5G mobile technologies and their QoS capabilities and approaches. The telecom networks are built for provision of services. In that manner, the course covers QoS-enabled services provisioning, including QoS and QoE for VoIP, video and IPTV services, as well as QoS for Internet data services (i.e., Over-The-Top services). Each telecommunication network interconnects to other networks forming the global network of Internet and managed IP networks, so the course includes interconnection and its QoS aspects. Further, it covers generic and specific QoS parameters, KPIs (Key Performance Indicators) and their measurements. The global Internet is based on network neutrality approach for OTT/data services, so the course also covers network neutrality and its regulation. The QoS constantly increases in its importance with the digitization and innovation of various critical services, so the course includes QoS regulatory framework based on technical, business and regulatory principles of QoS for services over fixed and mobile networks.

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Training topics	*Quality of Service* *Wireless and fixed broadband* *ICT/Telecom Regulation*
Certification	*Certificate*
Code	*23OI100225MUL-E*

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1. TARGET POPULATION

This course is targeted at managers, engineers and employees from regulators, government organizations, telecommunication companies and academia, who are interested in understanding, implementation and regulation of QoS for Fixed and Mobile networks, including technologies, standardization, and regulation. Other institutions and individuals that are dedicated in building their capacity related to QoS Technologies and Regulation for Fixed and Mobile Networks are also welcome to participate.

2. ENTRY REQUIREMENTS

No specific prerequisites in terms of knowledge or qualifications are required for the intended target population .3. TRAINING OBJECTIVES

At the end of the training, the participant should have gained an understanding of the key aspects of:

- QoS and QoE fundamentals by ITU
- Traffic and QoS management
- QoS for fixed ultra-broadband
- QoS for mobile ultra-broadband
- QoS and QoE for VoIP and IPTV
- QoS for Internet data services
- Interconnection and QoS
- QoS parameters, KPIs and measurements
- Network neutrality regulation
- QoS regulatory framework

4. METHODOLOGY

This course will be delivered using instructor-led online learning. The course methodology will be as follows:

- Each day from 21 August to 25 August 2023 there will be made available two recorded video lectures,. In total, there are 10 video lectures during the course.
- Course forum, asynchronous, will be organized based on discussion topics raised by the instructor on a daily basis, from Course Day 1 to Course Day 5, which will cover the course material on the given day. Also, participant responses will be asynchronous, keeping in mind the different time zones and daily commitments of participants from different countries around the world.
- General discussion forum, asynchronous, will be provided for participants to ask their own questions which can be answered by the instructor and other participants.
- Final Quiz test will be assigned on the last day of the course, 28 August 2023.
- All announcements for all events (lectures, quiz and forum) will be given in a timely manner (prior to the event) by the course tutor.

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5. ASSESSMENT AND GRADING

The evaluation of the participants will be based on 80% from the Final Quiz and 20% from the answers given in the course forum on the raised discussion topics on daily basis by the tutor, thus reflecting both the quantity and the quality of time spent on the course.

The Final Quiz will be open from 00:00 hours on Monday (28th of August 2023) according to the GMT+1 time, and will remain open for 30 hours after opening, so each participant can choose the most convenient time to solve it. However, after the start of the attempt the Quiz should be completed in 90 minutes. The Final Quiz contributes with 80% in the total grade.

The course is completed successfully with a total grade of 70% or higher. The grading will be completed by the course tutor after the course is fully completed.

Each fully registered participant who successfully completes the course with a total grade of 70% or higher will receive an ITU Certificate for this course.

The ITU certificates will be given to participants via the ITU Academy platform after completion of the course reporting and processing within the ITU.

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6. TRAINING DETAILS & INSTRUCTIONAL APPROACH

Day	Sessions/Topics covered	Key learning points (detail learning outcomes)	Training activities details
Day 1 Monday	Lecture 1. **QoS and QoE fundamentals by ITU** Lecture 2. **Traffic and QoS management**	Outline, discuss, use, analyze, design and evaluate the following topics using technical, business and regulatory aspects: - Convergence of telecom and Internet worlds and QoS - Telecom vs. Internet Protocol model - IPv4 vs. IPv6 comparison - Customer satisfaction, QoS and QoE - ITU's network model for QoS - Internet technologies (IP, TCP, UDP, DHCP, DNS) vs. QoS - Impact of Autonomous Systems on QoS - Internet/IP traffic characterization (video, audio, data) - Traffic management - IPv4 and IPv6 flow identification - Techniques to improve QoS - Traffic management intervention types - Traffic management vs. network capacity - ITU QoS framework - Internet QoS framework (DiffServ, IntServ, MPLS) - DPI (Deep Packet Inspection)	Watching and listening to video lectures 1 and 2. Answering on questions asked by the tutor, and possibility to ask questions to him via course forum.
Day 2 Tuesday	Lecture 3. **QoS for fixed ultra-broadband** Lecture 4. **QoS for mobile ultra-broadband**	Outline, discuss, use, analyze, design and evaluate the following topics using technical, business and regulatory aspects: - QoS for fixed ultra-broadband - QoS for DSL access - QoS for cable access - QoS for Passive Optical Networks (PONs) and NG-PONs - QoS support in Carrier Ethernet (e.g., mobile backhaul) - QoS Classes by ITU - End-to-end QoS provision - Framework for ultra-broadband infrastructure investment needs	Watching and listening to video lectures 3 and 4. Answering on questions asked by the tutor, and possibility to ask questions to him via course forum.

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		- Mobile generations coexistence - System Architecture Evolution (SAE) - LTE/LTE-Advanced QoS - LTE-Advanced-Pro QoS Class Identifiers - LTE-WiFi aggregation and QoS challenges - 5G/IMT-2020 targets and use cases - 5G mobile networks and deployment options - 5G QoS framework - Different 5G slices for different QoS - Mobile spectrum management and QoS - Coverage, capacity and latency characteristics of 5G frequency bands	
Day 3 Wednesday	Lecture 5. **QoS and QoE for VoIP and IPTV** Lecture 6. **QoS for Internet data services**	Outline, discuss, use, analyze, design and evaluate the following topics using technical, business and regulatory aspects: - QoS-enabled VoIP for telecom operators - VoIP QoE evaluation, MoS and R-factor - End-to-end QoS for VoLTE and ViLTE - 5G VoNR and EPS Fall-Back (EPS FB) - Multicast and unicast IPTV Content Delivery - IMS-based IPTV, mobile IPTV - IPTV QoE - Internet vs. managed IP traffic - QoS for data services in telecom networks - Comparison between Telco and OTT VoIP - OTT video services - Massive and Critical IoT services - Artificial Intelligence (AI) use for QoS/QoE - QoS metrics for cloud services - OTT services vs. QoS - OTT traffic management vs. network neutrality	Watching and listening to video lectures 5 and 6. Answering on questions asked by the tutor, and possibility to ask questions to him via course forum.

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		Outline, discuss, use, analyze, design and evaluate the following topics using technical, business and regulatory aspects:	
Day 4 Thursday	Lecture 7. **Interconnection and QoS** Lecture 8. **QoS parameters, KPIs and measurements**	- IP Packet eXchange (IPX) and SLA - IPX traffic classes and QoS - 5G at interconnection - Round trip delay, jitter and packet loss rate for IP interconnections - Bottlenecks at interconnection points - QoS parameters vs. measurement methods - KPI targets for Voice over LTE (VoLTE) - IPTV performance monitoring and KPIs - KPIs for data services - Main KPIs for VPN services - QoS layering model for mobile services - KPIs for Smart Sustainable Cities (SSCs) – use case: SSC over 5G mobile networks - Non-technical KPIs - Measurement methods - ITU's framework for monitoring QoS - ITU's minimum set of parameters (KPIs) for evaluating the quality of IP network service - HW and SW testing tools classification by ITU - QoS evaluation scenarios by ITU - Broadband data measurements and issues for consideration	Watching and listening to video lectures 7 and 8. Answering on questions asked by the tutor, and possibility to ask questions to him via course forum.
Day 5 Friday	Lecture 9. **Network neutrality regulation** Lecture 10. **QoS regulatory framework**	Outline, discuss, use, analyze, design and evaluate the following topics using technical, business and regulatory aspects: - Definition of network neutrality - Regulatory interventions in regard to network neutrality - Zero rating vs. network neutrality - Traffic management vs. network neutrality - Role of NRA on network neutrality regulation - Network neutrality regulation in Europe and US - Dimensions of QoS and network neutrality - Network neutrality enforcement	Watching and listening to video lectures 9 and 10. Answering on questions asked by the tutor, and possibility to ask questions to him via course forum.

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		- Scope of QoS regulation - Fundamentals of QoS regulation - Main regulator approaches on QoS - QoS regulation guidelines by ITU - SLA and QoS regulation - Specifying parameters, levels and measurement methods - KPIs for regulation of mobile networks - Mobile vs. fixed KPI measurements - QoS and pricing - QoS enforcement mechanisms	
Day 6 Saturday	Consolidation of knowledge	Summarizing the knowledge	Possibility to watch all video lecture once again with possibility to ask questions to the tutor.
Day 7 Sunday	Consolidation of knowledge	Summarizing the knowledge	Possibility to watch all video lectures once again with possibility to ask questions to the tutor.
Day 8 Monday	Final Quiz	Final assessment	Solving the Final Quiz.

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7. TUTORS/INSTRUCTORS

Name of tutor(s)/instructor(s)	Title	Contact details
Prof. Dr. Toni Janevski	Professor Doctor	tonij@feit.ukim.edu.mk

8. TRAINING COURSE COORDINATION

Course coordinator	ITU coordinator
Name: Dr. Sylwester Laskowski Title: Doctor. Chief Training Specialist Email address: s.laskowski@il-pib.pl	Name: Emil-Eugen Iuga Title: Capacity and Skills Development officer Email address: emil-eugen.iuga@itu.int

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