Subject: Network Architecture II
Code: 18477
Center: Escuela Politécnica Superior
Degree: Telecommunication Technologies and Services Engineering
Level: Undergraduate
Tipo: Core course
ECTS: 6

1. COURSE TITLE

Network Architecture II (AR2)

1.1. Course number

18477 at the Telecommunication Technologies and Services Engineering degree

1.2. Course area

Network Architecture

1.3. Course type

Core course common to the Telecommunications Branch

1.4. Course level

Undergraduate

1.5. Year

2nd

1.6. Semester

2nd

1.7. Credit allotment

6 ECTS credits

1.8. Prerequisites

Network Architecture II is part of the Network Architecture subject (12 ECTS credits) in the Syllabus. This subject is split in two semesters: *Network Architecture I* and *Network Architecture II*. This course is given in the second semester of the second course, and it is necessary to enroll first *Probability and Statistics* and *Network Architecture I* in the first semester, as well as those courses that are necessary for them, such as *Programming I and II*.
It is recommended to verify the comprehension of the contents and basic skills of this subject by solving the Problem Guides, which can be complemented with other

proposed and/or solved cases in the bibliography. The electronic material is available in the Moodle platform (http://moodle.uam.es). It is recommended to have English reading skills, because the documentation of the international standards (IEEE, ETSI, etc.), as well as vendors (data sheets, etc.) are written in English. Personal initiative and design tenacity are also required to design and start up lab assignments. Finally, it is also important to have work group skills.

1.9. Minimum attendance requirement

Two methods are proposed: continuous and non-continuous assessment, both for theory and practice. All students are continuous assessed by default.

Continuous assessment for theory is done if the students do with a minimum score all the proposed activities in the course. Lecture attendance is not mandatory but recommended. There can be, without prior notice, tests for the assessment. If a student does not attend that session, s/he will leave the continuous assessment.

Continuous assessment for practice is done if the students attend and do all the activities in the laboratory. The students can miss a maximum of two sessions just in very justified cases, and they have to present the results of these sessions anyway. If the student misses more sessions, s/he will leave the continuous assessment.

1.10. Faculty data

Add @uam.es to all email addresses below.

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1.11. Course objectives

Network Architecture II is an introductory course to the architecture of communication networks that completes *Network Architecture I*. It is intended that students acquire knowledge on the general foundations of these architectures and the technologies used in them. The course is aimed at developing students' ability to understand and apply the fundamental ideas that govern the design of the architecture of modern communication networks to real problems.

The **specific competencies** to be acquired in this course are:

CO7: Knowledge and use of the fundamentals of network, systems and telecommunications services programming.

CO12: Knowledge and use of the concepts of network architecture, protocols and communication interfaces.

CO13: Capacity to differentiate the concepts of access and transport networks, circuit switching networks and packets, fixed and mobile networks as well as distributed network systems and applications, voice, data, audio, video and interactive and multimedia services.

CO14: Knowledge of network connection and routing methods as well as the fundamentals of planning, network dimensioning according to traffic parameters.

The objectives to be achieved with this subject are:

GENERAL OBJECTIVES	
G1	Know how current networks, both fixed and mobile, work.
G2	Know and apply simple queuing models for network dimensioning.
G3	Understand the mechanisms of existing communication protocols, and be able to calculate its performance.
G4	Know and apply the security mechanisms that can be implemented in networks.
G5	Know and apply the network management mechanisms applied in Internet.

UNIT BY UNIT SPECIFIC OBJECTIVES	
UNIT 1.- QUEUING THEORY	
1.1.	Identify the parameters of a queuing system
1.2.	Formulate and apply the Little theorem
1.3.	Use Kendall's notation to identify the different queuing models
1.4.	Apply Poisson processes to obtain the expression of different queuing models
1.5.	Identify and solve problems with single server queues
1.6.	Identify and solve problems with multi-server queues
1.7.	Use Erlang-C formula for system dimensioning
1.8.	Identify and solve problems with truncated queues
1.9.	Use Erlang-B formula for system dimensioning
1.10.	Calculate parameters of a queue with a general service time
1.11.	Formulate and apply Burke's theorem
1.12.	Formulate and apply Jackson's theorem
1.13.	Identify and solve problems with open queuing networks
UNIT 2.- DATA LINK LAYER	
2.1.	State the services provided by the data link layer
2.2.	Identify how the data link layer is implemented in different systems
2.3.	State and apply the error detection and correction techniques
2.4.	List the multiple access protocols
2.5.	Calculate the performance of protocols
2.6.	Identify and distinguish MAC addresses
2.7.	Analyze the operation of the ARP protocol and use it
2.8.	Identify the format of an Ethernet frame
2.9.	Calculate the efficiency of CSMA / CD in Ethernet
2.10.	State the features and technologies associated with Ethernet
2.11.	State the characteristics of Ethernet switches
2.12.	Analyze the frames forwarding operation
2.13.	Distinguish the functionality offered by switches and routers
2.14.	Analyze the operation of virtual local area networks
2.15.	Analyze the operation of the PPP protocol
2.16.	Identify the format of a PPP frame
2.17.	State the link virtualization features and technologies
UNIT 3.- WIRELESS AND MOBILE NETWORKS	
3.1.	State the characteristics of networks and wireless links
3.2.	Identify the components of the WiFi architecture
3.3.	Analyze the operation of the Wi-Fi MAC protocol
3.4.	Identify the format of a WiFi frame
3.5.	Analyze the mechanism by which nodes can move in a subnet
3.6.	State advanced WiFi features

3.7.	Identify other wireless networking standards
3.8.	Identify the components of a mobile cellular network
3.9.	List the existing standards in mobile networks
3.10.	State the fundamental concepts of mobility management
3.11.	Distinguish between feasible mobility alternatives
3.12.	Analyze the operation of Mobile IP
3.13.	Analyze how to route calls in a cellular mobile network
3.14.	Analyze the GSM cell handoff
UNIT 4.- SECURITY	
4.1.	Distinguish between public key and symmetric key
4.2.	Know how to use different ciphering algorithms
4.3.	Know how to use different message integrity algorithms
4.4.	Know how to use X.509 certificates
4.5.	Apply security mechanisms that can be used in e-mail
4.6.	Apply security mechanisms that can be used in TCP
4.7.	Apply security mechanisms that can be used in IP
4.8.	Apply security mechanisms that can be used in wireless networks
4.9.	Distinguish the security mechanisms used in different layers of the protocol stack
4.10.	Apply operational security systems (firewalls and IDS)
UNIT 5.- NETWORK MANAGEMENT	
5.1.	State the concept of network management
5.2.	Identify the elements needed to deploy a network management system
5.3.	Identify the elements of the Internet network management framework
5.4.	Find the meaning of variables in a MIB
5.5.	Run commands to walk an SNMP MIB
5.6.	Analyze the obtained results
5.7.	Apply the data representation mechanisms in ASN.1

1.12. Course contents

Syllabus overview

UNIT 1. Queuing Theory
UNIT 2. Data link layer
UNIT 3. Wireless and mobile networks
UNIT 4. Security
UNIT 5. Network management

Detailed Syllabus

1. **QUEUING THEORY**

1.1. Queuing theory introduction
   a. Introduction
   b. Queuing system parameters
   c. Little's Theorem
   d. Queuing systems models. Kendall's notation
   e. Birth-death processes
   f. Poisson's processes
1.2. Single server queue: M/M/1
   a. Birth-death process for M/M/1
   b. State probability calculus for M/M/1
   c. Parameter calculus for M/M/1: units and sojourn time mean values
   d. Distribución del tiempo de estancia para M/M/1
1.3. Multi-server queue: M/M/c
   a. Birth-death process for M/M/c
   b. State probability calculus for M/M/c
   c. Erlang-C formula
   d. Parameter calculus for M/M/c: units and sojourn time mean values
1.4. Truncated queues: M/M/c/c and M/M/1/k
   a. M/M/c/c
      i. Birth-death process for M/M/c/c
      ii. State probability calculus for M/M/c/c
      iii. Erlang-B formula
      iv. Parameter calculus for M/M/c/c: units and sojourn time mean values
   b. M/M/1/k
      i. Birth-death process for M/M/1/k
      ii. State probability calculus for M/M/1/k
      iii. Parameter calculus for M/M/1/k: units and sojourn time mean values
1.5. General service time queues: M/G/1
   a. Parameter calculus for M/G/1: units and sojourn time mean values
   b. Exponential distribution approximation
1.6. Queuing networks
   a. Queuing network representation
   b. Burke's theorem
   c. Jackson's theorem

2.- DATA LINK LAYER

2.1. Introduction
   a. Data link layer services
   b. Implementation
2.2. Error detection and correction techniques
   a. Parity check
   b. Checksum
   c. CRC
2.3. Multiple access protocols
   a. Channel partitioning protocols
   b. Random access protocols: Aloha, CSMA

   c. Taking turns protocols
2.4. Data link layer addressing
   a. MAC addresses
   b. ARP protocol
2.5. Ethernet: IEEE 802.3 standard
   a. Frame format
   b. Mutiple access protocol: CSMA/CD
   c. Tecnologías de Ethernet
2.6. Data link layer switching
   a. Properties
   b. Frame forwarding and filtering
   c. Self-learning
   d. Switches versus routers
   e. Virtual Local Area Networks
2.7. PPP
   a. Frame format
   b. Character escape
2.8. Link virtualization

3.- WIRELESS AND MOBILE NETWORKS

3.1. Introduction
3.2. Wireless links and networks characteristics
   a. CDMA
3.3. WiFi: IEEE 802.11 standard
   a. Architecture
   b. MAC protocol
   c. Frame format
   d. Subnet mobility
   e. Advanced features
   f. Other standards: Bluetooth and WiMAX
3.4. Mobile cellular networks
   a. Architecture
   b. Standards
3.5. Mobility management fundamentals
   a. Concepts
   b. Working alternatives
3.6. Mobile IP
3.7. Mobility management in cellular networks
   a. Call routing
   b. GSM handoffs

4.- SECURITY

4.1. Introduction
4.2. Cryptography principles
   a. Symmetric key
   b. Public key
4.3. Message Integrity
   a. Hash functions

   b. Message authentication codes
   c. Digital signatures
   d. Certificates
4.4. Security in correo electrónico
4.5. Security in TCP: SSL/TLS
4.6. Security in the network layer: IPSec
4.7. Security in wireless networks
4.8. Operational security
   a. Firewalls
   b. Intrusion Detection Systems

5.- NETWORK MANAGEMENT
5.1. Introduction
5.2. Network management infrastructure
5.3. Internet network management framework
   a. Structure of Management Information: SMI
   b. Management Information Base: MIB
   c. SNMP protocol
5.4. Data representation: ASN.1

1.13. Course bibliography

Basic:

"Computer Networking", James F. Kurose, Keith W. Ross, Ed. Addison-Wesley, 5ª edición (*temas 2-5*)

"Fundamentals of Queueing Theory", Donald Gross, Carl M. Harris, Ed. Wiley, 4ª edición (*tema 1*)

Complementary:

"Redes de computadoras", Andrew. S Tanenbaum, Ed. Prentice Hall. 4ª edición. (t*emas 2-5*)

"Teoría de colas y simulación de eventos discretos", José Juan Pazos Arias, Pearson Educación. (*tema 1*)

"Comunicaciones y redes de computadores", William Stallings, Ed. Prentice Hall, 7ª edición (*temas 2-5*)

"Communication Networks. Fundamental concepts and key architectures", Alberto Leon-Garcia, Indra Widjaja, Ed. McGraw-Hill. 2ª edición (*temas 1-5*)