Program	59TL – Telematics Engineering B. Eng.

Course number and name	
Number	595000227
Name	Signaling and Switching
Semester	S5 [(September-January)]

Credits and contact hours	
ECTS Credits	6
Contact hours	60

Coordinator's name	Parada Gélvez, Hugo Alexer [hugoalexer.parada@upm.es]

Specific course information

Description of course content

This course is based on the knowledge already acquired by the students in the previous subjects "Telecommunication Networks and Services" and "Computer Networks". It delves into modern network service provision systems, mainly through connection-oriented packet switching technologies.

The course begins with an introduction to the concepts of layer 2 switching, virtual LANs (VLANs) and dot1q encapsulation (IEEE 802 1Q). It also deals with the study of the switching systems used in the core of the network, the technologies that allow traffic management to offer the required quality of service and the basic concepts of VoIP.

Also it is included the study of IP network configuration and administration techniques with dynamic routing, as well as an introduction to IPv6 protocol concepts.

So finally the student acquires both from the theoretical point of view and through laboratory practices, a more specialized and in-depth knowledge of the telematic mechanisms used in a large part of the modern nuclei of telecommunication networks.

List of topics to be covered

1. VLAN Topic: Virtual LANs (VLANs)
    - 1.1. Layer 2 switching and VLANs
    - 1.2. dot1q encapsulation (IEEE 802.1Q)
    - 1.3. Spanning Tree Protocol (STP, IEEE 802.1d)
2. VoIP Topic: Voice over IP
    - 2.1. Introduction and motivations
    - 2.2. Architecture of a VoIP network
    - 2.3. User plane: RTP/RTCP
    - 2.4. SIP signaling protocol (Session Initiation Protocol)
3. MPLS Topic: Packet Switching Techniques (MPLS)
    - 3.1. Origins and motivation of MPLS
    - 3.2. Basic principles of MPLS operation

3.2.1. Tunnels in MPLS
3.3. LSP signaling protocols
3.3.1. LDP
4. QoS Topic: Characterization of Traffic and Quality of Service
4.1. Source Traffic Characterization
4.2. Service Quality Requirements
4.3. Traffic Contract: SLA, SLS
4.4. Traffic Management
4.5. Exemplification of Service Quality in Specific Technologies
4.6. Traffic Engineering Principles
5. IP version 6 (IPv6)
5.1. IPv6 Introduction
5.2. IPv6 Features
5.3. IPv6 header and extension headers
5.4. IPv6 addressing
5.5. Dynamic configuration (auto-configuration) of IPv6 addresses
6. VLAN Practice: Configuring Layer 2 Switches with VLANs
6.1. Basic configuration of a layer 2 switch
6.2. Analysis of the Spanning Tree protocol
7. VoIP practice: Configuration and administration of a VoIP network
7.1. Configuration and administration of an IP PBX
7.2. IP PBX interconnection through SIP trunks
7.3. SIP traffic analysis
8. OSPF Practice: Configuration and administration of an IP network with dynamic routing
8.1. Study of an IP numbering plan for a medium-sized network.
8.2. Network Configuration with OSPF: Single Area.
8.3. Network Configuration with OSPF: Multiple Areas.
8.4. Traffic analysis in various scenarios
9. MPLS practice: Basic configuration of an MPLS network
9.1. Configuring an MPLS network
9.2. Parsing of LDP messages

Lab sessions:
1. VLAN: Virtual LANs (VLANs).
2. VoIP: Configuration and administration of a VoIP network
3. OSPF: Configuration and administration of a dynamically routed IP network
4. MPLS: Basic configuration of an MPLS network.

Prerequisites or co-requisites

- Statistics and Stochastics Processes
- Telecommunication Networks and Services
- Computer Networks

Specific goals for the course

Specific outcomes of instruction

- RA727 – To configure a network that uses a connection-oriented packet-switching technologies.

- RA718 – To define the parameters that characterize traffic in origin.
- RA717 – To analyze a real flow of signaling traffic.
- RA719 – To define the parameters that characterize the requirements of quality of service.
- RA720 – To define the management procedures of traffic more common in the QoS networks.
- RA721 – To explain what kind of information is on a traffic contractual-agreement, or Service Level Agreement.
- RA722 – To define the basic principles and models applied to traffic engineering.
- RA724 – To describe the characteristics of the nodes, architectures, protocols and functions of traffic management of the connection-oriented packet-switching technologies.
- RA1064 – To describe and prove the functional elements and the characteristics of the protocols used in a VoIP network.
- RA1178 – To describe and show the characteristics that distinguish IPv6 and IPv4.
- RA1063 – To identify the required elements, functions and protocols for the interconnection between VoIP and the circuit switching networks.
- RA723 – To measure the resources of a simple network thanks to the traffic engineering principles.
- RA725 – To explain the basic principles of tunneling and VPNS.
- RA1062 – To apply the knowledges of IP networks to the configuration and administration of a network with a dynamic routing.
- RA1204 – To apply the knowledges of VoIP networks to the configuration and administration of a real network with this technology.

Further reading and supplementary materials

– Data and computer communications. W. Stallings. 9th ed. Upper Saddle River (New Jersey): Pearson, cop., 2011.
– ISDN and Broadband ISDN with Frame Relay and ATM. William Stallings. 4th ed. Ed. Prentice Hall, 1999.
– Connection-oriented networks: SONET/SDH, ATM, MPLS and optical networks. Harry G. Perros. John Wiley & Sons, 2005.
– IP telephony: packet-based multimedia communications systems. Olivier Hersent. Pearson Education, 2000.
– http://www.tech-invite.com/index.html
– End-to-End QoS Network Design: Quality of Service for Rich-Media & Cloud Networks. T. Szigeti, C. Hattingh, R. Barton, K. Briley Jr. Cisco Press, November, 2013.
– The Internet Engineering Task Force: http://www.ietf.org/
– Broadband Forum: http://www.broadbandforum.org/
– International Telecommunication Union: http://www.itu.int/
– VoipForo. H.323: http://www.voipforo.com/H323/H323objetivo.php
– IPv6 Forum - The new Internet: http://www.ipv6forum.com/
– OpenVPN. Community Resources: https://openvpn.net/community-

resources/#documentation
- TIC CCNSTIC 836. ENS. Security in VPN. National Cryptology Centre:: https://www.ccn-cert.cni.es/series-ccn-stic/800-guia-esquema-nacional-de-seguridad/2299-ccn-stic-836-seguridad-en-vpn-en-el-marcodel-ens/file.html
- Moodle.