

Course guide

230353 - FTMC - Future Trends in Mobile Communications: From 5G to 6g

Last modified: 09/11/2022

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: Academic year: 2022 **ECTS Credits:** 2.5
Languages: English

LECTURER

Coordinating lecturer: Consultar aquí / See here:
<https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura>

Others: Consultar aquí / See here:
<https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma>

PRIOR SKILLS

Basic knowledge about radiocommunications.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

CE1. Ability to apply information theory methods, adaptive modulation and channel coding, as well as advanced techniques of digital signal processing to communication and audiovisual systems.

CE2. Ability to develop radio-communication systems: antennas design, equipment and subsystems, channel modeling, link dimensioning and planning.

CE3. Ability to implement wired/wireless systems, in both fix and mobile communication environments.

CE9. Ability to deal with the convergence, interoperability and design of heterogeneous networks with local, access and core networks, as well as with service integration (telephony, data, television and interactive services).

Transversal:

CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

TEACHING METHODOLOGY

- Lectures
- Individual work (distance)
- Final Exam

LEARNING OBJECTIVES OF THE SUBJECT

Mobile communication systems have experienced tremendous growth in the last decades. In the near future, an explosion of data traffic is expected, driven by the progressive penetration of 5G networks, the exponential increase in mobile devices, as well as applications that consume a lot of bandwidth, such as the video transmission or mobile games, highly integrated into our daily lives, but also new applications that will be gradually introduced such as virtual and augmented reality, holographic communications or communications to provide intelligence services artificial. In order to support this high demand for data traffic, new and innovative physical layer techniques, with very high spectral efficiency (for example, using massive MIMO), the exploitation of the new spectrum working at much higher frequencies (e.g. , considering millimeter waves and terahertz bands), the densification of wireless networks, the intensive use of network virtualization techniques and the application of artificial intelligence in the radio interface are some of the proposed techniques.

The aim of this seminar is to present rationality in order to apply these innovative techniques, as well as the main and most relevant technical aspects behind them. To achieve this goal, the seminar, based on a brief explanation of the main features of 5G systems, understood as a starting point, traces the foreseeable technological evolution to reach 6G systems, with special emphasis on innovative techniques planned for this new generation of mobile communications.

Learning results of the subject:

- Ability to understand the technical specificities behind the innovative communication technology envisaged for systems beyond 5G and the future 6G systems
- Ability to analyse, and model new architectures, network protocols and communication interfaces for systems beyond 5G and the future 6G systems.

STUDY LOAD

Type	Hours	Percentage
Hours large group	20,0	32.00
Self study	42,5	68.00

Total learning time: 62.5 h

CONTENTS

Future Trends in Mobile Communications: From 5G to 6G

Description:

Topic 1 – INTRODUCTION

- FORECAST OF THE TRAFFIC EVOLUTION
- 5G SCENARIOS : eMBB, IoT, V2X, Industry 4.0
- 5G TECHNOLOGY CHALLENGES
- REQUIREMENTS FOR THE NEXT GENERATION MOBILE COMMUNICATIONS (6G)

Topic 2 – TECHNOLOGY ISSUES

- OVERVIEW OF THE 5G NEW RADIO STANDARD (5G NR)
- TECHNOLOGICAL EVOLUTION TO 6G
 - o Communication in Millimeter and Terahertz Bands
 - * Reconfigurable Intelligent Surfaces (RIS)
 - o Massive MIMO techniques: holographic beamforming
 - o Cell-free Massive MIMO Communications
 - o Application of artificial intelligence techniques in systems beyond 5G and 6G.

Topic 3 – SYSTEM RELATED ISSUES

- NETWORK VIRTUALIZATION (NFV) AND SOFTWARE DEFINED NETWORKS (SDN):
 - o Network Function Virtualization (NFV)
 - o Software Defined Networks (SDN): Concept and functional architecture
 - o Dynamic Network Slicing
 - o O-RAN Architecture
- ULTRA-DENSITY NETWORKS and C-RAN ARCHITECTURES (Cloud RAN)
 - o Features, architectures and benefits of ultra-dense networks
 - o Centralized RAN and cloud RAN concept
 - o Requirements of the X-haul transport system between the different network nodes.

Related competencies :

CE9. Ability to deal with the convergence, interoperability and design of heterogeneous networks with local, access and core networks, as well as with service integration (telephony, data, television and interactive services).

CE3. Ability to implement wired/wireless systems, in both fix and mobile communication environments.

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Full-or-part-time: 62h 30m

Theory classes: 20h

Self study : 42h 30m

GRADING SYSTEM

Continuous assessment 50% of the final grade

Final exam 50% of final grade.



RESOURCES

Other resources:

Basic:

- Slides of the course
- Papers and presentation published in IEEE, ITU, ETSI and other standardization bodies

Complementary:

- Papers published in magazines, conferences and other research bodies.