NETWORK SIMULATION

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SUSTech

Network Simulator (NS)

- NS (NS2/3) is a discrete event simulator targeted at networking research.

- It provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless (local and satellite) networks.

- Simulator provided by telecommunication equipment suppliers:
  - Packet tracer (Cisco)
  - HCL (h3c)
  - eNSP (huawei)
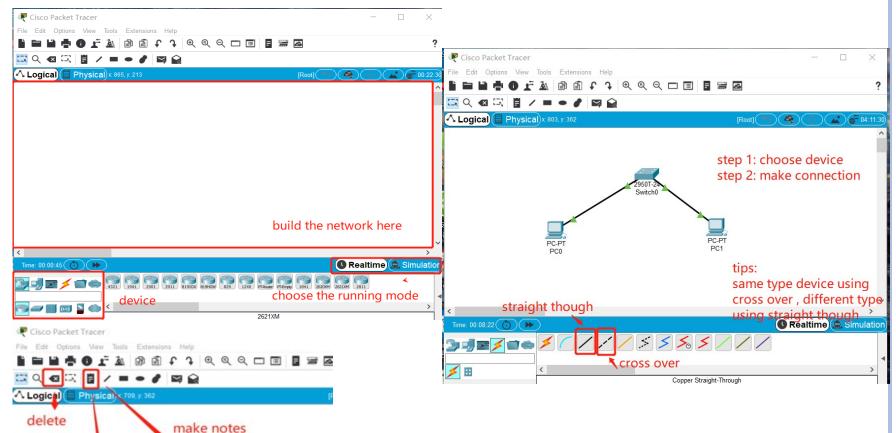
https://www.isi.edu/nsnam/ns/

Packet tracer

- Packet Tracer allows users to create simulated network topologies by dragging and dropping routers, switches and other types of network devices.

- Packet Tracer supports an array of simulated Application Layer protocols, and basic routing with RIP, OSPF, EIGRP, BGP.

- Packet Tracer can be run on Linux and MS Windows.

  - Similar Android and iOS apps are also available.

PACKET TRACER BUILD NETWORK

Cisco Packet Tracer

build the network here

device

choose the running mode

step 1: choose device
step 2: make connection

tips:
same type device using cross over, different type using straight though

straight though

cross over

Copper Straight-Through

delete

make notes

FE 0\1

192.169.1.20 /24

2950T-24
Switch0

PC-PT
PC0

PC-PT
PC1
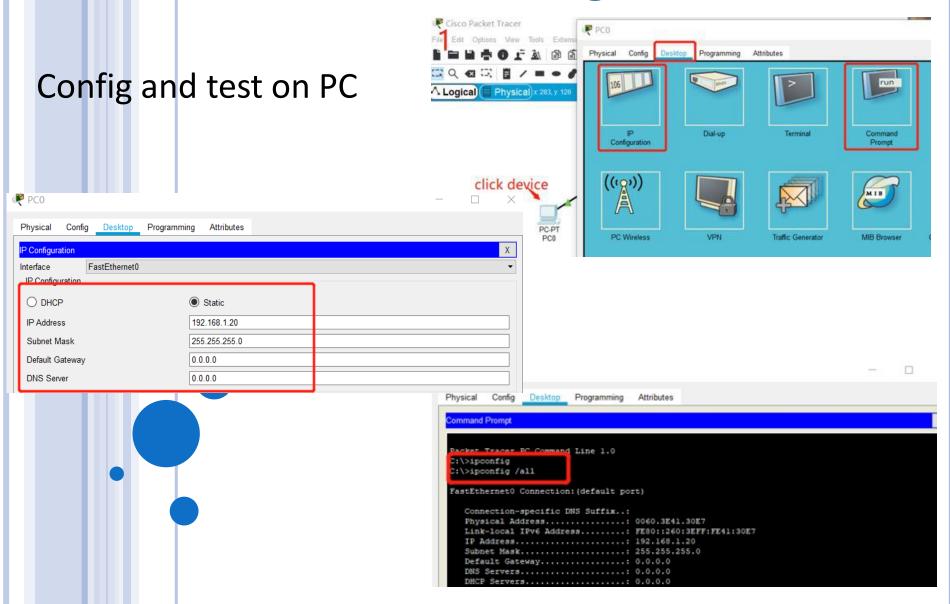
Download from:
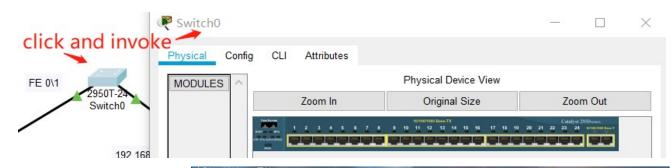
https://www.netacad.com/courses/packet-tracer

Packet tracer build configuration

Config and test on PC
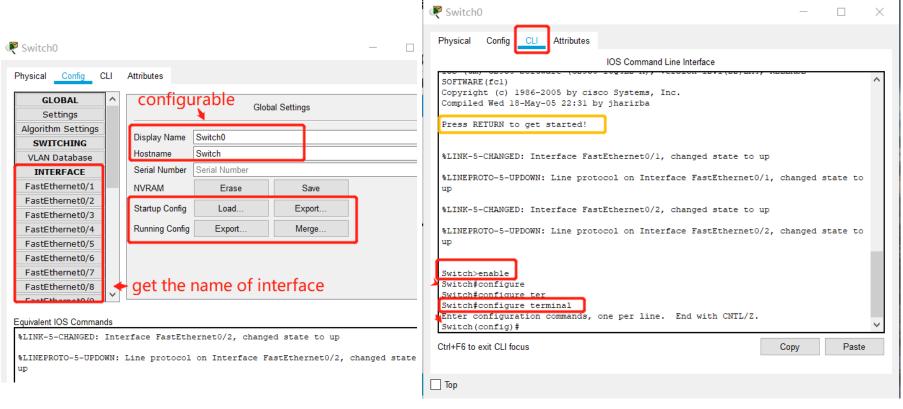
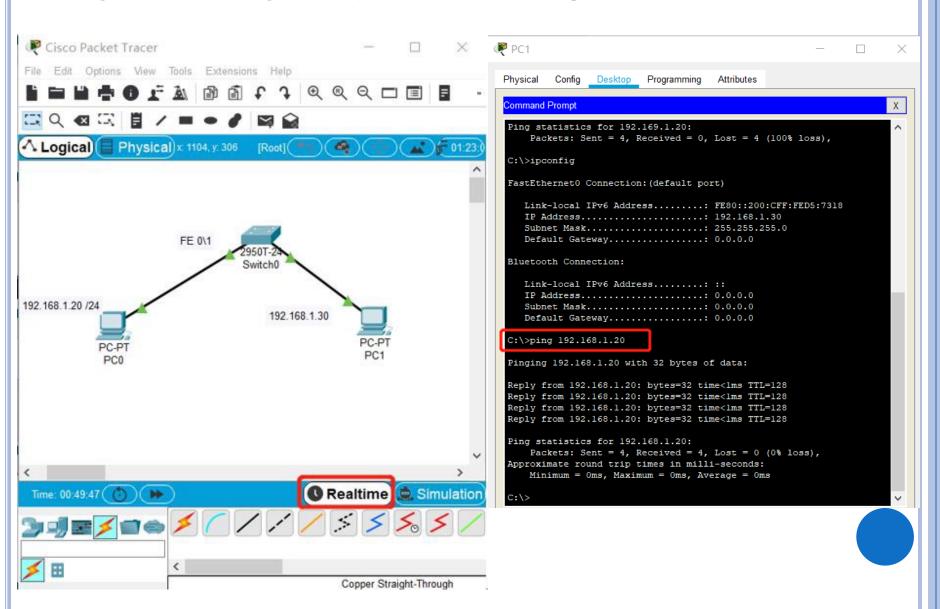# PACKET TRACER BUILD CONFIGURATION

Configure and test on a network device

click and invoke

Switch0

Physical | Config | CLI | Attributes

MODULES

Physical Device View

Zoom In | Original Size | Zoom Out

FE 0\1
2950T-24
Switch0

192 168

Switch0

Physical | Config | CLI | Attributes

GLOBAL
Settings
Algorithm Settings
SWITCHING
VLAN Database
INTERFACE
FastEthernet0/1
FastEthernet0/2
FastEthernet0/3
FastEthernet0/4
FastEthernet0/5
FastEthernet0/6
FastEthernet0/7
FastEthernet0/8
FastEthernet0/0

configurable

Global Settings

Display Name | Switch0
Hostname | Switch
Serial Number | Serial Number
NVRAM | Erase | Save
Startup Config | Load... | Export...
Running Config | Export... | Merge...

get the name of interface

Equivalent IOS Commands

```
%LINK-5-CHANGED: Interface FastEthernet0/2, changed state to up

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

Switch0

Physical | Config | CLI | Attributes

IOS Command Line Interface

```
SOFTWARE (fc1)
Copyright (c) 1986-2005 by cisco Systems, Inc.
Compiled Wed 18-May-05 22:31 by jharirba

Press RETURN to get started!


%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to
up

%LINK-5-CHANGED: Interface FastEthernet0/2, changed state to up

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


Switch>enable
Switch#configure
Switch#configure ter
Switch#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#
```

Ctrl+F6 to exit CLI focus | Copy | Paste

☐ Top

PACKET TRACER REALTIME MODE

PACKET TRACER
SIMULATION MODE

Cisco CLI

- Different views
  - From **user view** to **system view**, using command "enable" ,
  - From **system view** to **function view**, using function name or object name as command, such as "interface giga 0/0"
- Frequently used commands
  - **show** //display the info (ip routing table , interface ,mac-address table)
  - **exit** , **end** //back to upper layer , back to root layer
  - **?** , **Tab** // help to find the rest part of command
  - **no** //the 1st word of command to cancel the following command ,such as: using "route rip" to config rip while using " no route rip" to cancel the setting
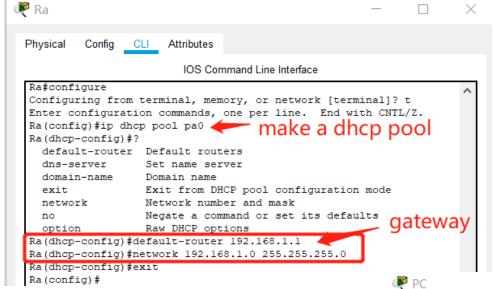
Demo1 DHCP

Tips: the state of interface of router is down by default

Would you like to enter the initial configuration dialog? [yes/no]: n

Press RETURN to get started!

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#hostname Ra
Ra(config)#interface fa
Ra(config)#interface fastEthernet 0/0
Ra(config-if)#ip address 192.168.1.1 255.255.255.0
Ra(config-if)#no shutdown

Ra(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to up
```

```
Ra#show interfaces fastEthernet 0/0
FastEthernet0/0 is up, line protocol is up (connected)
  Hardware is Lance, address is 00d0.d30b.0201 (bia 00d0.d30b.0201)
  Internet address is 192.168.1.1/24
  MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Full-duplex, 100Mb/s, media type is RJ45
```

Config panel:

```
Equivalent IOS Commands

Router>enable
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#hostname Ra
Ra(config)#
```
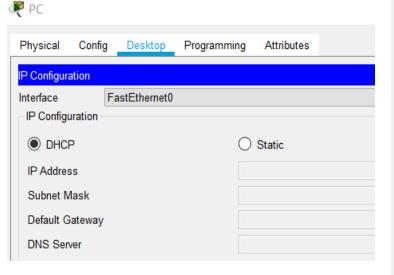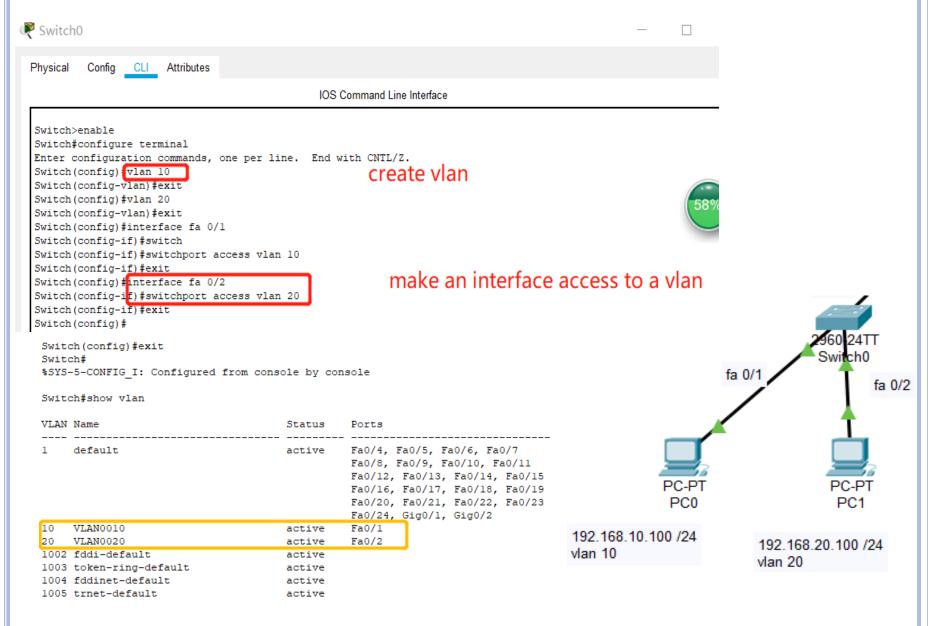
DEMO1 DHCP

1. Configure the IP address of the interface above.
2. Make a DHCP pool
   - configure the default router with the IP address of the interface
   - Configure the network with the same sub-net ID as the default router
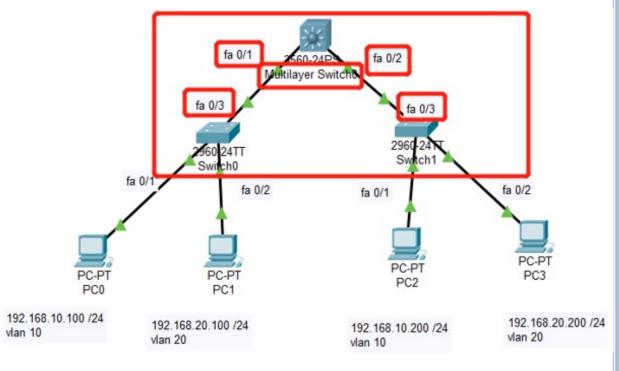
```
Ra#configure
Configuring from terminal, memory, or network [terminal]? t
Enter configuration commands, one per line.  End with CNTL/Z.
Ra(config)#ip dhcp pool pa0        make a dhcp pool
Ra(dhcp-config)#?
  default-router  Default routers
  dns-server      Set name server
  domain-name     Domain name
  exit            Exit from DHCP pool configuration mode
  network         Network number and mask
  no              Negate a command or set its defaults
  option          Raw DHCP options               gateway
Ra(dhcp-config)#default-router 192.168.1.1
Ra(dhcp-config)#network 192.168.1.0 255.255.255.0
Ra(dhcp-config)#exit
Ra(config)#
```

PC — IP Configuration

Interface	FastEthernet0

IP Configuration
- ◉ DHCP   ○ Static
- IP Address
- Subnet Mask
- Default Gateway
- DNS Server

PC — Command Prompt

```
C:\>ipconfig

FastEthernet0 Connection:(default port)

   Link-local IPv6 Address.........: FE80::204:9AFF:FE48:3DD4
   IP Address......................: 192.168.1.2
   Subnet Mask.....................: 255.255.255.0
   Default Gateway.................: 0.0.0.0

Bluetooth Connection:
                                              get ipv4 address by DHCP
   Link-local IPv6 Address.........: ::
   IP Address......................: 0.0.0.0
   Subnet Mask.....................: 0.0.0.0
   Default Gateway.................: 0.0.0.0

C:\>
```

Demo2 VLAN

Switch0 — CLI (IOS Command Line Interface)

```
Switch>enable
Switch#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#vlan 10
Switch(config-vlan)#exit
Switch(config)#vlan 20
Switch(config-vlan)#exit
Switch(config)#interface fa 0/1
Switch(config-if)#switch
Switch(config-if)#switchport access vlan 10
Switch(config-if)#exit
Switch(config)#interface fa 0/2
Switch(config-if)#switchport access vlan 20
Switch(config-if)#exit
Switch(config)#
```

create vlan

make an interface access to a vlan

```
Switch(config)#exit
Switch#
%SYS-5-CONFIG_I: Configured from console by console

Switch#show vlan

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
20   VLAN0020                         active    Fa0/2
1002 fddi-default                     active
1003 token-ring-default               active
1004 fddinet-default                  active
1005 trnet-default                    active
```

2960 24TT
Switch0

fa 0/1

fa 0/2

PC-PT
PC0

PC-PT
PC1

192.168.10.100 /24
vlan 10

192.168.20.100 /24
vlan 20

Demo3 VLAN

fa 0/1
2560-24PS
Multilayer Switch0
fa 0/2
fa 0/3
fa 0/3
2960-24TT
Switch0
2960-24TT
Switch1
fa 0/1
fa 0/2
fa 0/1
fa 0/2
PC-PT
PC0
PC-PT
PC1
PC-PT
PC2
PC-PT
PC3

192.168.10.100 /24
vlan 10

192.168.20.100 /24
vlan 20

192.168.10.200 /24
vlan 10

192.168.20.200 /24
vlan 20

PC0

| Physical | Config | Desktop | Programming | Attributes |

IP Configuration

Interface   FastEthernet0

IP Configuration

○ DHCP   ● Static

svi address of vlan

IP Address   192.168.10.100

Subnet Mask   255.255.255.0

Default Gateway   192.168.10.254

For switch 0 and switch 1,
adjust the mode of interface
which connected with
multilayer switch as trunk

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

DEMO3
VLAN

```
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#
```

For a multilayer switch
1. Make the mode of interface connect with switch0 and switch1 as trunk
   - Interface fa 0/1
   - Switch port trunk encapsulation dot1q
   - Switch port mode trunk
2. Make the same vlan as switch0 and switch1
   - Vlan 10 //to create vlan 10
3. Make the interface of vlan ,configure its ip address and subnet mask
   - Interface vlan10
   - Ip address 192.168.10.254 255.255.255.0
4. invoke the ip routing function of multilayer switch
   - Ip routing
5. show the ip route table to check if there are routing items on connections
6. Test on pc using "ping"

DEMO4
STATIC ROUTE

192.168.1.2

192.168.1.1 /24
fa 0/0

192.168.3.1 /24
fa 0/0

192.168.3.2 /24

PC-PT
PCa

2811
Ra

2811
Rb

PC-PT
PCb

192.168.2.1 /24
fa 0/1

192.168.2.2 /24
fa 0/1

```
Ra#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    192.168.1.0/24 is directly connected, FastEthernet0/0
C    192.168.2.0/24 is directly connected, FastEthernet0/1
Ra#
```

```
PCa
Physical   Config   Desktop   Programming   Attributes

Command Prompt

C:\>
C:\>ipconfig

FastEthernet0 Connection:(default port)

    Link-local IPv6 Address.........: FE80::204:9AFF:FE48:3DD4
    IP Address......................: 192.168.1.2
    Subnet Mask.....................: 255.255.255.0
    Default Gateway.................: 0.0.0.0

Bluetooth Connection:

    Link-local IPv6 Address.........: ::
    IP Address......................: 0.0.0.0
    Subnet Mask.....................: 0.0.0.0
    Default Gateway.................: 0.0.0.0

C:\>ping 192.168.3.2

Pinging 192.168.3.2 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.3.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>
```

```
Rb#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    192.168.2.0/24 is directly connected, FastEthernet0/1
C    192.168.3.0/24 is directly connected, FastEthernet0/0

Rb#
```
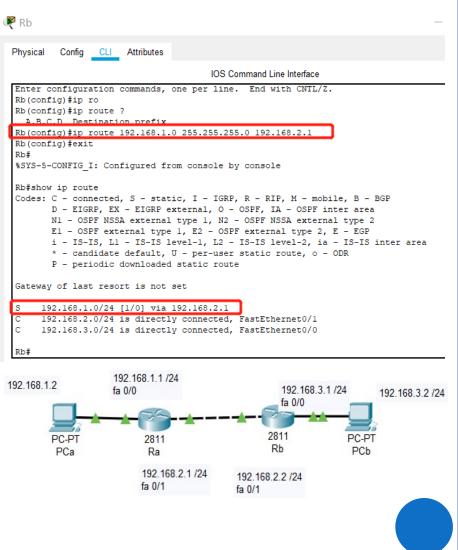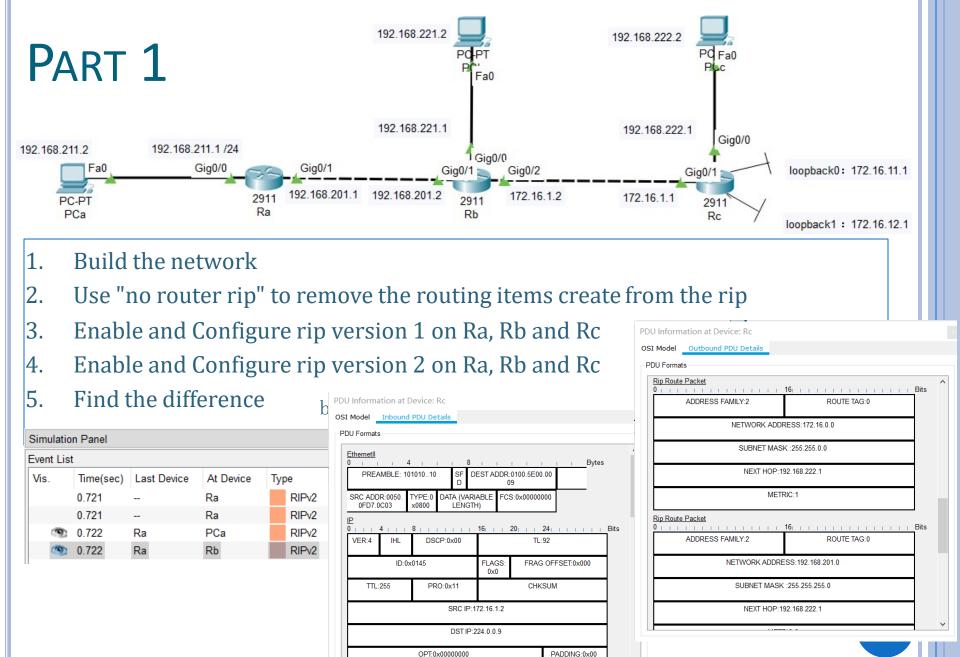
DEMO4 STATIC ROUTE

ASSIGNMENT 12

1. Run Simulations
2. Prepare Report with Screenshots and Explanation of the Results

PART 1

192.168.221.2 — PC-PT PC'
192.168.221.1
Gig0/0

192.168.222.2 — PC Fa0 Pcc
192.168.222.1
Gig0/0

192.168.211.2 — PC-PT PCa
Fa0
192.168.211.1 /24
Gig0/0

Gig0/1
192.168.201.1
2911 Ra
192.168.201.2

Gig0/1
2911 Rb
Gig0/2
172.16.1.2
172.16.1.1

Gig0/1
2911 Rc
Gig0/0

loopback0: 172.16.11.1
loopback1: 172.16.12.1

1. Build the network
2. Use "no router rip" to remove the routing items create from the rip
3. Enable and Configure rip version 1 on Ra, Rb and Rc
4. Enable and Configure rip version 2 on Ra, Rb and Rc
5. Find the difference

Simulation Panel

Event List

Vis.	Time(sec)	Last Device	At Device	Type
	0.721	--	Ra	RIPv2
	0.721	--	Ra	RIPv2
👁	0.722	Ra	PCa	RIPv2
👁	0.722	Ra	Rb	RIPv2

PDU Information at Device: Rc

OSI Model   Inbound PDU Details

PDU Formats

EthernetII

PREAMBLE: 101010..10	SFD	DEST ADDR:0100.5E00.00 09		
SRC ADDR:0050. 0FD7.0C03	TYPE:0 x0800	DATA (VARIABLE LENGTH)	FCS:0x00000000	

IP

VER:4	IHL	DSCP:0x00		TL:92
ID:0x0145			FLAGS: 0x0	FRAG OFFSET:0x000
TTL:255		PRO:0x11		CHKSUM
SRC IP:172.16.1.2				
DST IP:224.0.0.9				
OPT:0x00000000			PADDING:0x00	
DATA (VARIABLE LENGTH)				

PDU Information at Device: Rc

OSI Model   Outbound PDU Details

PDU Formats

Rip Route Packet

ADDRESS FAMILY:2	ROUTE TAG:0
NETWORK ADDRESS:172.16.0.0	
SUBNET MASK :255.255.0.0	
NEXT HOP:192.168.222.1	
METRIC:1	

Rip Route Packet

ADDRESS FAMILY:2	ROUTE TAG:0
NETWORK ADDRESS:192.168.201.0	
SUBNET MASK :255.255.255.0	
NEXT HOP:192.168.222.1	

TIPS: RIP1

192.168.221.2 PC-PT PC' Fa0

192.168.222.2 PC Fa0 PCc

192.168.221.1

192.168.222.1

Gig0/0

192.168.211.2

192.168.211.1 /24

Fa0   Gig0/0   Gig0/1   Gig0/0   Gig0/1   Gig0/2   Gig0/1   loopback0: 172.16.11.1

PC-PT   2911   192.168.201.1   192.168.201.2   2911   172.16.1.2   172.16.1.1   2911   loopback1 : 172.16.12.1
PCa   Ra   Rb   Rc

```
Router(config)#router rip
Router(config-router)#:
Router(config-router)#network 192.168.211.0
Router(config-router)#network 192.168.201.0
Router(config-router)#end
```

```
Router(config)#router rip
Router(config-router)....
Router(config-router)#network 192.168.201.0
Router(config-router)#network 192.168.221.0
Router(config-router)#
% A
Router(config)#end
```

```
Ra show ip route
Codes: L - local, C - connected, S - static, 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

      192.168.201.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.201.0/24 is directly connected, GigabitEthernet0/1
L        192.168.201.1/32 is directly connected, GigabitEthernet0/1
      192.168.211.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.211.0/24 is directly connected, GigabitEthernet0/0
L        192.168.211.1/32 is directly connected, GigabitEthernet0/0
R     192.168.221.0/24 [120/1] via 192.168.201.2, 00:00:12, GigabitEthernet0/1
```

```
Router show ip route
Codes: L - local, C - connected, S - static, 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

      172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C        172.16.1.0/24 is directly connected, GigabitEthernet0/2
L        172.16.1.2/32 is directly connected, GigabitEthernet0/2
      192.168.201.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.201.0/24 is directly connected, GigabitEthernet0/1
L        192.168.201.2/32 is directly connected, GigabitEthernet0/1
R     192.168.211.0/24 [120/1] via 192.168.201.1, 00:00:20, GigabitEthernet0/1
      192.168.221.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.221.0/24 is directly connected, GigabitEthernet0/0
L        192.168.221.1/32 is directly connected, GigabitEthernet0/0

Router#
```

TIPS: RIP2


```
192.168.221.2              192.168.222.2
PC-PT                       PC  Fa0
PC'                         Pcc
    Fa0
                                        Gig0/0
   192.168.221.1           192.168.222.1
                    Gig0/0
192.168.211.2   192.168.211.1 /24
    Fa0     Gig0/0    Gig0/1   Gig0/1  Gig0/2      Gig0/1   loopback0: 172.16.11.1
PC-PT        2911   192.168.201.1 192.168.201.2  172.16.1.2  172.16.1.1  2911
PCa          Ra                    2911                      Rc    loopback1: 172.16.12.1
                                   Rb
```

```
Ra(config)#router rip
Ra(config-router)#network 192.168.211.0
Ra(config-router)#network 192.168.201.0
Ra(config-router)#version 2
Ra(config-router)#end


Router(config)#router rip
Router(config-router)#network 192.168.201.0
Router(config-router)#network 192.168.221.0
Router(config-router)#network 172.16.1.0
Router(config-router)#version 2
Router(config-router)#end
```

```
Router#show ip rip database
172.16.1.0/24     auto-summary
172.16.1.0/24     directly connected, GigabitEthernet0/2
172.16.11.0/24      auto-summary
172.16.11.0/24
    [1] via 172.16.1.1, 00:00:11, GigabitEthernet0/2
172.16.12.0/24      auto-summary
172.16.12.0/24
    [1] via 172.16.1.1, 00:00:11, GigabitEthernet0/2
192.168.201.0/24     auto-summary
192.168.201.0/24     directly connected, GigabitEthernet0/1
192.168.211.0/24     auto-summary
192.168.211.0/24
    [1] via 192.168.201.1, 00:00:19, GigabitEthernet0/1
192.168.221.0/24     auto-summary
192.168.221.0/24     directly connected, GigabitEthernet0/0
192.168.222.0/24     auto-summary
192.168.222.0/24
    [1] via 172.16.1.1, 00:00:11, GigabitEthernet0/2
Router#
```

PART 2:

192.168.221.2 — PC-PT PC' Fa0

192.168.222.2 — PC Fa0 Pbc

192.168.221.1

192.168.222.1

Gig0/0

192.168.211.2

192.168.211.1 /24

Fa0   Gig0/0

PC-PT
PCa

2911
Ra

Gig0/1

192.168.201.1   192.168.201.2

Gig0/0
Gig0/1   Gig0/2

2911
Rb

172.16.1.2

172.16.1.1

Gig0/1

2911
Rc

Gig0/0

loopback0: 172.16.11.1

loopback1: 172.16.12.1

```
Ra(config)#router ospf 1
Ra(config-router)#network 192.168.211.0 0.0.0.255 area 0
Ra(config-router)#network 192.168.201.0 0.0.0.255 area 0
Ra(config-router)#end
Ra#
```

1. Build the network
2. Use "no router rip" to remove the routing items from RIP
3. Enable and Configure Single domain OSPF
4. Test the system and find the difference between RIP and OSPF

```
Rc#show ip route
Codes: L - local, C - connected, S - static, 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

     172.16.0.0/16 is variably subnetted, 6 subnets, 2 masks
C       172.16.1.0/24 is directly connected, GigabitEthernet0/1
L       172.16.1.1/32 is directly connected, GigabitEthernet0/1
C       172.16.11.0/24 is directly connected, Loopback0
L       172.16.11.1/32 is directly connected, Loopback0
C       172.16.12.0/24 is directly connected, Loopback1
L       172.16.12.1/32 is directly connected, Loopback1
O    192.168.201.0/24 [110/2] via 172.16.1.2, 00:01:16, GigabitEthernet0/1
O    192.168.211.0/24 [110/3] via 172.16.1.2, 00:01:16, GigabitEthernet0/1
O    192.168.221.0/24 [110/2] via 172.16.1.2, 00:01:16, GigabitEthernet0/1
     192.168.222.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.222.0/24 is directly connected, GigabitEthernet0/0
L       192.168.222.1/32 is directly connected, GigabitEthernet0/0

Rc#
```