IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Volume-4, Issue-7 E-ISSN: 2347-2693

A Simulation Based Study on Inter-VLAN Routing

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Available online at: www.ijcseonline.org

Received:21/Jun/2016 Revised: 29/Jun/2016 Accepted: 22/Jul/2016 Published: 31/Jul/2016

***Abstract*—**The VLAN technology is a technology which is used to logically divide the network into different broadcast domains. So that the packets are delivered within the port of same VLAN group. According to this paper the VLAN is the basis of the Inter-VLAN connection. Inter-VLAN routing technique is a technique which is used to allow different VLANs to communicate. In order to communicate we make use of router interface or multilayer switches. We have implemented this Inter-VLAN routing concepts using Packet Tracer Tool 6.0.1.

Keywords- *VLAN; Subinterface; Inter-VLAN; VLAN ID; Access mode; Trunk mode*

I. INTRODUCTION

The VLAN technology functions by logically segmenting the network into different broadcast domains so that packets can only delivered between ports with the same VLAN group member. VLAN (virtual LAN) is a technology which, can configure logical networks independent of the physical network structure. With VLAN, users in common spaces (such as meeting rooms) can access their department networks temporarily because changing of logical network structure is achieved only by configuration of VLAN switches. However, in the general configuration method, because VLANs are managed statically by administrators, various problems such as high administrative cost and conflict or insufficiency of VLAN-IDs may arise especially in large scale organizations where VLANs are managed by each department [1].

Inter-VLAN routing is used to permit different VLANs to communicate. Different router interface configurations facilitate inter-VLAN routing. VLAN is a unique broadcast domain, so computers on separate VLANs are, by default, not able to communicate. There is a way to permit these end stations to communicate; it is called inter-VLAN routing. [2]

Inter-VLAN routing using a separate router connected to the switch infrastructure. We define inter-VLAN routing as a process of forwarding network traffic from one VLAN to another VLAN using a router. VLANs are associated with unique IP subnets on the network. This subnet configuration facilitates the routing process in a multi-VLAN environment.[6] [12]

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II. PROBLEM DEFINITION

A. *Inter-VLAN Routing*

Inter-VLAN routing technique is a technique which is used to allow different VLANs to communicate. In order to communicate we make use of router interface or multilayer switches. Different methods for accomplishing inter-VLAN routing.[6][11]

B. *Traditional inter-VLAN*

Traditionally, LAN routing has used routers with multiple physical interfaces. Each interface needed to be connected to a separate network and configured for a different subnet. In a traditional network that uses multiple VLANs to segment the network traffic into logical broadcast domains, routing is performed by connecting different physical router interfaces to different physical switch ports. The switch ports connect to the router in access mode; in access mode, different static VLANs are assigned to each port interface. Each switch interface would be assigned to a different static VLAN. Each router interface can then accept traffic from the VLAN associated with the switch interface that it is connected to, and traffic can be routed to the other VLANs connected to the other interfaces. In Fig1: Traditional inter-VLAN routing requires multiple physical interfaces on both the router and the switch. However, not all inter-VLAN routing configurations require multiple physical interfaces. Some router software permits configuring router interfaces as trunk links. This opens up new possibilities for inter-VLAN routing. [2] [7] [9] [15] [16]

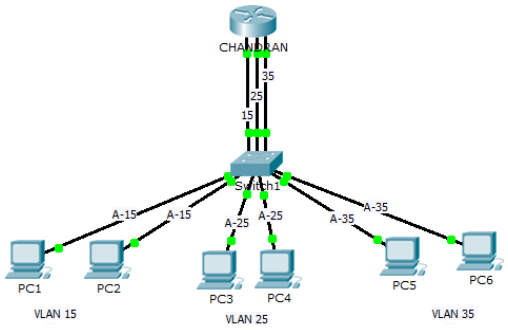


Fig1: Traditional inter-VLAN

C. Router-on-a-stick

Fig2:"Router-on-a-stick" is a type of router configuration in which a single physical interface routes traffic between multiple VLANs on a network. As you can see in the figure, the router (CHANDRAN) is connected to switch1 using a single, physical network connection.[4]

The router interface is configured to operate as a trunk link (T) and is connected to a switch port configured in trunk mode. The router performs the inter-VLAN routing by accepting VLAN tagged traffic on the trunk interface coming from the adjacent switch and internally routing between the VLANs using subinterfaces. The router then forwards the routed traffic-VLAN tagged for the destination VLAN-out the same physical interface. [3] [9]

Subinterfaces are multiple virtual interfaces, associated with one physical interface. These subinterfaces are configured in software on a router that is independently configured with an IP address and VLAN assignment to operate on a specific VLAN. Subinterfaces are configured for different subnets corresponding to their VLAN assignment to facilitate logical routing before the data frames are VLAN tagged and sent back out the physical interface.[2] [7] [10] [15] [16].

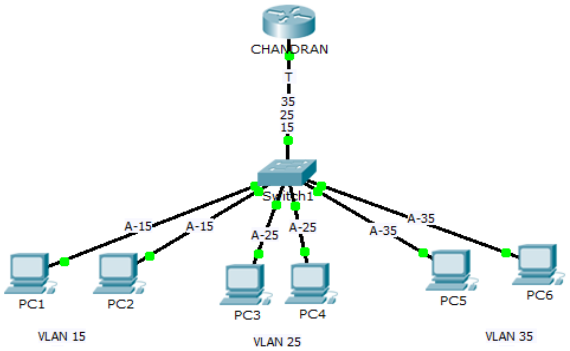


Fig2: Router-on-a-stick

D. Inter-VLAN routing using Multilayer switch

Switches can perform Layer 3 functions, replacing the need for dedicated routers to perform basic routing on a network. Multilayer switches are capable of performing inter-VLAN routing.[4][5][9]

In Fig3 multilayer switch to perform routing functions, VLAN interfaces on the switch need to be configured with the appropriate IP addresses that match the subnet that the VLAN is associated with on the network. The multilayer switch also must have IP routing enabled.[7] [8] [15][16].

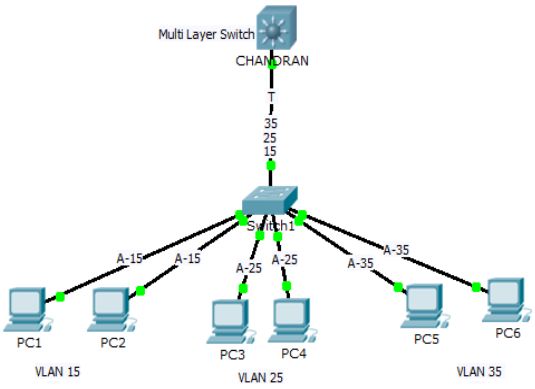


Fig3: Inter-VLAN routing using Multilayer switch

III. METHODOLOGY

A. Gateway

Traditional routing requires routers to have multiple physical interfaces to facilitate inter-VLAN routing. The router accomplishes the routing by having each of its physical interfaces connected to a unique VLAN. Each interface is also configured with an IP address for the subnet associated with the particular VLAN that it is connected to. By configuring the IP addresses on the physical interfaces, network devices connected to each of the VLANs can communicate with the router using the physical interface connected to the same VLAN. [2] [3][14]

B. Subinterface

Configuring router subinterfaces is similar to configuring physical interfaces, except that you need to create the subinterface and assign it to a VLAN.[5]

Subinterface	Physical Interface
One interface for Multiple VLAN	Each interface per VLAN
Less Expensive	More Expensive
Configuration is Less complex	Configuration is difficult
Using Trunk mode on switchport	Using Access mode on switchport

Table1: Subinterface vs Physical Interface

C. *Port Setting*

1) *Access Ports*

Connecting physical interfaces for inter-VLAN routing requires that the switch ports be configured as access ports.[2] [13]

2) *Trunk Ports*

Subinterfaces require the switch port to be configured as a trunk port so that it can accept VLAN tagged traffic on the trunk link. Using subinterfaces, many VLANs can be routed over a single trunk link rather than a single physical interface for each VLAN. [6] [11]

IV. RESULT AND DISCUSSION

A. *Traditional inter-VLAN*

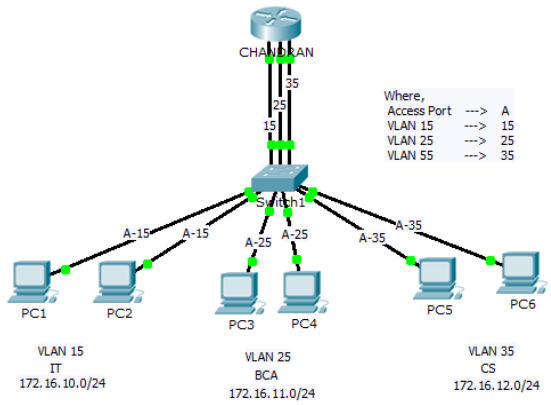


Fig4: Traditional inter-VLAN implemented Packet Tracer Tool

```
Switch>enable
Switch(config)#hostname SOMU
SOMU(config)#vlan 15
SOMU(config-vlan)#name IT
SOMU(config-vlan)#exit
SOMU(config)#vlan 25
SOMU(config-vlan)#name BCA
SOMU(config-vlan)#exit
SOMU(config)#vlan 35
SOMU(config-vlan)#name CS
```

```
SOMU#show vlan brief
VLAN Name                Status    Ports
---- ------------------- --------- -------------------------------
1    default             active    Fa0/1, Fa0/2, Fa0/3, Fa0/4, Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                   Fa0/9, Fa0/10, Fa0/11, Fa0/12, Fa0/13, Fa0/14, Fa0/15, Fa0/16
                                   Fa0/17, Fa0/18, Fa0/19, Fa0/20, Fa0/21, Fa0/22, Fa0/23, Fa0/24
15   IT                  active
25   BCA                 active
35   CS                  active
1002 fddi-default        active
1003 token-ring-default  active
1004 fddinet-default     active
1005 trnet-default       active
SOMU#
```

Fig5: Verifying VLAN Details

```
SOMU(config)#interface range fastEthernet 0/1-2
SOMU(config-if-range)#switchport mode access
SOMU(config-if-range)#switchport access vlan 15
SOMU(config-if-range)#^Z

SOMU(config)#interface range fastEthernet 0/3-4
SOMU(config-if-range)#switchport mode access
SOMU(config-if-range)#switchport access vlan 25
SOMU(config-if-range)#exit

SOMU(config)#interface range fastEthernet 0/5-6
SOMU(config-if-range)#switchport mode access
SOMU(config-if-range)#switchport access vlan 35
SOMU(config-if-range)#^Z
SOMU(config)#interface FastEthernet0/21
SOMU(config-if)#switchport mode access
SOMU(config-if)#switchport access vlan 15
SOMU(config-if)#exit

SOMU(config)#interface FastEthernet0/22
SOMU(config-if)#switchport mode access
SOMU(config-if)#switchport access vlan 25
SOMU(config-if)#exit

SOMU(config)#interface FastEthernet0/23
SOMU(config-if)#switchport mode access
SOMU(config-if)#switchport access vlan 35
SOMU(config-if)#^Z
```

```
SOMU#show vlan
VLAN Name                Status    Ports
---- ------------------- --------- -------------------------------
1    default             active    Fa0/7, Fa0/8, Fa0/9, Fa0/10, Fa0/11, Fa0/12, Fa0/13, Fa0/14
                                   Fa0/15, Fa0/16, Fa0/17, Fa0/18, Fa0/19, Fa0/20, Fa0/24
15   IT                  active    Fa0/1, Fa0/2, Fa0/21
25   BCA                 active    Fa0/3, Fa0/4, Fa0/22
35   CS                  active    Fa0/5, Fa0/6, Fa0/23
1002 fddi-default        act/unsup
1003 token-ring-default  act/unsup
1004 fddinet-default     act/unsup
1005 trnet-default       act/unsup
```

Fig6: VLAN assigning particular interface

```
Port              Link   VLAN  IP Address         MAC Address
FastEthernet0/1   Up     15    --                 000A.F3E5.0D01
FastEthernet0/2   Up     15    --                 000A.F3E5.0D02
FastEthernet0/3   Up     25    --                 000A.F3E5.0D03
FastEthernet0/4   Up     25    --                 000A.F3E5.0D04
FastEthernet0/5   Up     35    --                 000A.F3E5.0D05
FastEthernet0/6   Up     35    --                 000A.F3E5.0D06
FastEthernet0/7   Down   1     --                 000A.F3E5.0D07
FastEthernet0/8   Down   1     --                 000A.F3E5.0D08
FastEthernet0/9   Down   1     --                 000A.F3E5.0D09
FastEthernet0/10  Down   1     --                 000A.F3E5.0D0A
FastEthernet0/11  Down   1     --                 000A.F3E5.0D0B
FastEthernet0/12  Down   1     --                 000A.F3E5.0D0C
FastEthernet0/13  Down   1     --                 000A.F3E5.0D0D
FastEthernet0/14  Down   1     --                 000A.F3E5.0D0E
FastEthernet0/15  Down   1     --                 000A.F3E5.0D0F
FastEthernet0/16  Down   1     --                 000A.F3E5.0D10
FastEthernet0/17  Down   1     --                 000A.F3E5.0D11
FastEthernet0/18  Down   1     --                 000A.F3E5.0D12
FastEthernet0/19  Down   1     --                 000A.F3E5.0D13
FastEthernet0/20  Down   1     --                 000A.F3E5.0D14
FastEthernet0/21  Up     15    --                 000A.F3E5.0D15
FastEthernet0/22  Up     25    --                 000A.F3E5.0D16
FastEthernet0/23  Up     35    --                 000A.F3E5.0D17
FastEthernet0/24  Down   1     --                 000A.F3E5.0D18
Vlan1             Down   1     <not set>          0060.70B9.B925
Hostname: SOMU
```

Fig7: Screening the VLAN Details

```
Router>enable
```



```
Router#configure terminal
Router(config)#hostname CHANDRAN
CHANDRAN(config)#interface FastEthernet0/0
CHANDRAN(config-if)#no shutdown
CHANDRAN(config-if)#ip address 172.16.10.10 255.255.255.0
CHANDRAN(config-if)#exit
CHANDRAN(config)#interface FastEthernet1/0
CHANDRAN(config-if)#no shutdown
CHANDRAN(config-if)#ip address 172.16.11.10 255.255.255.0
CHANDRAN(config-if)#exit
CHANDRAN(config)#interface FastEthernet6/0
CHANDRAN(config-if)#no shutdown
CHANDRAN(config-if)#ip address 172.16.12.10 255.255.255.0
CHANDRAN(config-if)#
```

B. Router- on a Stick

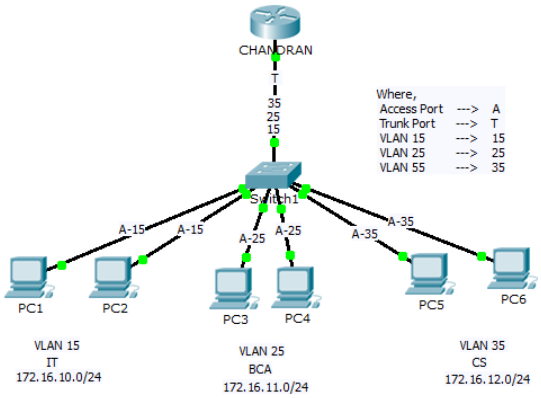


Fig8: Router-on a Stick implemented Packet Tracer Tool

```
Switch>enable
Switch(config)#hostname SOMU
SOMU(config)#vlan 15
SOMU(config-vlan)#name IT
SOMU(config-vlan)#exit
SOMU(config)#vlan 25
SOMU(config-vlan)#name BCA
SOMU(config-vlan)#exit
SOMU(config)#vlan 35
SOMU(config-vlan)#name CS

SOMU(config)#interface range fastEthernet 0/1-2
SOMU(config-if-range)#switchport mode access
SOMU(config-if-range)#switchport access vlan 15
SOMU(config-if-range)#^Z

SOMU(config)#interface range fastEthernet 0/3-4
SOMU(config-if-range)#switchport mode access
SOMU(config-if-range)#switchport access vlan 25
SOMU(config-if-range)#exit

SOMU(config)#interface range fastEthernet 0/5-6
SOMU(config-if-range)#switchport mode access
SOMU(config-if-range)#switchport access vlan 35
SOMU(config-if-range)#^Z
SOMU(config)#interface FastEthernet0/21
SOMU(config-if)#switchport mode trunk
SOMU(config-if)#exit
```

```
SOMU#show vlan
VLAN  Name                Status    Ports
----  --------------------  --------  -------------------------------
1     default               active    Fa0/7, Fa0/8, Fa0/9, Fa0/10, Fa0/11, Fa0/12, Fa0/13, Fa0/14
                                      Fa0/15, Fa0/16, Fa0/17, Fa0/18, Fa0/19, Fa0/20, Fa0/24
15    IT                    active    Fa0/1, Fa0/2
25    BCA                   active    Fa0/3, Fa0/4
35    CS                    active    Fa0/5, Fa0/6
1002  fddi-default          act/unsup
1003  token-ring-default    act/unsup
1004  fddinet-default       act/unsup
1005  trnet-default         act/unsup
```

Fig9: Screening the VLAN details of Switch (SOMU)

```
CHANDRAN(config)#interface FastEthernet0/0
CHANDRAN(config)#no shutdown
CHANDRAN(config)#interface FastEthernet0/0.15
CHANDRAN(config-subif)#no shutdown
CHANDRAN(config-subif)#encapsulation dot1Q 15
CHANDRAN(config-subif)#ip address 172.16.10.10 255.255.255.0
CHANDRAN(config-subif)#exit

CHANDRAN(config)#interface FastEthernet0/0.25
CHANDRAN(config-subif)#no shutdown
CHANDRAN(config-subif)#encapsulation dot1Q 25
CHANDRAN(config-subif)#ip address 172.16.11.10 255.255.255.0
CHANDRAN(config-subif)#exit

CHANDRAN(config)#interface FastEthernet0/0.35
CHANDRAN(config-subif)#no shutdown
CHANDRAN(config-subif)#encapsulation dot1Q 35
CHANDRAN(config-subif) #ip address 172.16.12.10
255.255.255.0
```

```
CHANDRAN#show ip interface brief
Interface              IP-Address      OK?  Method  Status                Protocol
FastEthernet0/0        unassigned      YES  NVRAM   up                    up
FastEthernet0/0.15     172.16.10.10    YES  manual  up                    up
FastEthernet0/0.25     172.16.11.10    YES  manual  up                    up
FastEthernet0/0.35     172.16.12.10    YES  manual  up                    up
FastEthernet1/0        unassigned      YES  NVRAM   administratively down down
Serial2/0              unassigned      YES  NVRAM   administratively down down
Serial3/0              unassigned      YES  NVRAM   administratively down down
```

Fig10: Verifying subinterface details

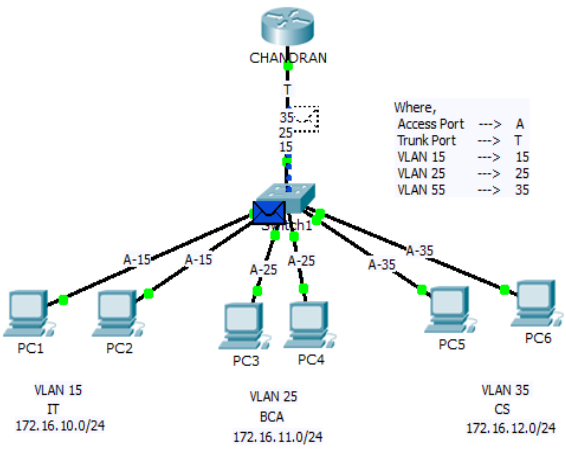


Fig11: packet moving from Switch to Router (CHANDRAN)

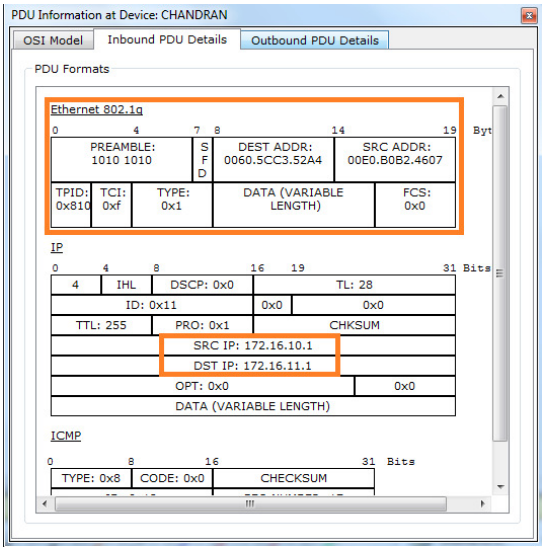


Fig12: Verifying routing table (CHANDRAN)

C. Inter-VLAN routing using Multilayer switch

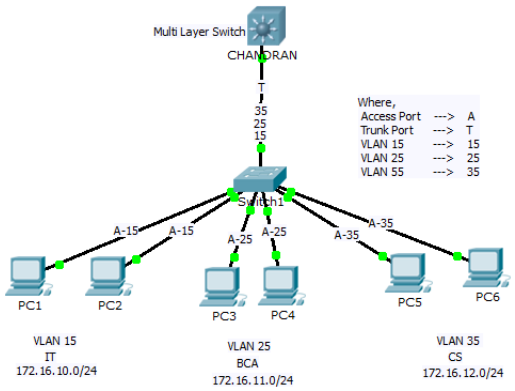
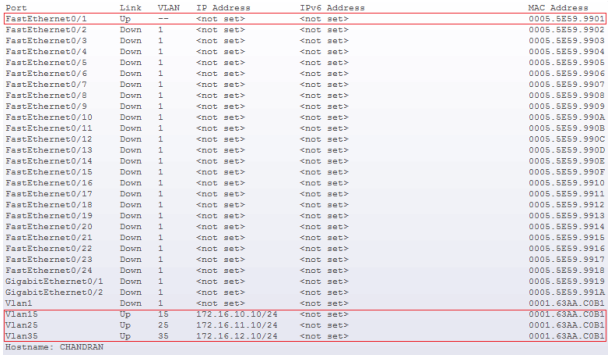


Fig13: Inter-VLAN routing using Multilayer switch Implemented Packet Tracer Tool



Port	Link	VLAN	IP Address	IPv6 Address	MAC Address
FastEthernet0/1	Up	--	<not set>	<not set>	0005.5E59.9901
FastEthernet0/2	Down	1	<not set>	<not set>	0005.5E59.9902
FastEthernet0/3	Down	1	<not set>	<not set>	0005.5E59.9903
FastEthernet0/4	Down	1	<not set>	<not set>	0005.5E59.9904
FastEthernet0/5	Down	1	<not set>	<not set>	0005.5E59.9905
FastEthernet0/6	Down	1	<not set>	<not set>	0005.5E59.9906
FastEthernet0/7	Down	1	<not set>	<not set>	0005.5E59.9907
FastEthernet0/8	Down	1	<not set>	<not set>	0005.5E59.9908
FastEthernet0/9	Down	1	<not set>	<not set>	0005.5E59.9909
FastEthernet0/10	Down	1	<not set>	<not set>	0005.5E59.990A
FastEthernet0/11	Down	1	<not set>	<not set>	0005.5E59.990B
FastEthernet0/12	Down	1	<not set>	<not set>	0005.5E59.990C
FastEthernet0/13	Down	1	<not set>	<not set>	0005.5E59.990D
FastEthernet0/14	Down	1	<not set>	<not set>	0005.5E59.990E
FastEthernet0/15	Down	1	<not set>	<not set>	0005.5E59.990F
FastEthernet0/16	Down	1	<not set>	<not set>	0005.5E59.9910
FastEthernet0/17	Down	1	<not set>	<not set>	0005.5E59.9911
FastEthernet0/18	Down	1	<not set>	<not set>	0005.5E59.9912
FastEthernet0/19	Down	1	<not set>	<not set>	0005.5E59.9913
FastEthernet0/20	Down	1	<not set>	<not set>	0005.5E59.9914
FastEthernet0/21	Down	1	<not set>	<not set>	0005.5E59.9915
FastEthernet0/22	Down	1	<not set>	<not set>	0005.5E59.9916
FastEthernet0/23	Down	1	<not set>	<not set>	0005.5E59.9917
FastEthernet0/24	Down	1	<not set>	<not set>	0005.5E59.9918
GigabitEthernet0/1	Down	1	<not set>	<not set>	0005.5E59.9919
GigabitEthernet0/2	Down	1	<not set>	<not set>	0005.5E59.991A
Vlan1	Down	1	<not set>	<not set>	0001.63AA.C0B1
Vlan15	Up	15	172.16.10.10/24	<not set>	0001.63AA.C0B1
Vlan25	Up	25	172.16.11.10/24	<not set>	0001.63AA.C0B1
Vlan35	Up	35	172.16.12.10/24	<not set>	0001.63AA.C0B1

Hostname: CHANDRAN

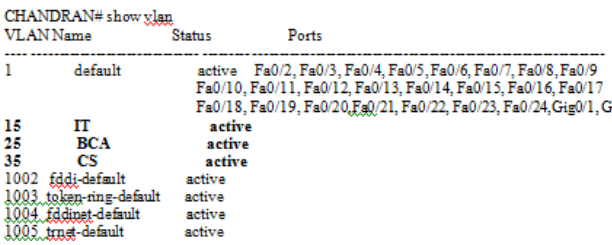
Fig14: Showing VLAN interface

CHANDRAN#config terminal
CHANDRAN(config)#ip routing
CHANDRAN(config)#interface fastEthernet 0/1
CHANDRAN(config-if)#no shutdown
CHANDRAN(config-if)#switchport mode trunk
CHANDRAN(config)#vlan 15
CHANDRAN(config-vlan)#name IT
CHANDRAN(config-vlan)#vlan 25
CHANDRAN(config-vlan)#name BCA
CHANDRAN(config-vlan)#vlan 35
CHANDRAN(config-vlan)#name CS
CHANDRAN(config-vlan)#exit

CHANDRAN(config)#interface vlan 15
CHANDRAN(config-if)#no shutdown
CHANDRAN(config-if)#ip address 172.16.10.10 255.255.255.0
CHANDRAN(config-if)#exit

CHANDRAN(config)#interface vlan 25
CHANDRAN(config-if)#no shutdown
CHANDRAN(config-if)#ip address 172.16.11.10 255.255.255.0
CHANDRAN(config-if)#exit

CHANDRAN(config)#interface vlan 35
CHANDRAN(config-if)#no shutdown
CHANDRAN(config-if)#ip address 172.16.12.10 255.255.255.0
CHANDRAN(config-if)#exit



CHANDRAN# show vlan

VLAN	Name	Status	Ports
1	default	active	Fa0/2, Fa0/3, Fa0/4, Fa0/5, Fa0/6, Fa0/7, Fa0/8, Fa0/9 Fa0/10, Fa0/11, Fa0/12, Fa0/13, Fa0/14, Fa0/15, Fa0/16, Fa0/17 Fa0/18, Fa0/19, Fa0/20, Fa0/21, Fa0/22, Fa0/23, Fa0/24, Gig0/1, Gig0/2
15	**IT**	**active**	
25	**BCA**	**active**	
35	**CS**	**active**	
1002	fddi-default	active	
1003	token-ring-default	active	
1004	fddinet-default	active	
1005	trnet-default	active	

Fig15: VLAN Creation of multi layer switch (CHANDRAN)

D. Inter-VLAN routing Comparision

Inter-VLAN communication done with the help of router or multilayer switches. Fig16 shows the comparative analysis between Traditional, Router on a stick and Switch based Inter-VLAN Routing. This comparison based on the Device Interface and switch port mode setting.

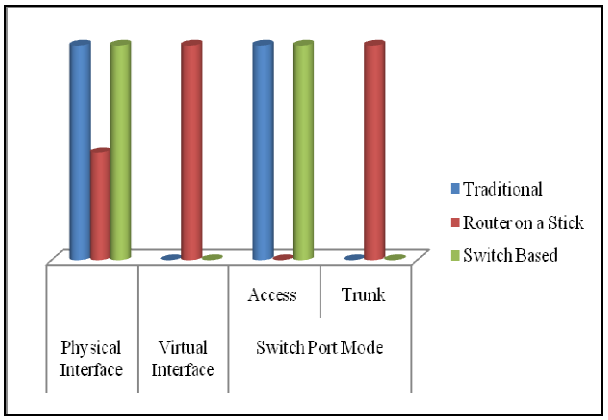


Fig16: Comparative Analysis

CONCLUSION

In this paper we analyze the importance of Inter-VLAN routing. The three different techniques that are used in this paper are implemented in all major industries. They make use of these technique as the following advantage arise broadcast control, Security, Cost Saving, Increase performance etc.

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