



Training Course Outline

ITU and National Institute of Telecommunications

Title	5G-Advanced mobile broadband and future services
Modality	Face-to-face
Level	Intermediate
Dates	26 – 27 October 2023
Location	National Institute of Telecommunications (NIT), Warsaw, Poland
Duration	2 days
Language	English
Region	World or Multi-Regional
Registration type	Application and training fees payment prior to the registration deadline
Registration deadline	12 October 2023
Training fees	500 USD

Description	<p>This course will focus on 5G-Advanced mobile broadband and future services, including technologies, regulation and business aspects. It will cover mobile broadband evolution, from IMT-Advanced (4G) to IMT-2020 (5G) and IMT-2030 (6G). The course will include 5G New Radio (NR) and 5G Core Network with 5G-Advanced enhancements. Further, it will focus on 5G/5G-Advanced services including enhanced mobile broadband (eMBB), massive IoT (mMTC), critical IoT (URLLC), and Vehicle-to-everything (V2X), then deployment of 5G/5G-Advanced networks by given QoS/QoE indicators, Integrated Access and Backhaul (IAB), and edge clouds, as well as 5G-Advanced spectrum management and regulation. The course will also include 5G-Advanced enhancements including mobility enhancements, multicast and broadcast evolution, boundless XR (eXtended Reality), RedCap (Reduced Capability) Internet of Things and UAV (Unmanned Aerial Vehicles). It will also include Artificial Intelligence (AI) / Machine Learning (ML) use cases in 5G-Advanced telecom networks, as well as 5G-Advanced NTN (Non-Terrestrial Network) / Satellite networks for future IoT services. Finally the course will cover 5G-Advanced business and regulatory aspects including 5G-Advanced services vs. Internet network neutrality, as well as developments towards future 6G mobile networks and services, IMT-2030 and beyond.</p>
Training topics	Wireless and Fixed Broadband
Certification	Certificate
Code	23WS100276MUL-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 5G-Advanced Mobile Broadband and Future Services, including technologies, standardization, regulation and content. Other institutions and individuals that are dedicated in building their capacity related to 5G-Advanced Mobile Broadband and Future Services are also welcome to participate.

2. ENTRY REQUIREMENTS

No prior knowledge or qualification is required to register for this course, considering the given 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: from IMT-Advanced (4G) to IMT-2020 (5G) and IMT-2030 (6G)
- 5G New Radio (NR) and 5G Core Network
- 5G/5G-Advanced services: enhanced mobile broadband (eMBB), massive IoT (mMTC), critical IoT (URLLC), V2X
- Deployment of 5G/5G-Advanced: QoS/QoE, Integrated Access and Backhaul (IAB), edge clouds
- 5G/5G-Advanced spectrum management and regulation
- 5G-Advanced enhancements: optimized XR (eXtended Reality), multicast and broadcast evolution, RedCap IoT
- Artificial Intelligence (AI) / Machine Learning (ML) in 5G-Advanced telecom networks
- 5G-Advanced NTN/Satellite networks and future IoT services
- Business and regulatory aspects of 5G-Advanced including QoS vs. Internet network neutrality
- Future 6G mobile networks and services: IMT-2030 and beyond

4. METHODOLOGY

This course will be delivered using face-to-face training methodology, which is defined as follows:

- The course will be conducted as two full days lecture sessions in a face to face manner at the premises of National Institute of Telecommunication (NIT) in Warsaw Poland, on 26th and 27th October 2023. The participants will be given possibility to listen to the lectures and to interact with the tutor on the given topics.
- All presentations from face to face lectures/sessions on a given course Day will be made available on the ITU Academy platform (before the start of that course day).
- Final Quiz test will be assigned online on the ITU Academy platform on 3rd of November 2023, however different date can be agreed in coordination with the course participants (depending on their travel plans back to home) at the end of Day 2.
- All information in the course be given in a timely manner (prior to the event) by the course tutor on the ITU Academy platform.

5. ASSESSMENT AND GRADING

The assessment and grading is based on a Final Quiz test that will be assigned online on the ITU Academy after returning of participants from Warsaw to their home countries. It will consist of 20 questions (multiple choices).

The Final Quiz will be open from 00:00 hours on Friday (3rd of November 2023) according to the GMT+1 time, and will remain open at least for 72 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 is passed with a grade of 70% or higher.

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 1:

Time (CEST)	Sessions/Topics covered	Key learning points (detail learning outcomes)	Training activities details
10:00 – 11:00	1. Mobile broadband evolution to 5G/5G-Advanced	<ul style="list-style-type: none"> • Mobile broadband evolution • Internet/IP technologies evolution • Internet Protocols (IPv4, IPv6) vs. mobility management • Convergence of Internet/IP and mobile networks • Mobile generations: 4G, 5G, towards 6G • ITU IMT-Advanced (4G), IMT-2020 (5G) towards IMT-2030 (6G) • 4G/4.9G mobile broadband (LTE/LTE-Advanced-Pro) • Evolved Packet System (EPS) architecture • Mobile IoT evolution 	Personal attendance at Lecture 1, with physical presence in the course and the opportunity to discuss questions with the tutor.
11:00 – 11:30	COFFEE BREAK		
11:30 – 13:00	2. 5G New Radio (NR) and 5G Core Network	<ul style="list-style-type: none"> • 5G SRIT (Set of Radio Interface Technologies) and 5G RIT (Radio Interface Technology) • 5G New Radio (5G NR) • 4G to 5G transition, LTE-NR Dual-Connectivity (DC) • 5G-Advanced RAN enhancements • 5G Core and network functions • Software-Based Architecture (SBA) • SDN/NFV for 5G/5G-Advanced • 5G/5G-Advanced network slicing in RAN and core • Slice capacity exposure • Business and regulatory aspects for 5G 	Personal attendance at Lecture 2, with physical presence in the course and the opportunity to discuss questions with the tutor.

13:00 – 14:00	LUNCH BREAK		
14:00 – 14:45	3. 5G/5G-Advanced services: enhanced mobile broadband (eMBB), massive IoT (mMTC), critical IoT (URLLC), V2X	<ul style="list-style-type: none"> • New 5G voice services (Voice over NR, EPS Fallback) • enhanced Mobile Broadband (eMBB) for mobile OTTs • Fixed-Wireless Access (FWA) architecture and spectrum • 5G/5G-Advanced FWA services • New massive MTC/IoT services • Ultra-Reliable and Low-Latency Communication (URLLC) for Critical IoT services • Internet of Smart Things: smart factories, smart grids, smart cities, smart transportation, smart farming, smart healthcare • Advanced V2X (Vehicular to Everything) services • Security for V2X • Support for UAV (Unmanned Aerial Vehicles) 	Personal attendance at Lecture 3, with physical presence in the course and the opportunity to discuss questions with the tutor.
14:45 – 15:30	4. Deployment of 5G/5G-Advanced: QoS/QoE, Integrated Access and Backhaul (IAB), edge clouds	<ul style="list-style-type: none"> • Integrated Access and Backhaul (IAB) enhancements for NR • ITU's Optical Transport Network (OTN) solution for 5G • Edge Computing in 5G/5G-Advanced • 5G/5G-Advanced QoS framework • NR QoE management and optimizations for diverse services • QoS/QoE and KPIs for mobile broadband Internet • Testing Mobile Internet access and QoE aspects • QoS for URLLC services • QoS operational strategy for supervision on mobile broadband 	Personal attendance at Lecture 4, with physical presence in the course and the opportunity to discuss questions with the tutor.
15:30 – 16:00	COFFEE BREAK		
16:00 – 17:00	5. 5G/5G-Advanced spectrum management and regulation	<ul style="list-style-type: none"> • ITU's spectrum management for 5G/5G-Advanced • 5G/5G-Advanced harmonized spectrum in low, mid and high bands 	Personal attendance at Lecture 5, with physical presence in the course

		<ul style="list-style-type: none"> • 5G-Advanced spectrum needs 2030 and beyond • Support for drones (UAVs) and enhanced satellite connectivity • Support for NR RedCap • Enhancements to Dynamic Spectrum Sharing (DSS) • 5G/5G-Advanced in unlicensed spectrum • 5G-Advanced spectrum utilization vs. energy efficiency • Spectrum for 5G/5G-Advanced on planes, Wi-Fi on the road • Spectrum for 5G/5G-Advanced backhaul • Spectrum policies vs. investments in 5G/5G-Advanced networks 	and the opportunity to discuss questions with the tutor.
Day 1 Conclusions			

Day 2:

Time (CEST)	Sessions/Topics covered	Key learning points (detail learning outcomes)	Training activities details
10:00 – 11:00	6. 5G-Advanced enhanced services: optimized XR (eXtended Reality), multicast and broadcast evolution, RedCap IoT	<ul style="list-style-type: none"> • Internet/IP services in 5G-Advanced and beyond • IPv6-only development for VR, AR, IoT, security, and IPv4 as a Service (IPv4aaS) • Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR) • Optimized XR (eXtended Reality) in 5G-Advanced • Metaverse with 5G-Advanced networking and computing • Evolution of NR multicast and broadcast services • Reduced Capacity (RedCap) NR for IoT services • Time synchronization in 5G/5G-Advanced • Enhanced Industrial IoT with 5G-Advanced 	Personal attendance at Lecture 6, with physical presence in the course and the opportunity to discuss questions with the tutor.

11:00 – 11:30	COFFEE BREAK		
11:30 – 13:00	7. Artificial Intelligence (AI) / Machine Learning (ML) in 5G-Advanced telecom networks	<ul style="list-style-type: none"> • Framework for Machine Learning (ML) in IMT-2020 by ITU • Network intelligence levels in IMT-2020 • AI/ML model transfer in 5G/5G-Advanced • Data handling to enable Machine Learning in IMT-2020 and beyond • Machine learning marketplace integration in future networks • ML based end-to-end multi-domain network slice management and orchestration • AI/ML assisted network slicing management and QoS/QoE support • AI/ML operations in 5G-Advanced (AI/ML operation splitting, AI/ML model/data distribution and sharing, Distributed/Federated Learning) 	Personal attendance at Lecture 7, with physical presence in the course and the opportunity to discuss questions with the tutor.
13:00 – 14:00	LUNCH BREAK		
14:00 – 14:45	8. 5G-Advanced NTN/Satellite networks and future IoT services	<ul style="list-style-type: none"> • 5G-Advanced and Satellite systems (LEO, MEO, GEO, HAPS) • 5G NTN Architectures (regenerative payload, transparent payload) • NTN enhancements in 5G-Advanced • 5G-Advanced system with Satellite backhaul • Service continuity between 5G NTN and 5G Terrestrial Networks • Satellite M2M/IoT services 	Personal attendance at Lecture 8, with physical presence in the course and the opportunity to discuss questions with the tutor.
14:45 – 15:30	9. Business and regulatory aspects of 5G-Advanced including QoS vs. Internet network neutrality	<ul style="list-style-type: none"> • 5G-Advanced vs. OTT services and Internet network neutrality • 5G-Advanced non-public (private) networks • V2X business and regulatory aspects • Cross-border corridors for 5G-Advanced and beyond • Business and regulatory aspects of 5G-Advanced Sattellites (5G NTN) • Spectrum regulation for 5G-Advanced and beyond • Regulatory aspects of AI/ML in 5G-Advanced and beyond • Business aspects of 5G-Advanced services 	Personal attendance at Lecture 9, with physical presence in the course and the opportunity to discuss questions with the tutor.

15:30 – 16:00	COFFEE BREAK		
16:00 – 17:00	10. Future 6G mobile networks and services: IMT-2030 and beyond	<ul style="list-style-type: none"> • IMT for 2030 and beyond • Main pillars for 6G • AI cognitive network for 6G • eMBB+, URLLC+, mMTC+, V2X+ • Cyber-physical continuum – 6G Internet of Everything • Holographic communication, Digital twins • Immersive cloud XR • 6G support for AI-powered intelligent machines • 3D global seamless coverage (space-air-ground-sea) – integrated terrestrial and non-terrestrial networks • Spectrum for 6G • Business and regulatory views for IMT-2030/6G and beyond 	Personal attendance at Lecture 10, with physical presence in the course and the opportunity to discuss questions with the tutor.
Day 2 Conclusions			

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