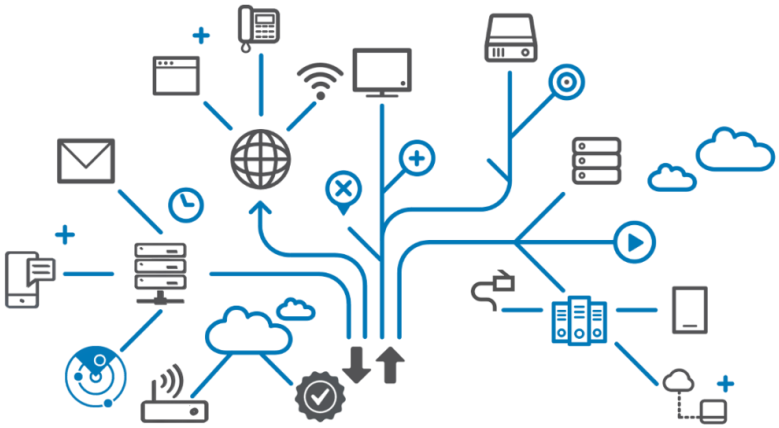

# LOYOLA UNIVERSITY'S NETWORK DESING

## Final Project

Create the Network Design of Loyola University

**Name:** Laura Ferrer and Trabajo realizado en colaboraciónTrabajo realizado en colaboración.

# INDEX

**OBJECTIVES/SUMMARY:**

The project aims to explain and provide the deployment of communications networks to the Loyola Andalucía University from a theoretical-practical point of view, in our case, it is to give the network design to the Seville and Cordoba campuses, how to provide the costs, requirements and estimates of said network.

For this, we will divide the work into five parts. The first will be to supply the scope that our network will have on the Seville and Córdoba campuses, we will have to consider the assumptions that we must make. The second part will deal with the requirements that are necessary to be able to make a hypothesis of the installation of said network. The third part of the network design we intend to do. The fourth part will deal with the bill of materials, which will consist of which components we are going to use, how many units of said components and their cost. The fifth will deal with the estimate of total costs that the project will require, that is, the comparison of the item and the labour that will be needed to set up the network.

**SCOPE:**

For this project, we will begin by saying where is located each campus of the University of Loyola Andalucía.

The Seville campus is in the Dos Hermanas the Seville municipality, which covers an area of 29,000 m2. It is divided, into four buildings. The furthest away is the gym. Then we find the main building, divided into three blocks (A, B and C). And finally, we will find the edifice of the library and the chapel. The Seville campus has reached the first construction phase, which means, the campus will be expanded to extend a surface area of nearly 100,000 m2.


Figure 1: Seville Campus Location


Figure 2: Seville Campus Location

The Cordoba campus is located, in Córdoba Capital, with an area of 11,286 m2. It is divided, into four buildings.


Figure 3: Cordoba Campus Location


Figure 4: Cordoba Campus Location

In the Seville's Campus, like we mentioned before there are three blocks in the main building. In every block there are twelve classes per floor, where there are six classes, so we have seventy-two classes in total. All this classes have Ethernet ports and access to Wi-Fi. There are five classes with computers, in total there are one hundred forty-four computers. There are one hundred twenty computers for staff and professors. In the Cordoba's Campus there is one class with thirty-six computers and there are seventy computers for staff and professors.

**ASSUMPTIONS:**

We have decided that our network will make up of wireless and wired networks. It will have a wireless part because it is easier to reach the classes via Wi-Fi and to the common areas of the University, such as the Library or outdoor rest areas. It will have a wired part for the teachers' jobs in the classroom and their work areas, cleaning or administration personnel, workshops, and laboratories. The connection between the Cordoba and Seville Campus will be through the wireless network (Internet)

**REQUIREMENTS:**

For the design of our network, we will need the following requirements for the Seville campus. The first thing we will do is differentiate two Wi-Fi-wireless networks with 120 antennas.

- **Eduroam:** 802.1x with LDAP (Lightweight Directory Access Protocol) users, a set of protocols that are used to access information stored centrally in a network, through FreeRadius (FreeRADIUS is a modular, high-performance free RADIUS (Remote Authentication Dial-In User Service) suite developed and distributed under the GNU General Public License, version 2, and is free for download and use). Allows Wi-Fi connection in other institutions.
- **WifiUloyola:** Captive portal with local users and LDAP (Lightweight Directory Access Protocol) users through FreeRadius.

So that the different clients can connect to these two networks, we will need an SSID *(Service Set Identifier)* that will serve as an access point to identify the clients on the network, it is a sequence of 0-32 octets.

For the wired network, we will need the following, switches, and rack positions *(the metallic structure that serves to house technological devices)*.

In general, we will need core ports *(central part of the network that serves to route traffic)*, Palo Alto *(Firewall, which is a security device that monitors the network)*, CheckPoint *(enables enterprises to deploy the industry's leading threat prevention capabilities at all points of their infrastructure, scaling security almost infinitely according to their changing business needs)*, a SAN *(Storage Area Network, is a comprehensive storage network)* infrastructure.

The main services that our network has will be the following:

- **DNS *(Domian Name System):*** program that needs to look up the IP address of some host name, for example, www.uloyola.es, can send a UDP packet containing the host name to a DNS server.
- **DHCP *(Dynamic Host Configuration Protocol):*** Network server that allows automatic assignment of IP addresses.
- **DFS *(Distributed File System):*** A single, logical, hierarchical file system that structures the files shared between various computers on the network in the form of a logical tree of system resources.
- **Identity Management:** AD *(Advertising Network, is a company that connect advertiser with web site that want to host ADS)*, LDAP, Radius, SSO *(Single Signe On, is a user authentication service).*
- **EPS systems *(Evolved Packet System, is a framework for providing convers data on 5G).***
- **Web portals hosted ad the University:** Uloyola, Portales, etc.
- **Moodles.**
- **Active Directory:** Team Management, User Management, Policy Deployment (GPO).
- **University corporate antivirus system (ESET *(Higher School of Technical Education.)*).**
- **University's systems.**
- **Windows Update Server.**

**DESING:**

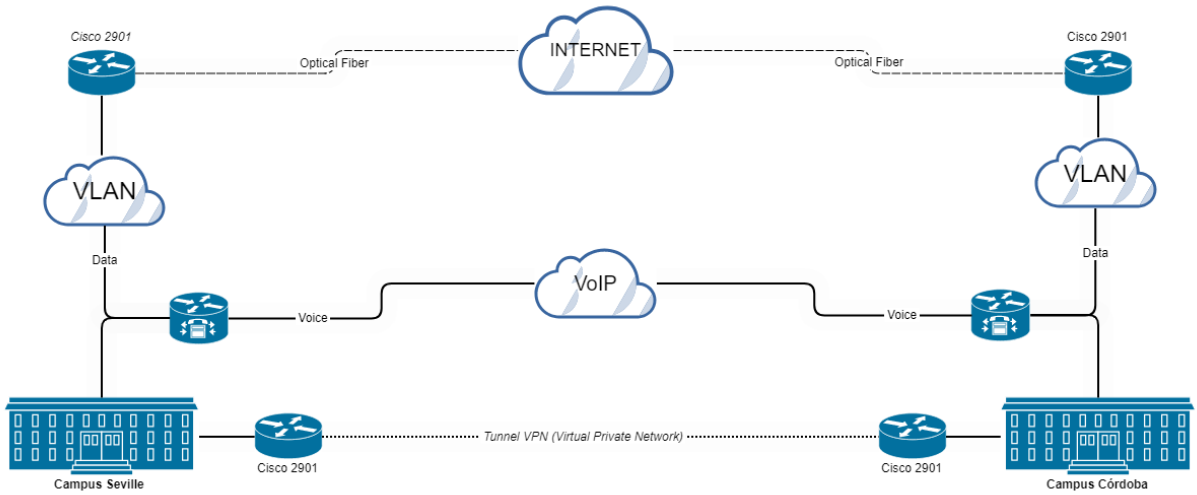


Figure 5: Campus Connection

In this figure we can see how we connect the Seville's Campus and Cordoba's Campus. We are using *Cisco 2901 (Router)* to connect with VPN. Another form to connect the Campus is through Internet and Optical Fibre. The last form that we can connect the Campus is through *VoIP (Voice Over IP)* using special router, which is *Telefonica Router*.

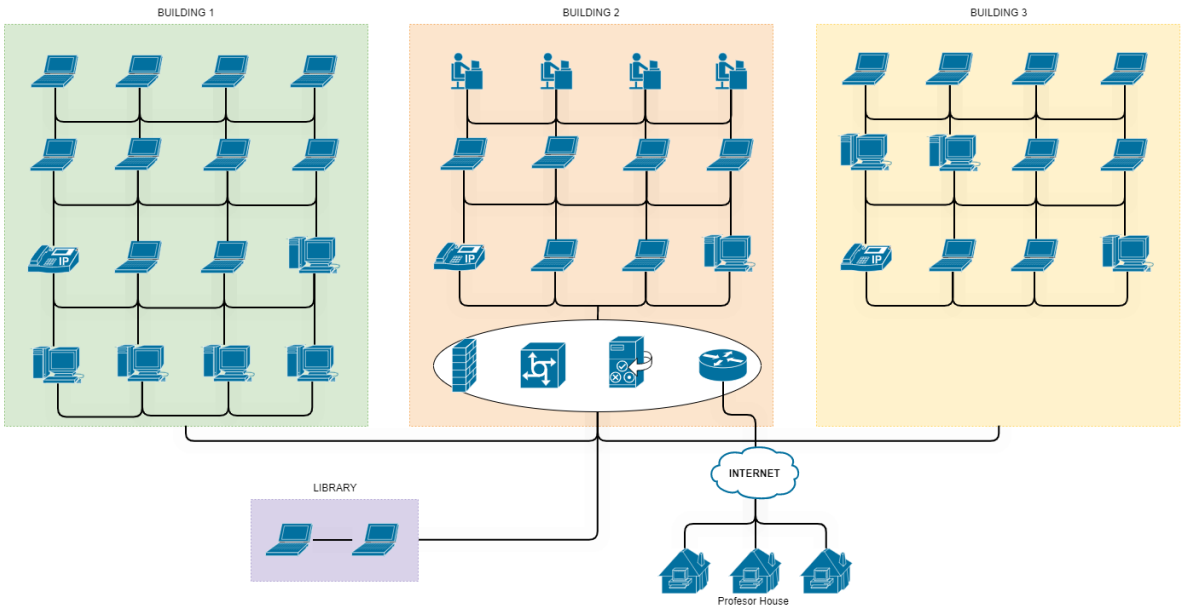


Figure 6: Building Design

This design it would be used for both Campus. We have organised the diagram in four different blocks. For the building one (in which we have four floors) and building three (in which we have four floors, the last one is the cafeteria, this floor does not need any computer) we have every computer connect to another computer (is a Bus topology, where all the PC are connected to a transmission line) and the router. In the basement of second building, we have the servers, firewall, etc (we will explain this in the next figure). Laptops are for the students with a wireless connection. PCs are for employees and laboratories.

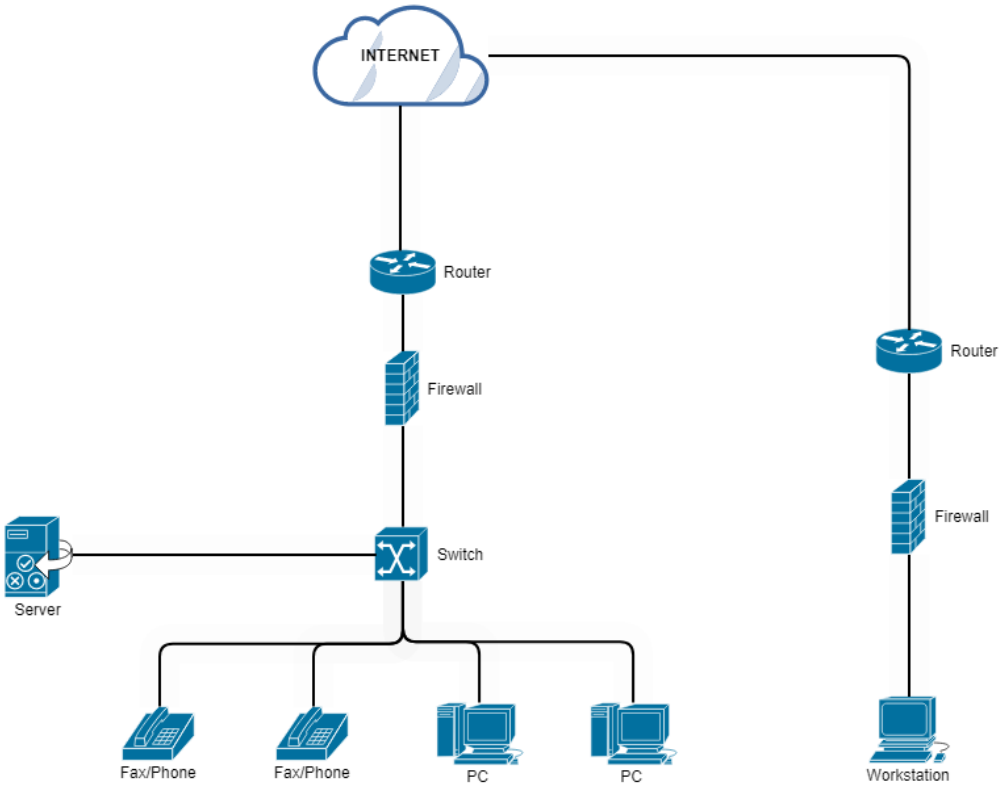


Figure 7: Firewall

In this diagram we are connecting all the PC, Fax/Phone and Servers to switches and this switcher is connected to a Firewall called *PaloAlto*. And the Workstation is connected to another *PaloAlto*. These two *PaloAltos* are connected to a router and these routers are connected to Internet.

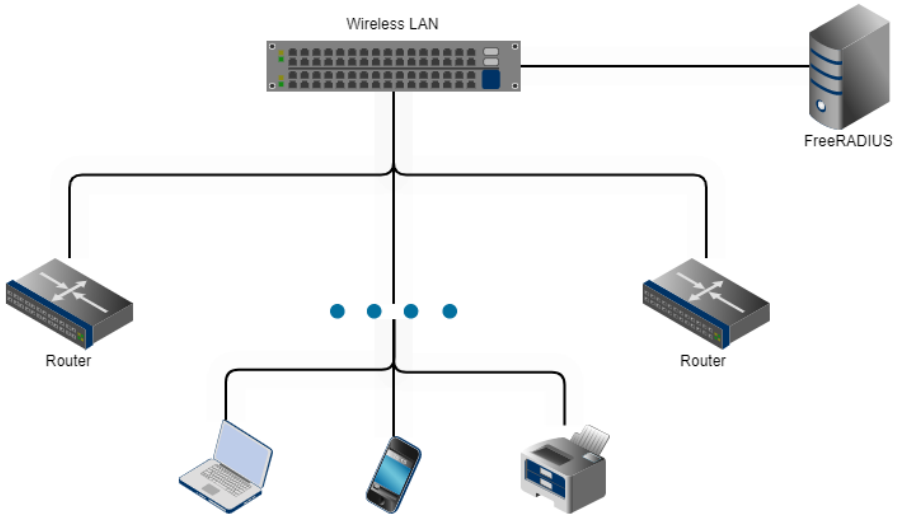


Figure 8: WIFI-Network

In this figure we have a Wireless LAN that is connected to the routers that give wireless Internet to computers, phones, printers, etc. Also, is connect to the FreeRADIUS that we are using as a server. Every device is connected to a different router depending on the location of the campus.

## BILL OF MATERIALS:

| COMPONENT | PRODUCT | DESCRIPTION |
|---|---|---|
| Router | Cisco 2901 | 2 integrated 10/100/1000 Ethernet ports |
| | | 4 high-speed WAN card slots |
| | | 2 onboard digital signal / 1 onboard Internal Service Module |
| | | Embedded hardaware-accelerated VPN encryption |
| | | Integrated threat control using Cisco IOS Firewall |
| | | High-density-packet voice DSP module |
| Switch | Cisco Catalyst 3650 | 40G wireless capacity per switch |
| | | 50 access points and 1000 wireless clients |
| | | 48 10/100/1000 data and PoE+ |
| | | 48 100 Mbps Cisco UPOE amd PoE+ models with EEE |
| | | Dual redundant |
| | | Full IEEE 802.3at (PoE+) with 30W power |
| | | IEEE 802.3bz (2.5GBASE-T and 5GBASE-T) |
| | | IEEE 802.1ba Audio Video Bridging (AVB) built in to provide a better AV experience |
| Optical Fibre | OM4 | 50/125 Core/Cladding (um) |
| | | 2 km fast Ethernet, 1100 m Gigabit (GbE), 400 m 10Gigabit (10GbE) |
| | OS2 | 9/125 Core/Cladding (um) |
| | | 40 km fast Ethernet, 100 km Gigabit (GbE), 40 km 10Gigabit (10GbE) |
| Wire | Copper Twisted | Dual shielding |
| | | 35 db shielding |
| | Coaxial | Internal driver of copper |
| | | Dielectric of Polyethylene |
| | | External driver of Aluminum tape |
| | | Total Tinned Copper Stranding |
| | | Cutoff frequency 41 GHz, power of 2,5 kW, 50 Ohm impedance |
| Class Wire | HDMI | 2 meters of wire |
| | | Supports 4K 50/60 (2160P) video streams |
| | Ethernet | 0,5 meters of UTP wire |
| | | Network cat 6 |
| | VSA | 2 x 15 pin male |
| | | 3 meters of wire |
| FireWall | Palo Alto 3220 | 12 Ethernet ports |
| | | 20 SFP ports |
| | | 24 QSFP+ ports |
| | | HSCI, HA1-A, HA1-B, MGT, CONSOLE, USB and Micro USB ports |
| | Check Point Quantum 6500 | 8 Ethernet ports (RJ-45) |
| | | 10/100/1000BASE-T, 1000BASE-F, 10GBASE-F |
| Rack | | Cabins for storing hardaware |
| Antenna | Cisco 2802 | 5,2 Gbps data transfer |
| | | Data Link: IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, IEEE 802.11ac |
| | | 2,4 GHz Frecuency Band |
| | Cisco 1852 | 1 GB RAM, 256 MB Flash Memory |
| | | Data Link: IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, IEEE 802.11ac |
| | | 2,4 GHz Frecuency Band |
| SAN | | |
| Server | Intel Xeon Gold 6126 | 12 cores and 24 threads |
| | HBA | 8 Gb Firbre channel |
| | | 8,5 Gbps data transfer |
| | RAM Memory 384 GB 2933 MHz | 2933 MHz frecuency, 1,2 V |
| | Logic CPU | 6 cores and 12 threads |
| Fabric Switch | Cisco MDS 9124 | 24 ports multilayer fabric |
| | | 4Gbps ports |
| Disk | Cabin | |
| | HD 600 GB | 60 GB storage at 10000 RPM of SAS |
| | HD 2 TB | 2 TB storage of 7200 RPM of SATA |
| SAI | | 720 W of power |
| Clima | | Machine with intelligent exchange |

**COST ESTIMATED:**

Cost estimated for Seville:

| COMPONENT | PRODUCT | QUANTITY | PRICE (€) | TOTAL PRICE (€) |
|---|---|---|---|---|
| Router | Cisco 2901 | 9 | 1.115 € | 10.035 € |
| Switch | Cisco Catalyst 3650 (48 ports) | 30 | 3.000 € | 90.000 € |
| Optical Fibre | OM4 | 12 x 100m | 0,45 €/m | 540 € |
| | OS2 | 3 x 100m | 0,38 €/m | 114 € |
| Wire | Copper Twisted | 50 km | 0,2 €/m | 10.000 € |
| | Coaxial | 50 km | 0,35 €/m | 17.500 € |
| Class Wire | HDMI | 72 | 5,6 € | 619,2 € |
| | Ethernet | 72 | 4,8 € | 345,6 € |
| | VSA | 72 | 4,25 € | 306,0 € |
| FireWall | Palo Alto 3220 | 2 | 15.400 € | 30.822 € |
| | Check Point Quantum 6500 | 2 | 14.400 € | 28.800 € |
| Rack | | 15 | 450 € | 6.750 € |
| Antenna | Cisco 2802 | 40 | 320 € | 12.800 € |
| | Cisco 1852 | 80 | 380 € | 30.400 € |
| SAN | | | | |
| Server | Intel Xeon Gold 6126 | 3 | 2.239 € | 6.717 € |
| | HBA | 6 | 464 € | 2.784 € |
| | RAM Memory 384 GB 2933 MHz | 3 | 2.700 € | 8.100 € |
| | Logic CPU | 144 | 300 € | 43.200 € |
| Fabric Switch | Cisco MDS 9124 | 2 | 1.798 € | 3.596 € |
| Disk | Cabin | 2 | 1.040 € | 2.080 € |
| | HD 600 GB | 9 | 60 € | 540 € |
| | HD 2 TB | 4 | 55 € | 220 € |
| SAI | | 2 | 100 € | 200 € |
| Clima | | 2 | 1.750 € | 3.000 € |
| COMPUTER | | | | |
| PC | | 120 | 1.000 € | 120.000 € |
| MAC | | 24 | 2.000 € | 48.000 € |
| Office | | 120 | 1.000 € | 120.000 € |
| LABOR | | | | 5.000.000 € |
| | | | | |
| | | | TOTAL | 5.597.469 € |

We use nine routers because we divide the building into floors and blocks (3x3). We use thirty switchers because we will use a switcher per building block and floor. In our case, we have three blocks with four floors, that are divided in two parts (Excluding two Cafeteria's floor). So, we have thirty switchers assigned to a part of the University. We use seventy-two of wire's HDMI, Ethernet and VSA because we have seventy-two classes. We have two *PaloAlto* and *CheckPoint* because one is for all the classes and the other one is for the departments. We have one hundred twenty antennas because we can bring service to all the Campus. We have three serves with these characteristics because with this can stand the University and connect with Cordoba's Campus.

We supposed this price because we supposed the transport of the merchandise and correct installation of said components. We search the price of every item that we need to set up our network

Cost estimated for Cordoba:

| COMPONENT | PRODUCT | QUANTITY | PRICE (€) | TOTAL PRICE (€) |
|---|---|---|---|---|
| Router | Cisco 2901 | 9 | 1.115 € | 10.035 € |
| Switch | Cisco Catalyst 3650 (48 ports) | 30 | 3.000 € | 90.000 € |
| Optical Fibre | OM4 | 12 x 100m | 0,45 €/m | 540 € |
| | OS2 | 3 x 100m | 0,38 €/m | 114 € |
| Wire | Copper Twisted | 25 km | 0,2 €/m | 5.000 € |
| | Coaxial | 25 km | 0,35 €/m | 8.750 € |
| Class Wire | HDMI | 50 | 5,6 € | 280,0 € |
| | Ethernet | 50 | 4,8 € | 240,0 € |
| | VSA | 50 | 4,25 € | 212,0 € |
| FireWall | Palo Alto 3220 | 2 | 15.400 € | 30.822 € |
| | Check Point Quantum 6500 | 2 | 14.400 € | 28.800 € |
| Rack | | 8 | 450 € | 3.600 € |
| Antenna | Cisco 2802 | 20 | 320 € | 6.400 € |
| | Cisco 1852 | 40 | 380 € | 15.200 € |
| SAN | | | | |
| Server | Intel Xeon Gold 6126 | 3 | 2.239 € | 6.717 € |
| | HBA | 6 | 464 € | 2.784 € |
| | RAM Memory 384 GB 2933 MHz | 3 | 2.700 € | 8.100 € |
| | Logic CPU | 144 | 300 € | 43.200 € |
| Fabric Switch | Cisco MDS 9124 | 2 | 1.798 € | 3.596 € |
| Disk | Cabin | 2 | 1.040 € | 2.080 € |
| | HD 600 GB | 9 | 60 € | 540 € |
| | HD 2 TB | 4 | 55 € | 220 € |
| SAI | | 2 | 100 € | 200 € |
| Clima | | 2 | 1.750 € | 3.000 € |
| COMPUTER | | | | |
| PC | | 36 | 1.000 € | 36.000 € |
| MAC | | 12 | 2.000 € | 48.000 € |
| Office | | 70 | 1.000 € | 70.000 € |
| LABOR | | | | 3.500.000 € |
| | | | | |
| | | | **TOTAL** | **3.924.430 €** |

The reason that we have so many components is the same as before. We supposed this price because we supposed the transport of the merchandise and correct installation of said components. We search the price of every item that we need to set up our network.

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