

Istanbul Technical University

Department of Computer Engineering

BLG609E - Special Topics: 4G Wideband Wireless Network Architectures (Spring 2012)

Catalog Data

Key system level technical issues involved in the design and deployment for 4G wireless mobile networks (e.g., network selection, location management and paging, mobility management, security) will be covered. Layer 2.5 and above will be covered, not going into details of physical layer.

Course Description

With the advent of wideband 4G mobile wireless networks (Long Term Evolution (LTE), and WiMAX), these networks are soon becoming the first hop for Internet traffic. The objective of this course is enable the students to understand how these networks are designed to provide the key service of mobility to low power mobile devices.

This course introduces LTE and WiMAX architecture to students in a stepwise progressive fashion. This helps students to break-down the typically complex architecture of such systems into simpler pieces and understand how these pieces fit together to form the complete system. Initially the basic architecture for registration is provided. Security, mobility, location management and paging aspects of the architecture are then covered. Policy and Quality of Service (QoS) architectural aspects are introduced next. Redundancy and availability design aspects, especially IP transport layer availability design, that are key to providing the high-availability expected of such wireless networks is also covered. Aspects of inter-working and co-existence of different wideband wireless technologies is covered finally.

As various functional aspects of the wireless network are discussed, e.g., security, mobility or location management, attempt is made not just to describe how these functions are implemented by LTE or WiMAX architecture, but an overview of the key design requirements on that particular issue is also provided. In this way the course is much more than an industry tutorial or standards overview of LTE or WiMAX. Students are exposed to some of the research areas in these areas and the practical considerations that form the constraints for the solution space.

While most books and courses on LTE and WiMAX deal with physical layer radio or radio resource management aspects, this course is focused more on the core network and systems aspects.

Course Objectives and Related Program Educational Objectives

- To strengthen students' knowledge in mobile/wireless communication systems.
- To understand how mobility is supported and how L2 and L3 mobility mechanisms interact
- To understand how to secure mobile wireless networks.
- To understand the key issues in the design of power management, location management and paging in cellular networks.
- To develop students' writing and research skills.
- Student's factual knowledge and understanding of LTE and WiMAX architecture.

Instructors

Irfan Ali, Instructor

Irfan Ali is a member of Nokia Siemens Networks (NSN) Advanced Technology group and represents NSN at LTE Standards Meetings. He is the vice-chair of the 3GPP Architecture Working Group (SA2).

He has been working in telecommunications industry for the past 10 years and has a PhD from Rensselaer Polytechnic Institute, New York.

Alper Yegin Instructor

Alper Yegin is a member of Samsung Electronics DMC R&D Center and represents Samsung at IETF, WiMAX Forum, and ETSI M2M standards meetings. He chairs the NWG Security Committee in WiMAX Forum and previously chaired the IETF PANA WG. He is a co-author of the book titled "Next Generation Mobile Systems: 3G & Beyond" and has a MS in CS degree from University of Illinois at Urbana-Champaign.

Credit 3 hours

**Prerequisites
by course**

**Prerequisite
by topics**

Each student should have the background in:

- Computer networks.

Class/Laboratory Schedule:

One 3 hour lecture/discussion session per week.
Monday, 13:30 – 16:30 (3 Hours).

Textbook

There is no required textbook for this course. Required materials will be provided during the course. Supplement articles and class Power Point slides will be provided regularly.

Lectures

Each lecture will cover a specific aspect of wireless network architecture. Some topics will be spread over two lectures. Since this is a senior graduate level course, only key concepts will be covered during the lectures. Additional papers (overview and/or research oriented) that supplement the lectures will be handed out. Students are REQUIRED to read these papers. Some of the homework assignment questions will be based on the handed out papers. The class will also entail a project. The details of the project will be provided during the first few weeks of the course.

Grading policy (Tentative):

HWs	25%
Midterm	20%
Project	15%
Final	40%

Course Topics (Tentative):

Week/Date	Topic
1 / Feb 06	Introduction Syllabus overview
2 / Feb 13	Network Architecture Overview of LTE and WiMAX Process of Standards and Evolution GSM family (3GPP) Standards Architecture (CS/PS Domain) Long Term Evolution (LTE) Architecture – Identities and Registration WiMAX Architecture- Identities and Registration

3 / Feb 20

Network Architecture Overview of LTE and WiMAX

Continuation of the lecture

Network Selection

3GPP Radio Access Technology and Network Selection

Selection Between 3GPP and non-3GPP architectures

Research in Network Selection

4 / Feb 27

Location Management, Power Management and Paging-I

Power Management – active/idle modes in UE

Paging and Concept of location-areas for idle mode mobility of devices

LTE LM/PM and Paging implementation

Research in LM/PM and Paging implementation

5 / Mar 05

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Location Management, Power Management and Paging-II

See above. Topic will be covered in two lectures.

6 / Mar 12

Security architecture and mechanisms-I

Fundamentals of securing wireless networks

Specific applications to 3GPP, WiMAX, WiFi networks

Privacy, lawful intercept, practical security, security stack, optimizations, trade-offs

IETF Security toolkit

7 / Mar 19

Security architecture and mechanisms-II

See above. Topic will be covered in two lectures.

8 / Mar 26

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Midterm

Quality of Service

Objectives: cost vs differentiation

Overall Policy and QoS design architecture for 3GPP

Concept of bearers and Deep Packet Inspection and transport QoS

Research topics

x / Apr 02

Spring Break

9 / Apr 09

Quality of Service

Part-2

Mobility Management -I

IP address management (IPv4 and IPv6)

L2 mobility, L3 mobility, all combined

Optimizations

11 / Apr 16

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Mobility Management-II

See above. Topic will be covered in two lectures

12 / Apr 23 (holiday)

Interworking and co-existence of heterogeneous networks

Various combinations of 3GPP, 3GPP2, WiMAX, WiFi,
and DSL networks

13 / Apr 30

Network Fault-tolerance design for wireless networks -I

Understanding the availability metrics: 5 - 9s

End-node availability design

IP Network availability design: L2/L3 and L4 techniques

14 / May 07

Network Fault-tolerance design for wireless networks -II

See above. Topic will be covered in two lectures

21/May -01/Jun

Final Exam