

CS 305 Lab Tutorial

Lab 15 Layer3 Switch & Daily use of network device

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Topic

- Realize interworking between VLANs
 - 802.1Q
 - Switch(Layer3)
- How to use network devices in daily scenarios
 - How to configure
 - by console
 - by telnet
 - How to monitor and analysis
 - monitor session on the network device
 - snippers
- Practices

802.1Q and VLAN

802.1Q(abbreviation: **dot1q**):

➤ The switch needs to **identify** the transmission and reception of frames belonging to different VLANs on one **trunk** link. Therefore, each frame transmitted on the **trunk** link needs to be assigned a unique **VLAN ID**. If the frame is to be sent to other trunk links, **VLAN ID** will **remain** in the frame header. The switch will not **delete the VLAN ID** until the frame is sent to an **access** link.

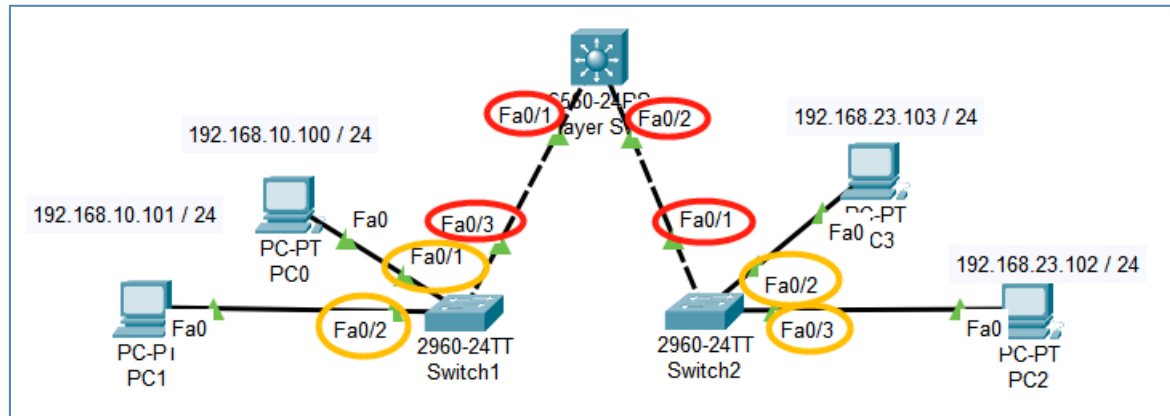
➤ Frame format in 802.1Q (add VPID and VCI to the frame)

Preamble	Seperator	Dst MAC addr	Src MAC addr	VPID	VCI	type	data	FCS
7B	1B	6B	6B	2B	2B	2B	46~1500B	4B

➤ VPID: 0X8100

➤ **VCID** = priority (3bits) + flag(1bit) + **VLAN ID(12bits)**

Tag / Trunk VLAN

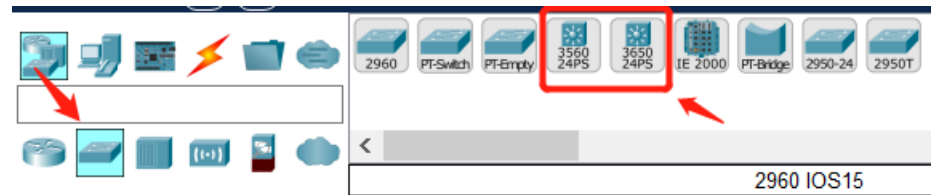


- Access VLAN port:
 - Fa0/1 and Fa0/2 of Switch1, Fa0/2 and Fa0/3 of Switch2.
- Trunk/tag VLAN port:
 - Fa0/1 and Fa0/2 of MultiLayerSwitch, Fa0/3 of Switch1 and Fa0/1 of Switch2.

Layer3 Switch

Layer3 Switch:

- The **Layer 3 switch** can be seen as a **Layer 2 switch plus a routing module**. When forwarding packets, it sends them to the **routing module** to provide the routing path, and then the switch completes the **forwarding**.
 - The **routing module** is Implemented in **hardware**, so Layer3 switch is **quicker** than the route on the forwarding.
 - The “routing” function is closed by default, it could be opened by “**ip routing**” command.
- **Virtual interface on VLAN**
 - Each VLAN could be related to a **virtual interface** on the switch.
 - The hosts in each VLAN use **the IP address of the virtual interface** on the layer 3 switch as the **gateway** of the VLAN.

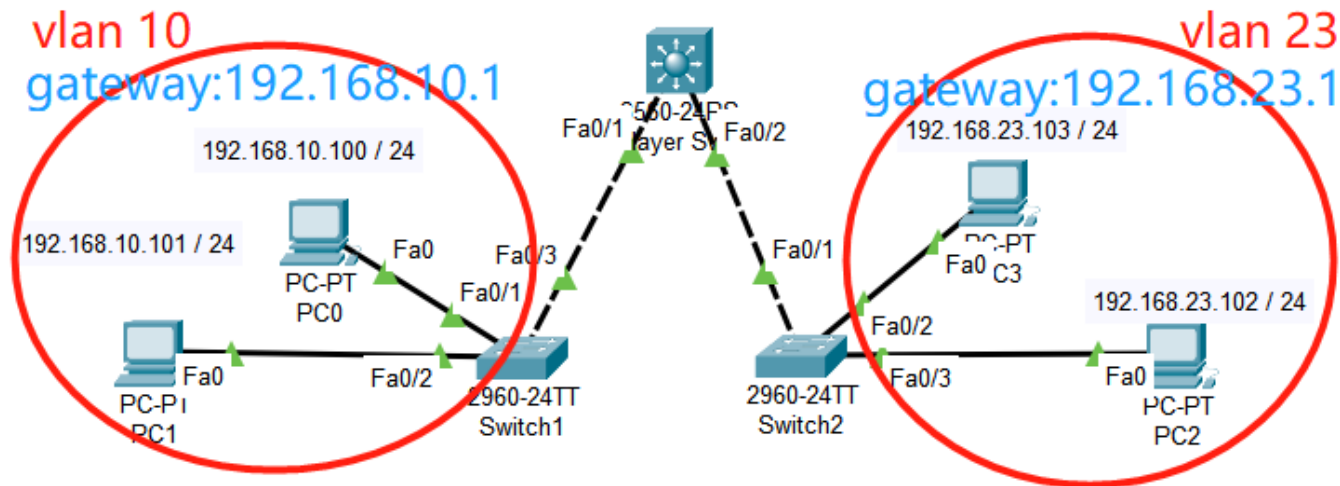


Realize interworking between VLANs(1)

Build the network refer to the following topology :

1. There are 4 PCs, 2 Layer2 switches and 1 Layer3 switch in the network.
2. There are two VLANs: VLAN 10 with PC0 and PC1 in it, VLAN 23 with PC2 and PC3 in it.
3. The gateway of PC0 and PC1 is 192.168.10.1, the gateway of PC2 and PC3 is 192.168.23.1.

Finish the configuration on the network to make PC2 and PC3 are reachable from PC0 and PC1.



Realize interworking between VLANs(2)

Switch1

Physical Config CLI Attributes

IOS Command Line Interface

```
Switch>en
Switch#show vlan brief
```

VLAN Name	Status	Ports
1 default	active	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
10 VLAN0010	active	Fa0/1, Fa0/2
1002 fddi-default	active	
1003 token-ring	active	
1004 fddi-trunk	active	
1005 trunks	active	

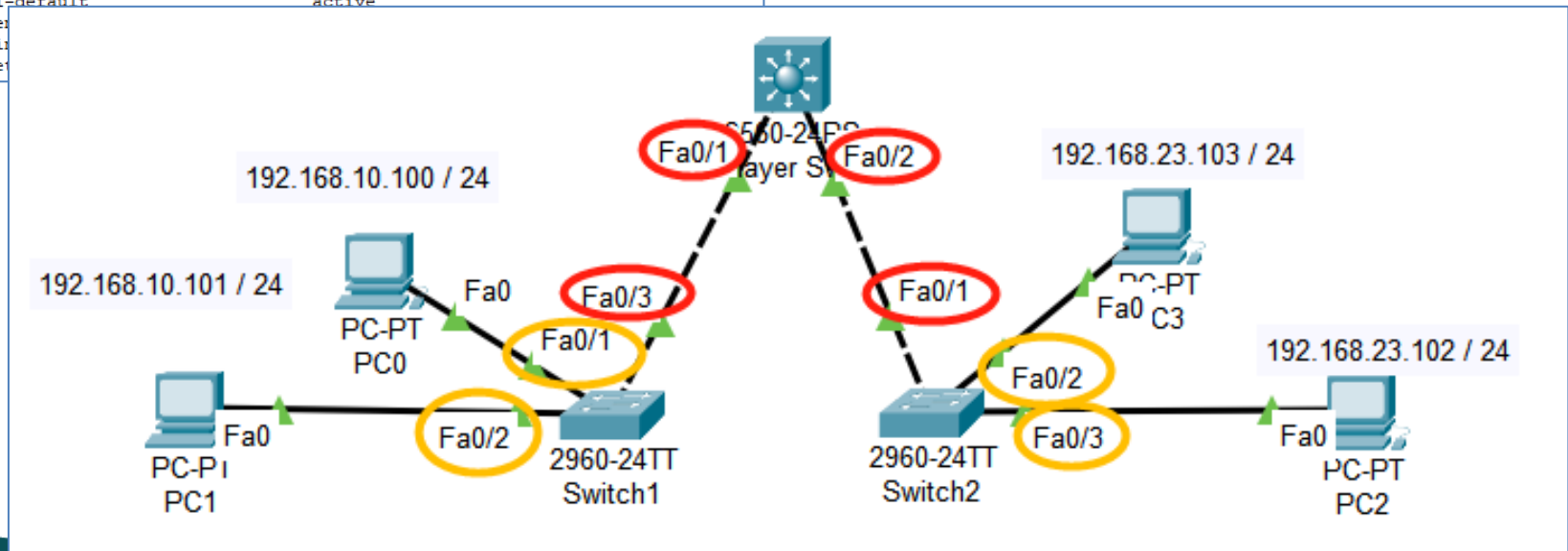
Switch2

Physical Config CLI Attributes

IOS Command Line Interface

```
Switch#show vlan brief
```

VLAN Name	Status	Ports
1 default	active	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
23 VLAN0023	active	Fa0/2, Fa0/3



Realize interworking between VLANs(3)

On the **Layer 3 switch**:



1) Create vlan 10, vlan 23

2) Set the ports connected to “switch1” and “switch2” to trunk.

tips: on Layer3 switch, the **encapsulation of switchport trunk** MUST be set as “**dot1q**”.

Multilayer Switch2

Physical Config CLI Attributes

IOS Command Line Interface

```
Switch#show vlan brief
```

VLAN	Name	Status	Ports
1	default	active	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
10	VLAN0010	active	
23	VLAN0023	active	
1002	fddi-default	active	
1003	token-ring-default	active	
1004	fddinet-default	active	
1005	trnet-default	active	

Switch#

```
Switch(config)#int fa0/1
Switch(config-if)#switchport mode trunk ?
<cr>
Switch(config-if)#switchport mode trunk
Command rejected: An interface whose trunk encapsulation is "Auto" can not be configured to "trunk" mode.
Switch(config-if)#switchport tr
Switch(config-if)#switchport trunk ?
    allowed      Set allowed VLAN characteristics when interface is in trunking
                  mode
    encapsulation Set trunking encapsulation when interface is in trunking mode
    native       Set trunking native characteristics when interface is in
                  trunking mode
Switch(config-if)#switchport trunk enca
Switch(config-if)#switchport trunk encapsulation ?
    dot1q        Interface uses only 802.1q trunking encapsulation when trunking
Switch(config-if)#switchport trunk encapsulation dot1q
Switch(config-if)#switchport mode trunk
```


Realize interworking between VLANs(4)

On the Layer 3 switch:



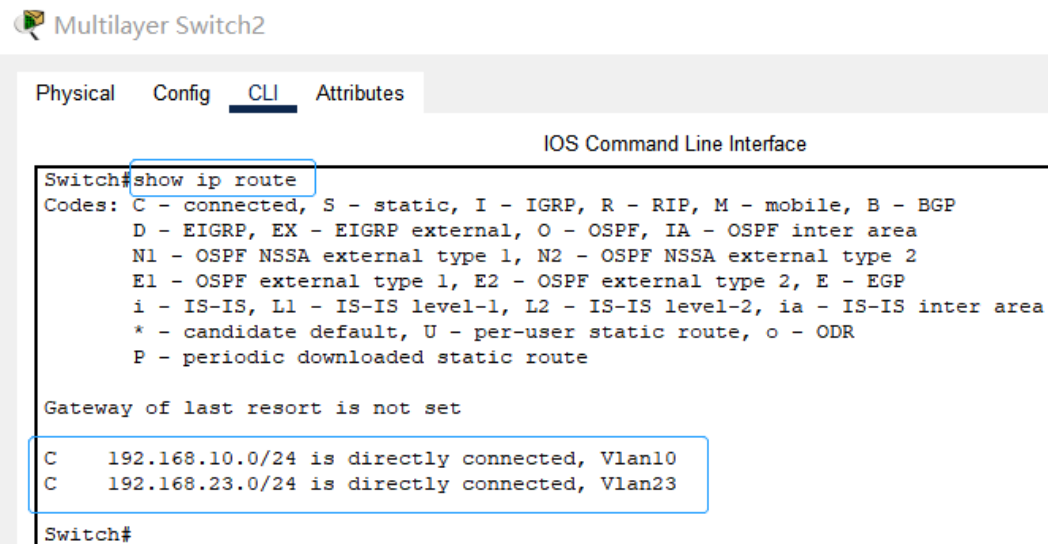
3) Set the **virtual interface** corresponding to vlan 10 and vlan 23, and set the **IP address of the virtual interfaces** (the IP address should be the default gateway of the PCs which access to the VLANs)

4) **Enable the routing** function of the Layer 3 switch by the command “ip routing”

```
Switch(config)#int vlan 10
Switch(config-if)#
%LINK-5-CHANGED: Interface Vlan10, changed state to up
Switch(config-if)#ip address 192.168.10.1 255.255.255.0
Switch(config-if)#
```

tips: “192.168.10.1” is the gateway of PC1 and PC2

```
Switch(config)#ip routing
```



Realize interworking between VLANs(5)

```
Multilayer Switch2
Physical Config CLI Attributes
IOS Command Line Interface
Switch#show vlan brief
VLAN Name                Status   Ports
1    default              active   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
10   VLAN0010             active
23   VLAN0023             active
1002 fddi-default         active
1003 token-ring-default   active
1004 fddinet-default      active
1005 trnet-default        active
Switch#
```

```
Multilayer Switch2
Physical Config CLI Attributes
IOS Command Line Interface
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

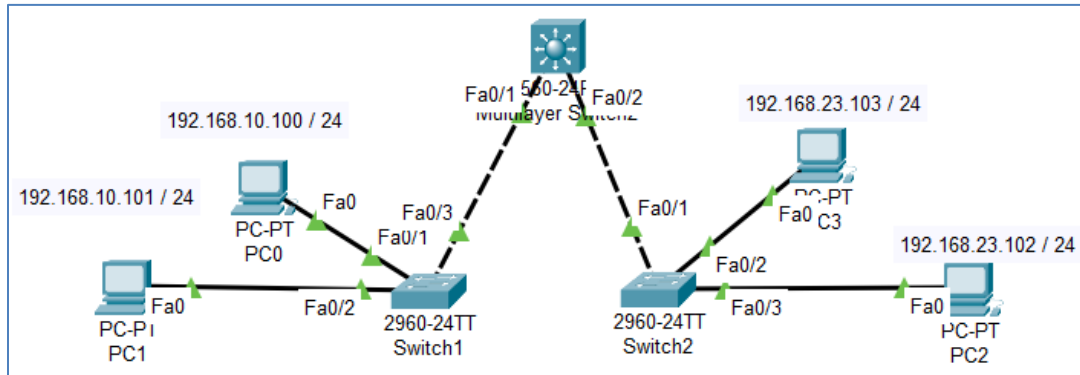
C    192.168.10.0/24 is directly connected, Vlan10
C    192.168.23.0/24 is directly connected, Vlan23
Switch#
```

```
Multilayer Switch2
Physical Config CLI Attributes
IOS Command Line Interface
% Invalid input detected at '^' marker.

Switch#show int vlan 10
Vlan10 is up, line protocol is up
  Hardware is CPU Interface, address is 000a.4192.3401 (bia 000a.4192.3401)
  Internet address is 192.168.10.1/24
  MTU 1500 bytes, BW 100000 Kbit, DLY 1000000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 21:40:21, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    1682 packets input, 530955 bytes, 0 no buffer
    Received 0 broadcasts (0 IP multicast)
    0 runs, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
    563859 packets output, 0 bytes, 0 underruns
    0 output errors, 23 interface resets
    0 output buffer failures, 0 output buffers swapped out

Switch#show int vlan 23
Vlan23 is up, line protocol is up
  Hardware is CPU Interface, address is 000a.4192.3402 (bia 000a.4192.3402)
  Internet address is 192.168.23.1/24
  MTU 1500 bytes, BW 100000 Kbit, DLY 1000000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 21:40:21, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
```

Test interworking between VLANs(1)



- There are two VLANs: VLAN 10 with PC0 and PC1 in it, VLAN 23 with PC3 and PC4 in it.
- The gateway of PC0 and PC1 is 192.168.10.1, the gateway of PC2 and PC3 is 192.168.23.1.

```
PC0
Physical Config Desktop Programming Attributes
Command Prompt
C:\>ipconfig

FastEthernet0 Connection: (default port)

Connection-specific DNS Suffix...:
Link-local IPv6 Address . . . . .: FE80::201:63FF:FEC4:99D2
IPv6 Address . . . . .: ::
IPv4 Address . . . . .: 192.168.10.100
Subnet Mask . . . . .: 255.255.255.0
Default Gateway . . . . .: 192.168.10.1

Bluetooth Connection:

Connection-specific DNS Suffix...:
Link-local IPv6 Address . . . . .: ::
IPv6 Address . . . . .: ::
IPv4 Address . . . . .: 0.0.0.0
Subnet Mask . . . . .: 0.0.0.0
Default Gateway . . . . .: ::
0.0.0.0

C:\>ping 192.168.23.103

Pinging 192.168.23.103 with 32 bytes of data:

Reply from 192.168.23.103: bytes=32 time<1ms TTL=127
Reply from 192.168.23.103: bytes=32 time<1ms TTL=127
Reply from 192.168.23.103: bytes=32 time<1ms TTL=127
Reply from 192.168.23.103: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.23.103:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 192.168.23.102

Pinging 192.168.23.102 with 32 bytes of data:

Request timed out.
Reply from 192.168.23.102: bytes=32 time<1ms TTL=127
Reply from 192.168.23.102: bytes=32 time<1ms TTL=127
Reply from 192.168.23.102: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.23.102:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

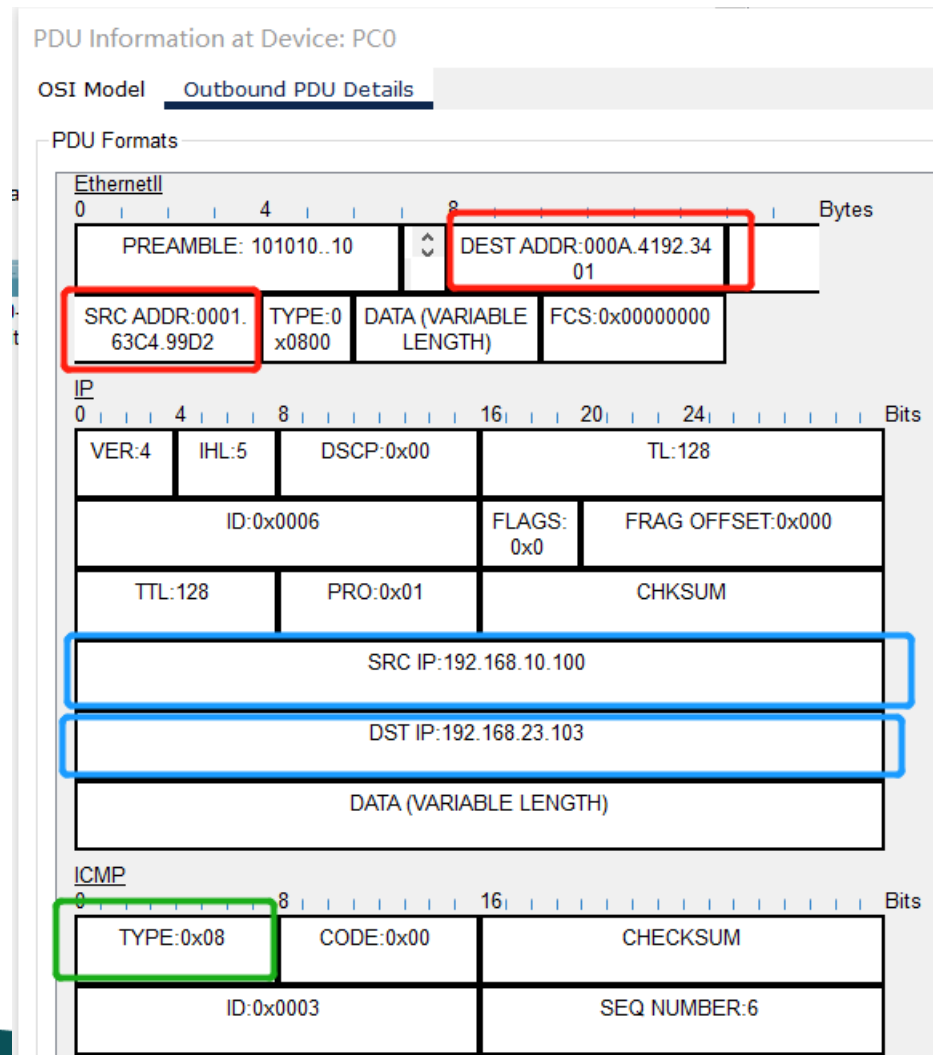
C:\>
```

Test interworking between VLANs(2)

On simulation mode, capture the packets and answer the following question:

- 1) Is this a ICMP request or reply packet?
- 2) Whose MAC address is the DEST ADDR(000A.4192.3401) here?

Simulation Panel				
Event List				
Vis.	Time(sec)	Last Device	At Device	Type
	0.000	--	PC0	ICMP
	0.001	PC0	Switch1	ICMP
	0.002	Switch1	Multilayer Switch2	ICMP
	0.003	Multilayer Switch2	Switch2	ICMP
	0.004	Switch2	PC3	ICMP
	0.005	PC3	Switch2	ICMP
	0.006	Switch2	Multilayer Switch2	ICMP
	0.007	Multilayer Switch2	Switch1	ICMP
	0.008	Switch1	PC0	ICMP



Test interworking between VLANs(3)

PDU Information at Device: Switch1

OSI Model

Inbound PDU Details

Outbound PDU Details

At Device: Switch1

Source: PC0

Destination: 192.168.23.103

In Layers

Layer7

Layer6

Layer5

Layer4

Layer3

Layer 2: Ethernet II Header
0001.63C4.99D2 >> 000A.4192.3401

Layer 1: Port FastEthernet0/1

Out Layers

Layer7

Layer6

Layer5

Layer4

Layer3

Layer 2: Dot1q Header 0001.63C4.99D2
>> 000A.4192.3401

Layer 1: Port(s): FastEthernet0/3

Simulation Panel

Event List

Vis.	Time(sec)	Last Device	At Device	Type
	0.000	--	PC0	ICMP
	0.001	PC0	Switch1	ICMP
	0.002	Switch1	Multilayer Switch2	ICMP
	0.003	Multilayer Switch2	Switch2	ICMP
	0.004	Switch2	PC3	ICMP
	0.005	PC3	Switch2	ICMP
	0.006	Switch2	Multilayer Switch2	ICMP
	0.007	Multilayer Switch2	Switch1	ICMP
	0.008	Switch1	PC0	ICMP

3) While Switch1 receive the packet from PC0, is there any fields about 802.1q in the layer2 frame? What are the values of these fields ?

4) While Switch1 send the packet to Multilayer Switch2, is there any fields about 802.1q in the layer2 frame? What are the values of these fields ?

Test interworking between VLANs(4)

PDU Information at Device: Multilayer Switch2

OSI Model Inbound PDU Details Outbound PDU Details

At Device: Multilayer Switch2
Source: PC0
Destination: 192.168.23.103

In Layers

Layer7
Layer6
Layer5
Layer4
Layer 3: IP Header Src. IP: 192.168.10.100, Dest. IP: 192.168.23.103
ICMP Message Type: 8
Layer 2: Dot1q Header 0001.63C4.99D2 >> 000A.4192.3401
Layer 1: Port FastEthernet0/1

Out Layers

Layer7
Layer6
Layer5
Layer4
Layer 3: IP Header Src. IP: 192.168.10.100, Dest. IP: 192.168.23.103
ICMP Message Type: 8
Layer 2: Dot1q Header 000A.4192.3402 >> 0030.A343.7DE8
Layer 1: Port(s): FastEthernet0/2

1. FastEthernet0/1 receives the frame.

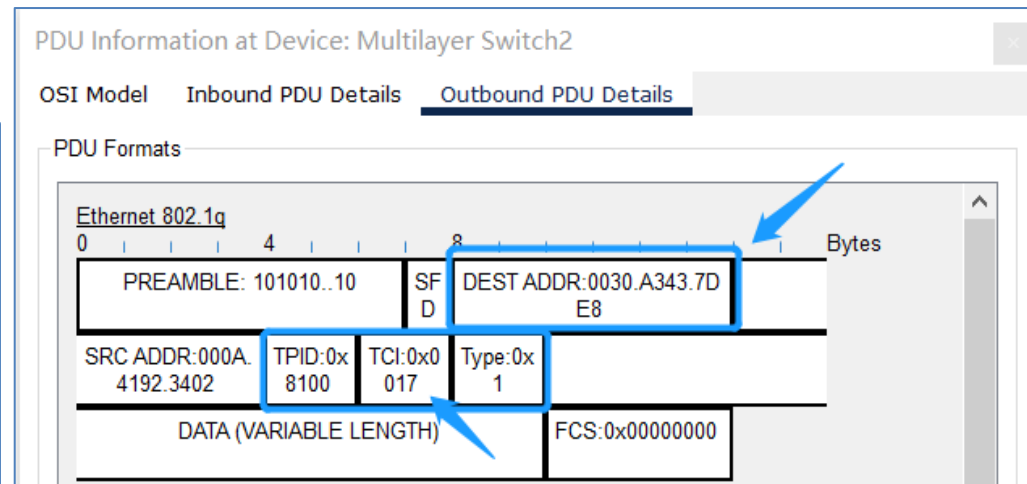
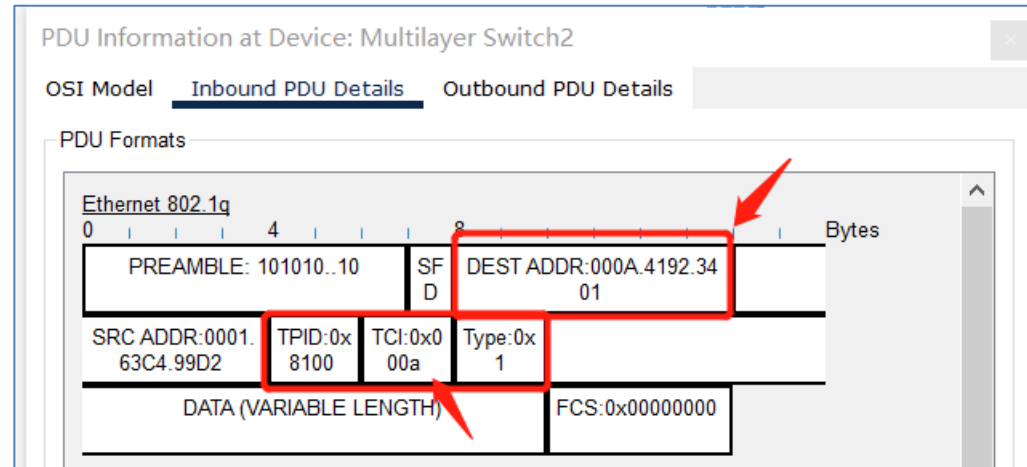
Simulation Panel				
Event List				
Vis.	Time(sec)	Last Device	At Device	Type
	0.000	--	PC0	ICMP
	0.001	PC0	Switch1	ICMP
	0.002	Switch1	Multilayer Switch2	ICMP
	0.003	Multilayer Switch2	Switch2	ICMP
	0.004	Switch2	PC3	ICMP
	0.005	PC3	Switch2	ICMP
	0.006	Switch2	Multilayer Switch2	ICMP
	0.007	Multilayer Switch2	Switch1	ICMP
	0.008	Switch1	PC0	ICMP

- 1) Which virtual interface of Multilayer Switch2 receive the packet?
- 2) Is there any routing item in the routing table related to the Dest IP(192.168.23.103) ? what's the type of the routing item: static, connected, dynamic ?

Test interworking between VLANs(5)

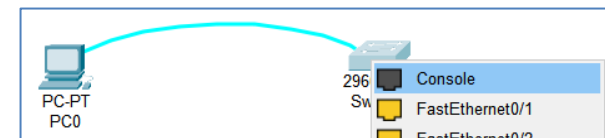
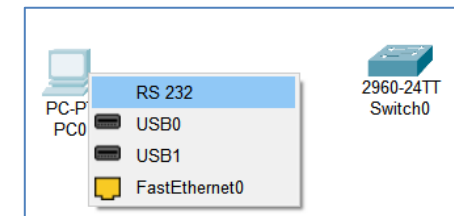
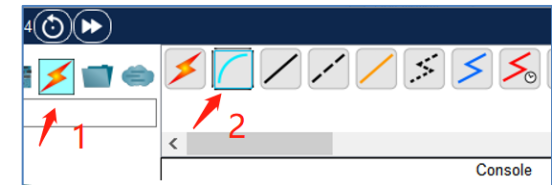
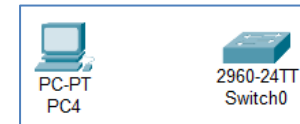
Simulation Panel				
Event List				
Vis.	Time(sec)	Last Device	At Device	Type
	0.000	--	PC0	ICMP
	0.001	PC0	Switch1	ICMP
	0.002	Switch1	Multilayer Switch2	ICMP
	0.003	Multilayer Switch2	Switch2	ICMP
	0.004	Switch2	PC3	ICMP
	0.005	PC3	Switch2	ICMP
	0.006	Switch2	Multilayer Switch2	ICMP
	0.007	Multilayer Switch2	Switch1	ICMP
	0.008	Switch1	PC0	ICMP

- 1) While Multilayer Switch2 receive the packet from Switch1, what's the VLAN ID in layer2 frame?
- 2) While Multilayer Switch2 send the packet to Switch2, what's the VLAN ID in layer2 frame?
- 3) Whose MAC address is the DEST ADDR (0030.A343.7DE8) here?



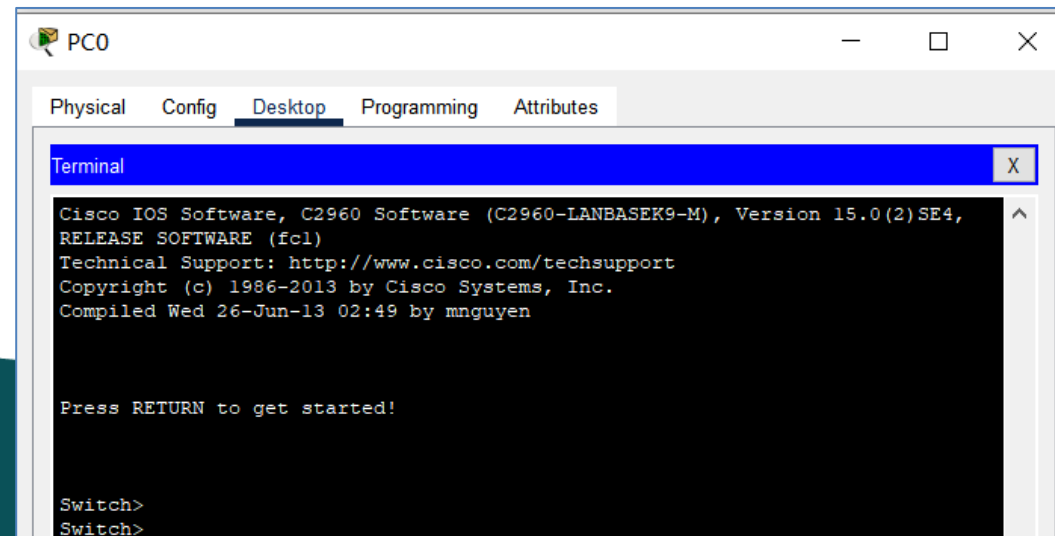
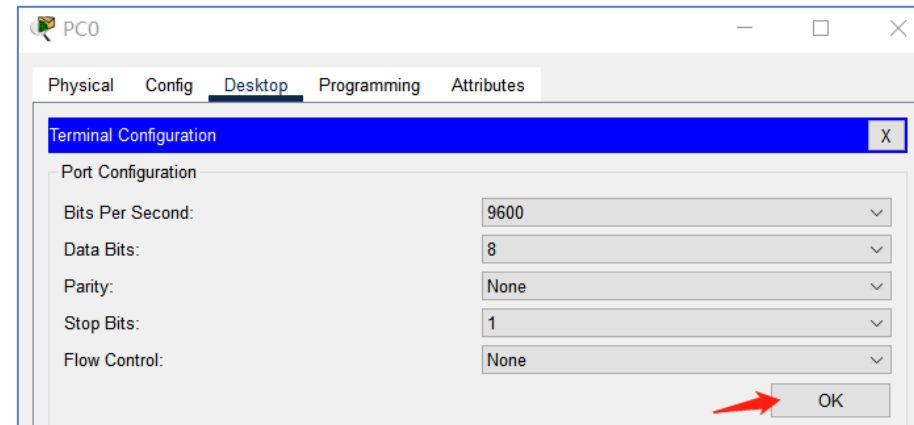
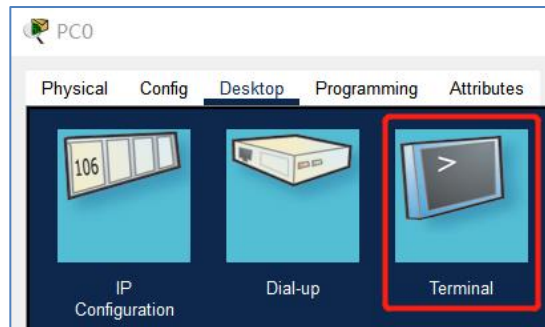
Configure the network device by Console(1)

- Step1:
 - Connect the network device with PC by console cable.
 - One end of the console cable is connected to the RS232 port of the PC
 - Another end of the console cable is connected to the console port of the network device



Configure the network device by Console(2)

- Step2: Open the “Terminal” on the PC, finish the related configuration on the “terminal”, then click “OK” .

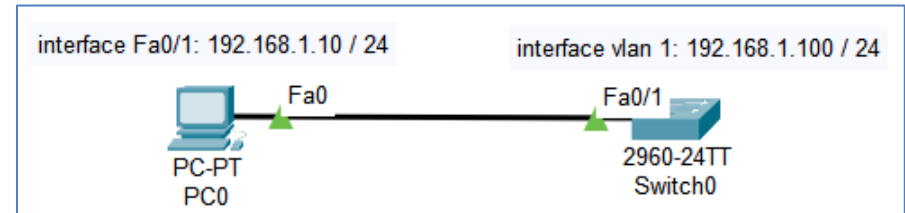


Configure the network device by telnet(1)

Preparation:

The configuration on the network device

1. Need an IP address
 - ✓ If there is no IP address on the device(e.g. switch), set the ip address on the virtual interface of the vlan 1(which is the default vlan on the device)
2. Set the line virtual terminal and its login password
3. If the user need to configure the device by telnet, set the password of “enable”



```
Switch>en
Switch#config t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int vlan 1
Switch(config-if)#ip address 192.168.1.100 255.255.255.0
Switch(config-if)#exit
Switch(config)#line vty 0-2
^
% Invalid input detected at '^' marker.

Switch(config)#line vty 0 2
Switch(config-line)#password 2022fcs305
Switch(config-line)#exit
Switch(config)#enable password sustechCSE
Switch(config)#exit
```

1

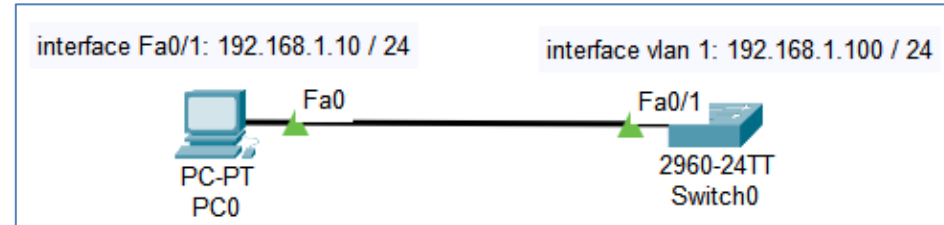
2

3

Configure the network device by telnet(2)

The steps on the PC which telnets to the network device:

1. open a “command window” to invoke “telnet”
2. telnet the network device, input its IP address and the “login” password
3. after login the device, you are in the user mode by default, input “enable” to switch to the system mode
4. input the “enable” password, if the “enable” password is right, it is permit to switch to the system mode by command “config t”.



PC0

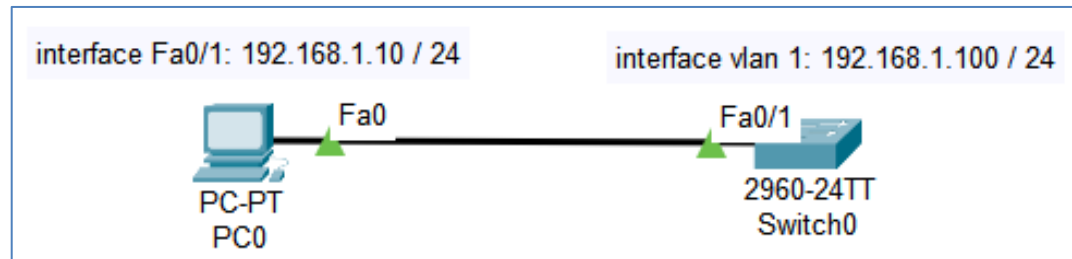
Physical Config Desktop Programming Attributes

Command Prompt

```
C:\>telnet 192.168.1.100
Trying 192.168.1.100 ...Open

User Access Verification
Password: 2022fcs305
Switch>enable
Password: sustechCSE
Switch#config t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#
```

Configure the network device by telnet(3)



PC0

```
Switch>en
Switch#config t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int vlan 1
Switch(config-if)#ip address 192.168.1.100 255.255.255.0
Switch(config-if)#exit
Switch(config)#line vty 0-2
^
% Invalid input detected at '^' marker.

Switch(config)#line vty 0 2
Switch(config-line)#password 2022fcs305
Switch(config-line)#exit
Switch(config)#enable password sustechCSE
Switch(config)#exit
```

Physical Config Desktop Programming Attributes

Command Prompt

```
C:\>telnet 192.168.1.100
Trying 192.168.1.100 ...Open
```

User Access Verification

Password:

Switch>enable

Password:

Switch#config t

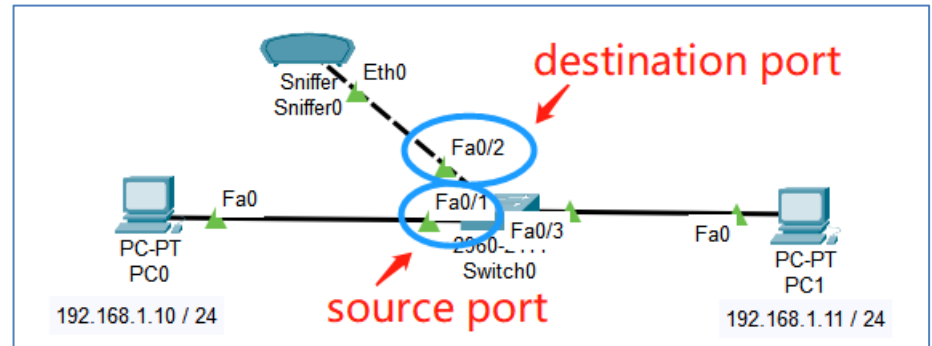
Enter configuration commands, one per line. End with CNTL/Z.

Switch(config)#

2022fcs305
sustechCSE

Monitor the ports on the network device(1)

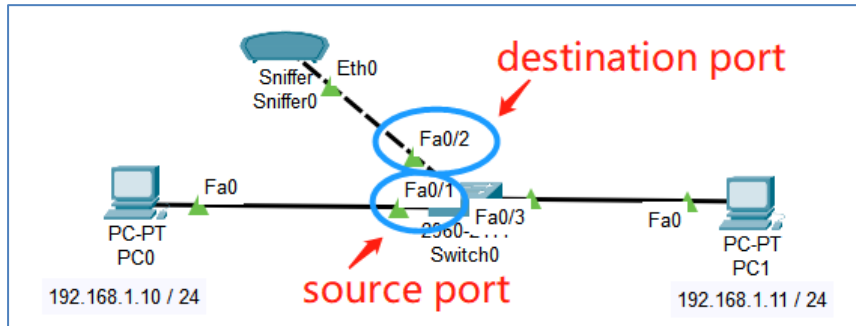
- Set a **monitor session** on the network device and the **source port** and **destination port** of the monitor session.
 - The packets received/sent by the source port would be **copied** to the destination port.
- Connect the destination port of the network device with a PC or Sniffer.
 - The PC or sniffer could capture the packet so as to monitor the data flow.



```
Switch(config)#monitor session 1 source int fa0/1
Switch(config)#monitor session 1 destination int fa 0/2
Switch(config)#monitor session 1 source int fa0/1 ?
,      comma
-      hyphen
both   SPAN copies both egress and ingress traffic
rx      SPAN copies only ingress traffic
tx      SPAN copies only egress traffic
<cr>
Switch(config)#monitor session 1 source int fa0/1
```

Monitor the ports on the network device(2)

Command "Show monitor detail" is useful to show the details about the monitor settings.



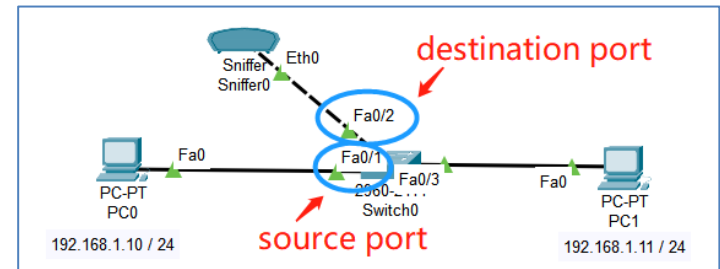
```
Switch(config)#monitor session 1 source int fa0/1
Switch(config)#monitor session 1 destination int fa 0/2
Switch(config)#monitor session 1 source int fa0/1 ?
,      comma
-      hyphen
both   SPAN copies both egress and ingress traffic
rx      SPAN copies only ingress traffic
tx      SPAN copies only egress traffic
<cr>
Switch(config)#monitor session 1 source int fa0/1
```

```
Switch#show monitor detail
Session 1
-----
Type                : Local Session
Description          : -
Source Ports        :
  RX Only           : None
  TX Only           : None
  Both              : Fa0/1
Source VLANs        :
  RX Only           : None
  TX Only           : None
  Both              : None
Source RSPAN VLAN   : None
Destination Ports   : Fa0/2
  Encapsulation     : Native
  Ingress           : Disabled
Filter VLANs        : None
Dest RSPAN VLAN     : None

Switch#
```

Monitor the ports on the network device(3)

Invoke “ping 192.168.1.11” on PC0, the packets sent and received by the port “Fa0/1” are copied to the “Fa0/2”, the “sniffer0” received and captured the packets.



Sniffer0

Physical Config **GUI** Attributes

Service ☒ On ☐ Off

Incoming Packets ☒ Port0 ☐ Port1

Buffer Size 371

ICMP REQUEST

Ethernet II			
0	4	8	Bytes
PREAMBLE: 101010...10		SFD	DEST ADDR: 0090.215C.4486
SRC ADDR: 0004.9A30.7E8C		TYPE: 0x0800	DATA (VARIABLE LENGTH)
FCS: 0x00000000			

IP			
0	4	8	16
VER: 4	IHL: 5	DSCP: 0x00	TL: 128
ID: 0x0001		FLAGS: 0x0	FRAG OFFSET: 0x000
TTL: 128		PRO: 0x01	CHKSUM
SRC IP: 192.168.1.10			
DST IP: 192.168.1.11			
DATA (VARIABLE LENGTH)			

ICMP			
0	8	16	Bits
TYPE: 0x08		CODE: 0x00	CHECKSUM
ID: 0x0002		SEQ NUMBER: 1	

Sniffer0

Physical Config **GUI** Attributes

Service ☒ On ☐ Off

Incoming Packets ☒ Port0 ☐ Port1

Buffer Size

ICMP REPLY

Ethernet II			
0	4	8	Bytes
PREAMBLE: 101010...10		SFD	DEST ADDR: 0004.9A30.7E8C
SRC ADDR: 0090.215C.4486		TYPE: 0x0800	DATA (VARIABLE LENGTH)
FCS: 0x00000000			

IP			
0	4	8	16
VER: 4	IHL: 5	DSCP: 0x00	TL: 128
ID: 0x0001		FLAGS: 0x0	FRAG OFFSET: 0x000
TTL: 128		PRO: 0x01	CHKSUM
SRC IP: 192.168.1.11			
DST IP: 192.168.1.10			
DATA (VARIABLE LENGTH)			

ICMP			
0	8	16	Bits
TYPE: 0x00		CODE: 0x00	CHECKSUM
ID: 0x0002		SEQ NUMBER: 1	

Practices

1. Finish the configuration to realize interworking between VLANs.
2. Answer the questions on the “test interworking between VLANs” pages.
3. Add a sniffer to the network and capture all the packets received by the interface fa0/2 on the Multilayer Switch2.