CS 305 Lab Tutorial
Lab10 Router

Dept. Computer Science and Engineering
Southern University of Science and Technology

SUSTech
Southern University of Science and Technology

thanks to wangwei

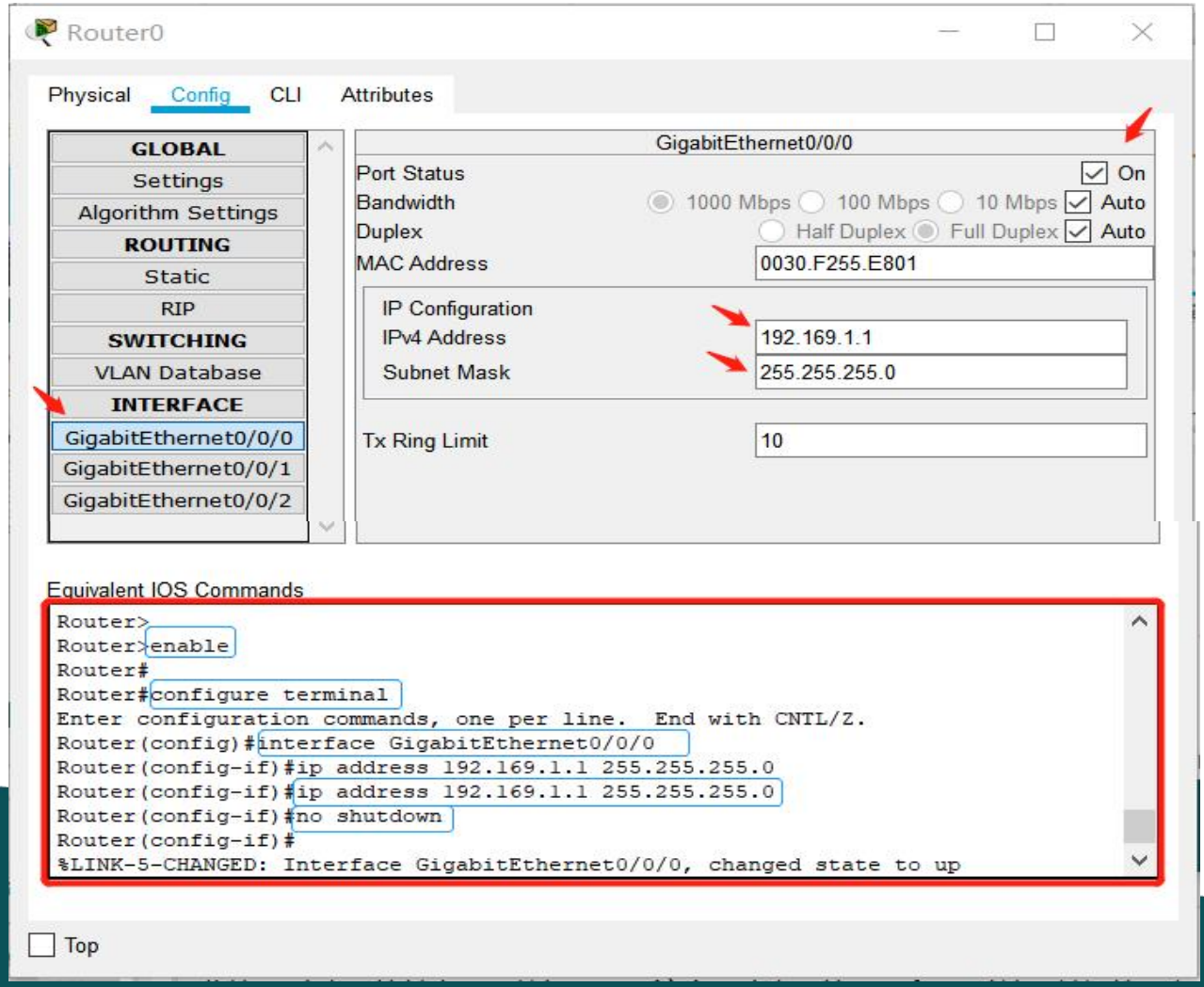
Topic

- Packet Tracer
  - CLI(Command Line Interface) on network device
- Router
  - DHCP Server
  - Gateway
  - Route-table, Route aggregation
- Practice
  - Build network on simulator
  - Configure and test the network

Packet Tracer: CLI on Network device(1)

While doing the configurations by using **GUI**(graphic user interface), and the corresponding **CLI** commands will be generated on bellowing.

```
Router>
Router#
Router(config)#
Router(config-if)#
```



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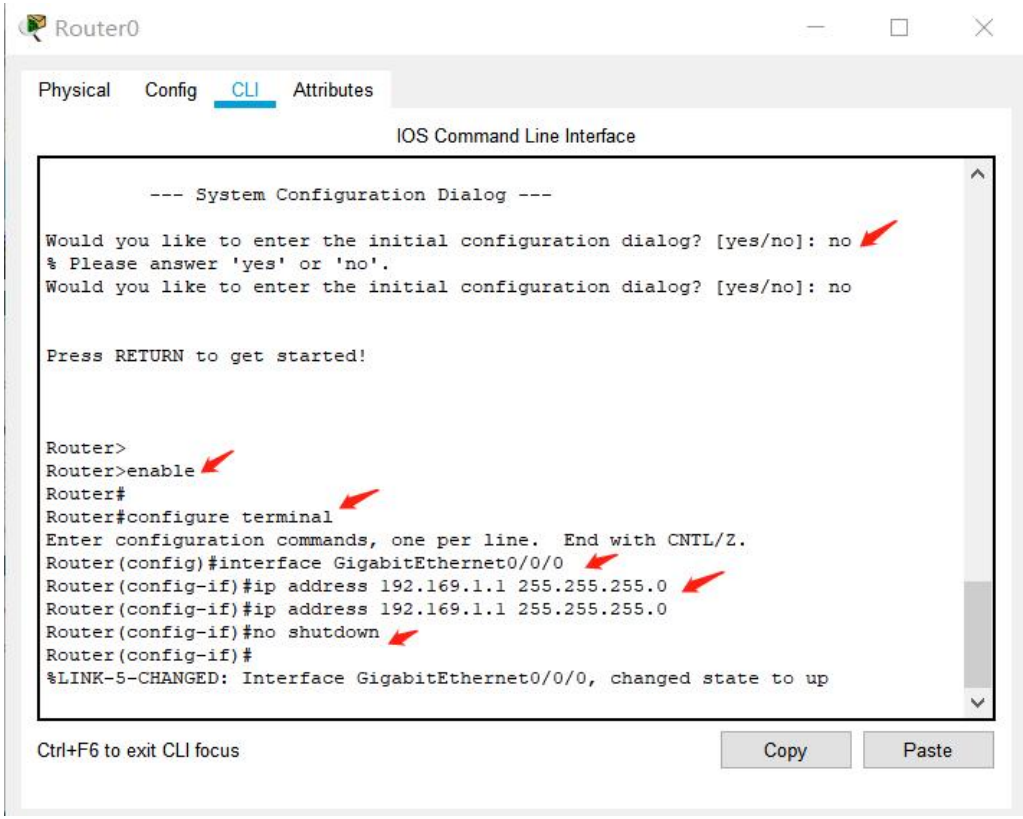
Packet Tracer: CLI on Network device(2)

- We can make all the configurations of Router by using CLI commands.
- Three kinds of view(**user**, **system**, **function**): each supports different operations, and each view has different command prompt.

```
Router>
Router#
Router(config)#
Router(config-if)#
```

- 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”

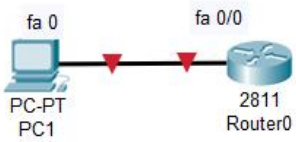


Packet Tracer: CLI on Network device(3)

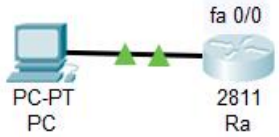
- Frequently used commands
  - show //display the info (ip routing table, interface, mac-address table)
  - exit, end //back to upper layer, back to root layer
  - ?, Tab // help to find the rest part of command
  - no *** //to cancel the following command ***, such as: using “route rip” to config rip while using “no route rip” to cancel the setting

DHCP Server on the Router (1)

Step1. Up the interface of the Router which connect with PC.



Red icons indicate unreachable



Green icons indicate reachable

Tips:

(1) The state of interface of router is down by default, we can use "**no shutdown**" command to up the interface.

```
Ra(config-if)#no shutdown
```

(2) **As soon as the interface is enabled, DHCP server is enabled by default**.

DHCP Server on the Router (2)

Step2. Configure the **interface's IP address and subnet mask**

Ra

Physical Config CLI Attributes

IOS Command Line Interface

```
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.d
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
```

Tips:

(1) Using "show" command to check the state of the interface.

DHCP Server on the Router (3)

Step3. Make and configure the DHCP pool

3-1) Configure the **default-router** with the IP address of the interface

3-2) Configure the **network** with the same sub-net ID as default-router

Ra

Physical Config CLI Attributes

IOS Command Line Interface

```
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
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
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)#
```

make a dhcp pool

gateway

DHCP Server on the Router (tips)

- Some CLI commands about DHCP configuration.
- The DHCP commands should be used in DHCP conf view.

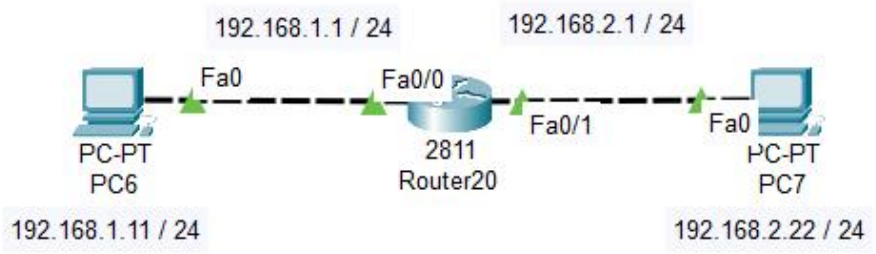
```
Router(config)#ip dhcp pool dhcpppp12
Router(dhcp-config)#network 192.168.2.0 255.255.255.0
```

Command	Function
show ip dhcp pool	Display information about DHCP address pool
show ip interface	Display information about interface
service dhcp	Launch DHCP server
ip dhcp pool	Configure DHCP address pool
network DHCP	Configure IP and network of server
default-router	Default gateway

Practise 10.1

1. Practice on Packet Tracer about DHCP server on the Router
   - Create a network with a Router and two PCs
     - tips: make the configuration of interface visible
   - Configure the Router and the PCS
     - configure the interface of Router with IP address and netmask, 'up' the interface
     - configure the IP DHCP pool with name, default-gateway and subnet
     - configure the PCs as DHCP client
     - connect the Router with two PCs
   - Test the DHCP service
     - test if two PCs could communicate with the Router
     - test if the two PCs could communicate with each other

Subnet



Q1. What's the subnet mask of 192.168.1.1/24 ?

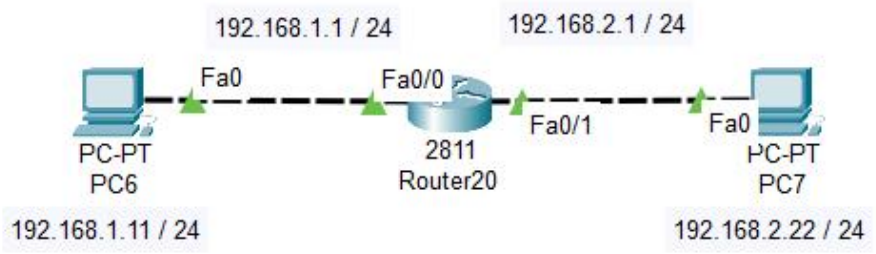
Q2: How many sub-net in the network? what are their net-id?

Q3: Does 192.168.1.1/24 and 192.168.1.11/24 belongs to the same sub-net?

Q4: Does 192.168.2.22/24 and 192.168.1.11/24 belongs to the same sub-net?

Q5: How to make PC7 reachable from PC6?

Subnet



Q1. What's the subnet mask of 192.168.1.1/24 ?

A. 255.255.255.0

Q2: How many sub-net in the network? what are their net-id?

A: 2

Q3: Does 192.168.1.1/24 and 192.168.1.11/24 belongs to the same sub-net?

A: Yes

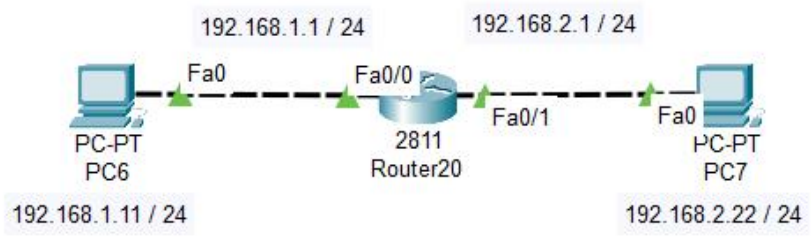
Q4: Does 192.168.2.22/24 and 192.168.1.11/24 belongs to the same sub-net?

A: NO

Q5: How to make PC7 reachable from PC6?

A: using Router to forward the IP packets from one subnet to the other subnet.

Default Gateway



Q: What are the right configs to make PC7 reachable from PC6?

PC6

1

Physical Config Desktop Programming Attributes

Command Prompt

```
FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Link-local IPv6 Address.........: FE80::202:16FF:FE9E:A297
   IPv6 Address....................: ::
   IPv4 Address....................: 192.168.1.11
   Subnet Mask.....................: 255.255.255.0
   Default Gateway.................: ::
                                     192.168.1.1
```

PC7

2

Physical Config Desktop Programming Attributes

Command Prompt

```
C:\>ipconfig

FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Link-local IPv6 Address.........: FE80::260:5CFF:FECD:80E6
   IPv6 Address....................: ::
   IPv4 Address....................: 192.168.2.22
   Subnet Mask.....................: 255.255.255.0
   Default Gateway.................: ::
                                     192.168.1.1
```

PC6

3

Physical Config Desktop Programming Attributes

Command Prompt

```
C:\>ipconfig /all

FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Physical Address................: 0009.7C67.3C2B
   Link-local IPv6 Address.........: FE80::209:7CFF:FE67:3C2B
   IPv6 Address....................: ::
   IPv4 Address....................: 192.168.1.11
   Subnet Mask.....................: 255.255.255.0
   Default Gateway.................: ::
                                     192.168.2.1
```

PC7

4

Physical Config Desktop Programming Attributes

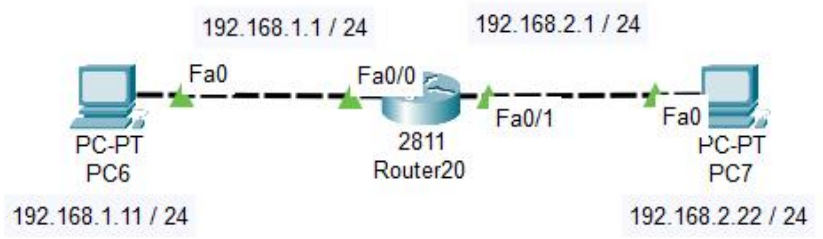
Command Prompt

```
C:\>ipconfig

FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Link-local IPv6 Address.........: FE80::260:5CFF:FECD:80E6
   IPv6 Address....................: ::
   IPv4 Address....................: 192.168.2.22
   Subnet Mask.....................: 255.255.255.0
   Default Gateway.................: ::
                                     192.168.2.1
```

Route-Table: Connected Route(1)



- Command "**show ip route**" is used on router to find its route-table.
- "**connected route**" is generated by defalut while the IP address of interface is assigned.
- Q: What's the function of route-table ?

Router20

Physical Config CLI Attributes

IOS Command Line Interface

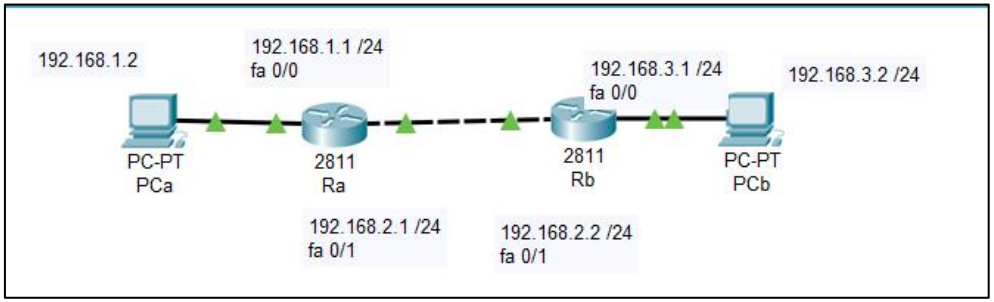
```
Router>en
Router#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external 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

Router#
```

Route-Table: Connected Route(2)



Q1:Is fa0/1 interface of Rb reachable from PCb?
Q2:Is fa0/1 interface of Ra reachable from PCb?
Q3:Is fa0/0 interface of Ra reachable from PCb?
Q4:Is PCb reachable from PCa?
Q5:How to make them reachable?

```
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#
```

```
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#
```

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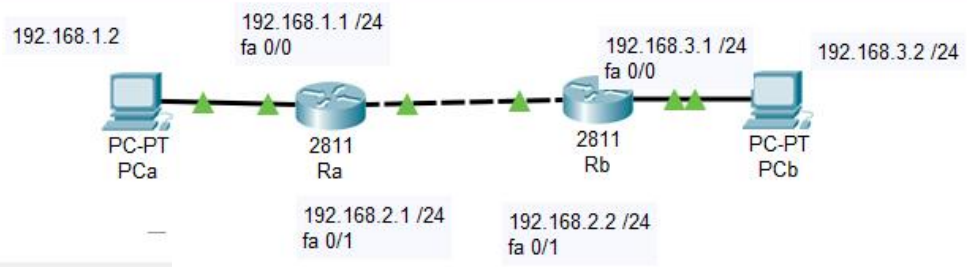
Route-Table: Static Route(1)



Rb

Physical Config CLI Attributes

IOS Command Line Interface

```
Enter configuration commands, one per line.  End with CNTL/Z.
Rb(config)#ip ro
Rb(config)#ip route ?
  A.B.C.D  Destination prefix
Rb(config)#ip route 192.168.1.0 255.255.255.0 192.168.2.1
Rb(config)#exit
Rb#
%SYS-5-CONFIG_I: Configured from console by console

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
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       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

S    192.168.1.0/24 [1/0] via 192.168.2.1
C    192.168.2.0/24 is directly connected, FastEthernet0/1
C    192.168.3.0/24 is directly connected, FastEthernet0/0

Rb#
```
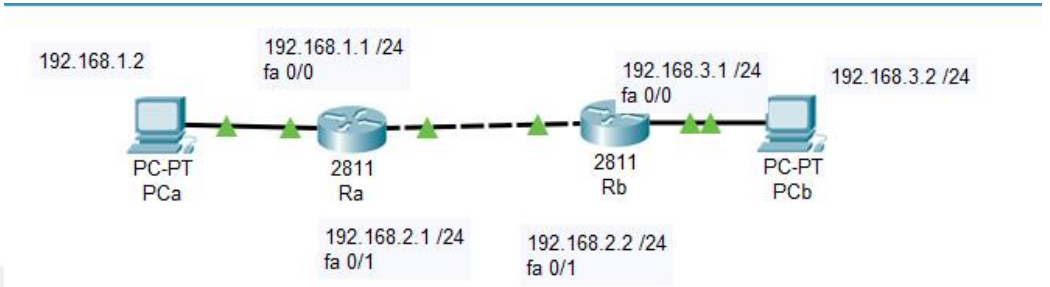

- Command "**ip route x.x.x.x m.m.m.m i.i.i.i**" is used to add static route in the router.
  - "**x.x.x.x**" is the subnet id
  - "**m.m.m.m**" is the subnet mask
  - "**i.i.i.i**" is the IP address of **next-hop** while forward IP packet.

Q. After add static route to Ra, is PCa reachable from PCb?

Route-Table: Static Route(2)



Ra

Physical Config CLI Attributes

IOS Command Line Interface

```
  scp               Scp commands
  ssh               Configure ssh options
  tcp               Global TCP parameters
Ra(config)#ip route 192.168.3.0 255.255.255.0 192.168.2.2
Ra(config)#
Ra(config)#exit
Ra#
%SYS-5-CONFIG_I: Configured from console by console

Ra#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter ar
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EG
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-I
       * - 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
S    192.168.3.0/24 [1/0] via 192.168.2.2

Ra#
```

Rb

Physical Config CLI Attributes

IOS Command Line Interface

```
Enter configuration commands, one per line.  End with CNTL/Z.
Rb(config)#ip ro
Rb(config)#ip route ?
  A.B.C.D  Destination prefix
Rb(config)#ip route 192.168.1.0 255.255.255.0 192.168.2.1
Rb(config)#exit
Rb#
%SYS-5-CONFIG_I: Configured from console by console

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
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       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

S    192.168.1.0/24 [1/0] via 192.168.2.1
C    192.168.2.0/24 is directly connected, FastEthernet0/1
C    192.168.3.0/24 is directly connected, FastEthernet0/0

Rb#
```

Is PCa reachable from PCb now?

Route aggregation

- **Why** Route aggregation?
  - **smaller** route-table
  - **faster** forword
  - **more stable**
  - ...

- **How** to make 4 subnets to be aggregated as 1 subnet?
  - 172.16.129.0/24
  - 172.16.130.0/24
  - 172.16.132.0/24
  - 172.16.133.0/24

Route aggregation

How to make 4 subnets to be aggregated as 1 subnet?

- 172.16.129.0/24
- 172.16.130.0/24
- 172.16.132.0/24
- 172.16.133.0/24

Step1: find the Maxim size of same continuous bit from highest bit to lowest bit among the 4 subnets IDs : **21**bits (**172.16.1000_0**)

① **172.16.129.0/24**
   - **172.16.1000_0001.0 /24**

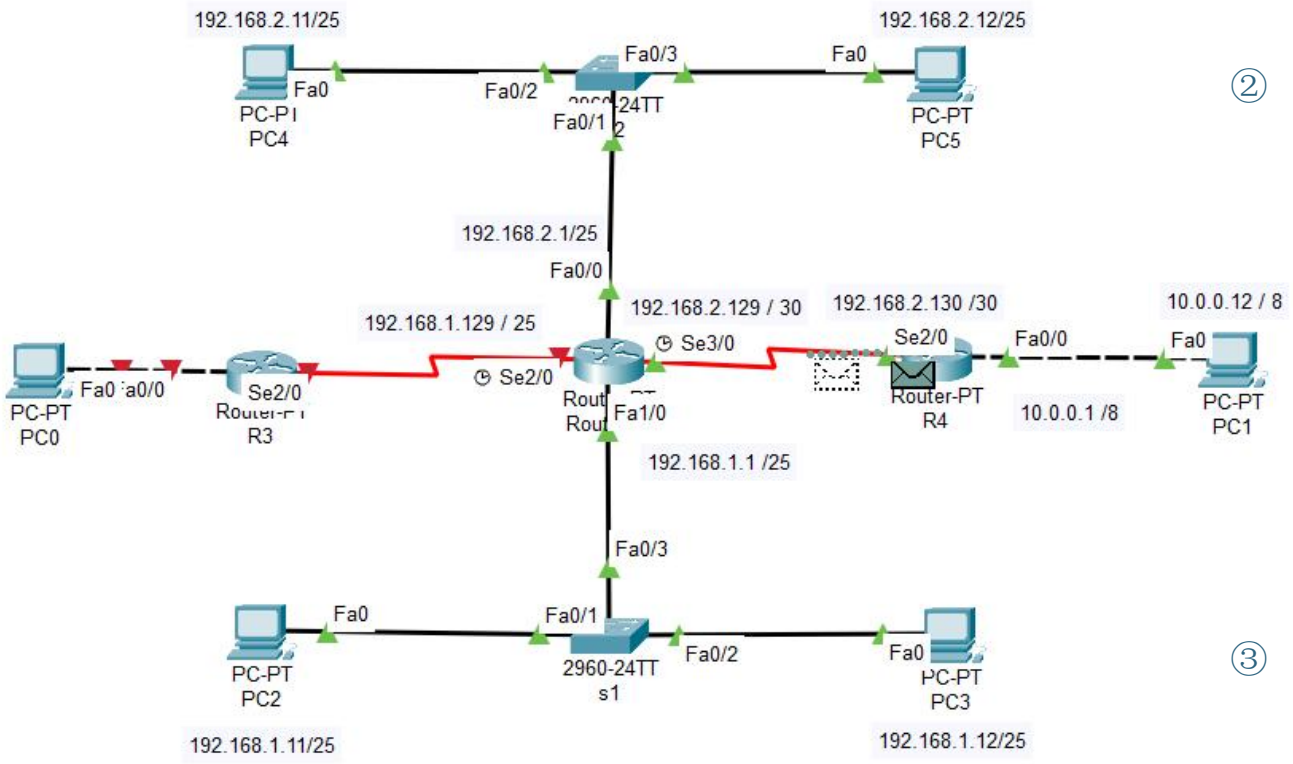
② **172.16.130.0/24**
   - **172.16.1000_0010.0 / 24**

③ **172.16.132.0/24**
   - **172.16.1000_0100.0 / 24**

④ **172.16.133.0/24**
   - **172.16.1000_0101.0 / 24**

Step2: using the bits get from step1 as hig bits of address, pad it with 0s to make a new 32bits subnet ID：(**172.16.1000_0000.0**) **172.168.128.0 / 21.** Now the 4 subnets are aggregated to be 1 subnet : **172.168.128.0 / 21.**

Practise 10.2(1)



Build the network:

① 2 **switches**

- there is no configuration on switches in this practice.

② 3 **routers**

- using **PT Route** which has more than two network interfaces.
- for the middle one, connect its **fast-ethernet interface** with switches; conncet its **serial interface** with other routers.
- configurations should include: interface, rout-table, make route-table as smaller as possible

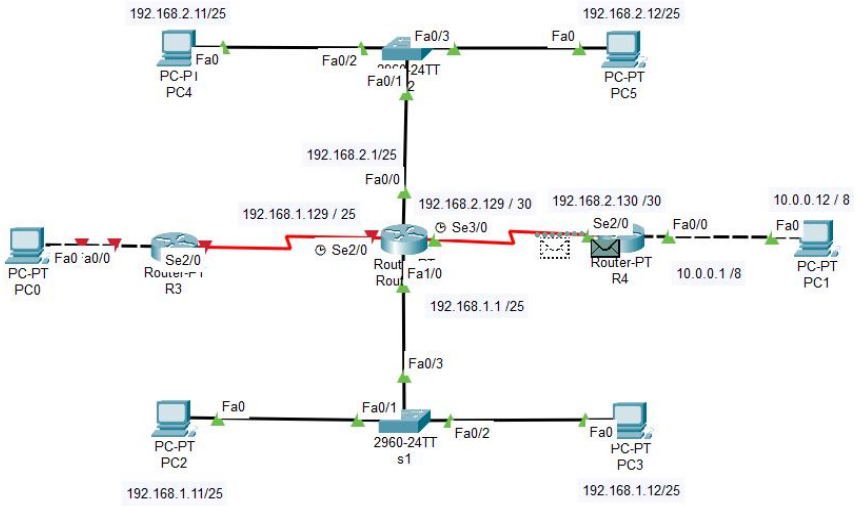
③ 6 **PCs**

- configurations include: static IP address, subnet Mask and ...

Finish the configuration, make all the PCs in the network reachable from each other.

Practise 10.2(2)

- Step1: Finish the configuration to make all the PCs are reachable from each other except PC0:
  - How many subnet are there in this network, what are their net-id?
  - what's the function of gateway in the network? show the configurations about gateway.
  - what's the function of route-table? how many types of routing items are there in the route-table?
- Step2 : Implement the route aggregation in this practice.
  - Is there any possible to make route aggregation? which subnet could be aggregated, where should the route aggregation be configured?



- Step3 : configure the PC0 and R3 to make PC0 reachable in the network(option):
  - after aggregation on Step2, is it possible to make PC0 reachable from other PCs while not changing the route-table which be configured with route aggregation?