

# Design and Implementation of VLANs WITH Circuit Group

## (A Case Study of Hohoe Municipal Hospital)

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**ABSTRACT:** Hohoe municipal hospital is a government hospital located in Volta region of Ghana. Bus network topology has been the existing network in the hospital and it has been operational for several years. The network services enable the hospital staff to share files, print documents on a shared printer send and receive emails. Using this existing network without Virtual Local Area Network (VLAN) causes poor network performance and staff pay a lot of money for making calls due to the absence of VoIP services. VLAN is putting network devices together in the same domain to avoid flooding the networks with unnecessary traffic.

Voice over IP is a technology which translates data, such as voice or video, into a digital signal and transmit it over the internet as packets. The service providers deliver these services for subscribers or users through 3G, 4G and 5G technologies.

**KEYWORDS:** VLAN, VoIP, Circuit Group

### I. INTRODUCTION

Virtual Local Area Network (VLAN) is a logical grouping of network devices on same broadcast domain[1]. The VLAN functions in a layer 2 of Open Systems Interconnection (OSI) reference model and defines a broadcast domain. In data communication networking, a broadcast refers to transmitting data that all network devices receive whether the devices need it or not. VLAN is normally defined on a switch device port to create a broadcast domain. Each of the VLAN is classified as a subnet of switch interfaces in a network. A switch is a layer 2 network device which forward broadcast traffic through its interfaces except the port that it received the traffic from. Network bandwidth is saved when VLAN is configured on the Switch network device.

A broadcast domain is the set of all devices that receive broadcast frames originating from any device within the set. Broadcast domains are classically constrained by routers because routers do not forward broadcast frames [2]. All devices which are connected to hub, bridge or switch are in the same broadcast domain except a router which separate a Local Area Network into several broadcast domain. On the hand, a router network device breaks a broadcast domain. A circuit group is also called a trunk group, it is a logical path through which traffic is communicated across VLANs.

#### 1.1 OBJECTIVES OF THE RESEARCH

1. To manage network bandwidth efficiently
2. To improve network performance
3. To implement Voice over IP(VoIP)

#### 1.2 PROBLEM STATEMENT

The existing network in Hohoe Municipal Hospital is often characterized with high inefficiency of bandwidth which leads to poor network performance.

### 1.3 IMPORTANCE OF THE STUDY

The VLAN will help to improve network performance, enhance security of data while the VoIP services will save cost for the users

## II. RELATED WORK

Hohoe Municipal Hospital does not have VoIP services and VLAN is not configured on the Local Area Network switch device. The hospital has just bus network topology which has been in operation for several years. The network services enable the hospital staff to share files, print documents on a shared printer, send and receive emails.

There is inefficient use of network bandwidths because traffic sent to a specific device is received by all the network devices. This is due to lack of implementation of VLAN in the network.

Voice over Internet Protocol (VoIP) is a technology that enable users of a telecom or internet service providers to make calls over LAN or internet unlike the Public Switched Telephone Network (PSTN) which does not provide such services. With VoIP services, packetized voice travels over the internet to a gateway which converts the VoIP to regular telephone calls [3].

Virtual Local Area Network physically divides separate users or servers into logical work groups. Each VLAN is a single broadcast domain, and the unicast and multicast of inter-VLAN cannot directly forward traffic to other VLANs, so VLAN need use router to achieve data communication [4]. This implies that when VLAN is implemented in a network, bandwidth can be managed efficiently since traffic sent to a specific device is not received by other devices outside that particular VLAN.

In this study, VLAN will be designed and implemented as well as VoIP to solve the bandwidth challenges currently being experienced at the Hohoe Municipal Hospital.

### 2.1 Importance of VLAN

- i. Broadcast domains are increased while reducing their sizes.
- ii. It mitigates security risks by decreasing the number of computers that receive frames that are forwarded by switches.
- iii. Computers or nodes that have sensitive data can be separated enhance security.
- iv. Flexible network designs can be done by grouping users by different departments rather than by physical locations.
- v. It is easier to manage network changes by just configuring a port into the appropriate VLAN.

### 2.3 Advantages of VoIP

The advantages of VoIP are: It saves cost for the users. Calls between individuals either national or international are free, the users only pay for internet services. Secondly, it improves productivity that is users can make or receive calls as well as have access data at any time in any location wherever is network coverage. Thirdly, it provides a wide array of many features such as call forwarding, blocking, caller ID and voicemail, remote management, automatic call distribution and interactive voice recognition [5].

## III. METHODOLOGY

Quantitative research approach and experimental research method were adopted in this study. The method allows for observation in a real time.

### 3.1 Data collection

Data about the network were collected from the administrator of Hohoe Municipal hospital through interview as the research instrument.

### 3.2 Existing Network

The existing hospital network has no VLAN and IP phones as shown in the figure 1 below

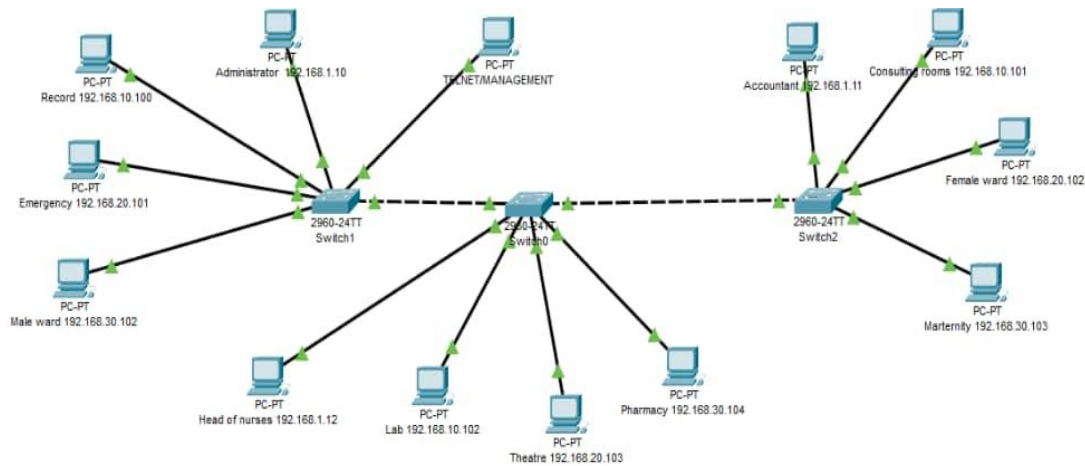


Figure 1

VLAN is not implemented in the above figure 1 the network, any traffic that is transferred from one computer will be received by all the devices on the network, this caused increased in the CPU overhead on each devices, wastage of bandwidth and a decrease in data security.

### 3.3 Proposed Network Design with VLAN and IP Phones

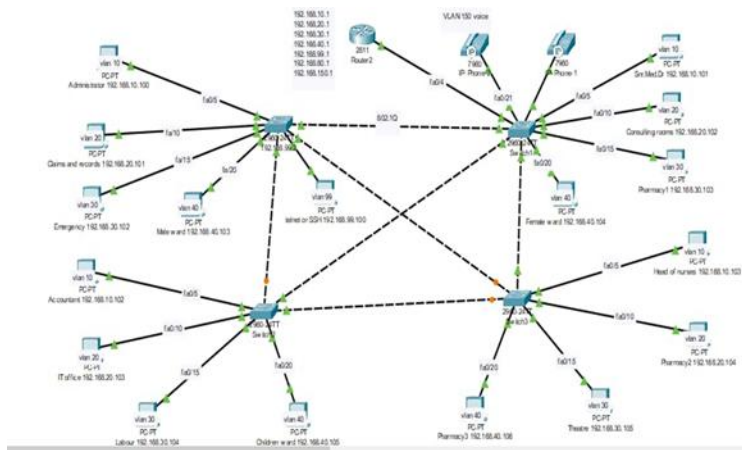


Figure 2

Figure 2 above represents proposed VLAN with sixteen (16) hosts/PCs, a management terminal, four (4) switches, a router and two (2) IP phones. These network devices are implemented and properly configures in the experimental results session.

The interfaces on both switches are separated on different VLAN so that traffic from one host can only be received by the devices inside the same VLAN, since each VLAN is a separate broadcast domain.

## IV. EXPERIMENTAL RESULTS

4.1 The below figures 3,4,5,6 and 7 represent IP phone installations, configurations and commissioning.

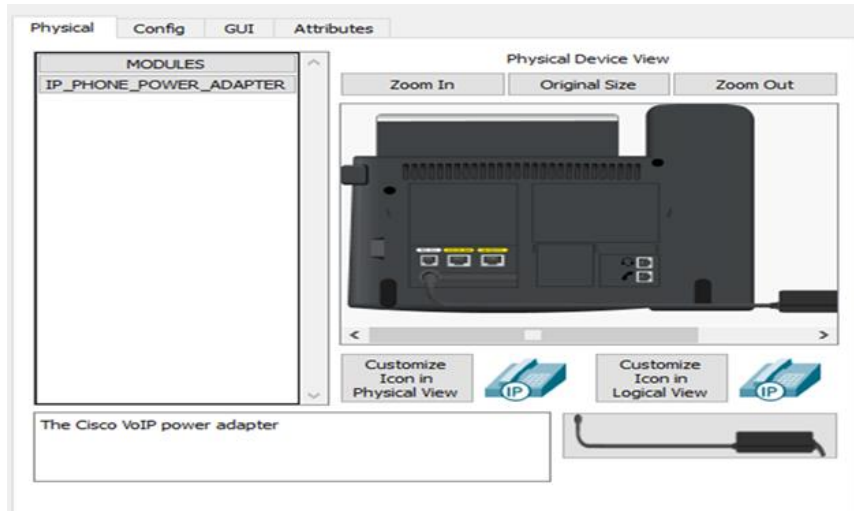


Fig 3:Physical IP Phone Device View



Fig 4: Global settings configuration view



Fig 5 :Graphic User Interface(GUI) for IP phone



Fig 6: Ring out call of IP phone



Fig 7: Call connection on IP phone

#### 4.2 Configuration processes of the network devices

1. Four switches and 16 hosts/PCs are setup. Basically, the switch is used to create a LAN and it is connected to a host/PC.
2. First PC on the network was assigned an IP address of 192.168.1.100 and the second PC was assigned 192.168.1.101 and it goes in that order till the last host. Four hosts were connected to a switch using a straight-through cables making the hosts to be on the same LAN.
3. The first PC with the IP address 192.168.1.100 was assigned to port 5 of the cisco switch and also assign the second PC with the IP address 192.168.1.101 was assigned to port 10 of the cisco switch. This made both hosts to communicate with each other since they are both on the same IP range.
4. A connectivity test was performed to verify if both hosts could communicate with each other. The test was successful when Ping 198.168.1.101 command was issues from the first host.
5. Note that all cisco switches are set up by default to be part of the default VLAN which is VLAN 1.
6. Switch>enable command will take you to Switch# show vlan as a command from privilege user mod. The command displayed all the ports on the cisco switch which are part of the default vlan 1 and you will also observe some other built in default vlan.
7. Additional vlan, need to be created from the last command show vlan by following the below steps:

Switch# (config) # vlan 50

Switch (config-vlan) # name staff

Switch (config-vlan) # vlan 99

Switch (config-vlan) # name mgt

Switch (config-vlan) #exit

Switch # show run

Switch # show vlan

8. Use the command show vlan to view the VLANs that were created This displayed VLAN 50 called staff and VLAN 99 called management (mgt). The created VLANs are both active but there is no port assigned to them. Next is to assign them to ports on the cisco switch.
9. The second PC which has IP address of 192.168.1.101 will be assigned to port 10 on the cisco switch, and assign that same second PC to port 10 of the staff vlan that was created. See the below commands:

Switch # configure terminal

Switch (config) # interface fast Ethernet 0/10 from here enter the interface configuration mode

Switch (config-if) # switch port mode access

Switch (config-if) # switch port access vlan 50

Switch# show run

10. After the show run command, you can see that interface 10 has been assigned to vlan 50, so now port 10 is on a different vlan while port 5 is on the default vlan.
11. Both first and the second PC cannot communicate with each other since the second PC is now part of the staff vlan 50, and the first PC which is connected to port 5 of the cisco switch which is on the default vlan. A connectivity test using Ping command failed. This was done to verify if both PCs could communicate with each other but the test was not successful because the first and the second PC are in different VLANs.
12. Since there is default VLAN, VLAN 50. Next is to introduce a PC which will be VLAN 99 for management and it will be part of the VLAN that was created for configuration on the cisco switch. A straight-through cable is used to connect the PC to port 24 of the cisco switch, an IP address which is 192.168.99.100 is assigned to the third PC which is on VLAN 99. Since we have introduced a third PC which has been connected to port 24 of the cisco switch, it is necessary to configure this port number on the switch, to do that, be on the cisco switch and type the commands as follows:

Switch>enable

Switch# configure terminal

Switch (config)# interface fast Ethernet 0/24

Switch(config-if) #switch port mode access

Switch(config-if) #switch port access vlan 99

Switch(config-if) #exit

Switch# show vlan

13. Data vlan is vital with respect to trunk(circuit) port. We have been able to create access ports with configured VLANs on them. A circuit or a trunk port, carry, multiple vlan across one link.
14. Now deal with trunks or circuit group (collection of circuits). The trunk connection occurs between two separate networks that is either within the same building but different floors or different building. There is need to create a separate network to have the trunk connection configured on them, to do that , we will take another switch that is 2960 switch and a different PC which will also be the default vlan for this network and also another PC will be introduced which will be on the staff vlan for this new network that is on vlan 50.
15. A straight through cable is used to connect the PC to the switch and assign the default VLAN to port5 on the switch and provide 192.168.1.101 as an IP address to that PC and also assign VLAN 50 to port10 on the switch and provide 192.168.50.102 as an IP address to that PC also and these will be on the same network that is on the same VLAN.

The PCs on the new network, new building need to communicate with the other PCs on other network across the switches. To establish this communication, a cross over cable is used to connect both switches together on port 1 of the switches.

16. After the connections have been completed, the two default VLANs on both networks should be able to communicate with each other and this can be verified by using Ping command.to perform connectivity test.
17. But the two staff VLAN 50 on both of the networks will not be able to communicate with each other because both are on a separate VLAN and also they have separate network addresses.
18. If we want these two VLAN 50 to communicate with each other across various switches on the different networks,, we will set up a trunk port in which both VLAN, that is the default VLAN and the VLAN 50 of the other network. The trunk can carry multiple VLANs. We need to configure port 10 on the switch for VLAN 50 through the following procedures. Enter the switch and go to the Command Line Interface(CLI) and type the following commands:

```
Switch>enable
```

```
Switch#configure terminal
```

```
Switch(config)#interface fa0/10
```

```
Switch(config-if) #switch port mode access
```

```
Switch(config-if) #switch port access vlan 50
```

19. The above command was not successful because the VLAN 50 on the switch was not created.

20. Switch#show run. With this command, you will be able to see that VLAN 50 was not created and hence it needs to be created using the below commands:

```
Switch#configure terminal
```

```
Switch(config)#vlan 50
```

```
Switch(config-vlan) #name staff
```

```
Switch#show vlan
```

You can verify that the vlan50 is created with the command above.

## V. CONCLUSION

The above results showed a successful configuration of VLAN to manage network bandwidth efficiently and improved network performance with enhanced security of data. The installations and implementations of VoIP will help users to pay less for calls and perform other features mentioned in this study.

## VI. RECOMMENDATIONS

It is recommended that the Hohoe Municipal Hospital should implement the VLAN in the hospital to improve network performance and enhance security of data. If this suggestion is not implemented, the hospital network will continue to experience inefficient use of bandwidth, poor network performance and the staff will still be paying a lot of money on phone calls.

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