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DESIGN AND IMPLEMENTATION OF A VIRTUAL LOCAL AREA NETWORK WITH USING CISCO OPERATING SYSTEM

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Abstract

The purpose of this document is describing the and implementation of a Virtual Local Area Network with using Cisco Operating System. This design aims to design VLANs are commonly incorporated into network design making it easier for a network to support the goals of an organization. The project will cover how to code VLANs and VLAN trunks. It will also examine security considerations and strategies relating to VLANs and trunks, and best practices for VLAN implementation and design. This document includes detailed information about requirements of the project. It reflects the identified constraints and proposed software functionalities.

Key words:

Virtual Local Area Network (VLAN), Cisco Operating System,

Özet:

Son yıllarda bulut bilişim, sosyal ağ teknolojileri ve İnternet üzerinden iletişim teknolojileri alanında hızlı bir büyüme yaşanmıştır. Bu nedenle, Ağ Mühendislerinin her geçen gün ihtiyaçları artmaktadır. Ağ performansı, bir kuruluşun üretkenliğinde önemli bir faktördür. Ağ performansını iyileştirmek için kullanılan teknolojilerden biri, büyük yayın alanlarının daha küçük alanlara ayrılmasıdır. Ağ Mühendisleri pahalı yönlendiricilere olan ihtiyacı azaltmak istiyorlar. Buna ek olarak, daha güvenli, trafiği en aza indiren veri iletimini istiyorlar. Vlan tasarımı, bu bulut bilgi işleminin, sosyal ağ teknolojilerinin ve ağlar arası iletişim teknolojilerinin eksikliği nedeniyle gelişmek için gerekli hale geldi. Yukarıdaki nedenlerden dolayı, bu projede bir sanal yerel ağ (VLAN) araştırılacak ve uygulanacaktır. Bu çalışmada Cisco İşletim Sistemi kullanarak bir Sanal Yerel Ağı oluşturulacaktır. Bu tasarım, VLAN'ların bir ağın bir organizasyonun hedeflerini desteklemeyi kolaylaştıran ağ tasarımına dahil edilmesini tasarlamayı amaçlar. Proje, VLAN'ların ve VLAN kanallarının nasıl kodlanacağını kapsar. Ayrıca projede, VLAN'ların gövdelerine ilişkin güvenlik konuları ve stratejileri ile VLAN tasarımı için en iyi uygulamalar yer alır. Tanımlanan kısıtlamaları ve önerilen yazılım işlevlerini yansıtır.

Anahtar Kelimeler:

Sanal Yerel Ağı, Ağ performansı, Cisco İşletim Sistemi, Sosyal Ağ Teknolojileri

1. Introduction

Using VLAN technology, logical networks are created on the devices that support this technology. Cisco IOS (Internetworking Operating Systems) and Packet Tracer Simulation program will be used to coding the switches and network design in this project.

1.1 Motivation

We are a group of students in computer engineering department who are interested in social networking technologies and internetworking technologies. As a group, we have taken the course of internetworking, computer network and data communications for a better understanding in Network management. We aimed to design VLAN that make easy to create and administration of logical groups which can communicate among themselves in this project. We have used the Cisco IOS (Internetworking Operating Systems) and Packet Tracer Simulation program were used to coding the switches and network design in this project. So in order to increase our knowledge in this field, we have researched cloud technologies and buffer overflow algorithms. For virtual local area network technologies, firstly we have install Packet Tracer Simulation which we can design vlan. We have read documents for how to design VLAN in Cisco Certified Network Associate Study Guide.

1.2 Problem Statement

The organizations of the designs can change frequently and in this case we have to adapt the changing organizations of these designs. Reconfiguring the devices, unplug the devices and carry them is difficult. Redesigning or reconfiguring is vulnerable. Errors can lead to network interruptions. We want to reduce CPU overhead on devices by reducing the number of devices reduce security risks by reducing the copies of frames sent and receive unnecessarily. Due to problems, the organization (design) must be flexible, efficient cost, more secure, minimize traffic etc. We need to design that incorporated into network design making it easier for a network to support the goals of an organization.

1.3 Background or Related Work

Hubs, switches and routers. They are most important devices for network designing. Hubs were using in early 10BASE-T networks in 90’s. In the following years switches are using in networks instead of hubs even today. Switches are connect end devices in same network and using for frame switching in networks. Routers have been using in networks from the beginning. They are routing packets between different networks. Also that two device is the name resource of Cisco’s number one topic, Routing and Switching.

LAN technology was a main technology in networks; However, network engineers realized, LAN technology with time. IEEE developed a new network technology can be used together with LANs. That technologs' name is VLAN.

Association's developed many standards, protocols and technologies used with routers and switches during this time period. One of these technologies is Virtual LAN (VLAN) and its protocols.

VLAN as Logically Defined Networks. Using VLAN technology, logical networks are created on the devices that support this technology. [1] A VLAN is a switched network that is logically segmented, by functions, project teams, or applications rather than on a physical or geographical basis. Cisco IOS (Internetworking Operating Systems) and Packet Tracer Simulation program will be used to coding the switches and network design in this project.

1.4 Solution Statement

In this section, we will share our solutions to the problems that are mentioned in section of Problem Statement.

To solve this problem, we have come to conclusion that we need to use logical grouping of network users and resources on a local area network (LAN). In other words, VLAN that make easy to create and administration of logical groups which can communicate among themselves. We aim to describing and implementation of a Virtual Local Area Network with using Cisco Operating System. This design aims to design VLANs are commonly incorporated into network design making it easier for a network to support the goals of an organization. It will also examine security considerations and strategies relating to VLANs and trunks, and best practices for VLAN implementation and design. Instead of all problems, we can use VLANs to reconfigure. This technology(VLAN) allows the reduce CPU overhead on devices by reducing the number of devices reduce security risks by reducing the copies of frames sent and receive unnecessarily. Also another security advantage is VLANs keep important data inside VLAN, hosts who in other VLANs can't see any data from other VLANs even if in same campus LAN. Network engineers are more flexible to design networks with VLANs.

1.5 Contribution

IEEE developed a new network technology can be used together with LANs. That technologs' name is VLAN. Now we look at difference between LANs and VLANs. Difference can be summarized as:

- VLANs have better performance than LANs.
- In VLANs, Network administration work is less when compared to LANs. LANs require physical administration as the need for recabling, the location of the user changes, reconfiguration of routers, addressing the new station and hubs arises.
- VLANs reduce the need for expensive routers. Thus, the vlan reduces the cost.
- Data transmission is more secure on VLANs.

VLANs reduce latency, switches are used instead of routers unlike in traditional LANs, VLAN creates broadcast domains and VLANs can help to minimize traffic. For example, if the broadcast traffic is meant for ten users, they can be placed on ten different VLANs which will in turn reduce the traffic.

2. Literature Search

This Literature includes detailed information about requirements of the project. It reflects the identified constraints and proposed software functionalities. While working on our project, we have compiled a database of literature that supports our work. Literature sources can include the following:

2.1 Library Research

Hubs, switches and routers. They are most important devices for network designing. Hubs were using in early 10BASE-T networks in 90's. In the following years switches are using in networks instead of hubs even today. Switches are connect end devices in same network and using for frame switching in networks. Routers have been using in networks from the beginning. They are routing packets between different networks. Also that two device is the name resource of Cisco's number one topic, Routing and Switching.

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Association's developed many standards, protocols and technologies used with routers and switches during this time period. One of these technologies is Virtual LAN (VLAN) and its protocols.

[2]By default, switches break up collision domains and routers break up broadcast domains. Nowadays, modern network design is characterized by a flatter architecture when compared to earlier designs. Switches are key devices for that modern flatter architecture. Well, how do we break up broadcast domains in network which builded only switches? By creating VLANs using switches. Using VLAN technology, logical networks are created on the devices that support this technology.[3] These logical networks are actually split broadcast domains.

[4] VLANs make easy to create and administration of logical groups which can communicate among themselves. Of course they must be on the same LAN. VLANs also simplify administration of moves, adds, removes and all other changes in hosts of these logical groups. VLANs are often associated with IP subnetworks. [4] For example, all the end stations in a particular IP the subnet belongs to the same VLAN.

[6] Use more VLANs which have a small number of devices improve campus LANs in many ways.

- VLANs reduce CPU overhead on devices by reducing the number of devices.
- VLANs reduce security risks by reducing the copies of frames sent and receive unnecessarily.
- Also another security advantage is VLANs keep important data inside VLAN, hosts who in other VLANs can't see any data from other VLANs even if in same campus LAN.
- Network engineers are more flexible to design networks with VLANs. Engineers can create VLANs by campus LAN requirements.
- Problems in one VLAN don't effect all campus LAN and can solve quickly within inoperative VLAN.

[7] Packets can't pass directly to another VLAN in same switch or connected different switches. If you want connect VLANs to another VLAN, you must add router to network design or use Layer 3 switches (multilayer switch) instead of Layer 2 switches.

[8] Two types of ports are use in VLANs. Access ports and trunk ports. Administrators can choose right type for configure VLAN. Switches' access ports are used for connected to a host and trunk ports are used for connected to other switches. An access port work in single VLAN. Administrator can create an access port by statically configured or dynamically assigned. Also a trunk ports works in multiple VLANs, and they can be created manually configured or run with a protocol like VLAN Trunking Protocol (VTP).

[9] Number of links between switches increase quickly when adding new VLANs to network. That situation forced associations and network engineers to find a new solution for reduce cabling and efficient use of physical interfaces. End of that process, the solution was VLAN Trunks. A trunk link can transport more than one VLAN through a single switch port. Trunk links are most beneficial when switches are connected to other switches or routers. A trunk link is available for all active VLANs. Active VLANs can transport frames between switches using a single trunk link.

[10] To know to which VLAN a frame belongs, the sending switch, router, or PC adds a header to the original frame, with that header having a field in which to place the VLAN ID of the associated VLAN. In this way, one trunk link can be enough for all VLANs. Two main trunking protocols available for adding VLAN ID to the header. Inter-Switch Link (ISL) defined by Cisco and 802.1Q defined by IEEE. Nowadays, many network devices even Cisco's recent switches support only 802.1Q.

[11] Host mobility can be easier with VLANs. If administrators want to use wireless in network, they allocate a single VLAN for wireless network. In this way, hosts can retain their original IP addresses when they move from one access point to another. These hosts can be use laptops, mobile phones, tablets etc. Hosts can stay connected to network uninterrupted even if they move across the campus.

2.2 Internet Research

VLAN and Cloud Technology

Cloud technology is the simplest online storage service that provides operational convenience with web-based applications that do not require any installation. All the applications, programs and data stored on the internet in the cloud, we can easily provide access to programs and data. Cloud-based services that provide convenience for users and their daily lives and save them from hardware hitches have been around 3 years for my life.

[12] Network virtualization is the key to the current and future success of cloud computing. The most important supporter for all virtualisations is the Internet and various computer network technologies. It turns out that the computer network itself needs to be virtualized. Several new standards and technologies have been developed for network virtualization.

[13] VLAN is important technology of all network branches. Cloud computing is one of them. Data centers are most important places for the cloud computing. In addition to virtual machine is one of the most important atomic units of a modern data center.

Server virtualization is a key component in cloud computing, offering native agility, standardization, mobility, and resilience to applications deployed in such environments. At the same time server virtualization create simple but challenging problem: How to control Virtual Machine traffic inside of a hypervisor.

VLAN is the best traffic isolation way for virtual networking solutions. Imagine two VM connect same VLAN, they can exchange frames. If they connect from different VLANs, VMs isolated to each other. If necessary, router as a layer 3 device is solution for connects them.

VMware created the concept of the virtual switch in the early 2000's. Briefly, simplified Layer 2 Ethernet switch software working on hypervisor for control VM traffic.

vSwitch is used the physical NICs as uplinks, conducting VM traffic beyond the access switch. vSwitch can forward frames between VM and physical switch. All VMs emulates at least one NIC. Real ethernet frames sending and receiving by that virtual technology. vSwitch decides the road of frames, after analyzing the destination MAC address. vSwitch route the frame to physical NIC or to VM which connected to the same VLAN.

vSwitch support more than one VLAN in these interfaces. Using VLAN tagging in its physical NICs. Based on the 12-bit VLAN ID field defined in the IEEE 802.1Q standard.

Buffer overflow: is one of the Main problems on switches

[14] Cisco IOS can not handle a specially crafted Virtual Trunking Protocol(VTP) summary advertisement with an overly long VLAN name. Buffer overflow vulnerability can allow a remote or unauthenticated attacker to execute arbitrary code. Also this vulnerability can cause a denial-of-service condition. Cisco's VLAN Trunking Protocol adds, deletes, and renames the Virtual Local Area Network throughout the entire network. The Virtual Trunking Protocol is supported by IOS and CentOS operating systems. There are a buffer overflow vulnerability in some versions of IOS

and CatOS when their handling of certain VTP summary advertisements.Depending on local network configuration, reaching the target system on a trunk enabled port may limit the systems from which the attacker can stage an attack. Following the workarounds can lead to a security vulnerability. VTP domain password can applied. VTP domain password is standard suggested practice.

Workarounds:

- Administrators are advised to apply the appropriate update.
- Administrators are advised to set passwords on VTP domains.
- Administrators are advised to restrict access to affected devices.
- Administrators are advised to monitor affected systems for signs of suspicious activities.

3. Summary

3.1 Technology Used

Using VLAN technology, logical networks are created on the devices that support this technology. Cisco IOS (Internetworking Operating Systems) and Packet Tracer Simulation program will be used to coding the switches and network design in this project. This technology(VLAN) allows the reduce CPU overhead on devices by reducing the number of devices reduce security risks by reducing the copies of frames sent and receive unnecessarily.

4. Software Requirements Specification

4.1 Introduction

4.1.1 Purpose

The purpose of this document is describing the and implementation of a Virtual Local Area Network with using Cisco Operating System. This design aims to design VLANs are commonly incorporated into network design making it easier for a network to support the goals of an organization. The project will cover how to code VLANs and VLAN trunks. It will also examine security considerations and strategies relating to VLANs and trunks, and best practices for VLAN implementation and design. This document includes detailed information about requirements of the project. It reflects the identified constraints and proposed software functionalities. Moreover, the SRS document explains how participants interact with the simulation.

4.1.2 Scope of Project

In recent years there has been rapid growth in cloud computing, social networking technologies and internetworking technologies. Therefore, the need is increasing with each passing day that the Network Engineers all over the world. Network performance is an important factor in the productivity of an organization. One of the technologies used to improve network performance is the separation of large broadcast domains into smaller ones. Network Engineers want to reduce the need for expensive routers. In addition to this,they want to data transmission that is more secure,minimize traffic. The project has become necessary to develop due to lack of these cloud computing, social networking technologies and internetworking technologies. Because of the above reasons, A virtual local area network (VLAN) will be investigated and applied in this project.

The purpose of this project is to design VLAN that make easy to create and administration of logical groups which can communicate among themselves. VLAN as Logically Defined Networks.

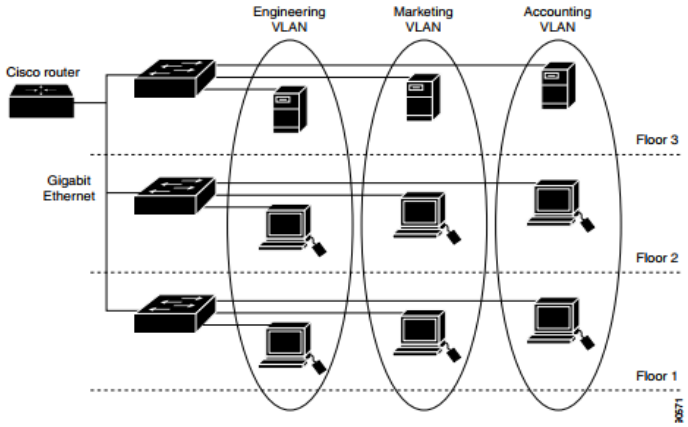


Figure 1: shows an example of VLAN as Logically Defined Networks. There are 3 separate departments: engineering, marketing and accounting departments. Each department is assigned to another VLAN.

Using VLAN technology, logical networks are created on the devices that support this technology. Cisco IOS (Internetworking Operating Systems) and Packet Tracer Simulation program will be used to coding the switches and network design in this project. This technology(VLAN) allows the reduce CPU overhead on devices by reducing the number of devices reduce security risks by reducing the copies of frames sent and receive unnecessarily.Also another security advantage is VLANs keep important data inside VLAN, hosts who in other VLANs can’t see any data from other VLANs even if in same campus LAN.Network engineers are more flexible to design networks with VLANs. Engineers can create VLANs by campus LAN requirements.Problems in one VLAN don’t effect all campus LAN and can solve quickly within inoperative VLAN.This project creates opportunities such as flexible, efficient cost, more secure,minimize traffic etc.

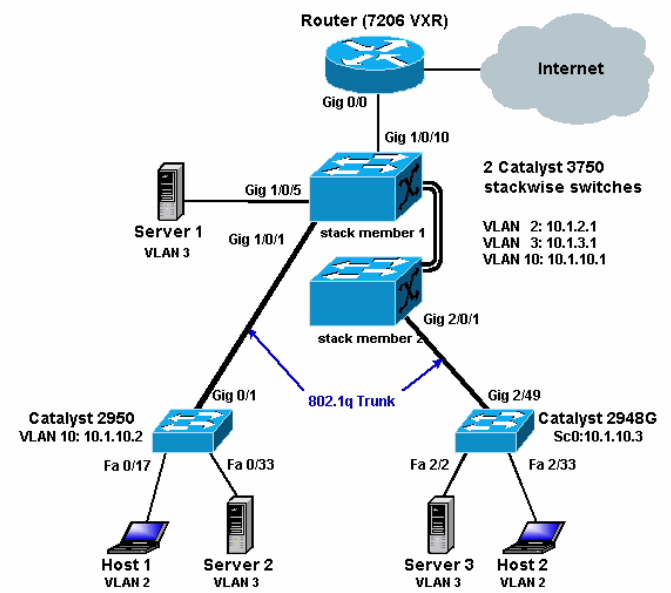


Figure 2: Network Diagram. This project is an example that uses the network setup shown in the diagram above.

References:

[1] https://www.cisco.com/c/en/us/support/docs/switches/catalyst-3750-series-switches/45002-intervlan3750-45002.html

In our project, we will design a total of 8 virtual local area networks. VLANs are named:

- Vlan1 is default Vlan.
- Vlan2 & Vlan3 are basic Vlan.
- Vlan4 is a wireless Vlan.
- Vlan5 is a VOIP Vlan.
- Vlan6 is a VOIP data Vlan.
- Vlan90 is a native Vlan.
- Vlan99 is a management Vlan.

4.1.3 Glossary

Table 1 Glossary of SRS

Term	Definition
Cisco IOS	Cisco network devices need an operating system like PC. Cisco calls this OS the Internetworking Operating Systems (IOS).
Router	Network layer device that determine the best path in forwarded network traffic. Routers forward packets between networks. Routers known as gateway in network topologies. Cisco 2911 that we used in our network is a new and trend router of Cisco.
Switch	Data link layer device that forward framesaccording to destination address of frames. Cisco 2960 that we used in our network is a commonswitch of Cisco.
Interface	Connection between two devices. Also configure ports with interface command in Cisco IOS.
Cisco Packet Tracer	Cisco network simulation software.
Network Topology	Arrangement of network devices and connections in a networking structure.
VLAN Trunk	Trunk is a link (connection) type between devices. Trunking add VLAN identification informations in frame headers. In this way, many VLANs connected together with one trunk link.
Broadcast Domain	Device group that will receive broadcast frame creating from any device in the same group.
Campus LAN	Campus LAN build by interconnected LANs. All network eqiupments of Campus LAN owned by campus user. (University, company etc.)
Access Point	Network device that create wireless connection for Wi-Fi devices to connect wired networks.
DHCP	Dynamic Host Configuration Protocol. DHCP configure host parameters for connect hosts to network, such as IP address, Subnet Mask, Default Gateway etc.
Media	Physical environments which transmitted data signals between network devices.

Copper Straight-Through	Network media that use for connect to different type of devices. Such as, PC – Switch connection.
Copper Cross-Over	Network media that use for connect to same type of devices. Such as, Router - Router connection.
Subnet Mask	32 bit IP address mask. Subnet Masks divides the IP addressesfor networks and hosts.
Default Gateway	Router thatstart forwarding packets to other networks.
VoIP	Voice over Internet Protocol. VoIP deliver voice comminications over IP with VoIP Phones.
Participant	The user who interacts with the Virtual Local Area Network environment.
Scrum	Scrum is a methodology which is an agile software development process.

4.1.4 References

1. https://www.cisco.com/c/en/us/support/docs/switches/catalyst-3750-series-switches/45002-intervlan3750-45002.html
2. S. Al-Zaghir, S. T. Özyer and M. Al-Dagdoog, "Recruitment of security features for securing VTP3 domain in campus environment" Computer Science and Engineering (UBMK), 2017 International Conference on, Antalya, Turkey, October 5-8, 2017.
   Available: http://ieeexplore.ieee.org/document/8093390/

4.1.5 Overview of Document

The second part of the document describes functionalities of a Virtual Local Area Network: describing the and implementation of a Virtual Local Area Network with using Cisco Operating System. This design aims to design VLANs are commonly incorporated into network design making it easier for a network to support the goals of an organization. Informal requirements are described and it is a context for technical requirement specification in the Requirement Specification chapter.

4.2 Overall Description

4.2.1 Product Perspective

Virtual Local Area Network Project is defined Networks for making easy to create and administration of logical groups which can communicate among themselves. In our Virtual Local Area Newtwork Project, *Figure 3* explains that there are 6 different types of VLANs. with a total of 8 VLANs created.

Created virtual local networks;

- VLAN-1: Default VLAN
- VLAN-2 & 3 Basic VLAN
- VLAN-4: Wireless VLAN
- VLAN-5: VOIP VLAN
- VLAN-6: VOIP Data VLAN
- VLAN-99: Management VLAN

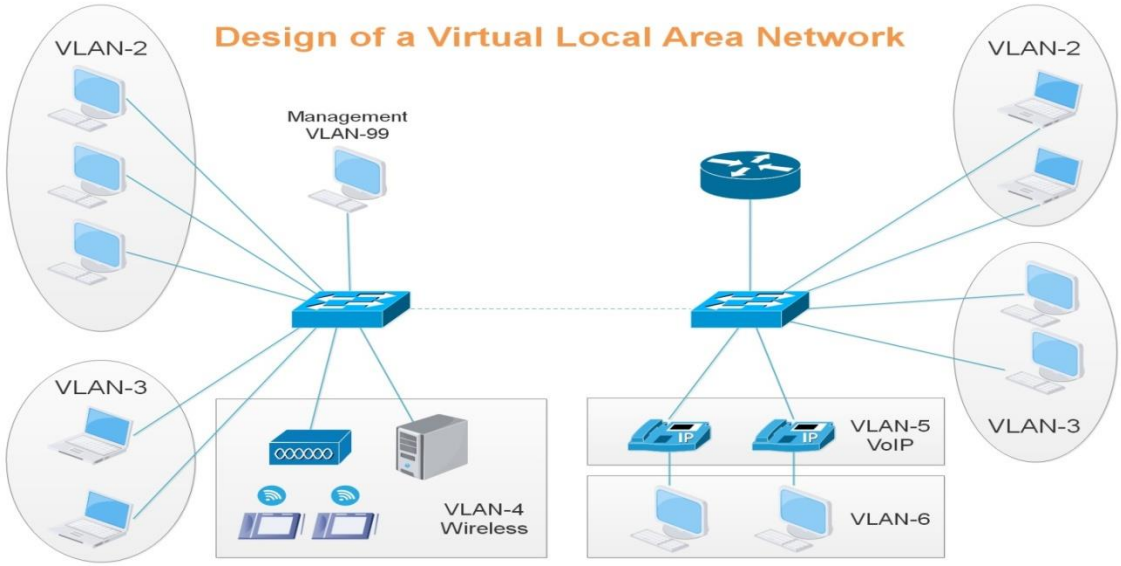


Figure 3: Prototype 1

4.2.2 Development Methodology

For developing the project, we are using Scrum which is an agile software development process. There are some advantages of Scrum. The essence of each Sprint is the same, but it is divided into various sub-branches that differ in their process. It is aimed primarily at developing important requirements for the project. Scrum provides an environment that allows to build up a strong team. We define a 'goal' each time and every time, we do try to reach it together. Scrum shows the overall scenery of our on-going project. After every sprint, we have a new release which provides the chance to try newly implemented

components of the product (continuous integration). [4] *Figure 4* represents four sprints of the project on the table. We schedule meetings every week and we discuss about both the implemented components and the future ones. Development team should have a daily meeting every morning which should be maximum 15 minutes. With this daily meeting, everybody knoweach other's tasks. This meeting is an opportunity for the Scrum Team to develop itself. We can reduce the risk of conflicts and this makes development faster.It is better to show everything you've got and make the best of the feedback you get.Sometimes we change our components because there can be misunderstandings, but if youare working with Scrum, change is the norm and you have to tolerate changes which prevents future too large changes. Scrum is the most suitable methodology for the project.

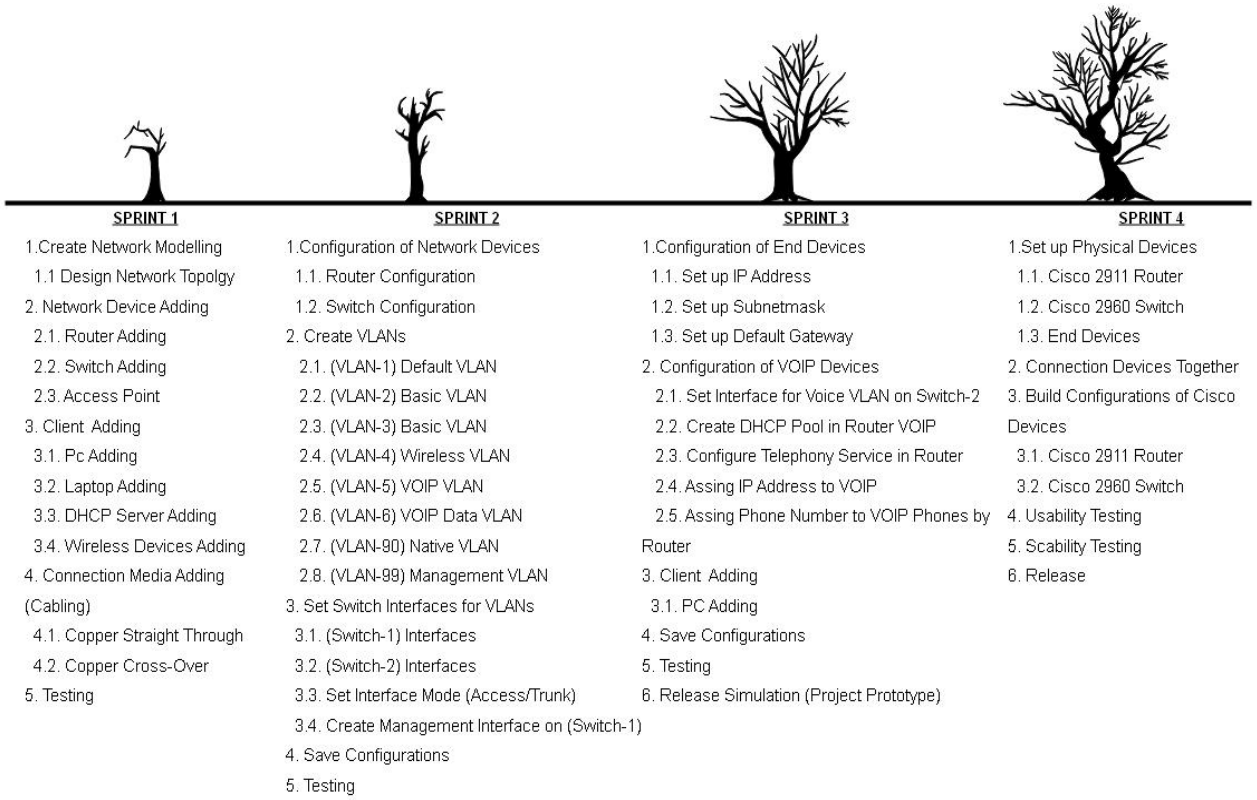


Figure 4: All Sprints of the Project on the Table

4.2.3 User Characteristics

Participants

- Participant must be a client of any VLAN.
- Participant must connect to Internet.
- Participant must have knowledge of networking softwares in computer OS.
- Participant must have knowledge of network equipments on computer hardware.

Admin

- Admin must be administrator of network.
- Admin must read and understand English language.
- Admin must know how to use a computer.
- Admin must know how to remoted or wired connect to Cisco Network devices.
- Admin must have knowledge of configure Cisco Network devices
- Admin must know VLAN creating techniques.

4.3 Requirements Specification

4.3.1 External Interface Requirements

4.3.1.1 User interfaces

The user interface will be worked any type of OS. Terminal which is most basic management tool of all OS and main interface of Cisco Network devices.

4.3.1.2 Hardware interfaces

The configuration requires personel computer which have connection with Cisco Network devices. That connection can be provided with wired media (console cable) or remote connection (Telnet or SSH).

4.3.1.3 Software interfaces

There are no external software interface requirements.

4.3.1.4 Communications interfaces

There are no external communications interface requirements.

4.3.2 Functional Requirements

Internet Management Use Case

Use Case:

- Connect
- Configure as Admin
- Exit

Diagram:

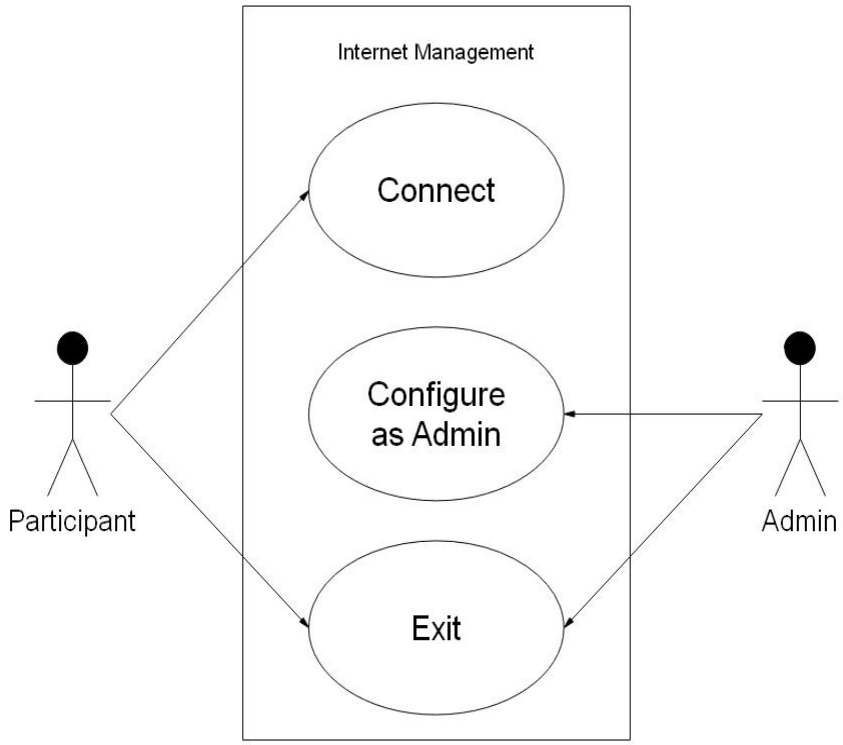


Figure 5: Internet Management Use Case

Brief Description:

In Internet Management diagram (*Figure 5*) explains the basic operations which is related to entering system of participant and admin. Participant and admin are able to use the following function: Exit. Apart from these, participant can also use the Connect function and Admin can use the Configure as Admin functions.

Initial Step by Step Description:

1. Participant shall connect the Internet without configure.
2. Admin shall configure to the system using password.
3. If the password is invalid for the admin name, admin should re-login.
4. Admin and Participant can exit from the connection.

Configure Management Use Case

Use Case

- Attendance VLAN
- Create VLAN
- VLAN name Change
- Delete VLAN
- Add Interface to VLAN
- Delete Interface to VLAN
- Create Bridges Between VLANs
- Shutdown all Connections
- Exit

Diagram:

Figure 6: Configure Management Use Case

Brief Description:

Figure 6 shows Configure Management use case diagram. When participant entered network within the system, he/she must attend one of VLANs and Exit Internet. Admin can configure functions of Create VLAN, VLAN Name Change, Delete VLAN, Add Interfaces to VLAN, Delete Interfaces to VLAN, Create Bridges between VLANs, Shtdown All Connections and Exit in Configure Management system.

Initial Step-By-Step Description:

1. If participant connect the Internet, he/she attend the one of VLANs.
2. If participant shutdown own computer or connection, he/she exit the VLAN which connected.
3. If Admin open connection with device, he/she reach the Commond Line Interface of device.
4. If Admin want to configure functions of device, he/she login with password initially.
5. If Admin want to create new VLAN, he/she enter configuration interface with password and must enter number of new VLAN.
6. If Admin want to change name of VLAN, he/she enter "name (chosen name)" command in VLAN-configuration interface.
7. If Admin want to delete one of VLANs, he/she enter "no vlan (#vlan)" command in VLAN-configuration interface.
8. If Admin want to add new participants to one of VLANs, he/she enter "switchport access vlan 4" command in interface-configuration interface.
9. If Admin want to delete participants to one of VLANs, he/she enter "no interface vlan (#vlan)" command in interface-configuration interface.
10. If Admin want to create bridges between VLANs, he/she build a trunk link between router and switches which include selected VLANs.
11. If Admin want to shutdown all connections, he/she enter "shutdown" command for all interfaces in interface-configuration interface.
12. If Admin shutdown own computer or connection, he/she exit the VLAN which connected.

VOIP Management Use Case

Use Case:

- IP Phone Call
- Regular Phone Call
- Call Ending
- User Settings
- Device Settings
- Assign IP Address
- Assign Phone Number
- Shutdown Connection
- Exit

Diagram

Figure 7: VOIP Management Use Case

Brief Description:

Figure 7 shows VoIP Management use case diagram. Diagram explains basic operations which are related to VoIP network of participant and admin. Participant and admin are able to use the following functions: User Settings, Device Settings and Shutdown Connection. Apart from these, participant can also use the IP Phone Call, Regular Phone Call, Call Ending and Admin can use Assign IP Address, Assign Phone Number and exit functions.

Initial Step-By-Step Description:

1. If participant want to IP Phone Call, he/she call any IP Phone Number in VLAN.
2. If participant want to Regular Phone Call, he/she call any telephone number.
3. If participant want to Call Ending, he/she put handset to handset place or push the handset button manually.
4. If participant want to reach user settings, he/she push settings button, next user settings button in main menu.
5. If participant want to reach device settings, he/she push settings button, next device settings button in main menu.
6. If participant want to shutdown connection, he/she disconnect network media on hub which embedded back of IP Phone.

7. If Admin want to change user settings, he/she enter Router's Telephony Service Configuration and configure user settings of IP Phone.

8. If Admin want to change device settings, he/she enter Router's Telephony Service Configuration and configure device settings of IP Phone.

9. If Admin want to Assign IP Address to IP Phone, he/she enters Router's Telephony Service Configuration and assigns IP address to IP Phone.

10. If Admin want to Assign Phone Number to IP Phone, he/she enters Router's Telephony Service Configuration and assigns Phone Number to IP Phone.

11. If Admin want to shutdown connection, he/she enter "shutdown" command for IP Phone interface in switch interface-configuration interface.

12. If Admin shutdown own computer or connection, he/she exit the all devices which connected.

4.3.3 Performance Requirement

Minimum requirement for attend to VLAN is any device which have internet connection.

4.3.4 Software System attributes

4.3.4.1 Portability

There is no portability requirement.

4.3.4.2 Performance

- VLANs increase the connection speed of all network.
- VLANs are provide more secure connections for networks
- VLANs are decrease CPU overhead of network devices.

4.3.4.3 Usability

There is no usability requirement.

4.3.4.4 Adaptability

- VLANs created with very basic logic for Cisco Network devices in this project.
- Commands can adaptable easily for non-Cisco Network devices.

4.3.4.5 Scalability

- Networks have scability for VLANs. Admin can create 1-4096 VLANs in one Network.
- Also he/she can delete any VLAN except VLAN 1.
- VLANs have scability. Admin add or delete interfaces as network allows.

4.4 Safety Requirement

- Since only one participant uses the system at a time, there is no safetyrequirement.

5. Software Design Description

5.1 Introduction

5.1.1 Purpose

The purpose of this Software Design Document is providing the details of project titled as “Design and Implementation of a Virtual Local Area Network with using Cisco Operating System”.

The organizations of the designs can change frequently and in this case we have to adapt the changing organizations of these designs. Redesigning or reconfiguring is vulnerable. Errors can lead to network interruptions. [15] Enterprise network operators must frequently change the design of their networks to reflect new organizational needs, that may arise due to the addition of new hosts, movement and reorganization of departments and personnel, revision of security policies, and upgrading of router hardware. Networks have high-level goals. These could be security and performance. These top-level targets are embedded in low-level configurations. Restructuring corporate networks is challenging in this sense. Regular changes are often necessary. It is necessary to make changes to more than one device while changing a specific design. There are dependencies between configurations in managing networks. This can cause complexity. Thus, in reconfiguration and redesign, errors may occur. Errors in changing configurations have been known to result in outages, business service disruptions, violations of Service Level Agreements (SLA) and cyber-attacks [16], [17], [18]. When a company is developing, it needs new departments and host categories. Similarly, it can be in situations such as merging or closing departments. That's why we need VLANs. In a network without VLANs, network management is a challenge. In VLANs, Network administration work is less. [19] VLANs make easy to create and administration of logical groups which can communicate among themselves. Network engineers are more flexible to design networks with VLANs. VLANs can help to minimize traffic. [20] Our results show that our VLANs and algorithms can produce significantly better designs than current practice, while avoiding errors and minimizing human work.

The purpose of this project is describing the implementation of a Virtual Local Area Network with using Cisco Operating System. This design aims to design VLANs are commonly incorporated into network design making it easier for a network to support the goals of an organization. The project will cover how to code VLANs and VLAN trunks. It will also examine security considerations and strategies relating to VLANs and trunks, and best practices for VLAN implementation and design. This document includes detailed information about requirements of the project. It reflects the identified constraints and proposed software functionalities. Moreover, In order to provide a better comprehension, this SDD includes various diagrams such as UML diagram of the project, activity diagram and block diagram.

5.1.2 Scope

This document contains a complete description of the design of VLAN: is the logical grouping of network users and resources on a local area network (LAN) and is assigned to ports on the switch.

The need is increasing with each passing day that the Network Engineers all over the world. Network performance is an important factor in the productivity of an organization. One of the technologies used to improve network performance is the separation of large broadcast domains into smaller ones. Network Engineers want to reduce the need for expensive routers. In addition to this,they want to data transmission that is more secure,minimize traffic. The project has become necessary to develop due to lack of these cloud computing, social networking technologies and internetworking technologies. Because of the above reasons, A virtual local area network (VLAN) will be investigated and applied in this project.

The purpose of this project is to design VLAN that make easy to create and administration of logical groups which can communicate among themselves. VLAN as Logically Defined Networks. Using VLAN technology, logical networks are created on the devices that support this technology. [21] A VLAN is a switched network that is logically segmented, by functions, project teams, or applications rather than on a physical or geographical basis. Cisco IOS (Internetworking Operating Systems) and Packet Tracer Simulation program will be used to coding the switches and network design in this project. If you want to reconfigure the devices, you do not need to unplug the devices and carry them. Instead of all this, we can use VLANs to reconfigure. This technology(VLAN) allows the reduce CPU overhead on devices by reducing the number of devices reduce security risks by reducing the copies of frames sent and receive unnecessarily.Also another security advantage is VLANs keep important data inside VLAN, hosts who in other VLANs can’t see any data from other VLANs even if in same campus LAN.Network engineers are more flexible to design networks with VLANs. Engineers can create VLANs by campus LAN requirements.Problems in one VLAN don’t effect all

campus LAN and can solve quickly within inoperative VLAN.This project creates opportunities such as flexible, efficient cost, more secure,minimize traffic etc.

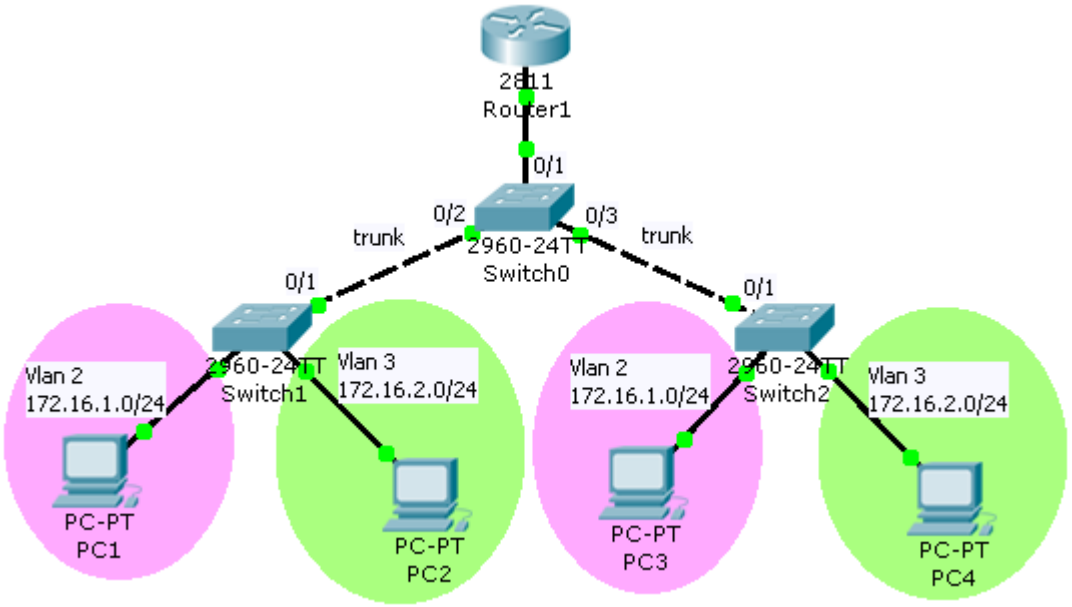


Figure 8: An example of VLAN design

When a company is developing, it needs new departments and host categories. Similarly, it can be in situations such as merging or closing departments. Making changes to VLANs can cause complexity. The process of redesigning and reconfiguring VLANs can be complex and error-prone as we discuss above. Sometimes this may be possible by well-chosen design strategies. VLAN's offer a number of advantages over traditional LAN's. These are:

- Performance
- Formation of Virtual Workgroups
- Simplified Administration
- Reduced Cost
- Security

A VLAN consists of a number of end systems, either hosts or network equipment (such as bridges and routers), connected by a single bridging domain. The bridging domain is supported on various pieces of network equipment such as LAN switches that operate bridging protocols between them with a separate group for each VLAN.[22]. Routers must be only used to communicate between two VLANs.

There are a few things to consider when designing VLANs.

- Correctness criterion: If a different machine belongs to a different category, it should be placed in a different VLAN.
- Feasibility criterion: [23] The maximum number of hosts a VLAN can have is determined by the size of the IP block it is assigned. For example, a VLAN with a /24 IP block can have no more than 256 hosts.
- Performance and cost criteria: [24] Hosts in the same VLAN belong to the same broadcast domain, and it is important to keep the cost of broadcast traffic small.

5.1.3 Glossary

Table 2 Glossary of SDD

Term	Definition
Cisco IOS	Cisco network devices need an operating system like PC. Cisco calls this OS the Internetworking Operating Systems (IOS).
Router	Network layer device that determine the best path in forwarded network traffic. Routers forward packets between networks. Routers known as gateway in network topologies. Cisco 2911 that we used in our network is a new and trend router of Cisco.
Switch	Data link layer device that forward framesaccording to destination address of frames. Cisco 2960 that we used in our network is a commonswitch of Cisco.
Interface	Connection between two devices. Also configure ports with interface command in Cisco IOS.
Cisco Packet Tracer	Cisco network simulation software.
Network Topology	Arrangement of network devices and connections in a networking structure.
VLAN Trunk	Trunk is a link (connection) type between devices. Trunking add VLAN identification informations in frame headers. In this way, many VLANs connected together with one trunk link.
Broadcast Domain	Device group that will receive broadcast frame creating from any device in the same group.
Campus LAN	Campus LAN build by interconnected LANs. All network eqiupments of Campus LAN owned by campus user. (University, company etc.)

Access Point	Network device that create wireless connection for Wi-Fi devices to connect wired networks.
DHCP	Dynamic Host Configuration Protocol. DHCP configure host parameters for connect hosts to network, such as IP address, Subnet Mask, Default Gateway etc.
Media	Physical environments which transmitted data signals between network devices.
Copper Straight-Through	Network media that use for connect to different type of devices. Such as, PC – Switch connection.
Copper Cross-Over	Network media that use for connect to same type of devices. Such as, Router - Router connection.
Subnet Mask	32 bit IP address mask. Subnet Masks divides the IP addressesfor networks and hosts.
Default Gateway	Router thatstart forwarding packets to other networks.
VoIP	Voice over Internet Protocol. VoIP deliver voice comminications over IP with VoIP Phones.
Participant	The user who interacts with the Virtual Local Area Network environment.
Scrum	Scrum is a methodology which is an agile software development process.
UML Diagram	It is a modelling language which is used in Software Engineering.
Block Diagram	The type of schema which the components in the system are displayed in blocks.
SDD	Software Design Document

5.1.4 References:

[1] Reference: Xin Sun, Yu-Wei E. Sung, Sunil D. Krothapalli, and Sanjay G. Rao , “A Systematic Approach for Evolving VLAN Designs”, IEEE INFOCOM, 2010

5.1.5 Overview of Document

The remaining chapters and their contents are listed below.

Section 2 is the Architectural Design which describes the project development phase.

Also it contains class diagram of the system and architecture design of the project which describes actors, exceptions, basic sequences, priorities, pre-conditions and post conditions.

Section 3 is related to prototype. In this section, we have shown the sample of VLANs in the prototype and have described simulation.

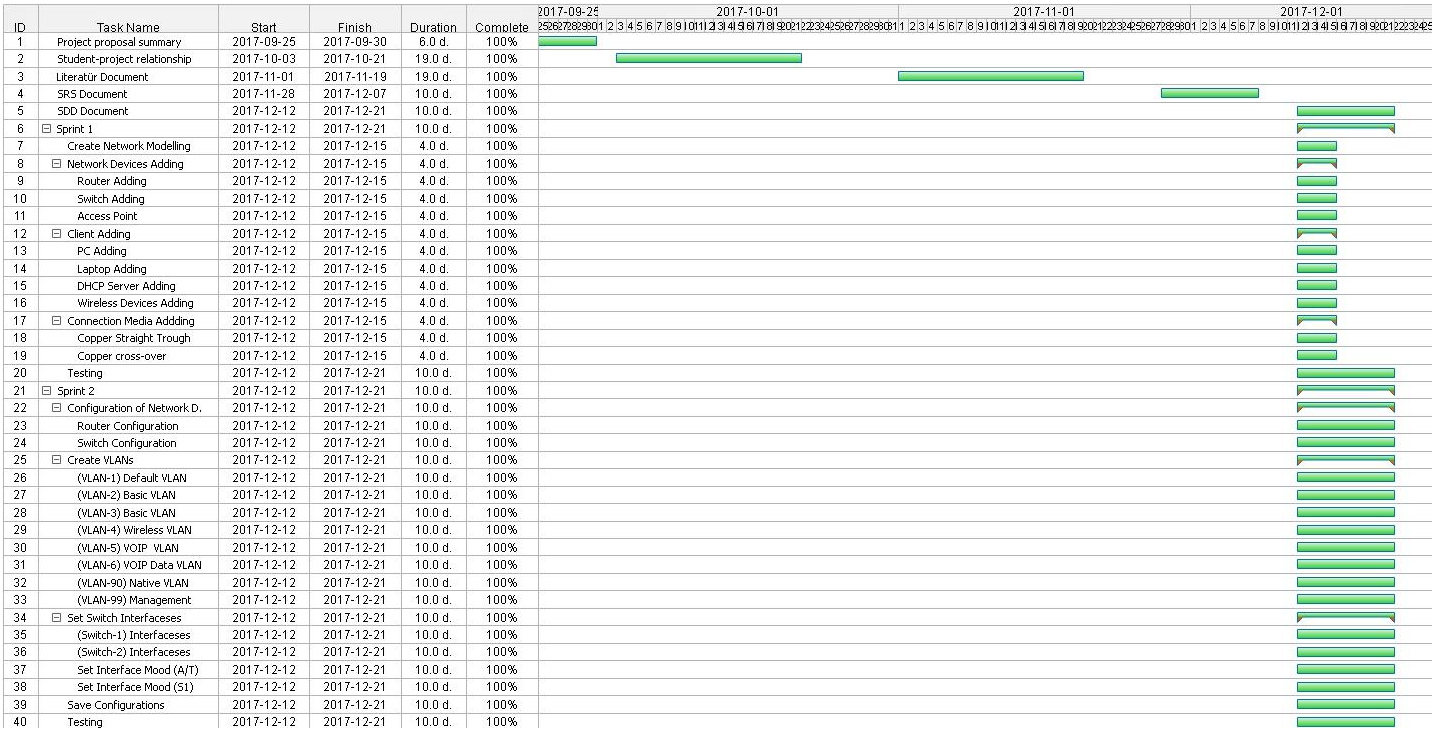
5.1.6 Motivation

We are a group of students in computer engineering department who are interested in social networking technologies and internetworking technologies. As a group, we have taken the course of internetworking, computer network and data communications for a better understanding in Network management. We aimed to design VLAN that make easy to create and administration of logical groups which can communicate among themselves in this project. We have used the Cisco IOS (Internetworking Operating Systems) and Packet Tracer Simulation program were used to coding the switches and network design in this project. So in order to increase our knowledge in this field, we have researched cloud technologies and buffer overflow algorithms. For virtual local area network technologies, firstly we have install Packet Tracer Simulation which we can design Vlan. We have read documents for how to design VLAN in Cisco Certified Network Associate Study Guide.

5.2 Deployment diagram

Gantt Chart in Figure 9 includes three parts which are research & documentation and sprints part. A Gantt Chart in which a series of horizontal lines shows the amount of work done or production completed in certain periods of time in relation to the amount planned for those periods. This Gantt Chart explains tasks and subtasks in a chart with status and chronological relationships. This gives a full picture of the progression of the project at a single glance, and helps identify potential or existing delays. Once a task is created, it can still be modified directly from the table or Gantt chart. Each activity is represented by a bar; the position and length of the bar reflects the starts date, duration and end date of the activity. First approximately 2 months are spent using waterfall for research and documentation which include information regarding project. After documentation, there are 4 sprints. After completing testing and release at the end of each sprints, if there are any tasks which are not completed, extra working days have been reserved for the purpose of completing these tasks.

- What the various activities are
- When each activity begins and ends
- How long each activity is scheduled to last
- Where activities overlap with other activities, and by how much
- The starts and end date of the whole project



ID	Task Name	Start	Finish	Duration	Complete
1	Project proposal summary	2017-09-25	2017-09-30	6.0 d.	100%
2	Student-project relationship	2017-10-03	2017-10-21	19.0 d.	100%
3	Literatür Document	2017-11-01	2017-11-19	19.0 d.	100%
4	SRS Document	2017-11-28	2017-12-07	10.0 d.	100%
5	SDD Document	2017-12-12	2017-12-21	10.0 d.	100%
6	Sprint 1	2017-12-12	2017-12-21	10.0 d.	100%
7	Create Network Modelling	2017-12-12	2017-12-15	4.0 d.	100%
8	Network Devices Adding	2017-12-12	2017-12-15	4.0 d.	100%
9	Router Adding	2017-12-12	2017-12-15	4.0 d.	100%
10	Switch Adding	2017-12-12	2017-12-15	4.0 d.	100%
11	Access Point	2017-12-12	2017-12-15	4.0 d.	100%
12	Client Adding	2017-12-12	2017-12-15	4.0 d.	100%
13	PC Adding	2017-12-12	2017-12-15	4.0 d.	100%
14	Laptop Adding	2017-12-12	2017-12-15	4.0 d.	100%
15	DHCP Server Adding	2017-12-12	2017-12-15	4.0 d.	100%
16	Wireless Devices Adding	2017-12-12	2017-12-15	4.0 d.	100%
17	Connection Media Addding	2017-12-12	2017-12-15	4.0 d.	100%
18	Copper Straight Trough	2017-12-12	2017-12-15	4.0 d.	100%
19	Copper cross-over	2017-12-12	2017-12-15	4.0 d.	100%
20	Testing	2017-12-12	2017-12-21	10.0 d.	100%
21	Sprint 2	2017-12-12	2017-12-21	10.0 d.	100%
22	Configuration of Network D.	2017-12-12	2017-12-21	10.0 d.	100%
23	Router Configuration	2017-12-12	2017-12-21	10.0 d.	100%
24	Switch Configuration	2017-12-12	2017-12-21	10.0 d.	100%
25	Create VLANs	2017-12-12	2017-12-21	10.0 d.	100%
26	(VLAN-1) Default VLAN	2017-12-12	2017-12-21	10.0 d.	100%
27	(VLAN-2) Basic VLAN	2017-12-12	2017-12-21	10.0 d.	100%
28	(VLAN-3) Basic VLAN	2017-12-12	2017-12-21	10.0 d.	100%
29	(VLAN-4) Wireless VLAN	2017-12-12	2017-12-21	10.0 d.	100%
30	(VLAN-5) VOIP VLAN	2017-12-12	2017-12-21	10.0 d.	100%
31	(VLAN-6) VOIP Data VLAN	2017-12-12	2017-12-21	10.0 d.	100%
32	(VLAN-90) Native VLAN	2017-12-12	2017-12-21	10.0 d.	100%
33	(VLAN-99) Management	2017-12-12	2017-12-21	10.0 d.	100%
34	Set Switch Interfaceses	2017-12-12	2017-12-21	10.0 d.	100%
35	(Switch-1) Interfaceses	2017-12-12	2017-12-21	10.0 d.	100%
36	(Switch-2) Interfaceses	2017-12-12	2017-12-21	10.0 d.	100%
37	Set Interface Mood (A/T)	2017-12-12	2017-12-21	10.0 d.	100%
38	Set Interface Mood (S1)	2017-12-12	2017-12-21	10.0 d.	100%
39	Save Configurations	2017-12-12	2017-12-21	10.0 d.	100%
40	Testing	2017-12-12	2017-12-21	10.0 d.	100%

Figure 9: Gantt Chart of Work Plan

5.3 ARCHITECTURE DESIGN

5.3.1 VLAN Design Approach

For developing the project, we are using Scrum which is an agile software development process. There are some advantages of Scrum. The essence of each Sprint is the same, but it is divided into various sub-branches that differ in their process. It is aimed primarily at developing important requirements for the project. Scrum provides an environment that allows to build up a strong team. We define a 'goal' each time and every time, we do try to reach it together. Scrum shows the overall scenery of our on-going project. After every sprint, we have a new release which provides the chance to try newly implemented components of the product (continuous integration). *Figure 3* represents four sprints of the project on the table. We schedule meetings every week and we discuss about both the implemented components and the future ones. Development team should have a daily meeting every morning which should be maximum 15 minutes. With this daily meeting, everybody know each other's tasks. This meeting is an opportunity for the Scrum Team to develop itself. We can reduce the risk of conflicts and this makes development faster.It is better to show everything you've got and make the best of the feedback you get. Sometimes we change our components because there can be misunderstandings, but if youare working with Scrum, change is the norm and you have to tolerate changes which prevents future too large changes.

Scrum is the most suitable methodology for the project.

5.3.2 Class Diagram

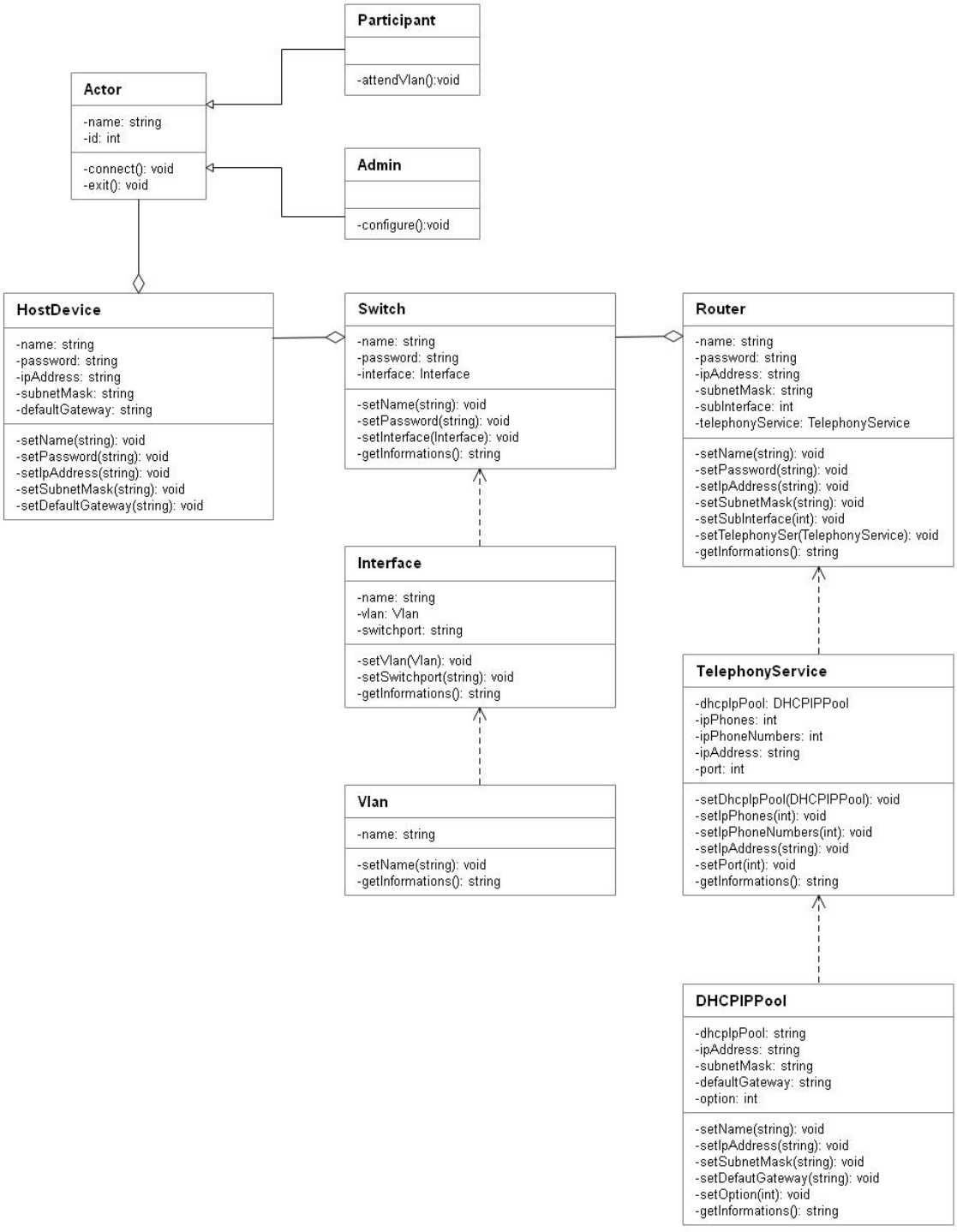


Figure 10: Class Diagram of Simulacrum Project

Figure 10 displays information about connections between the systems. Host Device Class is the starting system. It is responsible for connections between actors and other two main systems. Actor class represents all the users who use the system. Participant class is for users who will use the host device for connection network by attending any VLAN. Admin class is for actor which manages the system. Switch class is the switch device in network design. Interface class represents physical Ethernet ports on switch device. Vlan class is show Vlan information in upper interface class. Router class is router device in network design. Telephony Service class represents VoIP information in router. DHCP IP Pool class manages IP address pool in router's telephonyservice.

5.3.3 Architecture Design of Simulation

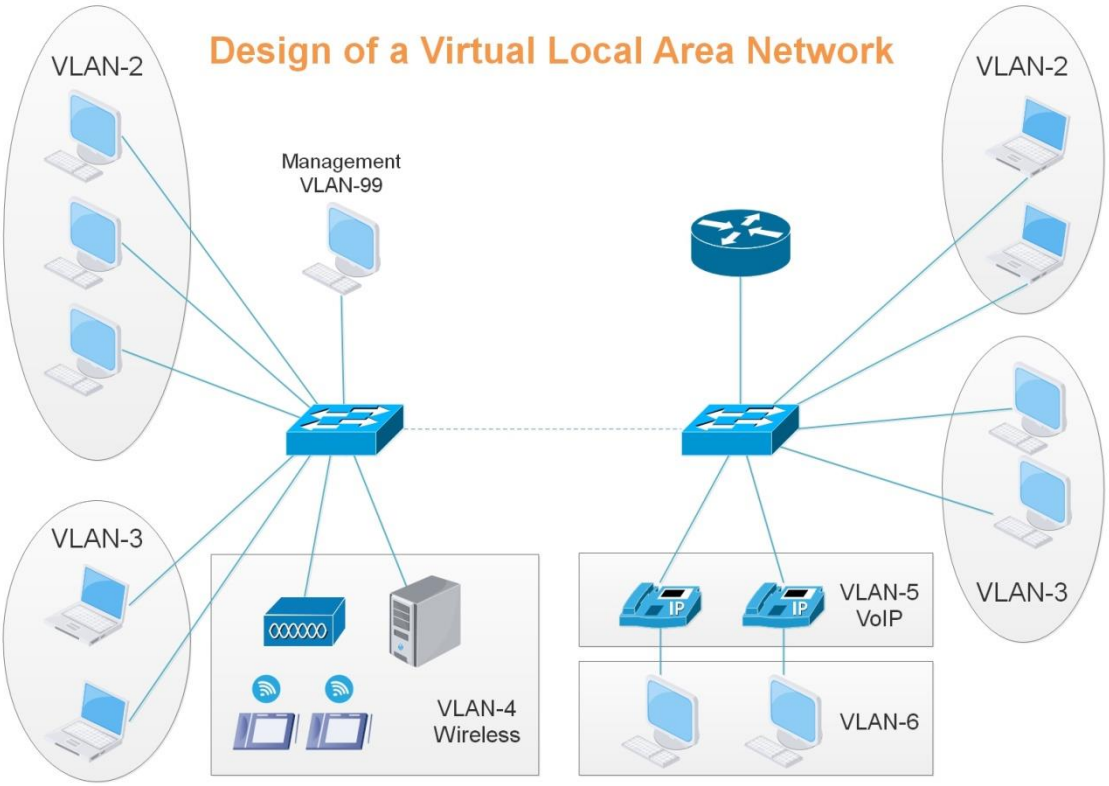


Figure 11: Architecture Design of VLANs

5.3.3.1 Internet Management

Summary: This system is used by participant and admin. Participant can connect and exit from the system. In addition to this, admin can configure network devicesand exit from the system.

Actor: Participant, Admin

Precondition: Participant must starts the device which have internet connection. Admin must connectnetwork device configuration interface.

Basic Sequence:

1. Participant must have device which have internet connection.

2. Participant can starts software which need internet connection.

3. Admin can connect the network device and configuredevice by Command Line Interface.

4. Admin must enter passwords of device if passwords set before.

5. Participant and admin can exit from the system by shutdown software or device.

Exception: Password input can be failed.

Post Conditions: None

Priority: Medium

5.3.3.2 Configure Management

Summary: This system is used by participant and admin. Participant can attend to VLANand exit from the system. Admin can attend to VLAN, create VLAN, change VLAN name, delete VLAN, add interface to VLAN, delete interface to VLAN, create bridges between VLANs, shutdown all connectionsand exit from the system.

Actor: Participant, Admin

Precondition: Participant must starts the device which have internet connection. Admin must connect network device configuration interface.

Basic Sequence:

1. Participant must have device which have internet connection.

2. Participant can starts software which need internet connection.

3. Admin can connect the network device and configure device by Command Line Interface.

4. Admin must enter passwords of device if passwords set before.

5. Admin must control all hosts and other devices in network before change VLAN structures.

6. Admin can create VLAN in Command Line Interface of switch.

7. Admin can change VLAN name in Command Line Interface of switch.

8. Admin can add and delete interface to VLAN in Command Line Interface of switch.

9. Admin can create bridges between VLANs in Command Line Interface of router.

10. Admin can shutdown all connections in Command Line Interface of network devices.

11. Participant and admin can exit from the system by shutdown software or device.

Exception: Password input can be failed.

Post Conditions: None

Priority: Medium

5.3.3.3 VOIP Management

Summary: This system is used by participant and admin. Participant can IP phone call, regular phone call, end call, change user settings, change device settings andshutdown phone connection in the system. Admin can change user settings, change device settings, assign IP address to IP phones, assign phone number to IP phones, shutdown connections and exit from the system.

Actor: Participant, Admin

Precondition: Participant must have and start the IP Phone. Admin must connect network device configuration interface.

Basic Sequence:

1. Participant must IP Phone which have internet connection.

2. Participant must starts IP Phone.

3. Participant can IP phone call by hold handset and enter contact person IP phone number.

4. Participantcan regular phone call by hold handset and enter contact person regular phone number.

5. Participant can end call by put handset in its place.

6. Participant can change user settings and device settings from IP Phone options menu by using IP Phone screen.

7. Participant can shutdown phone connection by disconnect power or ethernet cable of IP Phone.

8. Admin can connect the router and configure IP Phones by Command Line Interface of Router's Telephony Service configuration.

9. Admin must enters passwords of router if passwords set before.

10. Admin must controls all IP Phones in network before change VoIP structure.

11. Admin can change user settings and device settings in Command Line Interface of Router's Telephony Service configuration.

12. Admin can assign IP address and phone IP numbers to IP Phones in Command Line Interface of Router's Telephony Service configuration.

13. Admin can shutdown IP Phone connections in Command Line Interface of Router's Telephony Service configuration.

14. Admin can exit from the system by shutdown software or router

Exception: Password input can be failed.

Post Conditions: None

Priority: Medium

5.4 PROTOTYPE OF VLAN PROJECT

5.4.1 Modelling of VLANs

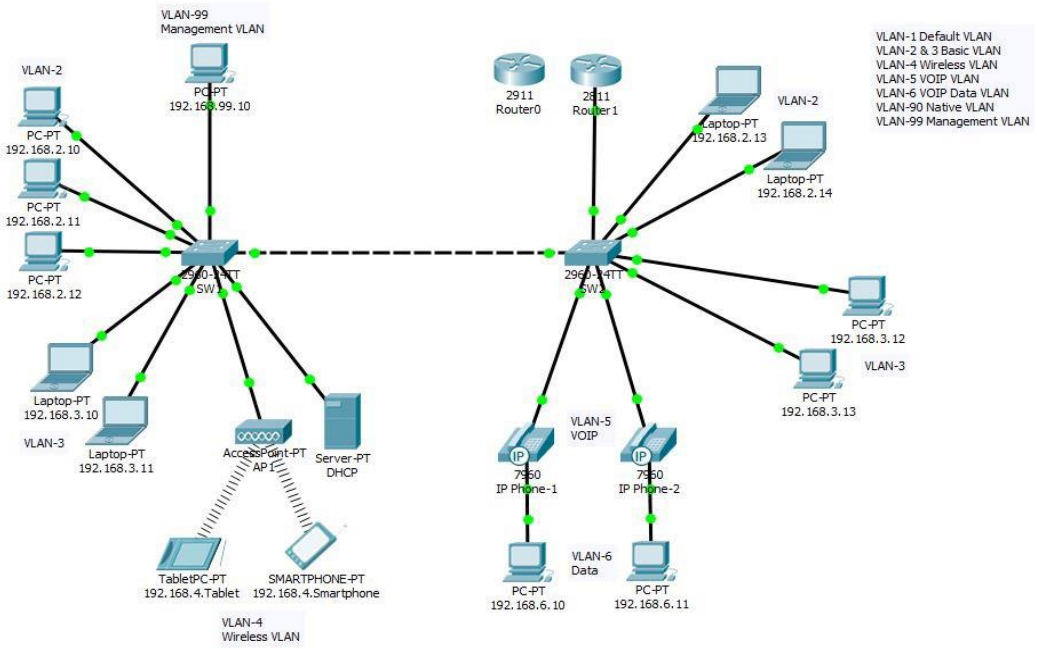


Figure 12: Prototype of VLAN Project with using Cisco Operating System

5.4.1.1 VLAN names and Functions

In our project, we designed a total of 8 virtual local area networks. VLANs are named:

- Vlan1 is default Vlan.
- Vlan2 & Vlan3 are basic Vlan.
- Vlan4 is a wireless Vlan.
- Vlan5 is a VOIP Vlan.
- Vlan6 is a VOIP data Vlan.
- Vlan90 is a native Vlan.
- Vlan99 is a management Vlan.

VLAN-1 (Default Vlan)

The virtual switch supports the each it of these VLAN types. The purpose of each is to assist in the management of VLAN assignments and traffic flow through the virtual switch.

Cisco switches always have Vlan1 that the default Vlan. We can't change or delete the default VLAN, it is mandatory.

VLAN-90 (Native Vlan)

The native VLAN is the only VLAN which is not tagged in a trunk. In other words, native VLAN frames are transmitted unchanged. Native Vlan traffic traverse untagged. There is no tagging.

VLAN-99 (Management Vlan)

Management VLAN is used for managing the switch from a remote location by using protocols such as telnet, SSH, SNMP, syslog etc. It is used to support remote connections from network administrators. Normally the Management VLAN is VLAN 1. But you can use any VLAN as a management VLAN.

VLAN-2 & VLAN-3 (Basic Vlan)

Basic VLANs is defined Networks for making easy to create and administration of logical groups which can communicate among themselves.

VLAN-4 Wireless VLAN

The basic wireless components of a VLAN consist of an access point and a client associated to it through wireless technology. The access point is physically connected through a trunk port to the network VLAN switch on which the VLAN is configured. The physical connection to the VLAN switch is through the access point Ethernet port. [25]

VLAN-5 VOIP VLAN

The voice VLAN feature enables access ports to carry IP voice traffic from an IP phone.

VLAN-6 VOIP DATA VLAN

The VOIP Data VLANs use hubs between phones to connect cables. In other words, it behaves like any other VLAN but can be connected to the phone.

5.4.1.2 Types of Connections for Project

1) Trunk Link
2) Access Link

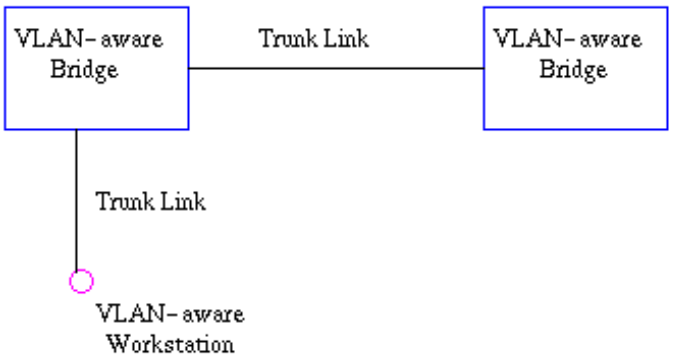


Figure 13: Trunk link between two VLAN-aware bridges

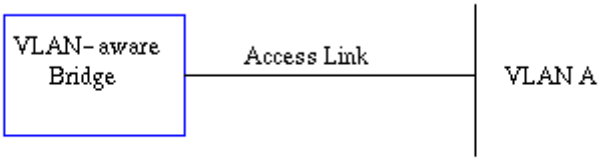


Figure 14: Access link between a VLAN-aware bridge and a VLAN-unaware device

6. Conclusions

This document includes wide information about our project that titled as “Design and Implementation of a Virtual Local Area Network with using Cisco Operating System”. In this project, we have aimed to design VLAN that make easy to create and administration of logical groups which can communicate among themselves. VLAN as Logically Defined Networks. We plan to use VLAN technology, logical networks are created on the devices that support this technology. [26] A VLAN is a switched network that is logically segmented, by functions, project teams, or applications rather than on a physical or geographical basis. Cisco IOS (Internetworking Operating Systems) and Packet Tracer Simulation program will be used to coding the switches and network design in this project. To develop project, first of all, we have made a lot of research about VLAN Technology, its usage area and similar projects. We have analyzed the similar projects, and tried to understand what features have made them effective. We have gained a lot of information about VLAN Technology and how to develop a project that includes VLAN Technology products. One of the most important advantage of that if you want to reconfigure the devices, you do not need to unplug the devices and carry them. Instead of all this, we can use VLANs to reconfigure. This technology(VLAN) allows the reduce CPU overhead on devices by reducing the number of devices reduce security risks by reducing the copies of frames sent and receive unnecessarily.Also another security advantage is VLANs

keep important data inside VLAN, hosts who in other VLANs can’t see any data from other VLANs even if in same campus LAN.Network engineers are more flexible to design networks with VLANs. Engineers can create VLANs by campus LAN requirements.Problems in one VLAN don’t effect all campus LAN and can solve quickly within inoperative VLAN.This project creates opportunities such as flexible, efficient cost, more secure,minimize traffic etc. After research part, we have received requirements from a representative of Virtual Local Area Network. Upon these requirements, a SRS document is prepared. After requirements are specified, design of the developing product are prepared and this design is explained in a SDD document. During this period, we have chosen our development methodology, designed the architecture of the product and to present the product to the customer, we have developed a basic prototype of the project.

7. Acknowledgement

At first we offer our thanks to Sibel Tarıyan ÖZYER, our consultant. We thank all our teachers who helped us with the feedback. We give thanks to everyone who contributes to the work. The help we received from them was a great asset to improve this project and ourselves.

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