

Internet Backbone

Antonio Virdis
Assistant Professor@ University of Pisa
antonio.virdis@unipi.it

Internet Backbone architecture



<https://www.youtube.com/watch?v=iDbyYGrswtg>

Outline

- Introduction to GNS3
- Basic commands for CISCO routers configuration
- MPLS

IOS

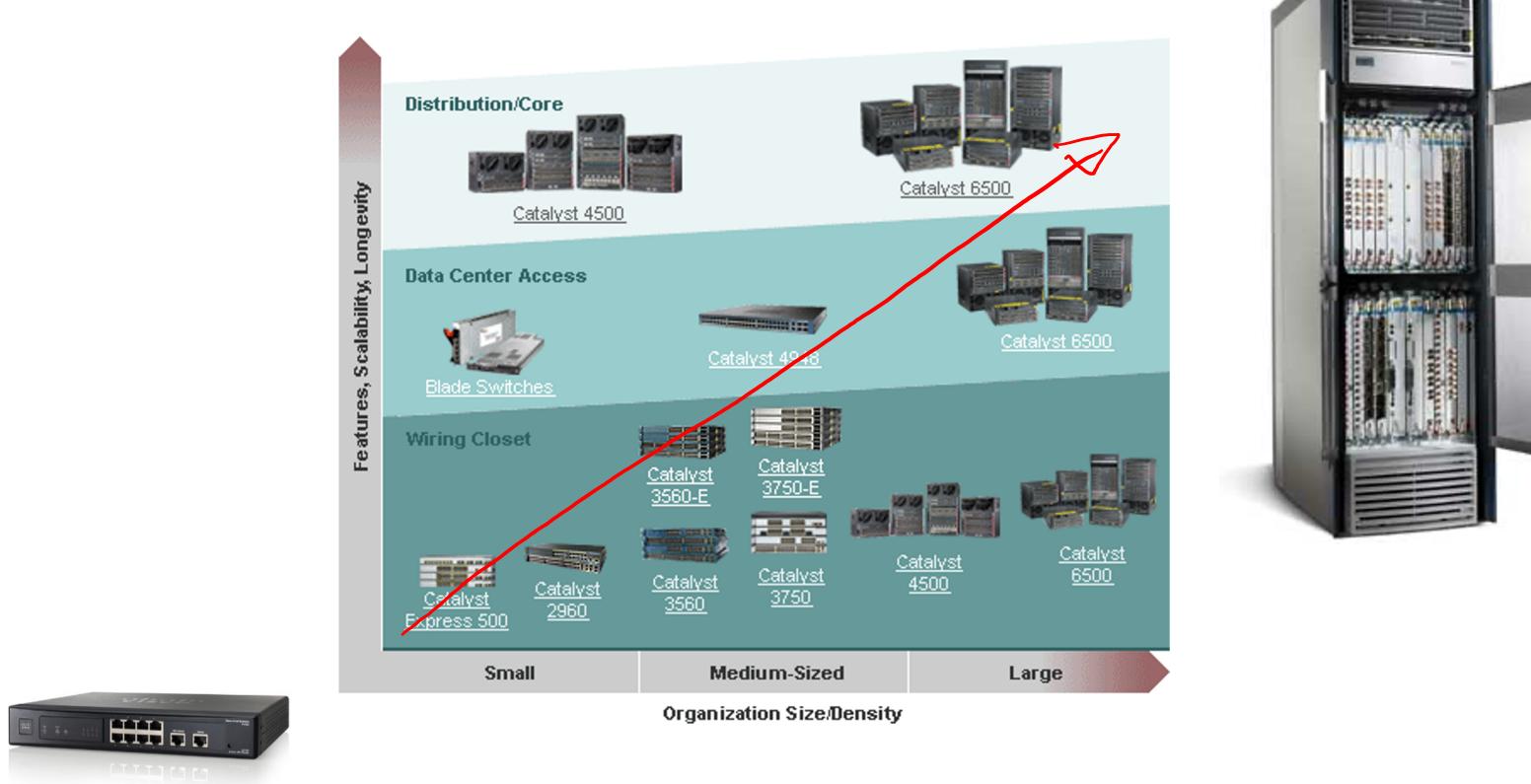
Cisco IOS: Basic commands

Antonio Virdis
Assistant Professor@ University of Pisa
antonio.virdis@unipi.it

Routers are “specialized” computers



From small to big



The operating system

- Cisco Internetwork Operating System (IOS)
- Juniper Network Operating System (Junos)
- ...

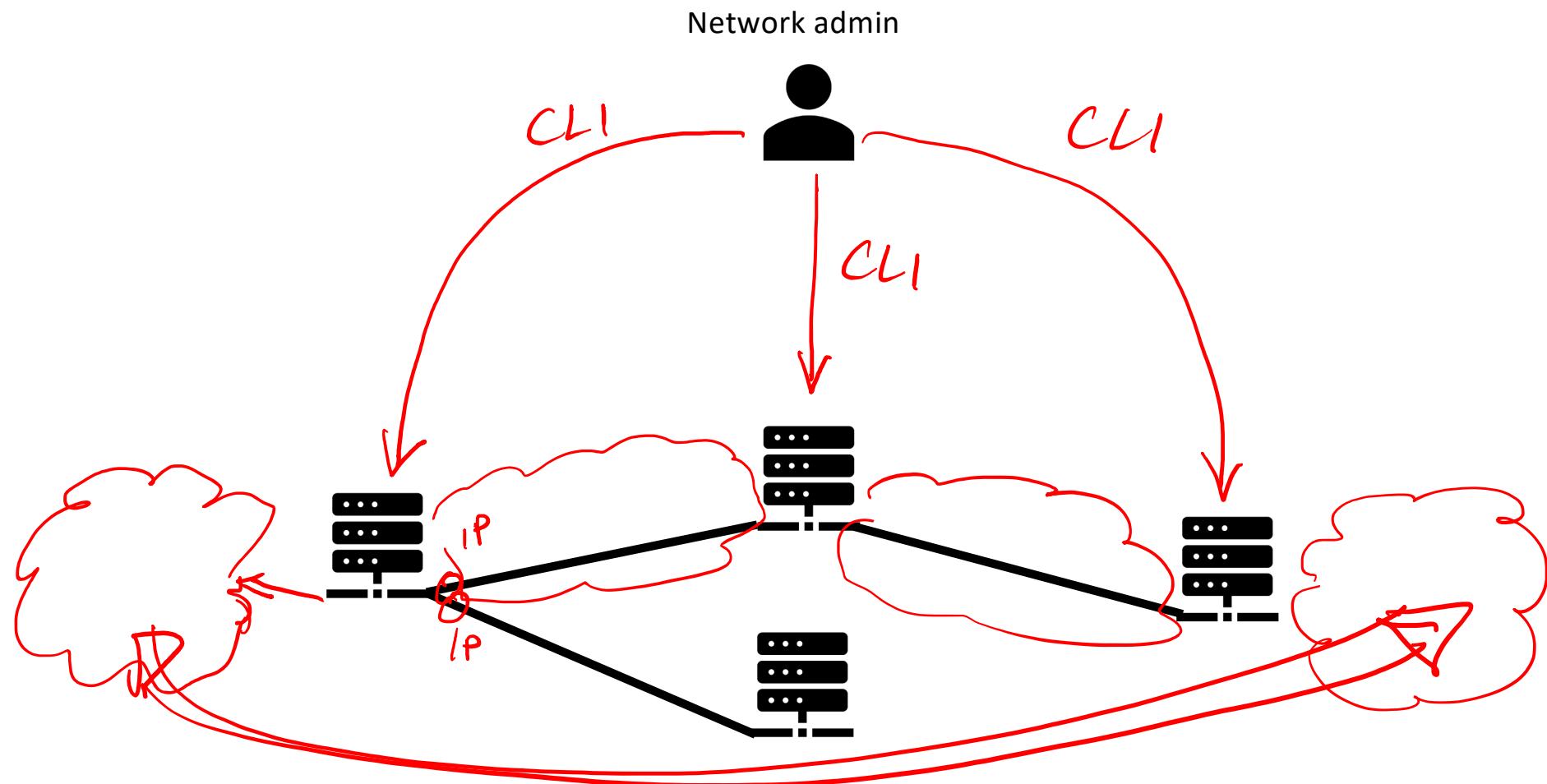
→ FFR



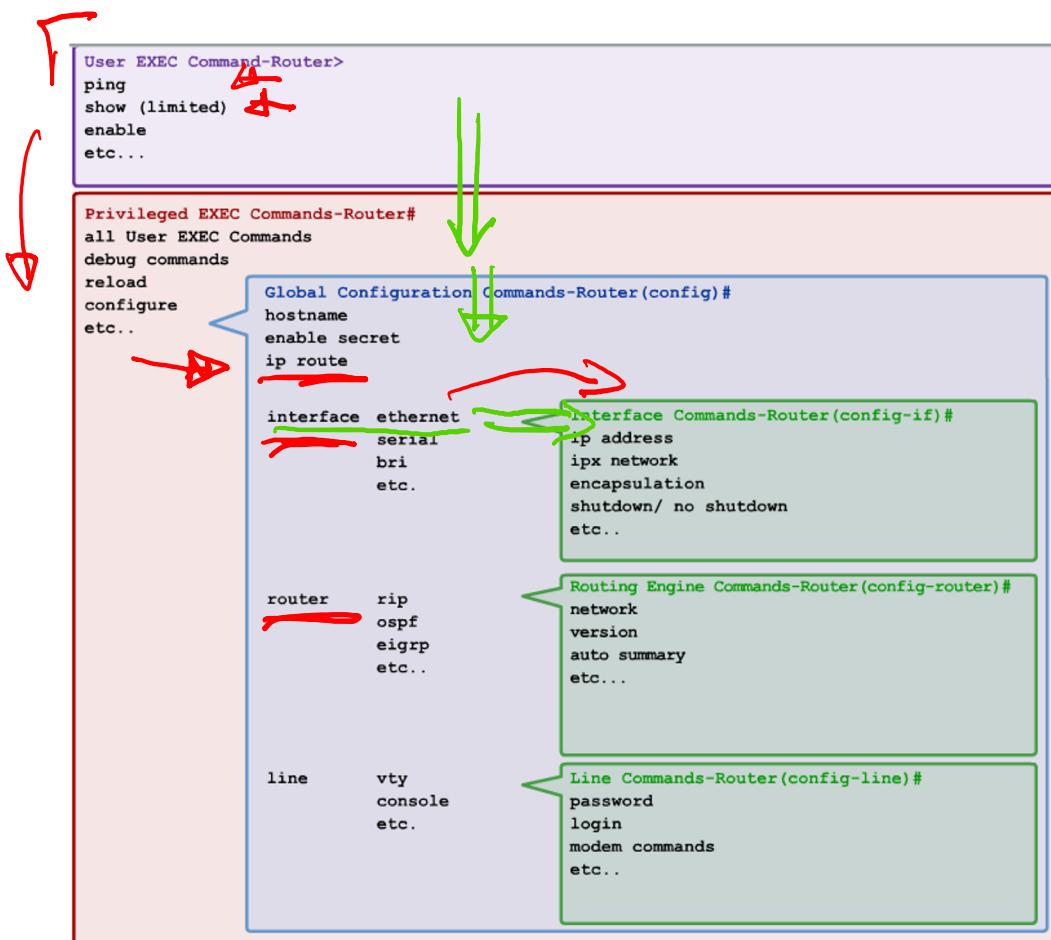
Internetwork Operating System for Cisco networking devices



Nodes configuration



Cisco IOS modes



IOS prompt structure

```
Router>ping 192.168.10.5  
  
Router#show running-config  
  
Router(config)#Interface FastEthernet 0/0  
  
Router(config-if)#ip address 192.168.10.1 255.255.255.0
```

The prompt changes to denote the current CLI mode.

```
Switch>ping 192.168.10.9  
  
Switch#show running-config  
  
Switch(config)#Interface FastEthernet 0/1  
  
Switch(config-if)#Description connection to WEST LAN4
```

Moving between primary modes

?

```
Router con0 is now available.
```

```
Press RETURN to get started.
```

```
User Access Verification
```

```
Password:
```

```
Router>enable
```



```
Password:
```

```
Router#configure terminal
```

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

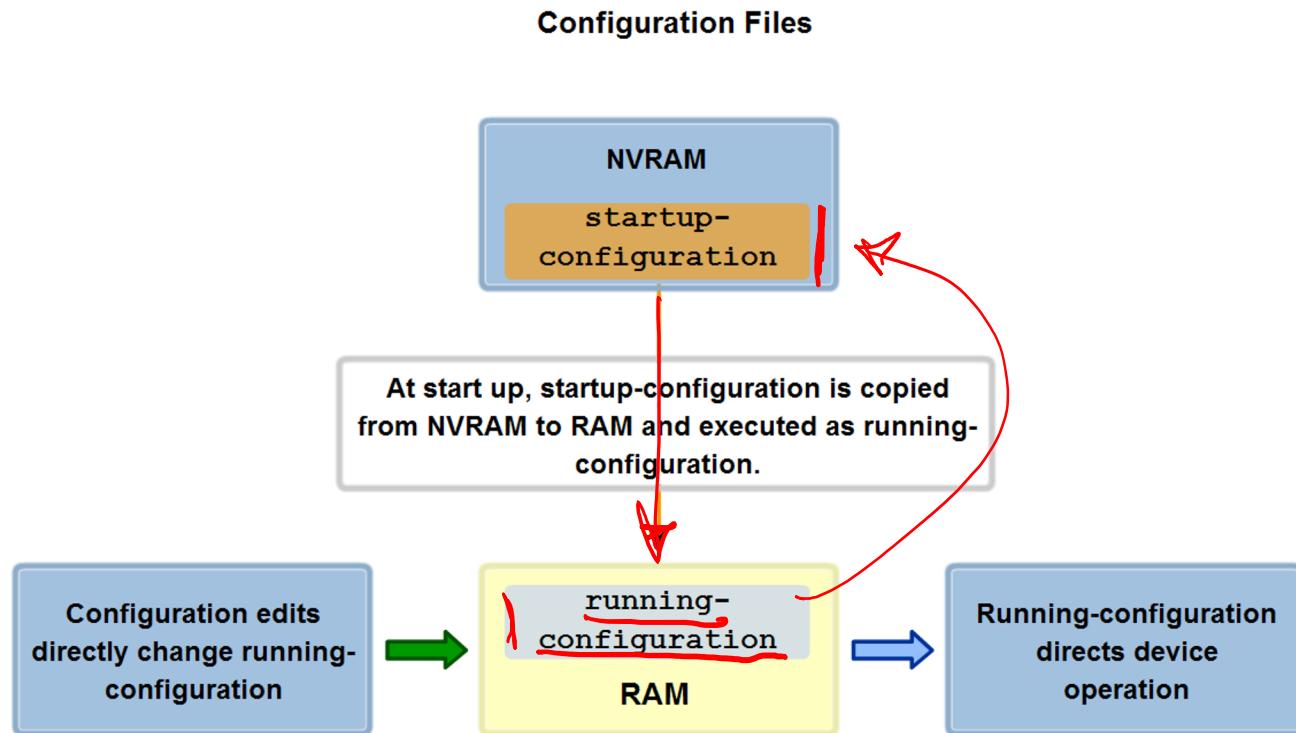
```
Router(config)#^Z
```

```
Router#disable
```

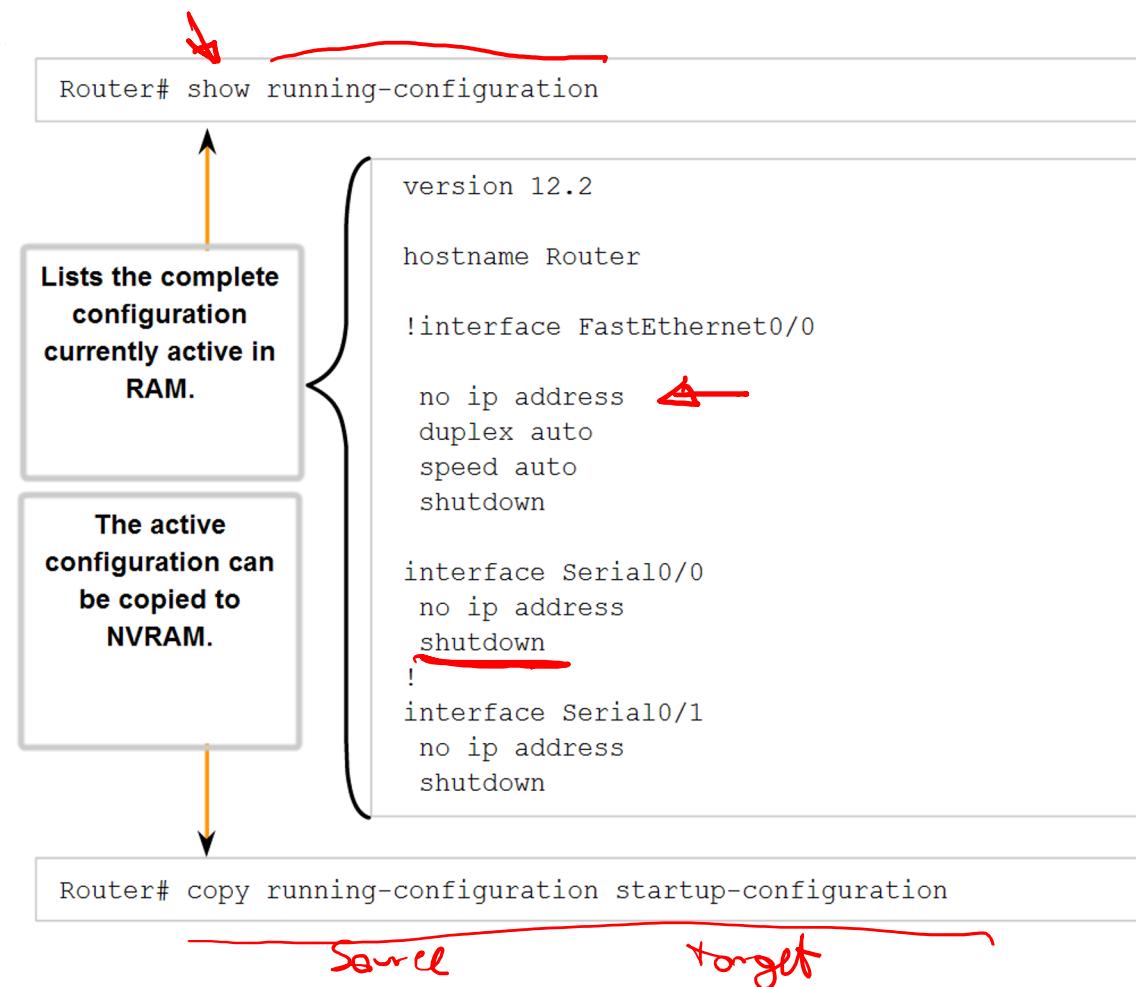


```
Router>exit
```

Configuration files

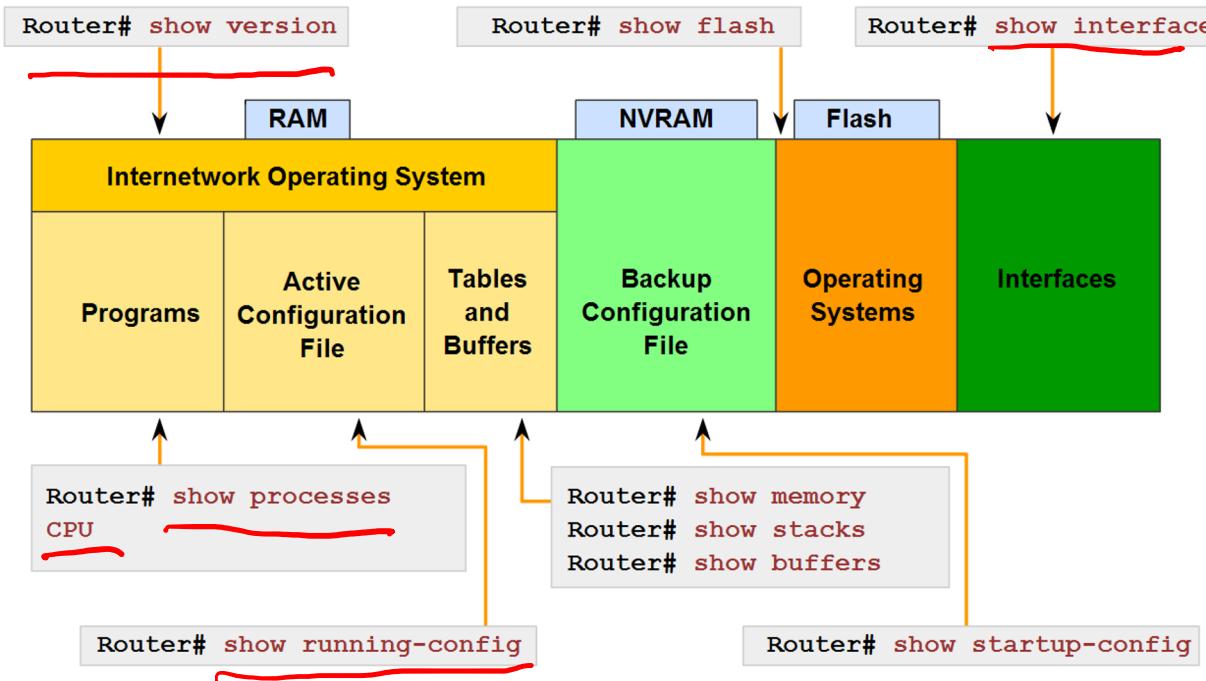


Managing configuration files

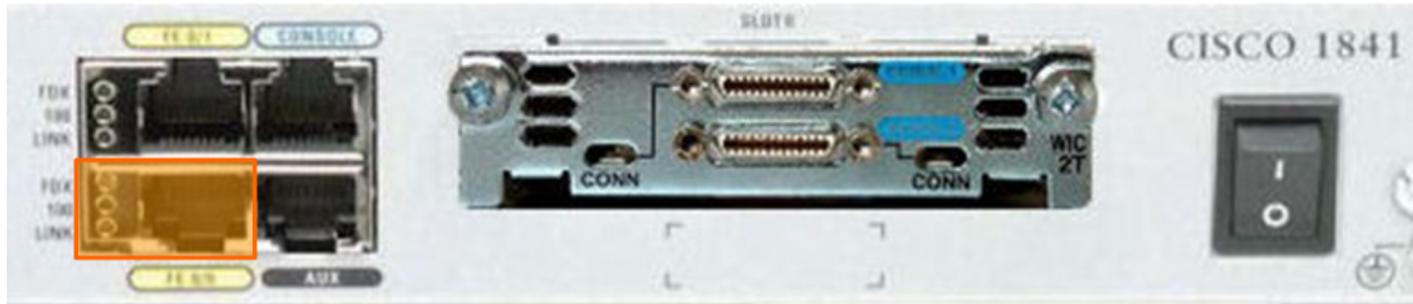


The IOS show command

IOS show commands can provide information about the configuration, operation and status of parts of a Cisco router.



Configuring Ethernet interfaces

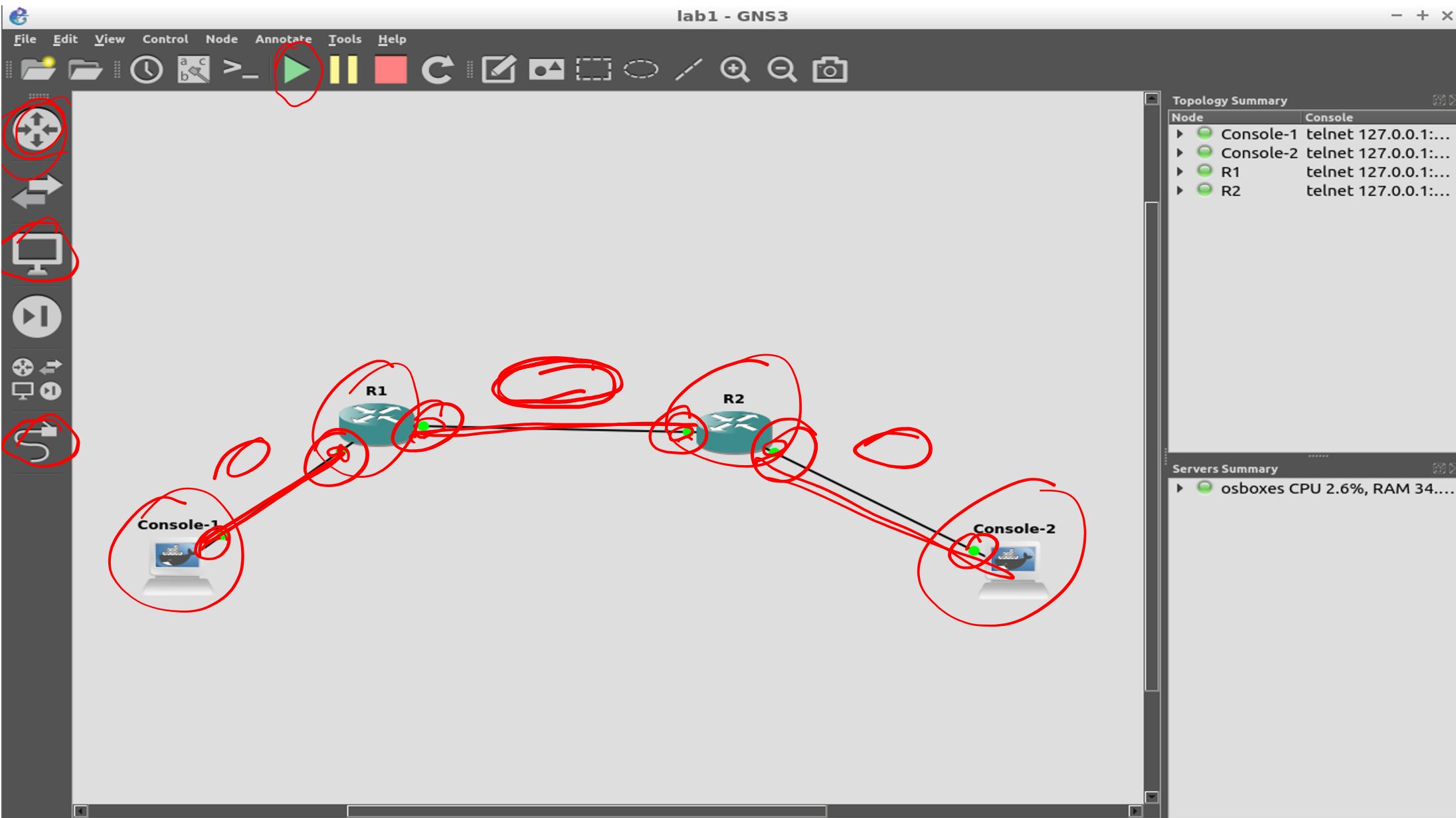


```
Router(config)#interface FastEthernet 0/0 ①
Router(config-if)#ip address 192.168.10.1 255.255.255.0 ②
Router(config-if)#no shutdown ③
Router(config-if)#exit
Router(config) #
```

GNS3

- Graphical Network Simulator 3 is a network software emulator
- It allows the combination of virtual and real devices to emulate complex networks
- Specifically it allows the emulation of real hosts and real routers
- The emulated routers run a real IoS image downloaded from a real router

lab1 - GNS3



Configure a DHCP server on a router

- Define a range of addresses that DHCP is not to allocate
 - static addresses reserved for the router interface, switch management IP address, servers, and local network printers
- Create the DHCP pool
- Configure the specifics of the pool.

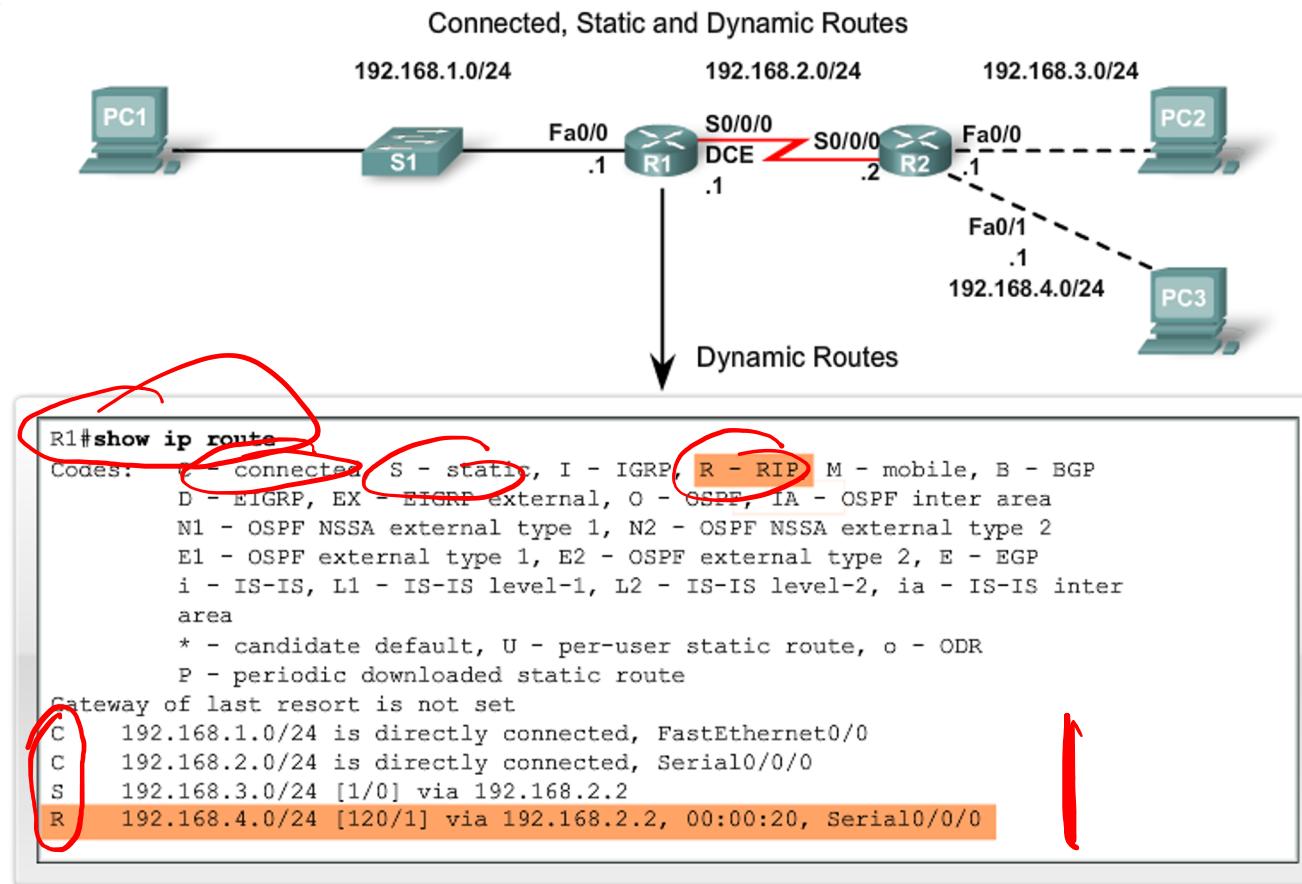
```
R1(config)# ip dhcp excluded-address 192.168.10.1 192.168.10.9
R1(config)# ip dhcp excluded-address 192.168.10.254
R1(config)# ip dhcp pool LAN-POOL-1
R1(dhcp-config)# network 192.168.10.0 255.255.255.0
R1(dhcp-config)# default-router 192.168.10.1
R1(dhcp-config)# domain-name span.com
R1(dhcp-config)# end
```

Required Tasks	Command
Define the address pool	network <i>network-number [mask /prefix-length]</i>
Define the default router or gateway	default-router <i>address2...address8</i>

Test 1

- Create a simple network composed of at least two routers and two hosts
- Boot the routers
- Configure the IP addresses of all the interfaces in the routers
- Set two DHCP servers to autoconfigure IPv4 address to the hosts
- Boot the hosts

Routing table

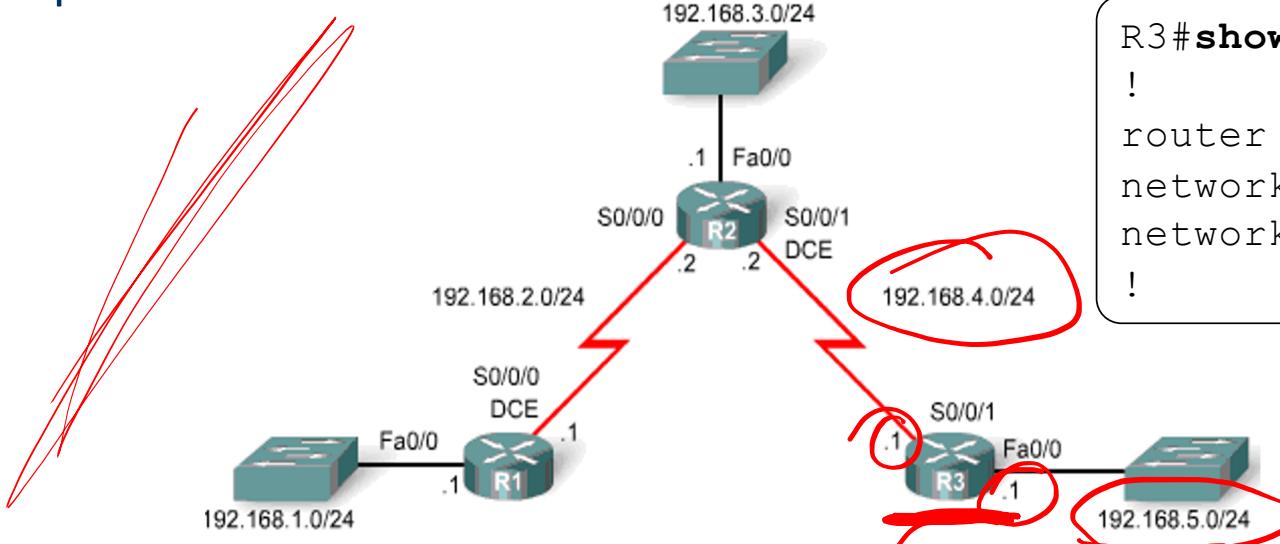


IOS RIPv1 configuration



```
Router(config-router) #network directly-connected-classful-network-address
```

- Enables RIP on all interfaces that belong to a specific network. Associated interfaces will now both send and receive RIP updates.
- Advertises the specified network in RIP routing updates



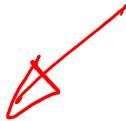
```
R3 (config) #router rip  
R3 (config-router) #network 192.168.4.0  
R3 (config-router) #network 192.168.5.1  
R3 (config-router) #exit
```

```
R3#show running-config  
!  
router rip  
network 192.168.4.0  
network 192.168.5.0  
!
```

Test 2

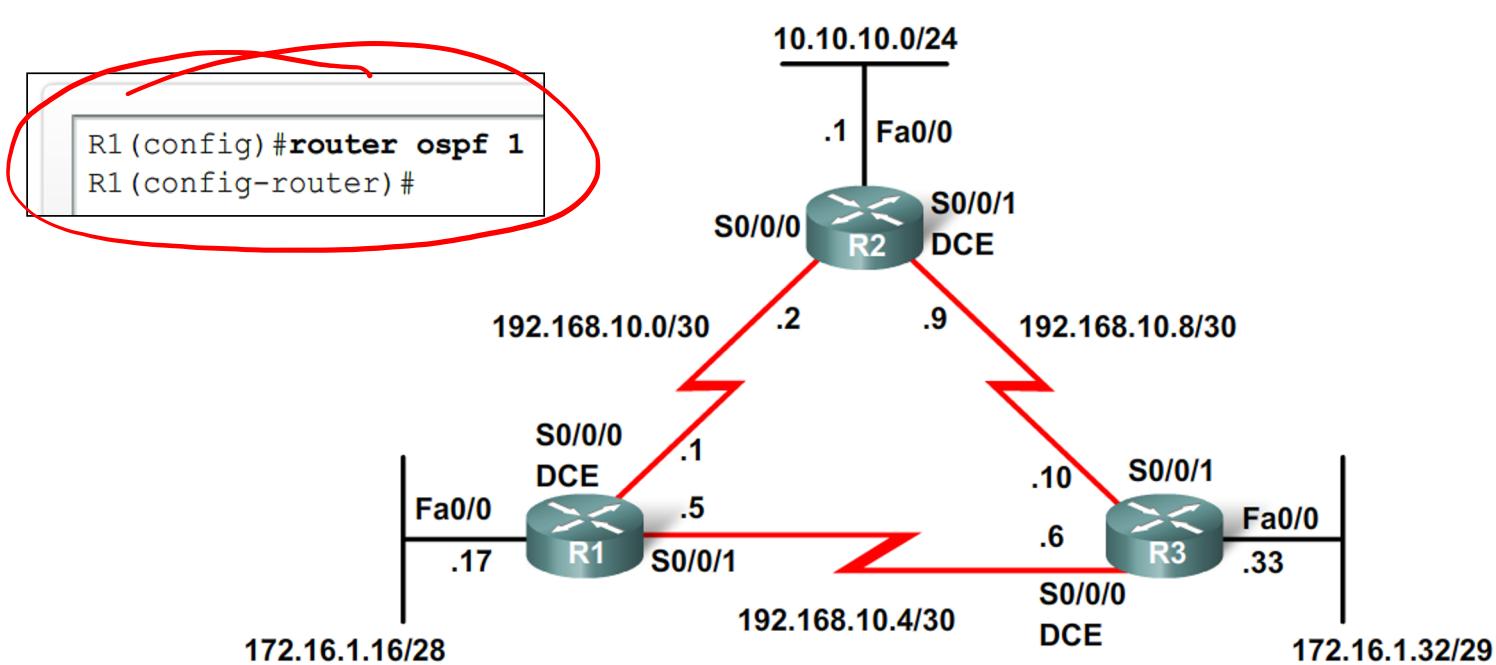
- Configure RIP as routing protocol
- Check connectivity between hosts
- Save the configuration
- Use wireshark to check traffic

Configuring OSPF



```
Router(config)#router ospf process-id
```

- Enabling OSPF routing
 - Default bandwidth 1544kbps on all serial links

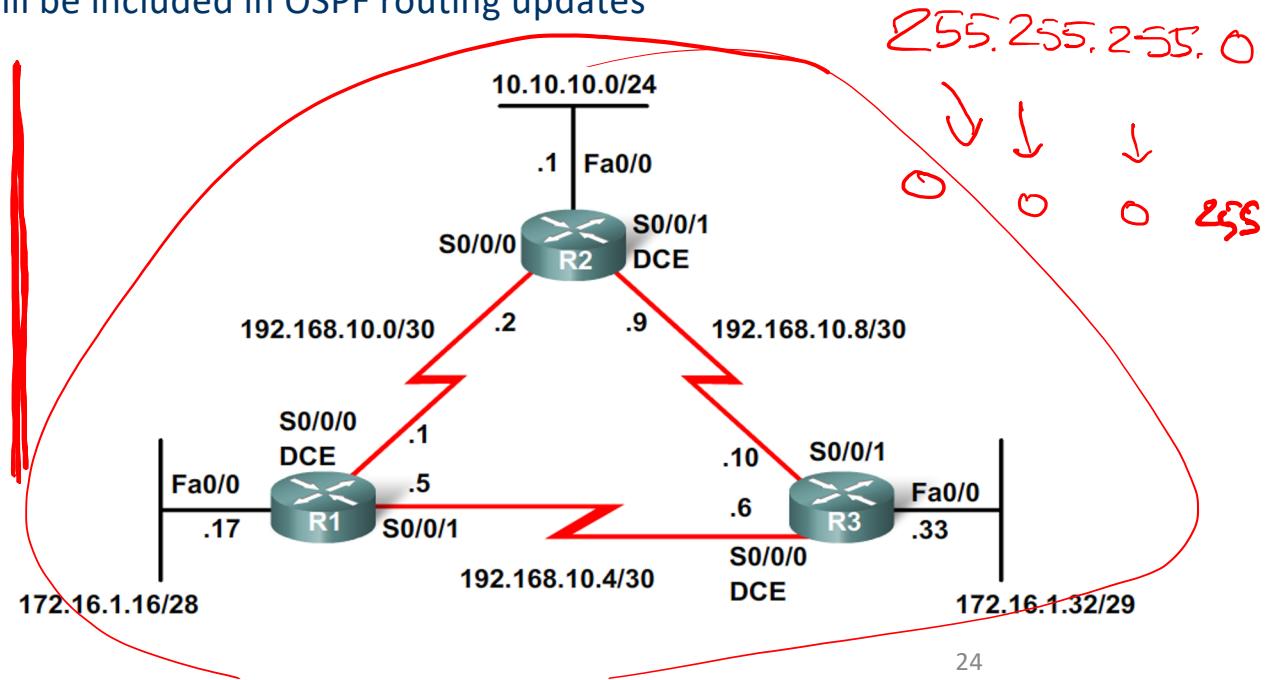


Configuring OSPF

```
Router(config-router)#network network-address wildcard-mask area area-id
```

- **Configuring OSPF subnetworks**
 - Any interface matching the network address will be enabled to send and receive OSPF packets
 - This network (or subnet) will be included in OSPF routing updates

```
R1(config)#router ospf 1
R1(config-router)#network 172.16.1.16 0.0.0.15 area 0
R1(config-router)#network 192.168.10.0 0.0.0.3 area 0
R1(config-router)#network 192.168.10.4 0.0.0.3 area 0
R2(config)#router ospf 1
R2(config-router)#network 10.10.10.0 0.0.0.255 area 0
R2(config-router)#network 192.168.10.0 0.0.0.3 area 0
R2(config-router)#network 192.168.10.8 0.0.0.3 area 0
R3(config)#router ospf 1
R3(config-router)#network 172.16.1.32 0.0.0.7 area 0
R3(config-router)#network 192.168.10.4 0.0.0.3 area 0
R3(config-router)#network 192.168.10.8 0.0.0.3 area 0
```

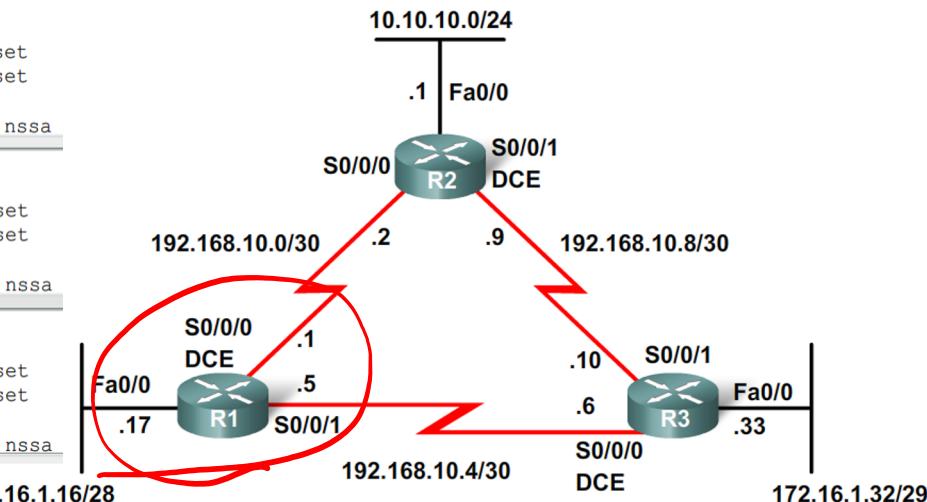


Configuring OSPF

```
Router(config-router)#router-id ip-address
```

- Determining the router id
 - 1. IP address configured with the router-id command
 - 2. The highest IP address of any of its loopback interfaces
 - 3. The highest active IP address of any of its physical interfaces

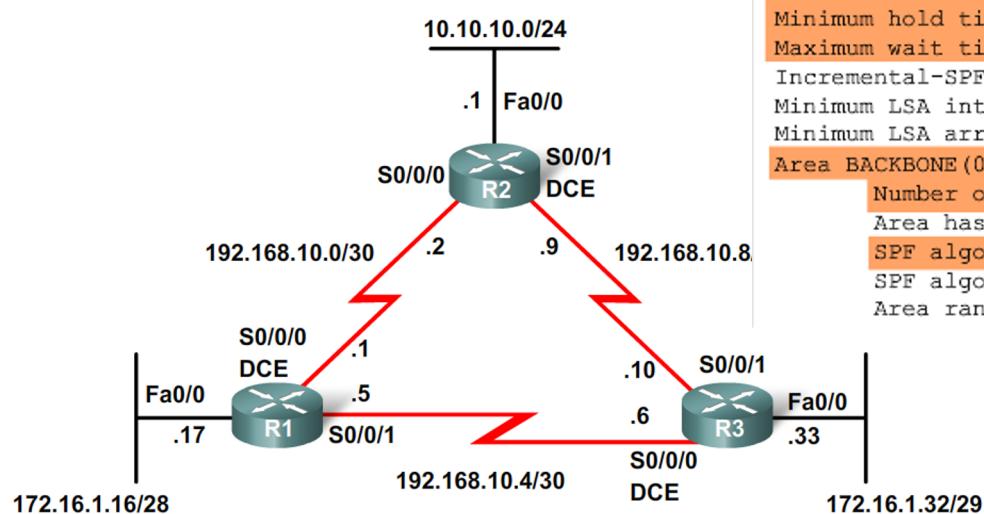
```
R1#show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
Router ID 192.168.10.5
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
R2#show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
Router ID 192.168.10.9
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
R3#show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
Router ID 192.168.10.10
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
```



Verifying OSPF configuration

- OSPF troubleshooting commands

- **show ip protocols**
- **show ip ospf**
- **show ip ospf interface**



```
R1#show ip ospf
***output omitted***
Routing Process "ospf 1" with ID 10.1.1.1
Start time: 00:00:19.540, Time elapsed: 11:31:15.776
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 5000 msec
Minimum hold time between two consecutive SPFs 10000 msec
Maximum wait time between two consecutive SPFs 10000 msec
Incremental-SPF disabled
Minimum LSA interval 5 secs
Minimum LSA arrival 1000 msec
Area BACKBONE(0)
    Number of interfaces in this area is 3
    Area has no authentication
    SPF algorithm last executed 11:30:31.628 ago
    SPF algorithm executed 5 times
    Area ranges are
```

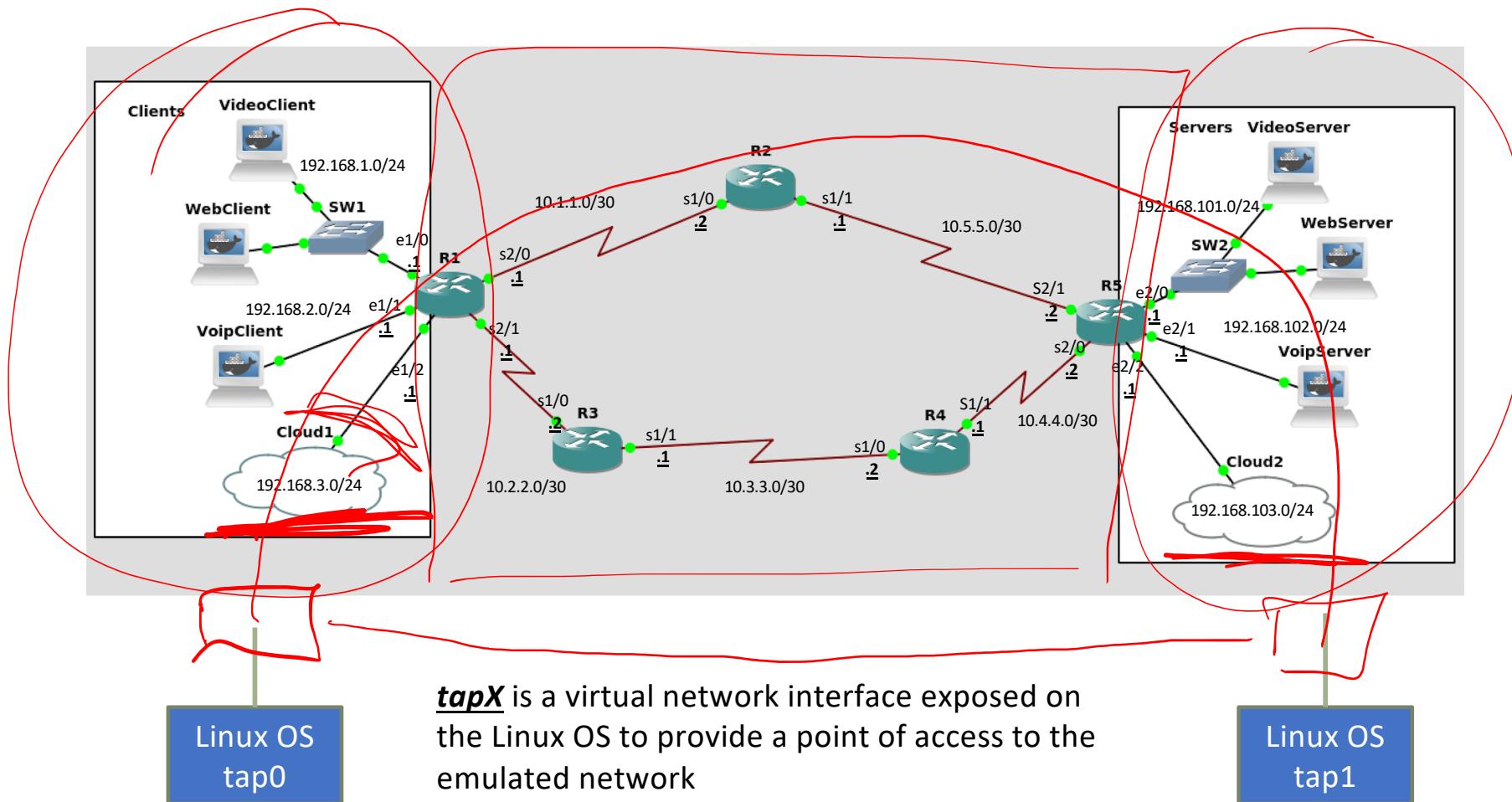
Test 3

- Configure OSPF as routing protocol
- Check connectivity between hosts
- Save the configuration
- Use wireshark to check traffic

Base Network

Antonio Virdis
Assistant Professor@ University of Pisa
antonio.virdis@unipi.it

Network Architecture



IPv6 Configuration

Antonio Virdis
Assistant Professor@ University of Pisa
antonio.virdis@unipi.it

IPv6 address configuration

- Configuration:
 - interface Ethernet0/0
 - ipv6 enable
 - (Automatically configure an IPv6 link-local address on the interface, and enable the interface for IPv6 processing)
 - ipv6 address 2001:aaaa:bbbb:cccc::/64 eui-64
 - ipv6 unicast-routing
 - Enable forwarding of IPv6 unicast data packets
- Check configuration status:
 - show ipv6 interface Ethernet0/0

IPv6 host configuration

- Go to Linux Console 1:
 - ifconfig
 - Address already obtained! When a Router Advertisement is received by a client, and IPv6 autoconfiguration is enabled (default on non-router), the client configures itself an IPv6 address according to the prefix contained in the advertisement.
- Ping:
 - ping6 [IPv6 address]
 - From Host, try both link-local and global
 - Use wireshark to see what's going on the net!

RIPv6 Configuration

- Configuration:
 - `ipv6 unicast-routing`
 - Enable forwarding of IPv6 unicast data packets
 - `interface fastEthernet0/0`
 - From Host, try both link-local and global
 - `ipv6 rip process1 enable`
- Check IPv6 Routing Table
 - `show ipv6 route`

Test 4

