Training Course Outline

ITU Centres of Excellence Network for Europe

ITU and Faculty of Electrical Engineering and Information Technologies in Skopje

Online Training Course on

5G-Advanced Mobile Broadband Internet and New Services

22 November - 19 December 2022

Title	5G-Advanced Mobile Broadband Internet and New Services
Modality	Online Training Course
Dates	22 November - 19 December 2022
Duration	4 weeks
Registration deadline	21 November 2022
Training fees	USD 150
Description	This course will focus on 5G-Advanced Mobile Broadband Internet and New Services, including technologies, regulation and business aspects. It will start with mobile broadband Internet, including IPv6 mobility, 4G/4.9G (LTE/LTE-Advanced-Pro) and its Evolved Packet System (EPS), QoS, QoE and KPIs for mobile broadband Internet, then NB-IoT and eMTC, mobile spectrum management, as well as regulation of the mobile broadband Internet. The course will also include 5G New Radio (NR), 5G Core (5GC) and Software-Based Architecture (SBA), edge computing, network slicing, 5G QoS and slicing QoE, ITU's OTN (Optical Transport Network) for 5G, spectrum management for 5G NR, as well as 5G business and regulatory aspects. Further, it focuses on future mobile broadband, including 5G-Advanced enhancements, Integrated Access and Backhaul (IAB), AI (Artificial Intelligence) / ML (Machine Learning) use in 5G-Advanced, interworking of 5G and future WLAN (WiFi 6 and WiFi 7). In addition, the course will include Non-Terrestrial Network/Satellite evolution for NR and IoT, 5G FWA (Fixed-Wireless Access), 5G/5G-Advanced private (non-public) networks, as well as business and regulatory aspects of future mobile broadband. Finally, the course will cover new 5G/5G-Advanced mobile services, including new 5G voice (VoNR, EPS Fallback), evolution of 5G multicast and broadcast, 5G XR (eXtended Reality) with application awareness, and evolved Mobile Broadband (eMBB) for OTTs. It will also include massive MTC/IoT services, URLLC for Industrial IoT over NR, Advanced V2X, 5G-Advanced services vs. Internet network neutrality, as well as business and regulatory aspects for new 5G-Advanced services.
Course code	22OI27814EUR-E

1. LEARNING OBJECTIVES

This course will focus on 5G-Advanced Mobile Broadband Internet and New Services, including technologies, regulation and business aspects. Module 1 will cover the Set of Radio Interface Technologies (SRITs) for use with 5G RAN in NSA (Non Stand-Alone) deployments. In that respect, Module 1 will include 4G/4.9G (LTE/LTE-Advanced-Pro) and its Evolved Packet System (EPS), QoS, QoE and KPIs for mobile Internet, then NB-IoT (Narrow-Band Internet of Things) and eMTC (enhanced Machine Type Communication), LTE in unlicensed bands, spectrum management, as well as business and regulatory aspects of mobile broadband. Further, the course will target 5G Stand-Alone (5G SA) solution. In that manner, Module 2 covers 5G New Radio (NR), 5G Core (5GC) and Software-Based Architecture (SBA), transition from 4G to 5G, network slicing, edge computing in the 5G Core, QoS and slicing QoE in 5G. It will also include transport network solutions for 5G, such as ITU's OTN (Optical Transport Network), ITU's spectrum management for 5G NR, as well as 5G business and regulatory aspects. Then, Module 3 will provide the future development of mobile broadband, including 5G-Advanced enhancements, Integrated Access and Backhaul (IAB), AI (Artificial Intelligence)/ML (Machine Learning) use cases in 5G-Advanced, interworking of 5G and future WLAN (WiFi 6 i.e. IEEE 802.11ax, and WiFi 7 i.e. IEEE 802.11be). In addition, Module 3 will include NTN (Non-Terrestrial Networks)/Satellite evolution including NR and IoT, 5G FWA (Fixed-Wireless Access), 5G/5G-Advanced private (non-public) networks for new services, as well as business and regulatory aspects of future mobile broadband. Last module, Module 4, will target new services in 5G and 5G-Advanced mobile networks. So, Module 4 will cover new 5G voice services (Voice over NR - VoNR, EPS Fallback), evolution of 5G multicast and broadcast services, 5G XR (eXtended Reality) with QoS and application awareness, and evolved Mobile Broadband (eMBB) for mobile Internet access and OTT (Over The Top) services. Finally, Module 4 will also include massive Machine Type Communication (mMTC)/IoT services, Ultra-Reliable and Low-Latency Communication (URLLC) for Industrial IoT over NR, Vehicular to Everything (V2X), new 5G services vs. Internet network neutrality, as well as business and regulatory aspects for new 5G-Advanced services.

2. LEARNING OUTCOMES

Upon completion of this course, participants will be able to:
- Understand mobile broadband Internet, including IPv6 mobility, as well as 5G Set of Radio Interface Technologies (SRIT) for use with 5G RAN, such as LTE/LTE-Advanced-Pro, NB-IoT and eMTC;
- Understand 5G technologies, including 5G New Radio (NR), 5G Core (5GC) and its Software-Based Architecture (SBA) and edge computing, network slicing and 5G spectrum management;
- Perform technical, business and regulatory analysis for mobile broadband and 5G mobile networks, including 5G NR spectrum as well as QoS, QoE and KPIs;
- Understand future 5G-Advanced mobile broadband, including Integrated Access and Backhaul (IAB), 5G and WLAN interworking, Non-Terrestrial Network i.e. Satellite access in 5G, Fixed-Wireless Access (FWA), and 5G-Advanced non-public networks;
- Understand new 5G-Advanced services, including new voice services (VoNR, EPS Fallback), evolution of 5G multicast and broadcast services, 5G XR with application awareness, 5G evolved Mobile Broadband (eMBB) for OTTs, massive MTC/IoT, URLLC for Industrial IoT over NR, Advanced V2X, as well as 5G-Advanced services vs. Internet network neutrality;
- Perform technical, business and regulatory analysis for new 5G-Advanced services, including telecoms and OTTs.

3. 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 5G-Advanced Mobile Broadband Internet and New Services, including technologies, regulatory and business aspects. Other institutions and individuals that are dedicated in building their capacity related to 5G-Advanced Mobile Broadband Internet and New Services.

4. ENTRY REQUIREMENTS

No prior knowledge or qualification is required to register for this course, considering the given target population.

5. TUTORS/INSTRUCTORS

NAME OF TUTOR(S)/INSTRUCTOR(S)	CONTACT DETAILS
Prof. Dr. Toni Janevski, tutor	tonij@feit.ukim.edu.mk (www.feit.ukim.edu.mk)
Dr. Pero Latkoski, tutor's assistant	
Dr. Tomislav Shuminoski, tutor's assistant	

6. TRAINING COURSE CONTENTS

The training contents are organized in 4 Modules, where each of the Modules is covering a given topic area with given contents, as shown in the table below:

Topic	Contents
Module 1: **Mobile Broadband Internet**	• Mobile broadband Internet evolution • IPv6 mobility management • 4G/4.9G mobile broadband (LTE/LTE-Advanced-Pro) • Evolved Packet System (EPS) architecture • QoS, QoE and KPIs for mobile broadband Internet • NB-IoT (Narrow Band IoT) and eMTC (enhanced Machine Type Communication) • LTE in unlicensed bands • Mobile spectrum management • Business and regulatory aspects of Mobile Broadband Internet
Module 2: **5G Technologies**	• 5G New Radio (5G NR) and 5G RAN • 4G to 5G transition, LTE-NR Dual-Connectivity (DC) • 5G Core (5GC) and Software-Based Architecture (SBA) • Edge Computing in 5G • 5G network slicing, RAN slicing for NR • 5G QoS and slicing QoE

Topic	Contents
	• ITU's Optical Transport Network (OTN) solution for 5G • ITU's spectrum management for 5G (towards WRC-23) • Business and regulatory aspects for 5G
Module 3: **Future 5G-Advanced Mobile Broadband**	• 5G-Advanced enhancements • Integrated Access and Backhaul (IAB) • AI (Artificial Intelligence)/ML (Machine Learning) use cases in 5G-Advanced • Future WLAN: WiFi 6 (IEEE 802.11ax) and WiFi 7 (IEEE 802.11be) • 5G - WLAN interworking • NTN (Non-Terrestrial Networks)/Satellite evolution including NR and IoT • 5G Fixed-Wireless Access (FWA) • 5G-Advanced non-public (private) networks • Business and regulatory aspects of future 5G-Advanced mobile broadband
Module 4: **New 5G-Advanced services**	• New 5G voice services (Voice over NR, EPS Fallback) • Evolution of 5G multicast and broadcast services • 5G eXtended Reality (XR) with application awareness • 5G evolved Mobile Broadband (eMBB) for mobile OTTs • New massive MTC/IoT services • Ultra-Reliable and Low-Latency Communication (URLLC) for Industrial IoT over NR • Advanced V2X (Vehicular to Everything) services • 5G-Advanced services vs. Internet network neutrality • Business and regulatory aspects for new 5G-Advanced services

7. TRAINING COURSE SCHEDULE

Week	Topic	Exercises and interactions
Week 1	Module 1: **Mobile Broadband Internet**	Learning topics from course materials: • Mobile broadband Internet evolution • IPv6 mobility management • 4G/4.9G mobile broadband (LTE/LTE-Advanced-Pro) • Evolved Packet System (EPS) architecture • QoS, QoE and KPIs for mobile broadband Internet • NB-IoT (Narrow Band IoT) and eMTC (enhanced Machine Type Communication) • LTE in unlicensed bands • Mobile spectrum management • Business and regulatory aspects of Mobile Broadband Internet Discussion / Forum Self test quiz
Week 2	Module 2:	

Week	Topic	Exercises and interactions
	5G Technologies	Learning topics from course materials: • 5G New Radio (5G NR) and 5G RAN • 4G to 5G transition, LTE-NR Dual-Connectivity (DC) • 5G Core (5GC) and Software-Based Architecture (SBA) • Edge Computing in 5G • 5G network slicing, RAN slicing for NR • 5G QoS and slicing QoE • ITU's Optical Transport Network (OTN) solution for 5G • ITU's spectrum management for 5G (towards WRC-23) • Business and regulatory aspects for 5G
		Discussion / Forum
		Self test quiz
Week 3	Module 3: **Future 5G-Advanced Mobile Broadband**	Learning topics from course materials: • 5G-Advanced enhancements • Integrated Access and Backhaul (IAB) • AI (Artificial Intelligence)/ML (Machine Learning) use cases in 5G-Advanced • Future WLAN: WiFi 6 (IEEE 802.11ax) and WiFi 7 (IEEE 802.11be) • 5G - WLAN interworking • NTN (Non-Terrestrial Networks)/Satellite evolution including NR and IoT • 5G Fixed-Wireless Access (FWA) • 5G-Advanced non-public (private) networks • Business and regulatory aspects of future 5G-Advanced mobile broadband
		Discussion / Forum
		Self test quiz
Week 4	Module 2: **New 5G-Advanced services**	Learning topics from course materials: • New 5G voice services (Voice over NR, EPS Fallback) • Evolution of 5G multicast and broadcast services • 5G eXtended Reality (XR) with application awareness • 5G evolved Mobile Broadband (eMBB) for mobile OTTs • New massive MTC/IoT services • Ultra-Reliable and Low-Latency Communication (URLLC) for Industrial IoT over NR • Advanced V2X (Vehicular to Everything) services • 5G-Advanced services vs. Internet network neutrality • Business and regulatory aspects for new 5G-Advanced services
		Discussion / Forum
		Self test quiz and Final Evaluation

8. METHODOLOGY (Didactic approach)

The course methodology will be as follows:

- Each module will be studied and discussed over a time period of one week;
- Course materials will be made available on a weekly basis;
- Discussion forums will be organized based on discussion topics given on a daily basis, where students are highly encouraged to participate and interact with instructors and other students;
- Quiz tests will be assigned weekly, one per module, at the end of a given course week;
- All announcements for all events (materials, quizzes and forums) will be given in a timely manner (prior to the event) by the course tutor.

9. EVALUATION AND GRADING

The evaluation of the participants will be based on 80% from the average Quiz marks (average score from the quizzes) and 20% from the participation with substantive posts in the discussion forums, reflecting both the quantity and the quality of time spent on the course. Overall grade higher than 60% success ratio is required to complete the course and obtain an ITU certificate.

10. COURSE COORDINATION

Course coordinator:	ITU coordinator:
Name: **Prof. Dr. Toni Janevski** Email address: tonij@feit.ukim.edu.mk	Name: **Elind Sulmina** Email address: elind.sulmina@itu.int

11. REGISTRATION AND PAYMENT

ITU Academy portal account

Registration and payment should be made online at the ITU Academy portal.
To be able to register for the course you **MUST** first create an account in the ITU Academy portal at the following address:
https://academy.itu.int/index.php/user/register

The instructions for course registration and payment are given in a separate file, which accompanies this Training Course Outline.

12. CERTIFICATES

Each fully registered participant who will successfully complete the course, based on the evaluation, will receive an ITU Certificate after the course.