Training Course Outline

ITU and National Institute of Telecommunications

Title	Technical, business and regulatory aspects of 5G network
Modality	Online instructor-led
Level	Intermediate
Dates	25 September – 2 October 2023
Duration	8 days
Language	English
Region	World or Multi-regional
Registration type	Application and selection
Registration deadline	18 September 2023
Training fees	150 USD
Description	This course will focus on technical, business and regulatory aspects of the 5G mobile networks. It include will 4G mobile technology transition toward the 5G, considering the access and core networks as well as end-user services. Mobile broadband Internet after 4G will continue with the next generation, 5G, so the course will cover also IPv6 and its impact on 5G mobile networks. Further, it will include M2M (Machine-to-Machine) and mobile Internet of Things (IoT) services are foreseen types in future 5G mobile environments, as well as mobile cloud computing implementations. The course will also include spectrum management for IMT (International Mobile Telecommunications) including the 5G considerations. The QoS in mobile networks going from 3G/4G mobile world toward the 5G will continue to be important hence the course will also focus on QoS and QoE in next generation mobile environments. Finally, the course will focus on emerging services and applications in 5G mobile networks in different verticals, including technology, as well as their business and regulation aspects.

Training topics	*Wireless and fixed broadband* *ICT/Telecom Regulation* *Digital economy*
Certification	*Certificate*
Code	*23OI100226MUL-E*

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 technical, business and regulatory aspects of 5G network, including technologies, standardization, regulation and content. Other institutions and individuals that are dedicated in building their capacity related to technical, business and regulatory aspects of 5G network 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:

- Mobile broadband evolution
- LTE-Advanced-Pro: transition from 4G toward 5G mobile networks
- 5G network architecture: network slicing
- 5G New Radio access
- 5G Next Generation core network
- 5G services: mobile ultra-broadband and ultra-reliable low latency services
- Massive Internet of Things (IoT) and IPv6 in 5G
- 5G Quality of Service (QoS)
- Business aspects of 5G networks and services
- 5G/IMT spectrum management and regulation

4. METHODOLOGY

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

- Each day from 25 September to 29 September 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, 2 October 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.

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 (2nd of October 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.

6. TRAINING DETAILS & INSTRUCTIONAL APPROACH

Day	Sessions/Topics covered	Key learning points (detail learning outcomes)	Training activities details
Day 1 Monday	Lecture 1. **Mobile broadband evolution** Lecture 2. **LTE-Advanced-Pro: transition from 4G toward 5G mobile networks**	Outline, discuss, use, analyze, design and evaluate the following topics using technical, business and regulatory aspects: - Mobile generations in the 21st century - ITU's IMT-Advanced: the 4G umbrella - 4G standard by 3GPP: LTE/LTE-Advanced - LTE-Advanced radio access: Carrier Aggregation - E-UTRAN and Evolved Packet Core (EPC) - LTE protocol stack: User Plane and Control Plane - LTE bearers, mobility and location management - IP Multimedia Subsystem (IMS) - IMT spectrum (4G) - LTE-Advanced Pro essential services - LTE-Advanced Pro carrier aggregation - LTE in unlicensed bands - Massive MIMO - Cellular Internet of Things (IoT) - Emergency services and public safety - Vehicle-to-anything (V2X) - Multi-access Edge Computing (MEC) LTE-Advanced Pro for IoT devices	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. **5G network architecture: network slicing** Lecture 4. **5G New Radio access**	Outline, discuss, use, analyze, design and evaluate the following topics using technical, business and regulatory aspects: - IMT-2020 – ITU framework for 5G - IMT-2020/5G vs. IMT-Advanced/4G requirements - Usage scenarios for IMT-2020/5G - Software Defined Networking (SDN)	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.

		- Network Functions Virtualization (NFV) - Network slicing in IMT-2020/5G - Use case - 5G eMBB network slice requirements - Design considerations for the IMT-2020/5G network - 5G end-to-end network slicing - 5G New Radio (NR) - Numerology in LTE and 5G New Radio - 5G NR (New Radio) frame structure - 5G Radio Access Network (RAN) topologies - Separation of Control Plane (CP) and User Plane (UP) - Standalone vs. Non-Standalone 5G RAN - 4G to 5G transition strategy - 5G millimeter waves considerations 5G Fixed Wireless Access (FWA)	
Day 3 Wednesday	Lecture 5. **5G Next Generation core network** Lecture 6. **5G services: mobile ultra-broadband and ultra-reliable low latency services**	Outline, discuss, use, analyze, design and evaluate the following topics using technical, business and regulatory aspects: - Core network evolution - 5G core network architecture and protocols - 5G core network slicing - Service Based Architecture (SBA) in 5G core - Drivers for traffic increase in 5G era - Voice and data services in 5G/IMT-2020 - Massive Internet of Things and Machine-to-Machine applications - Ultra-reliable and low latency applications - Packet Switched Streaming in 5G - VR 360◦ video streaming in 5G - Voice over NR (VoNR) - 5G with EPC NSA (Non-Stand-Alone) vs. 5G with 5GC (5G Core) - EPS Fall-Back from 5G, dual registration approach - User Generated Content (UGC) - 5G mobile operators vs. OTT providers - 4G/5G eMBMS (mobile multicast and broadcast)	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.

		- Vertical URLLC services - 5G performance requirements for low-latency and high-reliability scenarios Economic impact of 5G services	
Day 4 Thursday	Lecture 7. **Massive Internet of Things (IoT) and IPv6 in 5G** Lecture 8. **5G Quality of Service (QoS)**	Outline, discuss, use, analyze, design and evaluate the following topics using technical, business and regulatory aspects: - Internet of Things (IoT) and Web of Things (WoT) via mobile Internet access - Mobile IoT vs. Massive and Critical IoT - Mobile network API in 5G - Relation between IoT, M2M and Big Data - Use case: V2X through different slices - Artificial Intelligence (AI) / Machine Learning (ML) for 5G - 5G architecture based on IPv6 - Main QoS parameters in EPS - QoS Class Identifiers (QCI) for LTE-Advanced-Pro - QoS mechanisms in 3GPP networks - 5G QoS framework and model - 5G QoS profile - Additional QoS parameters in 5G - Different 5G slices for different QoS - 5G session and service continuity - ITU minimum QoS requirements 5G mobility and QoS	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. **Business aspects of 5G networks and services** Lecture 10. **5G/IMT spectrum management and regulation**	Outline, discuss, use, analyze, design and evaluate the following topics using technical, business and regulatory aspects: - 5G business start point - 5G investments and total cost of 5G ownership - Fiber for 5G - 5G and smartphones	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.

		- 5G and IoT business aspects - Automotive industry and 5G IoT - Mobile business with 5G network slicing - 5G and individual customers - 5G as unified ultra-broadband Internet worldwide - 5G and wholesale business models - 5G spectrum bands and their use cases - 3GPP technologies in unlicensed bands - Frequency planning for small cells deployments in 5G - 5G/IMT-2020 spectrum bands targets - Step by step spectrum transition from 4G to 5G - Definition of Frequency Ranges (FRs) for 5G New Radio - Channel bandwidth per operating NR band (below 6 GHz and above 6 GHz) - Coverage, capacity and latency characteristics of IMT-2020/5G bands 5G investments vs. 5G spectrum prices	
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.

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