CS 305 Lab Tutorial
Lab13 MAC, ARP and Switch

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Thanks to Wei WANG

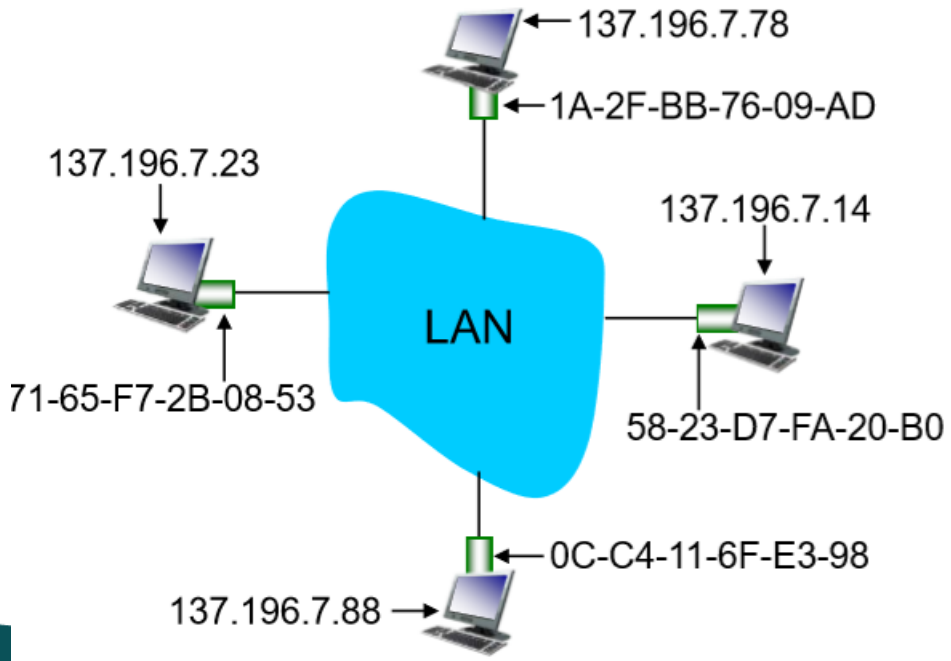
Topic

- MAC address & ARP
- Device
  - Bridge (Lay2) vs Hub (Lay1)
  - Switch (Lay2/Lay3)
- Practice
  - STP
  - VLAN
  - MultiLayer Switch

MAC address

- MAC (or LAN or physical or Ethernet) address:
  - function: *used 'locally" to get frame from one interface to another physically-connected interface (same network, in IP-addressing sense)*
  - 48 bit MAC address (for most LANs) burned in NIC ROM, also sometimes software settable
  - e.g.: 1A-2F-BB-76-09-AD

hexadecimal (base 16) notation
(each "numeral" represents 4 bits)



ARP(Address Resolution Protocol)

```
    23 3.409057   Micro-St_b3:5c:39   Broadcast         ARP          Who has 172.18.130.25? Tell 172.18.130.27
    24 3.409348   Micro-St_b0:d9:cd   Micro-St_b3:5c… ARP          172.18.130.25 is at 44:8a:5b:b0:d9:cd
<
> Frame 23: 42 bytes on wire (336 bits), 42 bytes captured (336 bits) on interface 0
> Ethernet II, Src: Micro-St_b3:5c:39 (44:8a:5b:b3:5c:39), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
v Address Resolution Protocol (request)
    Hardware type: Ethernet (1)
    Protocol type: IPv4 (0x0800)
    Hardware size: 6
    Protocol size: 4
    Opcode: request (1)
    Sender MAC address: Micro-St_b3:5c:39 (44:8a:5b:b3:5c:39)
    Sender IP address: 172.18.130.27 (172.18.130.27)
    Target MAC address: 00:00:00_00:00:00 (00:00:00:00:00:00)
    Target IP address: 172.18.130.25 (172.18.130.25)
```

1. using “arp -d” to clear the ARP table on PC
2. “ping” an reachable IP

```
    24 3.409348   Micro-St_b0:d9:cd   Micro-St_b3:5c… ARP          172.18.130.25 is at 44:8a:5b:b0:d9:cd
<
> Frame 24: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface 0
> Ethernet II, Src: Micro-St_b0:d9:cd (44:8a:5b:b0:d9:cd), Dst: Micro-St_b3:5c:39 (44:8a:5b:b3:5c:39)
v Address Resolution Protocol (reply)
    Hardware type: Ethernet (1)
    Protocol type: IPv4 (0x0800)
    Hardware size: 6
    Protocol size: 4
    Opcode: reply (2)
    Sender MAC address: Micro-St_b0:d9:cd (44:8a:5b:b0:d9:cd)
    Sender IP address: 172.18.130.25 (172.18.130.25)
    Target MAC address: Micro-St_b3:5c:39 (44:8a:5b:b3:5c:39)
    Target IP address: 172.18.130.27 (172.18.130.27)
```

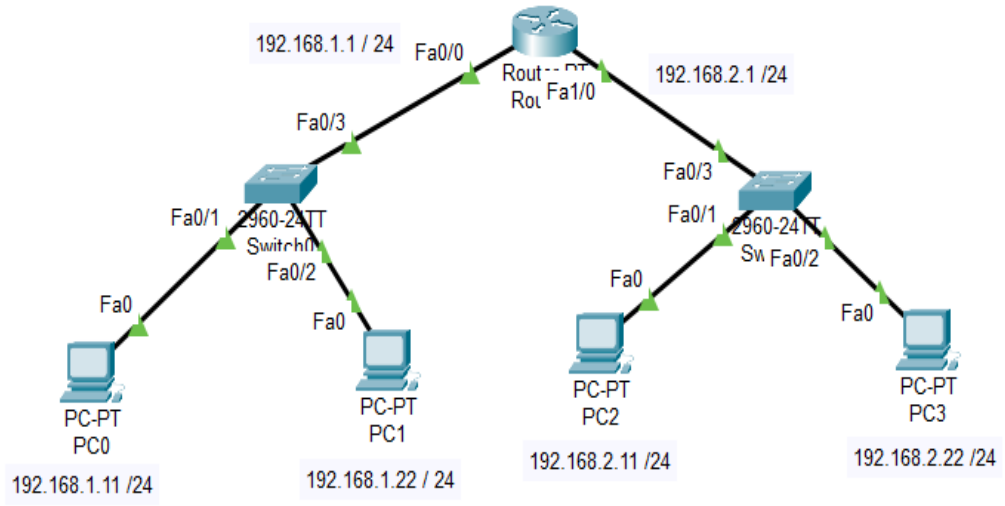
```
[H3C]display mac-address
MAC Address      VLAN ID    State          Port/Nickname          Aging
448a-5bb3-5c39   1          Learned        GE1/0/23               Y
448a-5bb3-5f55   1          Learned        GE1/0/1                Y
[H3C]
```


http://www.faqs.org/rfcs/rfc826.html

Practice1

Build the network as the topology below, do the following experiment on simulation mode of packet-tracer

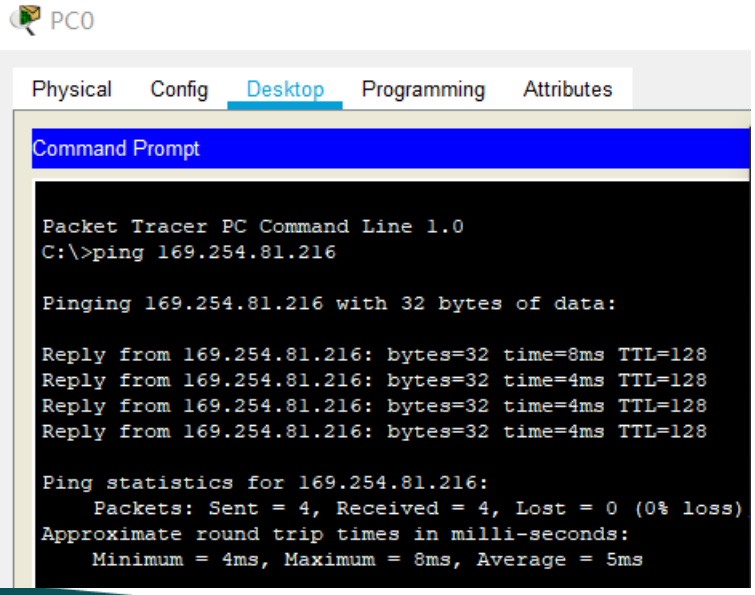
- Invoke “ping” on PC0 to reach PC1
  - Is there any ARP message?
  - Does the ARP message reach the router? what does the router do after receiving the ARP message?
- Invoke “ping” on PC0 to reach PC2
  - how many ARP messages are used before the 1st ICMP reply packet is received by PC0?
  - which device send these ARP messages?
  - is there any info about gateway in these ARP messages?

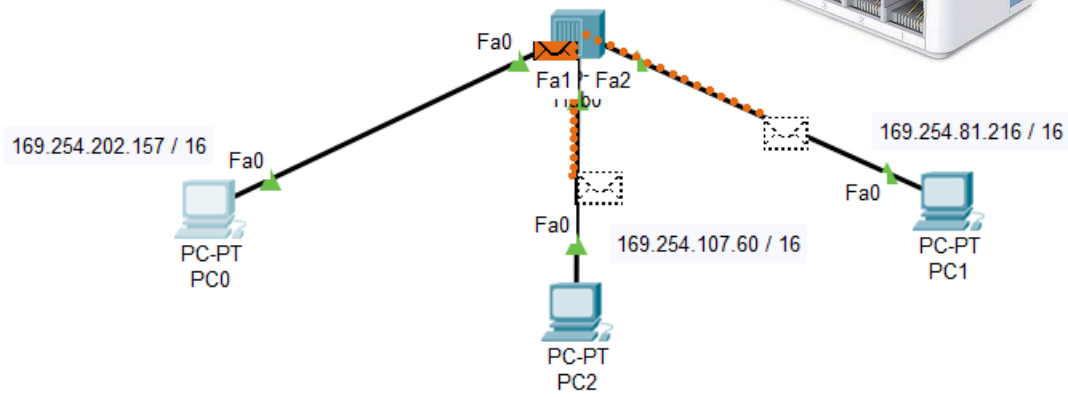


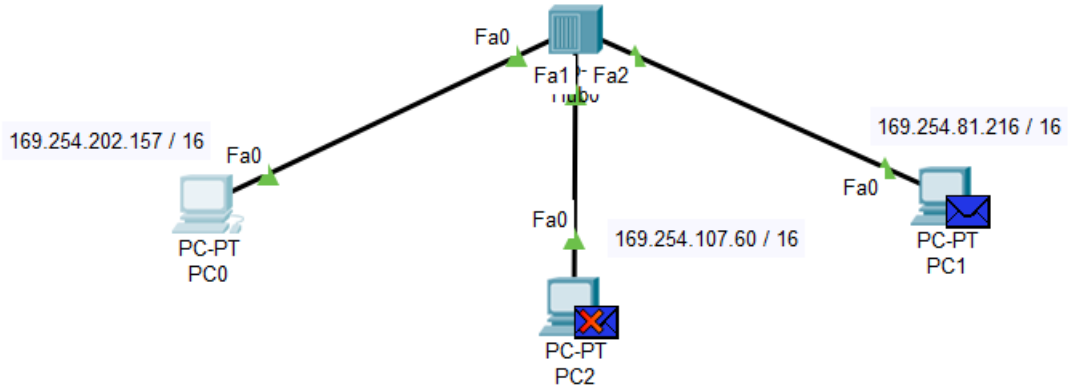
tips:
“arp -d” could be used to clear the arp-table on PC;
turning off the interface on Switch / Route could clear its arp-table table

Hub(Layer 1) broadcast

Hub is a Layer1 device which only broadcasts the package without checking the address of it.







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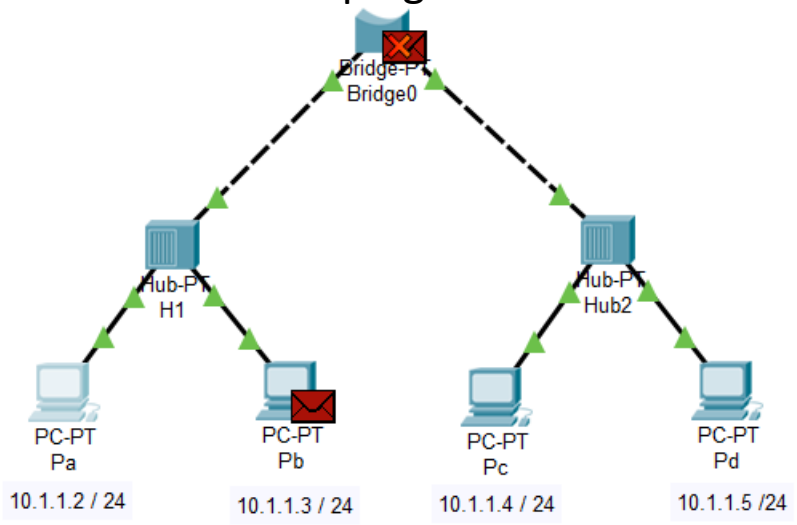
Bridge(Layer 2) forwarding

Test1: Pa ping Pb

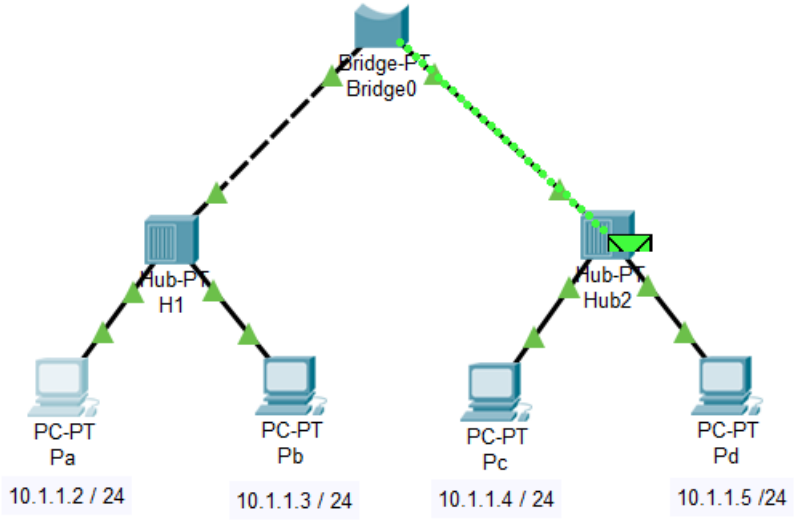


Simulation Panel

Event List

Vis.	Time(sec)	Last Device	At Device	Type
	1.012	--	Pa	ICMP
	1.013	Pa	H1	ICMP
	1.014	H1	Pb	ICMP
	1.014	H1	Bridge0	ICMP
	1.015	Pb	H1	ICMP
	1.016	H1	Pa	ICMP
	1.016	H1	Bridge0	ICMP

Test2: Pa ping Pd



Simulation Panel

Event List

Vis.	Time(sec)	Last Device	At Device	Type
	0.000	--	Pa	ICMP
	0.001	Pa	H1	ICMP
	0.002	H1	Pb	ICMP
	0.002	H1	Bridge0	ICMP
	0.003	Bridge0	Hub2	ICMP
	0.004	Hub2	Pc	ICMP
	0.004	Hub2	Pd	ICMP
	0.005	Pd	Hub2	ICMP
	0.006	Hub2	Pc	ICMP
	0.006	Hub2	Bridge0	ICMP
	0.007	Bridge0	H1	ICMP
	0.008	H1	Pa	ICMP
	0.008	H1	Pb	ICMP

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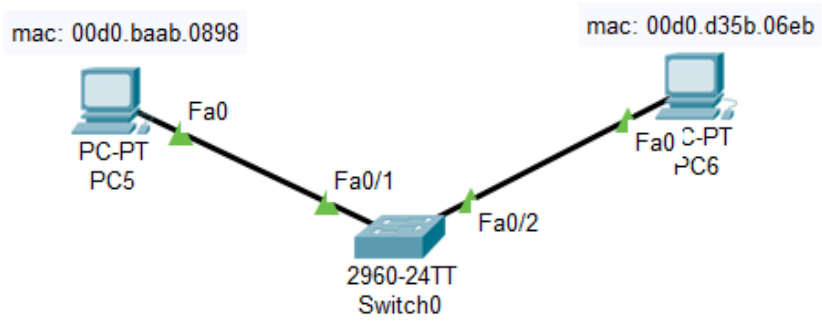
Switch(Layer 2)

Switch can **learn** from the received packet: store its source MAC address and the interface ID in the **MAC-address Table** (or switch table).

Switch uses the MAC-address Table to forward the packet on Layer2.

Tips：Both PC5 and PC6 has an local IPv6 address which are in the same network.

PC5 can “ping” **PC6,** so that **Switch0** can switch packets and
learn mac-address-table




```
Switch# show mac address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----

   1    00d0.baab.0898    DYNAMIC     Fa0/1
   1    00d0.d35b.06eb    DYNAMIC     Fa0/2
Switch#
```

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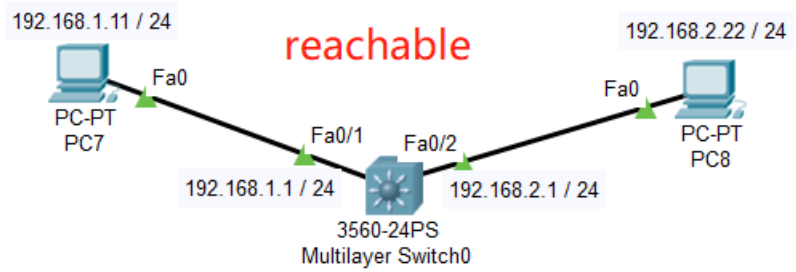
Switch(Layer 3)

The switch on Layer 3 gains the features on fast forwarding and routing

In the following topology, if the Multilayer switch is replaced by a Layer2 switch, could PC7 still communicate with PC8？



Tips：
1. In the Multilayer Switch, using ‘no switchport’ to change the work-mode of interface from Layer 2 to Layer 3.
2. Using ‘ip routing’ to make Multilayer Switch work on Layer 3

```
!
interface FastEthernet0/1
 no switchport
 ip address 192.168.1.1 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/2
 no switchport
 ip address 192.168.2.1 255.255.255.0
 duplex auto
 speed auto
!
```

Multilayer Switch0

Physical Config CLI Attributes

IOS Command Line Interface

```
Switch(config)#interface fastEthernet 0/2
Switch(config-if)#
Switch(config-if)#no switchport
Switch(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed state to up

Switch(config-if)#
Switch(config-if)#
%
Switch(config-if)#ip address 192.168.2.1 255.255.255.0
Switch(config-if)#
```

STP

Spanning Tree algorithm is always used in the Ethernet to create a spanning tree with an interface of a switch as the root, automatically block one or more redundant ports logically to avoid loops.

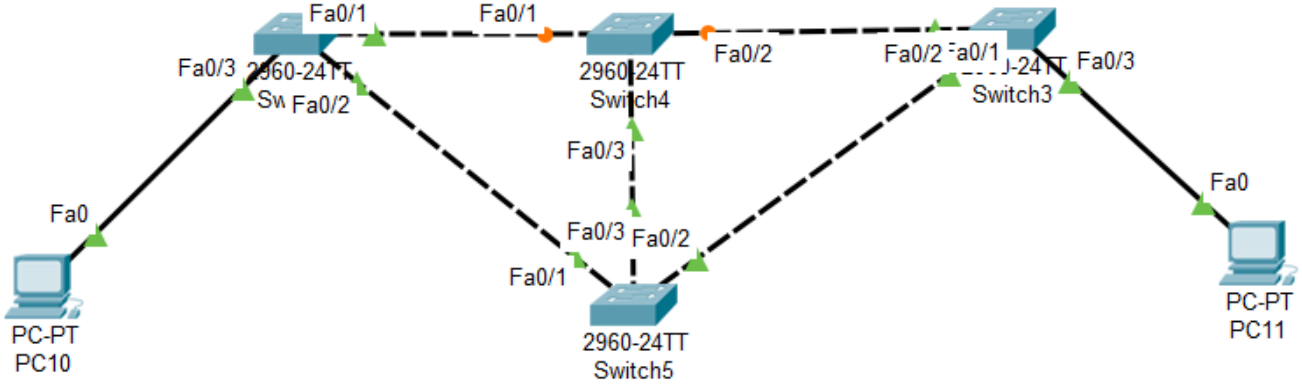

```
SS1#show spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID     Priority    32769
              Address     0090.0C79.A27E
              This bridge is the root
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15
sec

  Bridge ID   Priority    32769  (priority 32768 sys-id-ext 1)
              Address     0090.0C79.A27E
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15
sec
              Aging Time  20

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- --------
--------------------------------
Fa0/3            Desg FWD 19        128.3    P2p
Fa0/2            Desg FWD 19        128.2    P2p
Fa0/1            Desg FWD 19        128.1    P2p
```

```
SS2#show spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID     Priority    32769
              Address     0090.0C79.A27E
              Cost        19
              Port        1(FastEthernet0/1)
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15
sec

  Bridge ID   Priority    32769  (priority 32768 sys-id-ext 1)
              Address     00D0.5837.D0AC
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15
sec
              Aging Time  20

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- --------
--------------------------------
Fa0/1            Root FWD 19        128.1    P2p
Fa0/2            Desg FWD 19        128.2    P2p
Fa0/3            Altn BLK 19        128.3    P2p
```

Practice(2)

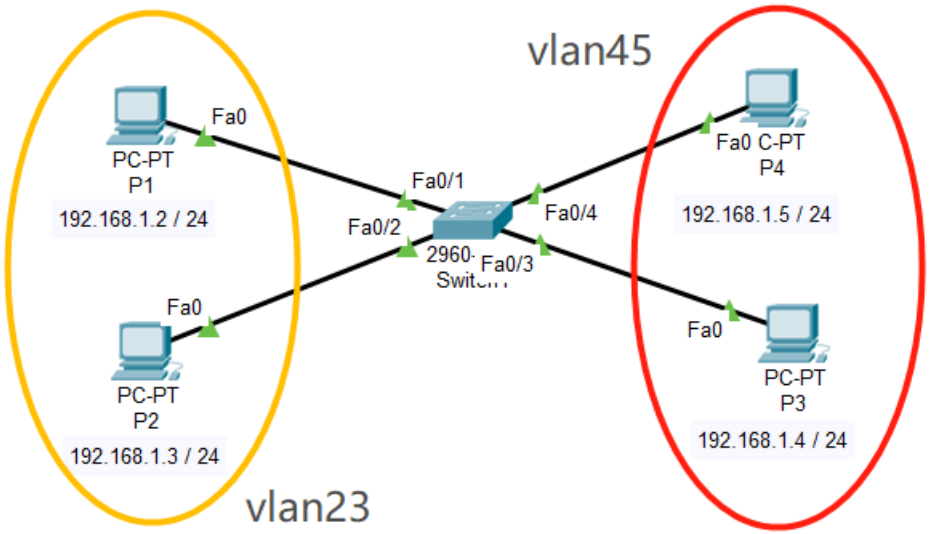
Build a LAN as the topology below:

- What's the state of link marked with **orange spot** in the following network, will it block the communication between PC10 and PC11?
- Find the **root of the spanning-tree**
- **Turn down the Fa0/3 of switch5**, will the root and orange spot changes? Will the communication between PC10 and PC11 be blocked?
- Is there any way to set a new root of the **spanning-tree?** (optional)



VLAN(1)

VLAN(Virtual Local Area Network) is a communication technology that divides a physical LAN into multiple broadcast domains logically. The hosts in one VLAN can communicate with each other directly, but hosts in different VLANs cannot communicate with each other directly, so the broadcast message is limited in one VLAN .




```
Switch(config)#vlan 23
Switch(config-vlan)#exit
Switch(config)#inter
Switch(config)#interface fast
Switch(config)#interface fastEthernet 0/1
Switch(config-if)#switchport access vlan 23
Switch(config-if)#exit
```

```
Switch#show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    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
23   VLAN0023                         active    Fa0/1, Fa0/2
45   VLAN0045                         active    Fa0/3, Fa0/4
1002 fddi-default                     active
```

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VLAN(2)

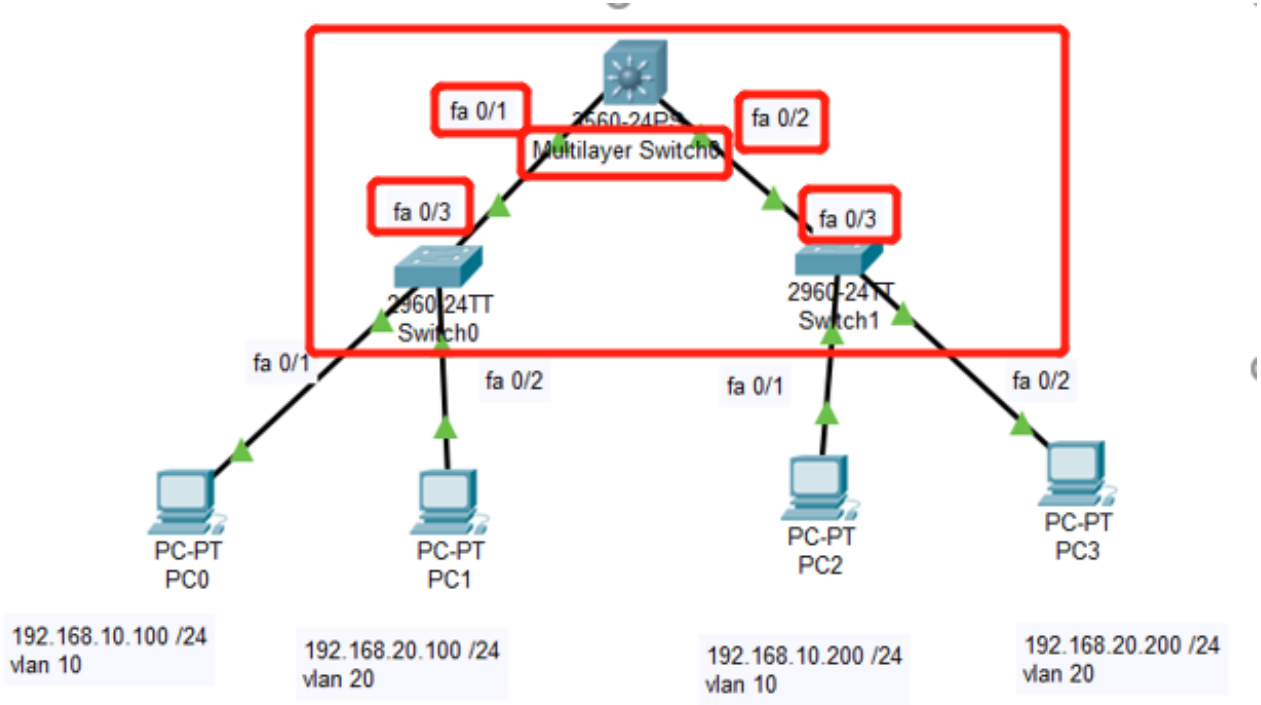
- **Access Link:**
  - A link used to connect **a user host to a switch**. Generally, the host does not need to know which VLAN it belongs to, and the host's hardware usually does not recognize the frame with VLAN tag. Therefore, the frames sent and received by the host are untagged frames.
- **Trunk Link:**
  - Used for **interconnection between switches or connection between switches and routers**. The trunk link can carry multiple different VLAN data. When the data frame is transmitted on the trunk link, the devices at both ends of the trunk link need to be able to identify which VLAN the data frame belongs to, so the frames transmitted on the trunk link are tagged frames.

```
Switch(config)#interface fa 0/3
Switch(config-if)#switchport mode trunk
Switch(config-if)#exit
```


http://grouper.ieee.org/groups/802/1/pages/802.1Q.html

Practice(3)

Build a LAN as the topology: **PC0, PC2 access to vlan 10; PC1, PC3 access to vlan 20**



1) check if PCs in the same VLAN could communicate with each other.

2) make '**trunk link**' in the network, configure on the **Multilayer Switch** to make the PC in vlan 10 be able to communicate with the PC in vlan 20

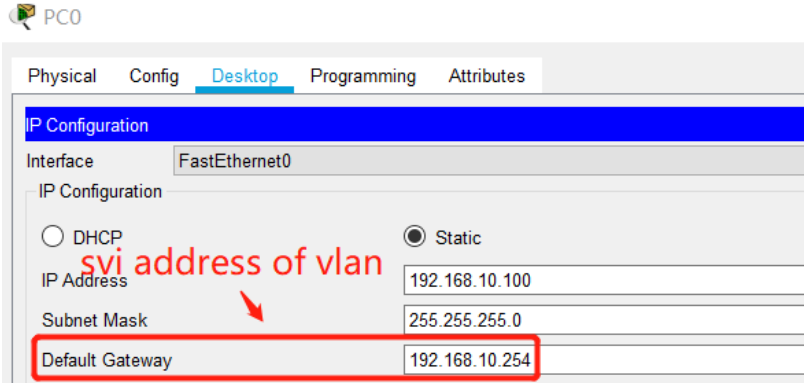
Tips:

For switch0 and switch 1, make the mode of interface which connected with multilayer switch as trunk

Tips

For **multilayer switch**

- configure the mode of interface connect with switch0 and switch1 as trunk
    1. interface fa 0/1
    2. switchport trunk encapsulation dot1q
    3. Switchport mode trunk
- setup the same vlan as switch0 and switch1
- setup the interface of vlan, configure its IP address and subnet mask
    1. interface vlan10
    2. IP address 192.168.10.254 255.255.255.0
- invoke the IP routing function of multilayer switch
    1. ip routing




```
Switch#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.10.0/24 is directly connected, Vlan10
C    192.168.20.0/24 is directly connected, Vlan20

Switch#
```

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