

Postgraduate Course Mobile Communications – 4G and Beyond (MSc)

Instructor Information

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Course Information

Course Description

In this course the student will learn the fundamentals of modern mobile communication systems, obtain insight into how current 4G cellular systems work and are designed, and acquire basic knowledge of what future systems will be like.

The course relies on some basic concepts related to digital communication, multi-antenna transmission and wireless propagation, which are assumed to be known.

It begins by presenting a set of fundamental techniques used in modern systems.

The LTE and LTE-A systems are then described with considerable detail. The description focuses on the radio interface, and covers not only aspects contained in the specifications, but also radio resource management algorithms and methods commonly used by LTE operators.

Radio network planning techniques applied in these systems are also discussed. This requires the introduction of some notions related to simulation of wireless networks, which is essential to network planning. Planning techniques are then presented, including advanced features such as partial frequency reuse and dynamic interference coordination.

Lastly, an outlook of future 5G systems is given.

Prerequisites

Digital Communication fundamentals.

Array Processing and MIMO Systems

Wireless Propagation

Course Goal

To develop an understanding of the basic concepts, system description and radio

Mobile Communications – 4G and Beyond

Track: Radiofrequency Technologies and Systems

Track: Radiocommunications and Multimedia

network planning of LTE/LTE-A, as well as to give a perspective on future 5G systems.

Summary of intended course outcomes

The students will understand the fundamental concepts that underpin current 4G systems, as well as those expected to be employed by future systems. In addition, they will gain detailed knowledge of how the LTE and LTE-A radio interfaces work, and how networks based on these technologies are designed and optimized. They will also acquire basic knowledge on the expected features of 5G systems.

By the end of the course, the students should be able to:

- Have fluency with the fundamental techniques used in 4G systems, and those anticipated for 5G systems.
- Have detailed knowledge of the radio interface in LTE and LTE-A systems, and be able to simulate specific parts of that interface.
- Plan an LTE/LTE-A cellular radio network.

Syllabus

Introduction

Basic concepts related to mobile communications
Evolution of mobile communication systems. Network generations

Fundamentals of modern mobile communication systems

Multipath channel modelling
Distortion effects produced by multipath
Overview of diversity and spatial multiplexing
Link adaptation
Opportunistic user scheduling

LTE and LTE-A: system description

Origin of LTE. Design targets.
Network architecture.
Radio interface. General characteristics.
Channels in the radio interface.
Physical-layer processing. Modulation, coding, and MIMO transmission.
Radio resource management: rate adaptation, HARQ with combination, power control, user scheduling.
Protocols. Connection states.
LTE-Advanced.

LTE and LTE-A: radio network planning

Radio network planning.
Link budget.
Simulation of the radio interface. Link level and system level.
Link-level to system-level interface in OFDM systems.
Spatial multipath channel models.
Link-level simulation.
System-level simulation.
Scheduling algorithms.
Frequency reuse techniques.
Inter-cell interference coordination.

Outlook of 5G systems

General features. Frequency bands
Technologies that will be used in 5G systems.

Textbooks

- E. Dahlman, Stefan Parkvall and Johan Sköold, *4G: LTE / LTE-Advanced for Mobile Broadband*, second edition. Academic Press, 2014.
- D. Tse and P. Viswanath, *Fundamentals of wireless communications*. Cambridge

University Press, 2005.

Recommended reading material

- Chris Johnson, *LTE in bullets*, second edition. 2012
- Stefania Sesia, Matthew Baker and Issam Toufik, *LTE - The UMTS Long Term Evolution: From Theory to Practice*, second edition. John Wiley and sons, 2011.
- Harri Holma and Anti Toskala (editors), *LTE for UMTS: Evolution to LTE-Advanced*, second edition. John Wiley and sons, 2011.

Research papers dealing with specific topics will also be provided by the instructor.

Student Assessment Criteria

Overview and critical assessment of a selected paper	15%
Practice work / student work on a specific subject	20%
Final Exam	65%

In addition to the final examination, each student will be required to:

- Hand in an overview and critical assessment of one of the papers provided during the course, or some other chosen by them.
- Do the course practice work and hand in a summary of results / Study a topic in depth and hand in an essay, discussing additional details not covered in the course. The topic will be selected from a list provided by the instructor, or selected by the student based on their interest.