

230253 - LCM - Mobile Communications Laboratory

Coordinating unit:	230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit:	739 - TSC - Department of Signal Theory and Communications
Academic year:	2019
Degree:	BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2010). (Teaching unit Optional) BACHELOR'S DEGREE IN TELECOMMUNICATIONS SCIENCE AND TECHNOLOGY (Syllabus 2010). (Teaching unit Optional) BACHELOR'S DEGREE IN TELECOMMUNICATIONS TECHNOLOGIES AND SERVICES ENGINEERING (Syllabus 2015). (Teaching unit Optional)
ECTS credits:	6
Teaching languages:	Catalan, Spanish, English

Teaching staff

Coordinator:	RAMON FERRÚS
Others:	ANNA UMBERT JULIANA JORDI PÉREZ-ROMERO

Prior skills

Fundamentals of radio communications and mobile communications.

Degree competences to which the subject contributes

Generical:

10 ECI N2. They will have acquired knowledge related to experiments and laboratory instruments and will be competent in a laboratory environment in the ICC field. They will know how to use the instruments and tools of telecommunications and electronic engineering and how to interpret manuals and specifications. They will be able to evaluate the errors and limitations associated with simulation measures and results.

Teaching methodology

The course is developed through practical activities in person at the laboratory, complemented by the activities of preparation of a preliminary work and a final report for each practice. For each content block, the teacher will provide the basic information and references necessary to allow the student to acquire the level of knowledge necessary for the proper development of the lab sessions. From this material, the student will carry out a preliminary study following a model provided for each practice. Practice sessions are held in groups of 2 or 3 people. In these sessions, activities aimed at developing skills to perform simulations and experiments and evaluate the results, comparing specifications with measurements. At the end of each practice, students must complete and submit a report of the work carried out in the laboratory.

- Lectures
- Laboratory classes
- Individual work (distance)
- Exercises
- Short answer test (Final Exam)
- Other activities.

Learning objectives of the subject

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Learning the capabilities and how to use tools and equipment in the field of mobile communication systems design, evaluation and testing:

- Computer tools for simulation of the physical layer of mobile communication systems.
- Computer tools for the planning and optimisation of mobile communication systems.
- Radio communications testing equipment (RF and signalling analyzers).
- Experimental private mobile networks with SDR equipment
- Drive testing tools for the analysis of the operation of mobile communications networks.

By means of using the previous tools:

- To acquire a practical knowledge of the operation of the main technologies and systems of mobile communication.
- To develop the ability to identify, analyze and solve engineering problems in the context of mobile communication systems.
- To develop the ability to perform simulations or experiments and evaluate their results, compare theoretical specifications with measurements and make performance evaluations in controlled or realistic environments of radio communication systems.

Study load

Total learning time: 150h	Hours large group:	13h	8.67%
	Hours small group:	39h	26.00%
	Self study:	98h	65.33%

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Content

<p>1. Introduction and preliminary concepts for the realization of the laboratory activities</p>	<p>Learning time: 12h Theory classes: 4h Self study : 8h</p>
<p>Description: Introduction to mobile communication systems. Technologies and standards. Mobile communications sector. Basic concepts and starting point for the realization of the laboratory activities.</p> <p>Related activities: Theory classes.</p> <p>Specific objectives: Understand the main characteristics of mobile communication systems.</p>	
<p>2. Lab sessions for LTE signal generation and performance assessment with MATLAB LTE Toolbox</p>	<p>Learning time: 24h Laboratory classes: 8h Self study : 16h</p>
<p>Description: Simulation, analysis and performance assessment of LTE radio technology with MATLAB LTE Toolbox. It covers the time-domain analysis of LTE signals, physical channels and reference signals, channel propagation modelling, duplexing modes (FDD, TDD), multi-antenna transmission modes (Transmit Diversity, Spatial Multiplexing) and link adaptation.</p> <p>Related activities: Lab sessions on LTE signal generation and performance assessment with MATLAB LTE Toolbox</p> <p>Specific objectives: The learning objectives are:</p> <ul style="list-style-type: none"> • Acquire a detailed knowledge of the radio transmission and reception technologies used in 4G / LTE mobile networks • Simulate, analyze and perform performance tests of the physical layer of an LTE link through simulation tools. 	

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<p>3. Lab sessions on planning and dimensioning of mobile networks</p>	<p>Learning time: 36h Laboratory classes: 12h Self study : 24h</p>
<p>Description: Introduction to planning and dimensioning of 4G/5G mobile systems. It covers the configuration of a network deployment (location of the antennas, transmission and reception equipment characteristics), radio propagation models, characterization of services, mobility and terminals, configuration of neighboring cells, frequencies and cell IDs , use of traffic maps, calculation of coverage predictions, capacity and quality of service. Performance comparisons are made for types of service, impact on the planning of radio resource management strategies (ICIC, uplink power control, scheduling policy) and the impact of channel configuration and frequency band.</p> <p>Related activities: Planning of 4G/5G mobile networks with ATOLL, a commercial tool for wireless planning and optimisation.</p> <p>Specific objectives: Learn the steps to plan and dimensioning mobile communications systems.</p>	
<p>4. Monitoring and performance assesement of operational mobile networks with drive testing tools</p>	<p>Learning time: 24h Laboratory classes: 8h Self study : 16h</p>
<p>Description: Learning the features and use of a drive testing commercial tool for monitoring and performance assesement of a commercial network in Campus Nord. It covers 2G, 3G and 4G access testing. Measurements of signal strength are taken across the Campus. Key Performance Indicators (KPIs) for voice and Internet services are assesed.</p> <p>Related activities: Monitoring and performance evaluation of a commercial network with QualiPoc Drive Test tool and post-processing analysis NQView tool from Rohde Schwarz.</p> <p>Specific objectives: Learn how to monitor real mobile networks.</p>	

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<p>5. Lab sessions with radio communications testing equipment</p>	<p>Learning time: 30h Laboratory classes: 10h Self study : 20h</p>
<p>Description: Study of physical layer aspects and signalling procedures with mobile terminals and radio communications testing equipment. It covers the analysis of the temporal structure of the signals, spectrum and the use of resources (slots, codes). Realization of different measurements such as adjacent channel interference leakage ratio (ACLR) and bit error rates (BER). Different configurations of services are studied (voice services, data services with different rates). It also covers the analysis of different mechanisms such as frequency hopping, attach / detach and handover.</p> <p>Related activities: Performance measures of commercial mobile phones with the equipment HP / Agilent 8922. Measures of the performance of mobile phones with the CMU-200 radio communications tester from Rhode & Schwarz.</p> <p>Specific objectives: Understand and learn how to characterise and measure the physical parameters of different radio access technologies as well as to analyse the main signaling procedures.</p>	
<p>6. Lab sessions with an experimental private 4G/5G network</p>	<p>Learning time: 24h Laboratory classes: 8h Self study : 16h</p>
<p>Description: In these lab session students work with an experimental private LTE network that allows performing functional tests and performance of conventional terminals. The LTE network, implemented with the OTS 100 system from Amarisoft, is operational in the D4-115 laboratory of the Mobile Communications Research Group (GRCM). The practice aims at students getting familiar with this type of experimental equipment that, in the case of the available equipment, allows for testing LTE access as well as technologies for IoT communications (LTE-M, NB-IoT) and 5G technologies (E-UTRAN New Radio configurations - Dual Connectivity [EN-DC]).</p> <p>Related activities: Lab sessions for the configuration and operation of a private LTE network with the Amarisoft OTS 100 test equipment</p> <p>Specific objectives: The objectives of the lab sessions are:</p> <ul style="list-style-type: none"> • Getting familiar with the configuration and operation of OTS 100. • Study the operation of an operational LTE network based on the analysis of signaling procedures and the monitoring of measurements and statistics. • Carry out tests for the characterization and assessment of different configurations and operating conditions of the LTE network, including configurations with different duplexing modes (FDD or TDD), use of different frequency bands and channel configurations, use of carrier aggregation mechanisms and MIMO 2x2 configurations, execution of handover procedures, configuration of QoS parameters and provision of voice services over LTE (called as VoLTE). 	

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Qualification system

The final mark will be obtained from continuous assessment mark (works proposed by the teacher throughout the course and lab) and the final exam, according to the following criteria:

Final examination, attendance and attitude in class: 25%

Exercises (Previous works): 15%

Laboratory assessments (Finals reports): 60%

Regulations for carrying out activities

The presentation of a preliminary questionnaire about the laboratory practises is a prerequisite to carry out the lab sessions.

During the lab sessions, students must fill out questionnaires to assess their progress. A final report has to be delivered after the finalisation of the work in the laboratory.

Bibliography

Basic:

Sallent Roig, O.; Pérez Romero, J. Fundamentos de diseño y gestión de sistemas de comunicaciones móviles celulares [on line]. Barcelona: Universitat Politècnica de Catalunya. Iniciativa Digital Politècnica, 2014 [Consultation: 25/06/2015]. Available on: <<http://hdl.handle.net/2099.3/36630>>. ISBN 9788498804812.

R. Agustí, F. Bernardo Álvarez, F. Casadevall, R. Ferrús, J. Pérez, O. Sallent. LTE: nuevas tendencias en comunicaciones móviles [on line]. [S.I.]: Fundación Vodafone, 2010 Available on: <http://www.fundacionvodafone.es/sites/default/files/libro_lte.pdf>. ISBN 8493474045.

Holma, H.; Toskala, A. WCDMA for UMTS - HSPA evolution and LTE. 5th ed. Chichester: John Wiley & Sons, 2010. ISBN 9780470686461.

Hernando, J.M. (Coord.). Comunicaciones móviles GSM y GPRS. Alcobendas: Fundación Vodafone España, 2007. ISBN 84-934740-1-0.

Complementary:

Lee, W.C.Y. Mobile communications design fundamentals. 2nd. New York: John Wiley & Sons, 1993. ISBN 0471574465.

Sallent, O.; Valenzuela, J.L.; Agustí, R. Principios de comunicaciones móviles [on line]. Barcelona: Edicions UPC, 2003 [Consultation: 10/03/2015]. Available on: <<http://hdl.handle.net/2099.3/36768>>. ISBN 84-8301-715-6.

Pérez-Romero, J.; Sallent, O.; Agustí, R.; Díaz-Guerra, M.A. Radio resource management strategies in UMTS. Chichester: John Wiley & Sons, 2005. ISBN 0470022779.

Laiho, J.; Wacker, A.; Novosad, T. Radio network planning and optimisation for UMTS. 2nd. ed. Chichester: John Wiley & sons, 2006. ISBN 0470015756.

Others resources:

User manuals of the equipment and software used in the laboratory in ATENEA