

Code Snippets

Many titles include programming code or configuration examples. To optimize the presentation of these elements, view the eBook in single-column, landscape mode and adjust the font size to the smallest setting. In addition to presenting code and configurations in the reflowable text format, we have included images of the code that mimic the presentation found in the print book; therefore, where the reflowable format may compromise the presentation of the code listing, you will see a “Click here to view code image” link. Click the link to view the print-fidelity code image. To return to the previous page viewed, click the Back button on your device or app.

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

```
User Access Verification
```

```
Password:
```

```
CertsSkills1>
```

```
CertsSkills1> reload
```

```
Translating "reload"
```

```
% Unknown command or computer name, or unable to find computer address
```

```
CertsSkills1> enable
```

```
Password:
```

```
CertsSkills1#
```

```
CertsSkills1# reload
```

```
Proceed with reload? [confirm] y
```

```
00:08:42: %SYS-5-RELOAD: Reload requested by console. Reload Reason: Reload Command.
```

```
CertsSkills1# show running-config
! Output has been formatted to show only the parts relevant to this discussion
hostname CertSkills1
!
enable secret love
!
line console 0
  login

password faith
! The rest of the output has been omitted
CertsSkills1#
```

```
CertsSkills1> show mac address-table dynamic
```

```
Mac Address Table
```

Vlan	Mac Address	Type	Ports
31	0200.1111.1111	DYNAMIC	Gi0/1
31	0200.3333.3333	DYNAMIC	Fa0/3
31	1833.9d7b.0e9a	DYNAMIC	Gi0/1
10	1833.9d7b.0e9a	DYNAMIC	Gi0/1
10	30f7.0d29.8561	DYNAMIC	Gi0/1
1	1833.9d7b.0e9a	DYNAMIC	Gi0/1
12	1833.9d7b.0e9a	DYNAMIC	Gi0/1

```
Total Mac Addresses for this criterion: 7
```

```
CertsSkills1>
```

```
Switch# configure terminal
Switch(config)# hostname Fred
Fred(config)# line console 0
Fred(config-line)# password hope
Fred(config-line)# interface FastEthernet 0/1
Fred(config-if)# speed 100
Fred(config-if)# exit
Fred(config)#
```

```
! Step 1 next (two commands)
!
hannah# show running-config
! (lines omitted)
hostname hannah
! (rest of lines omitted)

hannah# show startup-config
! (lines omitted)
hostname hannah
! (rest of lines omitted)
! Step 2 next. Notice that the command prompt changes immediately after
! the hostname command.

hannah# configure terminal
hannah(config)# hostname harold
harold(config)# exit
! Step 3 next (two commands)
!
harold# show running-config
! (lines omitted) - just showing the part with the hostname command
hostname harold
!
harold# show startup-config
! (lines omitted) - just showing the part with the hostname command
hostname hannah
```

```
SW1# show mac address-table dynamic
```

Mac Address Table

Vlan	Mac Address	Type	Ports
---	-----	-----	-----
1	02AA.AAAA.AAAA	DYNAMIC	Gi0/1
1	02BB.BBBB.BBBB	DYNAMIC	Gi0/2
1	02CC.CCCC.CCCC	DYNAMIC	Gi0/3

Total Mac Addresses for this criterion: 3

```
SW1# show mac address-table dynamic
      Mac Address Table
-----
Vlan      Mac Address          Type      Ports
----      -----
  1        0200.1111.1111    DYNAMIC   Fa0/1
  1        0200.2222.2222    DYNAMIC   Fa0/2
  1        0200.3333.3333    DYNAMIC   Fa0/3
  1        0200.4444.4444    DYNAMIC   Fa0/4

Total Mac Addresses for this criterion: 4
SW1#
```

```
SW1# show interfaces status
```

Port	Name	Status	Vlan	Duplex	Speed	Type
Fa0/1		connected	1	a-full	a-100	10/100BaseTX
Fa0/2		connected	1	a-full	a-100	10/100BaseTX
Fa0/3		connected	1	a-full	a-100	10/100BaseTX
Fa0/4		connected	1	a-full	a-100	10/100BaseTX
Fa0/5		notconnect	1	auto	auto	10/100BaseTX
Fa0/6		notconnect	1	auto	auto	10/100BaseTX
Fa0/7		notconnect	1	auto	auto	10/100BaseTX
Fa0/8		notconnect	1	auto	auto	10/100BaseTX
Fa0/9		notconnect	1	auto	auto	10/100BaseTX
Fa0/10		notconnect	1	auto	auto	10/100BaseTX
Fa0/11		notconnect	1	auto	auto	10/100BaseTX
Fa0/12		notconnect	1	auto	auto	10/100BaseTX
Fa0/13		notconnect	1	auto	auto	10/100BaseTX
Fa0/14		notconnect	1	auto	auto	10/100BaseTX
Fa0/15		notconnect	1	auto	auto	10/100BaseTX
Fa0/16		notconnect	1	auto	auto	10/100BaseTX
Fa0/17		notconnect	1	auto	auto	10/100BaseTX
Fa0/18		notconnect	1	auto	auto	10/100BaseTX
Fa0/19		notconnect	1	auto	auto	10/100BaseTX
Fa0/20		notconnect	1	auto	auto	10/100BaseTX
Fa0/21		notconnect	1	auto	auto	10/100BaseTX
Fa0/22		notconnect	1	auto	auto	10/100BaseTX
Fa0/23		notconnect	1	auto	auto	10/100BaseTX
Fa0/24		notconnect	1	auto	auto	10/100BaseTX
Gi0/1		notconnect	1	auto	auto	10/100/1000BaseTX
Gi0/2		notconnect	1	auto	auto	10/100/1000BaseTX

```
SW1# show interfaces f0/1 counters
```

Port	InOctets	InUcastPkts	InMcastPkts	InBcastPkts
Fa0/1	1223303	10264	107	18

Port	OutOctets	OutUcastPkts	OutMcastPkts	OutBcastPkts
Fa0/1	3235055	13886	22940	437

```
SW1# show mac address-table dynamic address 0200.1111.1111
      Mac Address Table
-----
Vlan      Mac Address          Type      Ports
----      -----
  1        0200.1111.1111    DYNAMIC    Fa0/1
Total Mac Addresses for this criterion: 1
```

```
SW1# show mac address-table dynamic interface fastEthernet 0/1
```

```
Mac Address Table
```

Vlan	Mac Address	Type	Ports
1	0200.1111.1111	DYNAMIC	Fa0/1

```
Total Mac Addresses for this criterion: 1
```

```
SW1# show mac address-table dynamic vlan 1
      Mac Address Table
-----
Vlan      Mac Address          Type      Ports
---  -----
1        0200.1111.1111    DYNAMIC   Fa0/1
1          0200.2222.2222    DYNAMIC   Fa0/2
1          0200.3333.3333    DYNAMIC   Fa0/3
1          0200.4444.4444    DYNAMIC   Fa0/4
Total Mac Addresses for this criterion: 4
SW1#
SW1# show mac address-table dynamic vlan 2
      Mac Address Table
-----
Vlan      Mac Address          Type      Ports
---  -----
```

```
SW1# show mac address-table aging-time
Global Aging Time: 300
Vlan      Aging Time
-----
SW1#
SW1# show mac address-table count

Mac Entries for Vlan 1:
-----
Dynamic Address Count   : 4
Static  Address Count   : 0
Total Mac Addresses     : 4

Total Mac Address Space Available: 7299
```

```
SW1# show mac address-table dynamic
      Mac Address Table
-----
Vlan     Mac Address          Type      Ports
----  -----
  1      0200.1111.1111    DYNAMIC   Fa0/1
  1      0200.2222.2222    DYNAMIC   Fa0/2
  1      0200.3333.3333    DYNAMIC   Gi0/1
  1      0200.4444.4444    DYNAMIC   Gi0/1
```

```
Total Mac Addresses for this criterion: 4
```

```
! The next output is from switch SW2
```

```
SW2# show mac address-table dynamic
  1      0200.1111.1111    DYNAMIC   Gi0/2
  1      0200.2222.2222    DYNAMIC   Gi0/2
  1      0200.3333.3333    DYNAMIC   Fa0/3
  1      0200.4444.4444    DYNAMIC   Fa0/4
```

```
Total Mac Addresses for this criterion: 4
```

(User now presses enter to start the process. This line of text does not appear.)

User Access Verification

Password: **faith**

Switch> **enable**

Password: **love**

Switch#

```
! Enter global configuration mode and set the enable password.  
!  
Switch# configure terminal  
Switch(config)# enable secret love  
!  
! At Step 2 in the checklist, enter console configuration mode, set the  
! password value to "faith" and enable simple passwords for the console.  
! The exit command moves the user back to global config mode.  
!  
Switch#(config)# line console 0  
Switch#(config-line)# password faith  
Switch#(config-line)# login  
Switch#(config-line)# exit  
!  
! The next few lines do basically the same configuration, except it is  
! for the vty lines. Telnet users will use "hope" to login.  
!  
Switch#(config)# line vty 0 15  
Switch#(config-line)# password hope  
Switch#(config-line)# login  
Switch#(config-line)# transport input all  
Switch#(config-line)# end  
Switch#
```

```
Switch# show running-config
!
Building configuration...

Current configuration: 1333 bytes
!
version 12.2
!
enable secret 5 $1$OwtI$A58c2XgqWyDNeDnv51mNR.
!
interface FastEthernet0/1
!
interface FastEthernet0/2
!
! Several lines have been omitted here - in particular, lines for
! FastEthernet interfaces 0/3 through 0/23.
!
interface FastEthernet0/24
!
interface GigabitEthernet0/1
!
interface GigabitEthernet0/2
!
line con 0
 password faith
login
!
line vty 0 4
 password hope
login
 transport input all
!
line vty 5 15
 password hope
login
 transport input all
```

```
SW2# telnet 10.9.9.19
Trying 10.9.9.19 ... Open

User Access Verification

Username: wendell
Password:
SW1> enable
Password:
SW1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SW1(config)#^Z
SW1#
*Mar 1 02:00:56.229: %SYS-5-CONFIG_I: Configured from console by wendell on vty0
(10.9.9.19)
```

```
SW1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.

!
! Step 1 next. The hostname is already set, but it is repeated just
! to be obvious about the steps.

!
SW1(config)# hostname SW1
SW1(config)# ip domain name example.com
SW1(config)# crypto key generate rsa
The name for the keys will be: SW1.example.com

Choose the size of the key modulus in the range of 512 to 2048 for your
General Purpose Keys. Choosing a key modulus greater than 512 may take
a few minutes.

How many bits in the modulus [1024]: 1024
% Generating 1024 bit RSA keys, keys will be non-exportable...
[OK] (elapsed time was 4 seconds)
SW1(config)#
!

! Optionally, set the SSH version to version 2 (only) - preferred
!

SW1(config)# ip ssh version 2
!

! Next, configure the vty lines for local username support, just like
! with Telnet
!

SW1(config)# line vty 0 15
SW1(config-line)# login local
SW1(config-line)# transport input all
SW1(config-line)# exit
!

! Define the local usernames, just like with Telnet
!

SW1(config)# username wendell secret odom
SW1(config)# username chris secret youdaman
SW1(config)# ^Z
SW1#
```

```
SW1# show ip ssh
SSH Enabled - version 2.0
Authentication timeout: 120 secs; Authentication retries: 3

SW1# show ssh
Connection Version Mode Encryption Hmac State Username
0          2.0     IN    aes128-cbc hmac-sha1 Session started wendell
0          2.0     OUT   aes128-cbc hmac-sha1 Session started wendell
%No SSHv1 server connections running.
```

```
Emma# configure terminal
Emma(config)# interface vlan 1
Emma(config-if)# ip address 192.168.1.200 255.255.255.0
Emma(config-if)# no shutdown
00:25:07: %LINK-3-UPDOWN: Interface Vlan1, changed state to up
00:25:08: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed
state to up
Emma(config-if)# exit
Emma(config)# ip default-gateway 192.168.1.1
```

```
Emma# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Emma(config)# interface vlan 1
Emma(config-if)# ip address dhcp
Emma(config-if)# no shutdown
Emma(config-if)# ^Z
Emma#
00:38:20: %LINK-3-UPDOWN: Interface Vlan1, changed state to up
00:38:21: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up
```

```
Emma# show dhcp lease
Temp IP addr: 192.168.1.101    for peer on Interface: Vlan1
Temp sub net mask: 255.255.255.0
    DHCP Lease server: 192.168.1.1, state: 3 Bound
    DHCP transaction id: 1966
    Lease: 86400 secs, Renewal: 43200 secs, Rebind: 75600 secs
Temp default-gateway addr: 192.168.1.1
    Next timer fires after: 11:59:45
    Retry count: 0    Client-ID: cisco-0019.e86a.6fc0-Vl1
    Hostname: Emma
Emma# show interfaces vlan 1
Vlan1 is up, line protocol is up
    Hardware is EtherSVI, address is 0019.e86a.6fc0 (bia 0019.e86a.6fc0)
    Internet address is 192.168.1.101/24
    MTU 1500 bytes, BW 1000000 Kbit, DLY 10 usec,
        reliability 255/255, txload 1/255, rxload 1/255
    ! lines omitted for brevity
Emma# show ip default-gateway
192.168.1.1
```

```
SW1# show running-config
! Lines omitted for brevity
interface GigabitEthernet1/0/1
!
interface GigabitEthernet1/0/2
!
interface GigabitEthernet1/0/3
!
! Lines omitted for brevity
SW1#
```

```
SW1# configure terminal
SW1(config)# interface gigabitEthernet 1/0/1
SW1(config-if)# speed auto
SW1(config-if)# duplex auto
SW1(config-if)# ^Z
SW1# show running-config interface gigabitEthernet 1/0/1
Building configuration...

Current configuration : 38 bytes
!
interface GigabitEthernet1/0/1
end
SW1#
```

SW1# show interfaces status						
Port	Name	Status	Vlan	Duplex	Speed	Type
Gi1/0/1		connected	1	a-full	a-1000	10/100/1000BaseTX
Gi1/0/2		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/3		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/4		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/5		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/6		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/7		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/8		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/9		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/10		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/11		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/12		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/13		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/14		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/15		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/16		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/17		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/18		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/19		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/20		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/21		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/22		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/23		notconnect	1	auto	auto	10/100/1000BaseTX
Gi1/0/24		notconnect	1	auto	auto	10/100/1000BaseTX
Tel1/1/1		connected	1	full	10G	SFP-10GBase-SR
Tel1/1/2		notconnect	1	auto	auto	unknown
Tel1/1/3		notconnect	1	auto	auto	unknown
Tel1/1/4		notconnect	1	auto	auto	unknown

```
SW1# show interfaces gigabitEthernet 1/0/1
GigabitEthernet1/0/1 is up, line protocol is up (connected)
  Hardware is Gigabit Ethernet, address is 4488.165a.f201 (bia 4488.165a.f201)
  MTU 1500 bytes, BW 1000000 Kbit/sec, DLY 10 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Full-duplex, 1000Mb/s, media type is 10/100/1000BaseTX
  input flow-control is on, output flow-control is unsupported
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:01, output 00:00:00, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/2000/0/0 (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
    14228 packets input, 1870879 bytes, 0 no buffer
    Received 14223 broadcasts (14222 multicasts)
    0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
    0 watchdog, 14222 multicast, 0 pause input
    0 input packets with dribble condition detected
    56865 packets output, 7901974 bytes, 0 underruns
    Output 17109 broadcasts (0 multicasts)
    0 output errors, 0 collisions, 2 interface resets
    0 unknown protocol drops
    0 babbles, 0 late collision, 0 deferred
    0 lost carrier, 0 no carrier, 0 pause output
    0 output buffer failures, 0 output buffers swapped out

SW1# show interfaces g1/0/2
GigabitEthernet1/0/2 is down, line protocol is down (notconnect)
  Hardware is Gigabit Ethernet, address is 4488.165a.f202 (bia 4488.165a.f202)
  MTU 1500 bytes, BW 1000000 Kbit/sec, DLY 10 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Auto-duplex, Auto-speed, media type is 10/100/1000BaseTX
! Lines omitted for brevity
```

```
SW1# show running-config interface g1/0/19
Building configuration...

Current configuration : 63 bytes
!
interface GigabitEthernet1/0/19
    speed 1000
    duplex full
end
```

```
! Now, on switch SW2
SW2# show running-config interface g1/0/20
Building configuration...

Current configuration : 64 bytes
!
interface GigabitEthernet1/0/20
    speed 1000
    duplex full
end
SW1#
```

```
SW1# show interfaces g1/0/20 status
```

Port	Name	Status	Vlan	Duplex	Speed	Type
Gi1/0/19		connected	1	full	1000	10/100/1000BaseTX

```
SW1# show interfaces g1/0/19
```

```
GigabitEthernet1/0/19 is up, line protocol is up (connected)
Hardware is Gigabit Ethernet, address is 4488.165a.f213 (bia 4488.165a.f213)
MTU 1500 bytes, BW 1000000 Kbit/sec, DLY 10 usec,
reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ARPA, loopback not set
Keepalive set (10 sec)
Full-duplex, 1000Mb/s, media type is 10/100/1000BaseTX
! Lines omitted for brevity
```

```
SW1# running-config interface GigabitEthernet 1/0/19
Building configuration...

Current configuration : 39 bytes
!
interface GigabitEthernet1/0/19
end

SW1# show interfaces 1/0/19 status

Port          Name           Status      Vlan      Duplex  Speed Type
Gi1/0/19      connected     1          a-full   a-1000 10/100/1000BaseTX
```

```
SW1# running-config interface GigabitEthernet 1/0/19
SW1# config t
Enter configuration commands, one per line.  End with CNTL/Z.
SW1(config)# int g1/0/19
SW1(config-if)# no mdix auto
SW1(config-if)#
*Oct  5 12:50:22.177: %LINEPROTO-5-UPDOWN: Line protocol on Interface
GigabitEthernet1/0/19, changed state to down
*Oct  5 12:50:23.175: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/19, changed state
to down
SW1(config-if)# ^Z
SW1#
SW1# show interfaces g1/0/19 status

Port          Name           Status      Vlan     Duplex  Speed Type
Gi1/0/19      notconnect    1          auto    auto   10/100/1000BaseTX
```

```
SW1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SW1(config)# interface GigabitEthernet 1/0/1
SW1(config-if)# description Link to PC1, using autonegotiation
SW1(config-if)# ^Z
SW1# show interfaces g1/0/1 status

Port          Name           Status      Vlan   Duplex  Speed Type
Gi1/0/1       Link to PC1, using connected    1       a-full  a-1000
10/100/1000BaseTX

SW1# show interfaces g1/0/1
GigabitEthernet1/0/1 is up, line protocol is up (connected)
  Hardware is Gigabit Ethernet, address is 4488.165a.f201 (bia 4488.165a.f201)
  Description: Link to PC1, using autonegotiation
! Lines omitted for brevity
SW1#
```

```
SW1# configure terminal
SW1(config)# interface range g1/0/2 - 10
SW1(config-if-range)# description Interface not in use
SW1(config-if-range)# ^Z
SW1#
```

```
SW1# show running-config
! Lines omitted for brevity
interface GigabitEthernet1/0/2
    description Interface not in use
!
interface GigabitEthernet1/0/3
    description Interface not in use
! Lines omitted for brevity
SW1# show interfaces description
Interface          Status      Protocol Description
Vl1                up          up
Gi0/0              admin down  down
Gi1/0/1            up          up      Link to PC1, using
autonegotiation
Gi1/0/2            down        down    Interface not in use
Gi1/0/3            down        down    Interface not in use
! Lines omitted for brevity
```

```
SW1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SW1(config)# interface GigabitEthernet 1/0/1
SW1(config-if)# shutdown
*Oct  6 16:33:14.911: %LINK-5-CHANGED: Interface GigabitEthernet1/0/1, changed state
to administratively down
*Oct  6 16:33:15.911: %LINEPROTO-5-UPDOWN: Line protocol on Interface
GigabitEthernet1/0/1, changed state to down
SW1(config-if)#

```

```
SW1# show interfaces g1/0/1 status

Port          Name           Status      Vlan   Duplex  Speed Type
Gi1/0/1       Link to PC1, using disabled    1        auto    auto
10/100/1000BaseTX

SW1# show interfaces g1/0/1
GigabitEthernet1/0/1 is administratively down, line protocol is down (disabled)
Hardware is Gigabit Ethernet, address is 4488.165a.f201 (bia 4488.165a.f201)
Description: Link to PC1, using autonegotiation
! Lines omitted for brevity
```

```
SW1# show running-config interface g1/0/21
Building configuration...

Current configuration : 96 bytes
!
interface GigabitEthernet1/0/21
description link to switch SW2
speed 1000
duplex full
shutdown
end
```

```
SW1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SW1(config)# interface gigabitethernet 1/0/21
SW1(config-if)# no speed
SW1(config-if)# no duplex
SW1(config-if)# no description
SW1(config-if)# no shutdown
SW1(config-if)# ^Z
SW1#
SW1# show running-config interface g1/0/21
Building configuration...

Current configuration : 39 bytes
!
interface GigabitEthernet1/0/21
end
SW1#
```

```
SW1# show interfaces gi1/0/1
! lines omitted for brevity
    Received 3943 broadcasts (3941 multicasts)
        0 runts, 0 giants, 0 throttles
        0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
        0 watchdog, 3941 multicast, 0 pause input
        0 input packets with dribble condition detected
    18843 packets output, 1726956 bytes, 0 underruns
    Output 10 broadcasts (16378 multicasts)
        0 output errors, 0 collisions, 3 interface resets
        0 unknown protocol drops
        0 babbles, 0 late collision, 0 deferred
        0 lost carrier, 0 no carrier, 0 pause output
        0 output buffer failures, 0 output buffers swapped out
```

```
SW1# show vlan brief
```

VLAN Name	Status	Ports
1 default	active	Fa0/1, Fa0/2, 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 Gi0/1, Gi0/2
1002 fddi-default	act/unsup	
1003 token-ring-default	act/unsup	
1004 fddinet-default	act/unsup	
1005 trnet-default	act/unsup	

```

SW1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SW1(config)# vlan 2
SW1(config-vlan)# name Freds-vlan
SW1(config-vlan)# exit
SW1(config)# interface range fastethernet 0/13 - 14
SW1(config-if)# switchport access vlan 2
SW1(config-if)# switchport mode access
SW1(config-if)# end

SW1# show vlan brief

VLAN Name                               Status      Ports
----- -----
1   default                             active     Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                         Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                         Fa0/9, Fa0/10, Fa0/11, Fa0/12
                                         Fa0/15, Fa0/16, Fa0/17, Fa0/18
                                         Fa0/19, Fa0/20, Fa0/21, Fa0/22
                                         Fa0/23, Fa0/24, Gi0/1, Gi0/2
2   Freds-vlan                          active     Fa0/13, Fa0/14
1002 fddi-default                      act/unsup
1003 token-ring-default                act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup

```

```

SW1# show running-config
! Many lines omitted for brevity
! Early in the output:
vlan 2
  name Freds-vlan
!
! more lines omitted for brevity
interface FastEthernet0/13
  switchport access vlan 2
  switchport mode access
!
interface FastEthernet0/14
  switchport access vlan 2
  switchport mode access
!

SW1# show vlan id 2
VLAN Name          Status      Ports
----- -----
2    Freds-vlan      active     Fa0/13, Fa0/14

VLAN Type   SAID      MTU      Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
----- -----
2    enet    100010    1500      -       -       -       -       0       0

Remote SPAN VLAN
-----
Disabled

Primary Secondary Type      Ports
----- -----

```

```

SW1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SW1(config)# interface range Fastethernet 0/15 - 16
SW1(config-if-range)# switchport access vlan 3
% Access VLAN does not exist. Creating vlan 3
SW1(config-if-range)# ^z

SW1# show vlan brief

VLAN Name          Status      Ports
----- -----
1 default          active      Fa0/1, Fa0/2, Fa0/3, Fa0/4
                           Fa0/5, Fa0/6, Fa0/7, Fa0/8
                           Fa0/9, Fa0/10, Fa0/11, Fa0/12
                           Fa0/17, Fa0/18, Fa0/19, Fa0/20
                           Fa0/21, Fa0/22, Fa0/23, Fa0/24
                           Gi0/1, Gi0/2
2 Freds-vlan       active      Fa0/13, Fa0/14
3 VLAN0003         active      Fa0/15, Fa0/16
1002 fddi-default  act/unsup
1003 token-ring-default  act/unsup
1004 fddinet-default  act/unsup
1005 trnet-default   act/unsup

```

```
SW1# show interfaces gigabit 0/1 switchport
Name: Gi0/1
Switchport: Enabled
Administrative Mode: dynamic auto
Operational Mode: static access
Administrative Trunking Encapsulation: dot1q
Operational Trunking Encapsulation: native
Negotiation of Trunking: On
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 1 (default)
Administrative Native VLAN tagging: enabled
Voice VLAN: none
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 1 (default)
Administrative Native VLAN tagging: enabled
Voice VLAN: none
Administrative private-vlan host-association: none
Administrative private-vlan mapping: none
Administrative private-vlan trunk native VLAN: none
Administrative private-vlan trunk Native VLAN tagging: enabled
Administrative private-vlan trunk encapsulation: dot1q
Administrative private-vlan trunk normal VLANs: none
Administrative private-vlan trunk private VLANs: none
Operational private-vlan: none
Trunking VLANs Enabled: ALL
Pruning VLANs Enabled: 2-1001
Capture Mode Disabled
Capture VLANs Allowed: ALL

Protected: false
Unknown unicast blocked: disabled
Unknown multicast blocked: disabled
Appliance trust: none

! Note that the next command results in a single empty line of output.
SW1# show interfaces trunk
SW1#
```

```
SW1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SW1(config)# interface gigabit 0/1
SW1(config-if)# switchport mode dynamic desirable
SW1(config-if)# ^Z
SW1#
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed state to
down
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed state to
up
SW1# show interfaces gigabit 0/1 switchport
Name: Gi0/1
Switchport: Enabled
Administrative Mode: dynamic desirable
Operational Mode: trunk
Administrative Trunking Encapsulation: dot1q
Operational Trunking Encapsulation: dot1q
Negotiation of Trunking: On
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 1 (default)
! lines omitted for brevity
```

```
SW1# show interfaces trunk
```

Port	Mode	Encapsulation	Status	Native vlan
Gi0/1	desirable	802.1q	trunking	1

Port Vlans allowed on trunk

Gi0/1 1-4094

Port Vlans allowed and active in management domain
Gi0/1 1-3

Port Vlans in spanning tree forwarding state and not pruned
Gi0/1 1-3

```
SW1# show vlan id 2
```

VLAN	Name	Status	Ports
2	Freds-vlan	active	Fa0/13, Fa0/14, G0/1
2	enet	100010	1500 - - - - 0 0

Remote SPAN VLAN

Disabled

```
Primary Secondary Type Ports
```

```
SW1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SW1(config)# vlan 10
SW1(config-vlan)# vlan 11
SW1(config-vlan)# interface range FastEthernet0/1 - 4
SW1(config-if)# switchport mode access
SW1(config-if)# switchport access vlan 10
SW1(config-if)# switchport voice vlan 11
SW1(config-if)#^Z
SW1#
```

```
SW1# show interfaces FastEthernet 0/4 switchport
Name: Fa0/4
Switchport: Enabled
Administrative Mode: static access
Operational Mode: static access
Administrative Trunking Encapsulation: dot1q
Operational Trunking Encapsulation: native
Negotiation of Trunking: Off
Access Mode VLAN: 10 (VLAN0010)
Trunking Native Mode VLAN: 1 (default)
Administrative Native VLAN tagging: enabled
Voice VLAN: 11 (VLAN0011)
! The rest of the output is omitted for brevity
```

```
SW1# show interfaces trunk
SW1# show interfaces F0/4 trunk

Port      Mode          Encapsulation  Status        Native vlan
Fa0/4     off           802.1q         not-trunking  1

Port      Vlans allowed on trunk
Fa0/4     10-11

Port      Vlans allowed and active in management domain
Fa0/4     10-11

Port      Vlans in spanning tree forwarding state and not pruned
Fa0/4     10-11
```

```

SW1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SW1(config)# no shutdown vlan 10
SW1(config)# shutdown vlan 20
SW1(config)# vlan 30
SW1(config-vlan)# no shutdown
SW1(config-vlan)# vlan 40
SW1(config-vlan)# shutdown
SW2(config-vlan)# end

```

```
SW1# show vlan brief
```

VLAN	Name	Status	Ports
1	default	active	Gi1/0/1, Gi1/0/2, Gi1/0/3 Gi1/0/4, Gi1/0/5, Gi1/0/6 Gi1/0/7, Gi1/0/8, Gi1/0/9 Gi1/0/10, Gi1/0/11, Gi1/0/12 Gi1/0/13, Gi1/0/14, Gi1/0/15 Gi1/0/16, Gi1/0/17, Gi1/0/18 Gi1/0/19, Gi1/0/20, Gi1/0/21 Gi1/0/22, Gi1/0/23, Gi1/0/24 Te1/1/1, Te1/1/2, Te1/1/3 Te1/1/4
10	VLAN0010	act/lshut	
20	VLAN0020	active	
30	VLAN0030	act/lshut	
40	VLAN0040	active	
1002	fdmi-default	act/unsup	
1003	token-ring-default	act/unsup	
1004	fdmnet-default	act/unsup	
1005	trnet-default	act/unsup	

Port	Name	Status	Vlan	Duplex	Speed	Type
Gi1/0/1		connected	10	a-full	a-1000	10/100/1000BaseTX
Gi1/0/2		connected	10	a-full	a-1000	10/100/1000BaseTX
Gi1/0/3		connected	10	a-full	a-1000	10/100/1000BaseTX
Gi1/0/4		connected	20	a-full	a-1000	10/100/1000BaseTX
Gi1/0/5		connected	20	a-full	a-1000	10/100/1000BaseTX
Gi1/0/6		connected	20	a-full	a-1000	10/100/1000BaseTX
! Lines For Gi1/0/7 - Gi1/0/24 omitted for brevity						
Te1/1/1		connected	trunk	full	10G	SFP-10Gbase-SR
Te1/1/2		connected	trunk	full	10G	SFP-10Gbase-SR
Te1/1/3		notconnect	1	auto	auto	unknown
Te1/1/4		notconnect	1	auto	auto	unknown

```
SW1# show interfaces TenGigabitEthernet1/1/1 switchport
Name: Te1/1/1
Switchport: Enabled
Administrative Mode: dynamic auto
Operational Mode: static access
Administrative Trunking Encapsulation: dot1q
Operational Trunking Encapsulation: native
! lines omitted for brevity
```

```
SW1# show interfaces trunk
```

Port	Mode	Encapsulation	Status	Native vlan
Tel/1/1	desirable	802.1q	trunking	1

Port	Vlans allowed on trunk
Tel/1/1	1-60

Port	Vlans allowed and active in management domain
Tel/1/1	1-59

Port	Vlans in spanning tree forwarding state and not pruned
Tel/1/1	1-58

```
SW1# show spanning-tree vlan 5
```

VLAN0005

Spanning tree enabled protocol rstp

Root ID Priority 32773

Address 1833.9d7b.0e80

Cost 15

Port 25 (GigabitEthernet0/1)

Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

```
SW1(config)# spanning-tree mode ?
mst          Multiple spanning tree mode
pvst         Per-Vlan spanning tree mode
rapid-pvst   Per-Vlan rapid spanning tree mode
SW1(config)#+
```

```
SW1(config)# spanning-tree vlan 1 priority ?
<0-61440>  bridge priority in increments of 4096
SW1(config)#

```

```

SW3# show spanning-tree vlan 9
VLAN0009
    Spanning tree enabled protocol rstp
    Root ID      Priority    24585
        Address    4488.165a.f200
        Cost        4
        Port        21 (GigabitEthernet1/0/21)
    Hello Time    2 sec  Max Age 20 sec  Forward Delay 15 sec

    Bridge ID    Priority    32777  (priority 32768 sys-id-ext 9)
        Address    5cfc.6608.2880
    Hello Time    2 sec  Max Age 20 sec  Forward Delay 15 sec
    Aging Time   300 sec

    Interface      Role Sts Cost      Prio.Nbr Type
    ----- -----
    Gi1/0/1        Desg FWD 4      128.1    P2p
    Gi1/0/2        Desg FWD 4      128.2    P2p
    Gi1/0/3        Desg FWD 4      128.3    P2p
    Gi1/0/21       Root FWD 4     128.21   P2p
    Gi1/0/23       Altn BLK 4     128.23   P2p

```

```
SW1# show spanning-tree vlan 9
VLAN0009
    Spanning tree enabled protocol rstp
    Root ID      Priority    24585
                  Address     4488.165a.f200
                  This bridge is the root
                  Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

    Bridge ID   Priority    24585  (priority 24576 sys-id-ext 9)
                  Address     4488.165a.f200
                  Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
                  Aging Time  300 sec

    Interface      Role Sts Cost      Prio.Nbr Type
    -----  -----
    Gi1/0/23       Desg FWD 4        128.23    P2p
    Te1/1/1       Desg FWD 2        128.25    P2p
```

```
SW1# show spanning-tree vlan 9 | begin Interface
Interface          Role Sts Cost      Prio.Nbr Type
-----  -----  -----  -----
Gi1/0/21           Root FWD 4       128.21   P2p
Gi1/0/23           Altn BLK 4       128.23   P2p
```

```

SW3# debug spanning-tree events
Spanning Tree event debugging is on

SW3# conf t
Enter configuration commands, one per line. End with CNTL/Z.
SW3(config)# int g1/0/21
SW3(config-if)# spanning-tree vlan 9 cost 10
SW3(config-if)#
Oct 19 11:34:38.983: RSTP(9): updт roles, received superior bpdu on Gi1/0/23
Oct 19 11:34:38.983: RSTP(9): Gi1/0/23 is now root port
Oct 19 11:34:38.987: RSTP(9): Gi1/0/21 blocked by re-root
Oct 19 11:34:38.987: RSTP(9): Gi1/0/21 is now alternate
Oct 19 11:34:38.987: STP[9]: Generating TC trap for port GigabitEthernet1/0/23
SW3(config-if)# end
SW3# show spanning-tree vlan 9
VLAN0009
  Spanning tree enabled protocol rstp
    Root ID      Priority    24585
                Address     4488.165a.f200
                Cost        6
                Port       23 (GigabitEthernet1/0/23)
    Hello Time   2 sec    Max Age 20 sec  Forward Delay 15 sec

    Bridge ID   Priority    32777 (priority 32768 sys-id-ext 9)
                Address     5cfc.6608.2880
    Hello Time   2 sec    Max Age 20 sec  Forward Delay 15 sec
    Aging Time  300 sec

  Interface      Role Sts Cost      Prio.Nbr Type
  -----  -----
  Gi1/0/21      Altn BLK 10      128.21    P2p
  Gi1/0/23      Root FWD 4      128.23    P2p

```

```
SW1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
SW1(config)#
SW1(config)# interface g1/0/1
SW1(config-if)# switchport mode access
SW1(config-if)# switchport access vlan 9
SW1(config-if)# spanning-tree portfast
%Warning: portfast should only be enabled on ports connected to a single
host. Connecting hubs, concentrators, switches, bridges, etc... to this
interface when portfast is enabled, can cause temporary bridging loops.
Use with CAUTION

%Portfast has been configured on GigabitEthernet1/0/1 but will only
have effect when the interface is in a non-trunking mode.
SW1(config-if)# spanning-tree bpduguard ?
    disable  Disable BPDU guard for this interface
    enable   Enable BPDU guard for this interface

SW1(config-if)# spanning-tree bpduguard enable
SW1(config-if)#

```

```

SW1# show spanning-tree interface g1/0/1
Vlan          Role Sts Cost      Prio.Nbr Type
----- -----
VLAN0009      Desg FWD 4        128.1      P2p Edge

SW1# show interfaces g1/0/1 status

Port          Name           Status      Vlan      Duplex  Speed Type
Gi1/0/1       Host A        connected   9         a-full a-1000
10/100/1000BaseTX

SW1#
SW1# ! The cable was removed from the PC and connected to a LAN switch.
SW1#
*Jan 30 17:08:19.024: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/1, changed state to down
*Jan 30 17:08:20.024: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/1, changed state to down
*Jan 30 17:08:30.364: %SPANTREE-2-BLOCK_BPDUGUARD: Received BPDU on port Gi1/0/1
with BPDU Guard enabled. Disabling port.
*Jan 30 17:08:30.364: %PM-4-ERR_DISABLE: bpduguard error detected on Gi1/0/1, putting
Gi1/0/1 in err-disable state
SW1#
SW1# show spanning-tree interface g1/0/1
no spanning tree info available for GigabitEthernet1/0/1

SW1# show interfaces g1/0/1 status

Port          Name           Status      Vlan      Duplex  Speed Type
Gi1/0/1       Host A        err-disabled 9         auto    auto
10/100/1000BaseTX

```

```
SW1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
SW1(config)# interface g1/0/2
SW1(config-if)# switchport mode trunk
SW1(config-if)# spanning-tree portfast trunk
%Warning: portfast should only be enabled on ports connected to a single
host. Connecting hubs, concentrators, switches, bridges, etc... to this
interface when portfast is enabled, can cause temporary bridging loops.
Use with CAUTION
SW1(config-if)# spanning-tree bpduguard enable
SW1(config-if)#

```

```
SW1# show spanning-tree vlan 9 | begin Interface
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
Gi1/0/1	Desg	FWD	4	128.1	P2p Edge
Gi1/0/2	Desg	FWD	4	128.2	P2p Edge
Gi1/0/3	Desg	FWD	4	128.3	P2p Edge
Gi1/0/23	Desg	FWD	4	128.23	P2p
Te1/1/1	Desg	FWD	2	128.25	P2p

```
SW1# show spanning-tree interface g1/0/7 detail | begin portfast
The port is in the portfast mode
Link type is point-to-point by default
Bpdu guard is enabled
BPDU: sent 387, received 0
```

```
SW1# show spanning-tree interface g1/0/8 detail | begin portfast
The port is in the portfast mode by default
Link type is point-to-point by default
Bpdu guard is enabled by default
BPDU: sent 774, received 0
```

```
spanning-tree portfast bpdufilter enable
!
interface GigabitEthernet1/0/23
    switchport mode access
    switchport access vlan 9
    spanning-tree portfast
! No BPDU Filter subcommands present
```

```

SW1# show spanning-tree vlan 9 | begin Interface
Interface          Role Sts Cost      Prio.Nbr Type
-----  -----  -----  -----
Gi1/0/1            Desg FWD 4       128.1    P2p Edge
Gi1/0/2            Desg FWD 4       128.2    P2p Edge
Gi1/0/3            Desg FWD 4       128.3    P2p Edge
Gi1/0/23           Desg FWD 4       128.23   P2p Edge
Te1/1/1            Desg FWD 2       128.25   P2p

SW1# show spanning-tree interface g1/0/23

Vlan          Role Sts Cost      Prio.Nbr Type
-----  -----  -----  -----
VLAN0009        Desg FWD 4       128.23   P2p Edge

SW1# show spanning-tree interface g1/0/23 detail | begin portfast
The port is in the portfast mode
Link type is point-to-point by default
Bpdu filter is enabled by default
BPDU: sent 11, received 0

```

```
! Someone disconnects the endpoint off SW1's G1/0/23 and attaches a switch:  
! G1/0/23 fails and recovers...
```

```
SW1# show spanning-tree vlan 9 | begin Interface  
Interface          Role Sts Cost      Prio.Nbr Type  
-----  
Gi1/0/23           Root FWD 4       128.23    P2p
```

```
SW1# show spanning-tree interface g1/0/23 detail | begin portfast  
The port is in the portfast mode  
Link type is point-to-point by default  
BPDU: sent 6, received 138  
! Line "bpdu filter is enabled by default" does not appear above.
```

```
interface TenGigabitEthernet 1/1/1
switchport mode trunk
spanning-tree bpdufilter enable
```

```
SW1# show spanning-tree vlan 9 interface tel/1/1 detail | begin Bpdu
Bpdu filter is enabled
BPDU: sent 0, received 0
```

```
SW3# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
SW3(config)# interface g1/0/11
SW3(config-if)# spanning-tree guard root
SW3(config-if)#
Oct 21 11:02:31.145: %SPANTREE-2-ROOTGUARD_CONFIG_CHANGE: Root guard enabled on port
GigabitEthernet1/0/11.
SW3#
```

```

SW3# show interfaces g1/0/11 status

Port      Name           Status      Vlan      Duplex  Speed Type
Gi1/0/11          connected    trunk     a-full  a-1000 10/100/1000BaseTX

SW3# show spanning-tree vlan 9 int g1/0/11

Vlan      Role  Sts Cost      Prio.Nbr Type
----- 
VLAN0009       Desg FWD 4        128.11   P2p

SW3#! Neighboring switch priority was lowered so it sends a superior BPDU.

Oct 21 11:03:14.472: %SPANTREE-2-ROOTGUARD_BLOCK: Root guard blocking port
GigabitEthernet1/0/11 on VLAN0009.

SW3# show interfaces g1/0/11 status

Port      Name           Status      Vlan      Duplex  Speed Type
Gi1/0/11          connected    trunk     a-full  a-1000 10/100/1000BaseTX

SW3# show spanning-tree vlan 9 int g1/0/11

Vlan      Role  Sts Cost      Prio.Nbr Type
----- 
VLAN0009       Desg BKN*4      128.11   P2p *ROOT_Inc

```

```
SW3# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
SW3(config)# interface g1/0/21
SW3(config-if)# spanning-tree guard loop
SW3(config-if)#

SW3# show spanning-tree vlan 9 int g1/0/21 detail
Port 21 (GigabitEthernet1/0/21) of VLAN0009 is root forwarding
  Port path cost 4, Port priority 128, Port Identifier 128.21.
  Designated root has priority 24585, address 4488.165a.f200
  Designated bridge has priority 24585, address 4488.165a.f200
  Designated port id is 128.23, designated path cost 0
  Timers: message age 16, forward delay 0, hold 0
  Number of transitions to forwarding state: 7
  Link type is point-to-point by default
  Loop guard is enabled on the port
  BPDU: sent 139, received 165425

! Link becomes unidirectional; switch SW3 G1/0/21 ceases to receive BPDUs
*Feb 23 17:11:19.087: %SPANTREE-2-LOOPGUARD_BLOCK: Loop guard blocking port
  GigabitEthernet1/0/23 on VLAN0009.

SW3# show spanning-tree vlan 9 int g1/0/21 detail | include 1/0/21
  Port 21 (GigabitEthernet1/0/21) of VLAN0009 is broken  (Loop Inconsistent)
```

```
! First, on switch SW1
SW1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SW1(config)# interface range g1/0/21-22
SW1(config-if-range)# switchport mode trunk
SW1(config-if-range)# channel-group 1 mode on
```

```
! Next, on switch SW2
SW2# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SW2(config)# interface range g1/0/23-24
SW2(config-if-range)# switchport mode trunk
SW2(config-if-range)# channel-group 2 mode on
```

```
SW1# show running-config
! Lines omitted for brevity
!
interface Port-channel1
    switchport mode trunk
!
! Lines omitted for brevity
interface GigabitEthernet1/0/21
    switchport mode trunk
    channel-group 1 mode on
!
interface GigabitEthernet1/0/22
    switchport mode trunk
    channel-group 1 mode on

SW1# show interfaces portchannel 1
Port-channel1 is up, line protocol is up (connected)
Hardware is EtherChannel, address is 4488.165a.f215 (bia 4488.165a.f215)
MTU 1500 bytes, BW 2000000 Kbit/sec, DLY 10 usec,
    reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ARPA, loopback not set
Keepalive set (10 sec)
Full-duplex, 1000Mb/s, link type is auto, media type is N/A
input flow-control is on, output flow-control is unsupported
Members in this channel: Gi1/0/21 Gi1/0/22
ARP type: ARPA, ARP Timeout 04:00:00
Last input 02:12:51, output 00:00:00, output hang never
Last clearing of "show interface" counters never
! Interface statistics output removed for brevity
```

```

SW1# show etherchannel
      Channel-group listing:
      -----
      Group: 1
      -----
      Group state = L2
      Ports: 2 Maxports = 8
      Port-channels: 1 Max Port-channels = 1
      Protocol: -
      Minimum Links: 0
      SW1# show etherchannel summary
      Flags: D - down          P - bundled in port-channel
             I - stand-alone s - suspended
             H - Hot-standby (LACP only)
             R - Layer3           S - Layer2
             U - in use            f - failed to allocate aggregator

             M - not in use, minimum links not met
             u - unsuitable for bundling
             w - waiting to be aggregated
             d - default port

             A - formed by Auto LAG

      Number of channel-groups in use: 1
      Number of aggregators:          1

      Group  Port-channel  Protocol    Ports
      -----+-----+-----+
      1      Po1 (SU)       -          Gi1/0/21 (P)   Gi1/0/22 (P)

```

```
! First, on switch SW1
SW1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SW1(config)# interface range g1/0/21-22
SW1(config-if-range)# switchport mode trunk
SW1(config-if-range)# channel-group 1 mode active
```

```
! Next, on switch SW2
SW2# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SW2(config)# interface range g1/0/23-24
SW2(config-if-range)# switchport mode trunk
SW2(config-if-range)# channel-group 2 mode passive
```

```

SW1# show etherchannel port-channel
      Channel-group listing:
      -----
      Group: 1
      -----
      Port-channels in the group:
      -----
      Port-channel: Po1      (Primary Aggregator)
      -----
      Age of the Port-channel = 0d:00h:11m:35s
      Logical slot/port = 31/1           Number of ports = 2
      HotStandBy port = null
      Port state          = Port-channel Ag-Inuse
      Protocol            = LACP
      Port security       = Disabled
      Fast-switchover     = disabled
      Fast-switchover Dampening = disabled

      Ports in the Port-channel:
      Index  Load   Port        EC state      No of bits
      -----+-----+-----+-----+
      0      00    Gi1/0/21   Active        0
      0      00    Gi1/0/22   Active        0

      Time since last port bundled: 0d:00h:02m:17s      Gi1/0/22
      Time since last port Un-bundled: 0d:00h:02m:25s     Gi1/0/22

```

```
SW1# show spanning-tree vlan 1 | begin Interface
Interface          Role Sts Cost      Prio.Nbr Type
-----
Gi1/0/23           Desg FWD 4       128.23    P2p
Gi1/0/24           Desg FWD 4       128.24    P2p
Po1               Desg FWD 3       128.456   P2p
```

```

SW1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SW1(config)# interface g1/0/21
SW1(config-if)# switchport trunk native vlan 21
SW1(config-if)# ^Z
SW1#
Jun 17 16:11:34.217: %EC-5-CANNOT_BUNDLE2: Gi1/0/21 is not compatible with Gi1/0/22
and will be suspended (native vlan of Gi1/0/21 is 21, Gi1/0/22 id 1)
Jun 17 16:11:35.220: %LINEPROTO-5-UPDOWN: Line protocol on Interface
GigabitEthernet1/0/21, changed state to down

SW1# show interfaces gigabitethernet 1/0/21
GigabitEthernet1/0/21 is up, line protocol is down (suspended)
    Hardware is Gigabit Ethernet, address is 4488.165a.f215 (bia 4488.165a.f215)
! lines omitted for brevity

SW1# show etherchannel port-channel
    Channel-group listing:
    -----
    Group: 1
    -----
        Port-channels in the group:
    -----
    Port-channel: Po1      (Primary Aggregator)
    -----
        Age of the Port-channel = 0d:05h:26m:48s
        Logical slot/port = 31/1          Number of ports = 1
        HotStandBy port = null
        Port state       = Port-channel Ag-Inuse
        Protocol         = LACP
        Port security    = Disabled
        Fast-switchover   = disabled
        Fast-switchover Dampening = disabled

        Ports in the Port-channel:
        Index  Load  Port          EC state      No of bits
        -----+-----+-----+-----+
        0      00    Gi1/0/22    Active       0
Time since last port bundled: 0d:00h:05m:44s Gi1/0/22

```

Time since last port Un-bundled: 0d:00h:01m:09s G11/0/21

```
R1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)# no ip subnet-zero
R1(config)# interface g0/1
R1(config-if)# ip address 10.0.0.1 255.255.255.0
Bad mask /24 for address 10.0.0.1
```

```
interface ethernet 0
interface fastethernet 0/1
interface gigabitetherent 0/0
interface gigabitetherent 0/1/0
interface serial 1/0/1
interface cellular 0/0/1
```

```

R1# show ip interface brief
Interface                  IP-Address      OK? Method Status          Protocol
Embedded-Service-Engine0/0 unassigned     YES NVRAM  administratively down down
GigabitEthernet0/0          172.16.1.1    YES NVRAM  down           down
GigabitEthernet0/1          unassigned     YES NVRAM  administratively down down
Serial0/0/0                172.16.4.1    YES manual up            up
Serial0/0/1                unassigned     YES unset   administratively down down
GigabitEthernet0/1/0        172.16.5.1    YES NVRAM  up             up

R1# show interfaces gigabitEthernet 0/1/0
GigabitEthernet0/1/0 is up, line protocol is up
Hardware is EHWIC-1GE-SFP-CU, address is 0201.a010.0001 (bia 30f7.0d29.8570)
Description: Link in lab to R3's G0/0/0
Internet address is 172.16.5.1/24
MTU 1500 bytes, BW 1000000 Kbit/sec, DLY 10 usec,
reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ARPA, loopback not set
Keepalive set (10 sec)
Full Duplex, 1Gbps, media type is RJ45
output flow-control is XON, input flow-control is XON
ARP type: ARPA, ARP Timeout 04:00:00
Last input 00:00:29, output 00:00:08, 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
12 packets input, 4251 bytes, 0 no buffer
Received 12 broadcasts (0 IP multicasts)
0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
0 watchdog, 0 multicast, 0 pause input
55 packets output, 8098 bytes, 0 underruns
0 output errors, 0 collisions, 0 interface resets
0 unknown protocol drops
0 babbles, 0 late collision, 0 deferred
0 lost carrier, 0 no carrier, 0 pause output
0 output buffer failures, 0 output buffers swapped out

```

```
R1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R1config)# interface G0/0
R1(config-if)# ip address 172.16.1.1 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)# interface S0/0/0
R1(config-if)# ip address 172.16.4.1 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)# interface G0/1/0
R1(config-if)# ip address 172.16.5.1 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)# ^Z
R1#
```

```
R1# show protocols
Global values:
    Internet Protocol routing is enabled
Embedded-Service-Engine0/0 is administratively down, line protocol is down
GigabitEthernet0/0 is up, line protocol is up
    Internet address is 172.16.1.1/24
GigabitEthernet0/1 is administratively down, line protocol is down
Serial0/0/0 is up, line protocol is up
    Internet address is 172.16.4.1/24
Serial0/0/1 is administratively down, line protocol is down
GigabitEthernet0/1/0 is up, line protocol is up
    Internet address is 172.16.5.1/24
```

```
! Output below is from IOS XE router R2
R2# show interfaces g0/0/0
GigabitEthernet0/0/0 is up, line protocol is up
  Hardware is C1111-2x1GE, address is 0200.1111.1111 (bia 2436.dadf.5680)
  Internet address is 10.1.1.1/24
  MTU 1500 bytes, BW 1000000 Kbit/sec, DLY 10 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive not supported
  Full Duplex, 1000Mbps, link type is auto, media type is RJ45
! Lines omitted for brevity
R2# show interfaces g0/0/0 controller | include Autoneg
Admin State Up MTU 1500 Speed 1000mbps Duplex full Autoneg On Stats Interval 5
```

```
R2# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)# interface g0/0/0
R2(config-if)# speed 1000
Auto-negotiation is enabled. Speed cannot be set

R2(config-if)# no negotiation auto
R2(config-if) # speed 1000
R2(config-if) # duplex full
*Oct 14 12:24:16.014: %LINEPROTO-5-UPDOWN: Line protocol on Interface
GigabitEthernet0/0/0, changed state to down
*Oct 14 12:24:24.207: %LINEPROTO-5-UPDOWN: Line protocol on Interface
GigabitEthernet0/0/0, changed state to up
R2(config-if)# ^Z
*Oct 14 12:19:10.210: %LINK-3-UPDOWN: Interface GigabitEthernet0/0/0, changed state
to up
R2#
R2# show interfaces g0/0/0 controller
GigabitEthernet0/0/0 is up, line protocol is up
Hardware is C1111-2x1GE, address is 0200.1111.1111 (bia 2436.dadf.5680)
Internet address is 10.1.1.1/24
MTU 1500 bytes, BW 1000000 Kbit/sec, DLY 10 usec,
    reliability 255/255, txload 1/255, rxload 1/255
Encapsulation ARPA, loopback not set
Keepalive not supported
Full Duplex, 1000Mbps, link type is force-up, media type is RJ45
output flow-control is on, input flow-control is on
! Lines omitted for brevity
Driver Configuration Block:
Admin State Up MTU 1500 Speed 1000mbps Duplex full Autoneg Off Stats Interval 5
! More lines omitted for brevity
```

```

! Excerpt from show running-config follows...

!
interface GigabitEthernet0/0
 ip address 172.16.1.1 255.255.255.0
!
interface Serial0/0/0
 ip address 172.16.4.1 255.255.255.0
!
interface GigabitEthernet0/1/0
 ip address 172.16.5.1 255.255.255.0

R1# 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
      i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
      a - application route
      + - replicated route, % - next hop override, p - overrides from PfR

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, GigabitEthernet0/0
L    172.16.1.1/32 is directly connected, GigabitEthernet0/0
C    172.16.4.0/24 is directly connected, Serial0/0/0
L    172.16.4.1/32 is directly connected, Serial0/0/0
C    172.16.5.0/24 is directly connected, GigabitEthernet0/1/0
L    172.16.5.1/32 is directly connected, GigabitEthernet0/1/0

```

```
R1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)# interface gigabitEthernet 0/0
R1(config-if)# ip address 172.16.1.0 255.255.255.0
Bad mask /24 for address 172.16.1.0
R1(config-if)# ip address 172.16.1.255 255.255.255.0
Bad mask /24 for address 172.16.1.255
R1(config-if)# ip address 172.16.1.1 255.0.255.0
Bad mask 0xFF00FF00 for address 172.16.1.1
R1(config-if)#

```

```
R1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)# interface gigabitEthernet 0/0
R1(config-if)# ip address 172.16.1.1 255.255.255.0
R1(config)# interface gigabitEthernet 0/1
R1(config-if)# ip address 172.16.1.2 255.255.255.0
% 172.16.1.0 overlaps with GigabitEthernet0/0
R1(config-if)#

```

```
R1# show ip arp
```

Protocol	Address	Age (min)	Hardware Addr	Type	Interface
Internet	172.16.1.1	-	0200.0101.0101	ARPA	GigabitEthernet0/0
Internet	172.16.1.9	35	0200.aaaa.aaaa	ARPA	GigabitEthernet0/0

```
ip route 172.16.2.0 255.255.255.0 G0/0/0
ip route 172.16.3.0 255.255.255.0 172.16.5.3
```

```
R1# show ip route static
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
! Legend lines omitted for brevity

    172.16.0.0/16 is variably subnetted, 8 subnets, 2 masks
S         172.16.2.0/24 is directly connected, GigabitEthernet0/0/0S
S         172.16.3.0/24 [1/0] via 172.16.5.3
```

```
R2# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)# ip route 0.0.0.0 0.0.0.0 172.16.4.1
R2(config)# ^Z
R2# 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
      i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
      + - replicated route, % - next hop override

Gateway of last resort is 172.16.4.1 to network 0.0.0.0S*
```



```
S*   0.0.0.0/0 [1/0] via 172.16.4.1
    172.16.0.0/16 is variably subnetted, 4 subnets, 2 masks
C     172.16.2.0/24 is directly connected, GigabitEthernet0/0/0
L     172.16.2.2/32 is directly connected, GigabitEthernet0/0/0
C     172.16.4.0/24 is directly connected, GigabitEthernet0/0/1
L     172.16.4.2/32 is directly connected, GigabitEthernet0/0/1
```

```
R1# configure terminal
! The static host route for one IP address within that same subnet
R1(config)# ip route 172.16.10.4 255.255.255.255 172.16.4.2
R1(config)# ^Z
R1# show ip route
! Irrelevant portions omitted for brevity

    172.16.0.0/16 is variably subnetted, 12 subnets, 4 masks
O IA      172.16.10.0/26 [110/3] via 172.16.5.3, 01:52:58, GigabitEthernet0/0/1
S          172.16.10.4/32 [1/0]  via 172.16.4.2
```

```
R1# show ip route static
! Legend omitted for brevity
    172.16.0.0/16 is variably subnetted, 6 subnets, 2 masks
S          172.16.2.0/24 is directly connected, Cellular0/1/0

R1# show ip route 172.16.2.0
Routing entry for 172.16.2.0/24
Known via "static", distance 130, metric 0 (connected)
Routing Descriptor Blocks:
* directly connected, via Cellular0/1/0
    Route metric is 0, traffic share count is 1
```

```
R1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1-8200(config)# ip route 172.16.2.1 255.255.255.0 G0/0/0
%Inconsistent address and mask
R1-8200(config)# ip route 172.16.3.1 255.255.255.0 172.16.5.3
%Inconsistent address and mask
R1-8200(config)#

```

```
ip route 172.16.2.0 255.255.255.0 G0/0/0 permanent  
ip route 172.16.3.0 255.255.255.0 172.16.5.3 permanent
```

```
B1# show running-config
! Only pertinent lines shown
interface gigabitethernet 0/0/0
! No IP address or encapsulation up here!
!
interface gigabitethernet 0/0/0.10
encapsulation dot1q 10
ip address 10.1.10.1 255.255.255.0
!
interface gigabitethernet 0/0/0.20
encapsulation dot1q 20
ip address 10.1.20.1 255.255.255.0
```

```
! First option: put the native VLAN IP address on the physical interface
interface gigabitethernet 0/0/0
    ip address 10.1.10.1 255.255.255.0
!
interface gigabitethernet 0/0/0.20
    encapsulation dot1q 20
    ip address 10.1.20.1 255.255.255.0

! Second option: like Example 18-1, but add the native keyword
interface gigabitethernet 0/0/0.10
    encapsulation dot1q 10 native
    ip address 10.1.10.1 255.255.255.0
!
interface gigabitethernet 0/0/0.20
    encapsulation dot1q 20
    ip address 10.1.20.1 255.255.255.0
```

```
B1# show ip route connected
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
! Legend omitted for brevity

10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C       10.1.10.0/24 is directly connected, GigabitEthernet0/0/0.10
L       10.1.10.1/32 is directly connected, GigabitEthernet0/0/0.10
C       10.1.20.0/24 is directly connected, GigabitEthernet0/0/0.20
L       10.1.20.1/32 is directly connected, GigabitEthernet0/0/0.20
```

```
B1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
B1(config)# interface g0/0/0
B1(config-if)# shutdown
B1(config-if)# ^Z
B1# show ip interface brief | include 0/0/0
GigabitEthernet0/0/0      unassigned    YES manual administratively down down
GigabitEthernet0/0/0.10    10.1.10.1   YES manual administratively down down
GigabitEthernet0/0/0.20    10.1.20.1   YES manual administratively down down
```

```
B1# show vlans

VLAN ID: 1 (IEEE 802.1Q Encapsulation)

Protocols Configured: Received: Transmitted:

VLAN trunk interfaces for VLAN ID 1:
GigabitEthernet0/0/0

GigabitEthernet0/0/0 (1)
    Total 5 packets, 330 bytes input
    Total 20 packets, 3134 bytes output

VLAN ID: 10 (IEEE 802.1Q Encapsulation)

This is configured as native Vlan for the following interface(s) :
GigabitEthernet0/0/0 Native-vlan Tx-type: Untagged

Protocols Configured: Received: Transmitted:
IP 0 0

VLAN trunk interfaces for VLAN ID 10:
GigabitEthernet0/0/0.10

GigabitEthernet0/0/0.10 (10)
    IP: 10.1.10.1
    Total 38 packets, 5696 bytes input
    Total 2 packets, 128 bytes output

VLAN ID: 20 (IEEE 802.1Q Encapsulation)

Protocols Configured: Received: Transmitted:
IP 0 0

VLAN trunk interfaces for VLAN ID 20:
GigabitEthernet0/0/0.20

GigabitEthernet0/0/0.20 (20)
    IP: 10.1.20.1
    Total 0 packets, 0 bytes input
    Total 2 packets, 128 bytes output
```

```
ip routing
!
interface vlan 10
    ip address 10.1.10.1 255.255.255.0
!
interface vlan 20
    ip address 10.1.20.1 255.255.255.0
!
interface vlan 30
    ip address 10.1.30.1 255.255.255.0
```

```
SW1# show ip route connected
! legend omitted for brevity

    10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C       10.1.10.0/24 is directly connected, Vlan10
L       10.1.10.1/32 is directly connected, Vlan10
C       10.1.20.0/24 is directly connected, Vlan20
L       10.1.20.1/32 is directly connected, Vlan20
C       10.1.30.0/24 is directly connected, Vlan30
L       10.1.30.1/32 is directly connected, Vlan30
```

```

SW1# show interfaces status
! Only ports related to the example are shown
Port      Name          Status     Vlan      Duplex   Speed Type
Gi1/0/1    connected    10        a-full   a-100  10/100/1000BaseTX
Gi1/0/2    notconnect   10        auto     auto   10/100/1000BaseTX
Gi1/0/3    connected    20        a-full   a-100  10/100/1000BaseTX
Gi1/0/4    connected    20        a-full   a-100  10/100/1000BaseTX
Gi1/0/9    connected    30        a-full   a-1000 10/100/1000BaseTX

SW1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.

! Case 1: Interface Gi1/0/1, the last up/up access interface in VLAN 10, is shutdown
SW1(config)# interface GigabitEthernet 1/0/1
SW1(config-if)# shutdown
SW1(config-if)#
*Apr 2 19:54:08.784: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan10, changed
state to down
*Apr 2 19:54:10.772: %LINK-5-CHANGED: Interface GigabitEthernet1/0/1, changed state
to administratively down
*Apr 2 19:54:11.779: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEther-
net1/0/1, changed state to down

! Case 2: VLAN 20 is deleted
SW1(config)# no vlan 20
SW1(config)#
*Apr 2 19:54:39.688: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan20, changed
state to down

! Case 3: VLAN 30, the VLAN from the switch to the router, is shutdown
SW1(config)# vlan 30
SW1(config-vlan)# shutdown
SW1(config-vlan)# exit
SW1(config)#
*Apr 2 19:55:25.204: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan30, changed
state to down
! Final status of all three VLAN interfaces is below
SW1# show ip interface brief | include Vlan
Vlan1          unassigned    YES manual administratively down down
Vlan10         10.1.10.1    YES manual up             down
Vlan20         10.1.20.1    YES manual up             down
Vlan30         10.1.30.1    YES manual up             down

```

```
SW1# show interfaces vlan 10
Vlan10 is up, line protocol is up , Autostate Disabled
! Lines omitted for brevity
SW1# show interfaces vlan 20
Vlan10 is up, line protocol is up , Autostate Enabled
! Lines omitted for brevity
```

```
ip routing
!
interface vlan 10
 ip address 10.1.10.1 255.255.255.0
!
interface vlan 20
 ip address 10.1.20.1 255.255.255.0
!
interface gigabitethernet 1/0/9
 no switchport
 ip address 10.1.30.1 255.255.255.0
```

```

SW1# show interfaces g1/0/9
GigabitEthernet1/0/9 is up, line protocol is up (connected)
  Hardware is Gigabit Ethernet, address is 4488.165a.f277 (bia 4488.165a.f277)
    Internet address is 10.1.30.1/24
! lines omitted for brevity

SW1# show interfaces status
! Only ports related to the example are shown; the command lists physical only


| Port    | Name | Status    | Vlan   | Duplex | Speed  | Type              |
|---------|------|-----------|--------|--------|--------|-------------------|
| Gi1/0/1 |      | connected | 10     | a-full | a-1000 | 10/100/1000BaseTX |
| Gi1/0/2 |      | connected | 10     | a-full | a-1000 | 10/100/1000BaseTX |
| Gi1/0/3 |      | connected | 20     | a-full | a-1000 | 10/100/1000BaseTX |
| Gi1/0/4 |      | connected | 20     | a-full | a-1000 | 10/100/1000BaseTX |
| Gi1/0/9 |      | connected | routed | a-full | a-1000 | 10/100/1000BaseTX |



SW1# show ip route
! legend omitted for brevity

      10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C        10.1.10.0/24 is directly connected, Vlan10
L        10.1.10.1/32 is directly connected, Vlan10
C        10.1.20.0/24 is directly connected, Vlan20
L        10.1.20.1/32 is directly connected, Vlan20
C        10.1.30.0/24 is directly connected, GigabitEthernet1/0/9
L        10.1.30.1/32 is directly connected, GigabitEthernet1/0/9

SW1# show interfaces g0/1 switchport
Name: Gi1/0/9
Switchport: Disabled

```

```
interface TenGigabit1/1/1
no switchport
no ip address
channel-group 12 mode on
!
interface TenGigabit1/1/2
no switchport
no ip address
channel-group 12 mode on
!
interface Port-channel12
no switchport
ip address 10.1.12.1 255.255.255.0
```

```
SW1# show interfaces port-channel 12
Port-channel12 is up, line protocol is up (connected)
  Hardware is EtherChannel, address is 4488.165a.f26c (bia 4488.165a.f26c)
    Internet address is 10.1.12.1/24
! lines omitted for brevity

SW1# show interfaces status
! Only ports related to the example are shown.

  Port      Name      Status      Vlan      Duplex      Speed Type
  Te1/1/1          connected   routed     full       10G SFP-10GBase-SR
  Te1/1/2          connected   routed     full       10G SFP-10GBase-SR
  Po12            connected   routed   a-full     a-10G N/A

SW1# show ip route
! legend omitted for brevity
  10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C        10.1.2.0/24 is directly connected, Vlan2
L        10.1.2.1/32 is directly connected, Vlan2
C        10.1.12.0/24 is directly connected, Port-channel12
L        10.1.12.1/32 is directly connected, Port-channel12
```

```
SW1# show etherchannel 12 summary
Flags:  D - down          P - bundled in port-channel
       I - stand-alone  S - suspended
       H - Hot-standby (LACP only)
       R - Layer3         S - Layer2
       U - in use         f - failed to allocate aggregator

       M - not in use, minimum links not met
       u - unsuitable for bundling
       w - waiting to be aggregated
       d - default port

       A - formed by Auto LAG

Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
-----+-----+-----+
  12    Po12(RU)      -          Tel1/1/1(P)   Tel1/1/2(P)
```

```
vlan 10
vlan 20
!
interface GigabitEthernet0/1/0
    switchport access vlan 10
!
interface GigabitEthernet0/1/1
    switchport access vlan 10
!
interface GigabitEthernet0/1/4
    switchport access vlan 20
!
interface GigabitEthernet0/1/5
    switchport access vlan 20
!
interface vlan 10
    ip address 10.1.10.1 255.255.255.0
!
interface vlan 20
    ip address 10.1.20.1 255.255.255.0
!
interface gigabitEthernet0/0/1
    description physical, routed interface
    ip address 10.1.40.1 255.255.255.0
```

```
B1# show ip route connected
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
! Remaining legend omitted for brevity

    10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks
C       10.1.10.0/24 is directly connected, Vlan10
L       10.1.10.1/32 is directly connected, Vlan10
C       10.1.20.0/24 is directly connected, Vlan20
L       10.1.20.1/32 is directly connected, Vlan20
C       10.1.30.0/24 is directly connected, GigabitEthernet0/0/1
L       10.1.30.1/32 is directly connected, GigabitEthernet0/0/1
```

```
B1# show mac address-table dynamic
```

Mac Address Table

Vlan	Mac Address	Type	Ports
10	0200.aaaa.aaaa	DYNAMIC	Gi0/1/0
10	0200.bbbb.bbbb	DYNAMIC	Gi0/1/1
20	0200.cccc.cccc	DYNAMIC	Gi0/1/4
20	0200.dddd.dddd	DYNAMIC	Gi0/1/5

Total Mac Addresses for this criterion: 4

```
B1# show interfaces status

Port      Name       Status    Vlan     Duplex  Speed Type
Gi0/1/0   connected 10        a-full  a-1000 10/100/1000BaseTX
Gi0/1/1   connected 10        a-full  a-1000 10/100/1000BaseTX
Gi0/1/2   notconnect 1        auto    auto   10/100/1000BaseTX
Gi0/1/3   notconnect 1        auto    auto   10/100/1000BaseTX
Gi0/1/4   connected  20        a-full  a-1000 10/100/1000BaseTX
Gi0/1/5   connected  20        a-full  a-1000 10/100/1000BaseTX
Gi0/1/6   notconnect 1        auto    auto   10/100/1000BaseTX
Gi0/1/7   notconnect 1        auto    auto   10/100/1000BaseTX

B1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
B1(config)# interface g0/1/7
B1(config-if)# ip address 10.1.90.1 255.255.255.0
^
% Invalid input detected at '^' marker.
B1(config-if)#

```

```
Macprompt$ ifconfig en0
En1: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
      options=10b<RXCSUM,TXCSUM,VLAN_HWTAGGING,AV>
      ether 00:6d:e7:b1:9a:11
      inet 172.16.4.2 netmask 0xffffffff broadcast 172.16.4.255
```

```
R1# show ip interface g0/0
GigabitEthernet0/0 is up, line protocol is up
  Internet address is 172.16.1.1/24
  Broadcast address is 255.255.255.255
  Address determined by non-volatile memory
  MTU is 1500 bytes
  Helper address is 172.16.2.11
! Lines omitted for brevity
```

```
Emma# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Emma(config)# interface vlan 1
Emma(config-if)# ip address dhcp
Emma(config-if)# no shutdown
Emma(config-if)# ^Z
Emma#
00:38:20: %LINK-3-UPDOWN: Interface Vlan1, changed state to up
00:38:21: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up
```

```
! First, output when the switch has not yet leased an IP address
Emma# show interfaces vlan 1
Vlan1 is up, line protocol is up, Autostate Enabled
Hardware is Ethernet SVI, address is 4488.165a.f247 (bia 4488.165a.f247)
Internet address will be negotiated using DHCP
! lines omitted for brevity
! Next, the output after DHCP works
Emma# show interfaces vlan 1
Vlan1 is up, line protocol is up, Autostate Enabled
Hardware is Ethernet SVI, address is 4488.165a.f247 (bia 4488.165a.f247)
Internet address is 192.168.1.101/24
! lines omitted for brevity
```

```
Emma# show dhcp lease
Temp IP addr: 192.168.1.101 for peer on Interface: Vlan1
Temp sub net mask: 255.255.255.0
DHCP Lease server: 192.168.1.1, state: 3 Bound
DHCP transaction id: 1966
Lease: 86400 secs, Renewal: 43200 secs, Rebind: 75600 secs
Temp default-gateway addr: 192.168.1.1
Next timer fires after: 11:59:45
Retry count: 0 Client-ID: cisco-0019.e86a.6fc0-Vl1
Hostname: Emma

Emma# show ip default-gateway
192.168.1.1
```

```
R1# configure terminal
R1(config)# interface gigabitethernet0/1
R1(config-if)# ip address dhcp
R1(config-if)# end
R1#
R1# show ip route static
! Legend omitted
Gateway of last resort is 192.0.2.1 to network 0.0.0.0

S* 0.0.0.0/0 [254/0] via 192.0.2.1
```

```
Windows_A> ipconfig
! Lines omitted for brevity
Ethernet adapter Ethernet 5:

Connection-specific DNS Suffix . :
Link-local IPv6 Address . . . . . : fe80::6878:1f3d:6223:f4db%6
IPv4 Address. . . . . : 10.1.1.103
Subnet Mask . . . . . : 255.255.255.0
Default Gateway . . . . . : 10.1.1.1

Windows_A> ipconfig /all
! Lines omitted for brevity
Ethernet adapter Ethernet 5:

Connection-specific DNS Suffix . :
Description . . . . . : Realtek USB GbE Family Controller
Physical Address. . . . . : 00-E0-4C-69-08-47
DHCP Enabled. . . . . : Yes
Autoconfiguration Enabled . . . . : Yes
Link-local IPv6 Address . . . . : fe80::6878:1f3d:6223:f4db%6 (Preferred)
IPv4 Address. . . . . : 10.1.1.103 (Preferred)
Subnet Mask . . . . . : 255.255.255.0
Lease Obtained. . . . . : Tuesday, October 25, 2022 8:25:19 AM
Lease Expires . . . . . : Wednesday, October 26, 2022 8:25:19 AM
Default Gateway . . . . . : 10.1.1.1
DHCP Server . . . . . : 10.1.12.2
DHCPv6 IAID . . . . . : 100720716
DHCPv6 Client DUID. . . . . : 00-01-00-01-19-A0-DC-F0-24-FD-52-CB-50-C9
DNS Servers . . . . . : 208.67.222.222
                                         208.67.222.220
NetBIOS over Tcpip. . . . . : Enabled
```

```
Windows_A> netsh interface ip show config

Configuration for interface "Ethernet 5"

DHCP enabled: Yes
IP Address: 10.1.1.103
Subnet Prefix: 10.1.1.0/24 (mask 255.255.255.0)
Default Gateway: 10.1.1.1
Gateway Metric: 0
InterfaceMetric: 25
DNS servers configured through DHCP: 208.67.222.222
208.67.222.220
Register with which suffix: Primary only
WINS servers configured through DHCP: None

! Next, use the network shell to allow repeated commands.
Windows_A> netsh
netsh> interface ip
netsh interface ip> show config

Configuration for interface "Ethernet 5"

DHCP enabled: Yes
IP Address: 10.1.1.103
Subnet Prefix: 10.1.1.0/24 (mask 255.255.255.0)
! Remaining lines omitted; same output as at the top of the example.

netsh interface ip> show dnsservers

Configuration for interface "Ethernet 5"
DNS servers configured through DHCP: 208.67.222.222
208.67.222.220
Register with which suffix: Primary only
```

```
Windows_A> netstat -rn
IPv4 Route Table
=====
Active Routes:
Network Destination      Netmask     Gateway       Interface   Metric
          0.0.0.0        0.0.0.0   10.1.1.1  10.1.1.103    25
        10.1.1.0  255.255.255.0   On-link     10.1.1.103    281
  10.1.1.103  255.255.255.255   On-link     10.1.1.103    281
        10.1.1.255  255.255.255.255   On-link     10.1.1.103    281
! Lines omitted for brevity
Windows_A> netsh interface ip show route
Publish Type      Met Prefix           Iidx Gateway/Interface Name
-----
No   Manual      0  0.0.0.0/0           6 10.1.1.1
No   System      256 10.1.1.0/24         6 Ethernet 5
No   System      256 10.1.1.103/32       6 Ethernet 5
No   System      256 10.1.1.255/32       6 Ethernet 5
!   Lines      omitted for brevity
```

```
Mac_B$ ifconfig en8
en8: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
      options=6467<RXCSUM,TXCSUM,VLAN_MTU,TSO4,TSO6,CHANNEL_IO,PARTIAL_CSUM,
      ZEROINVERT_CSUM>
        ether 00:e0:4c:68:1f:26
        inet6 fe80::184c:56f9:fd3b:d6e7%en8 prefixlen 64 secured scopeid 0x14
          inet 10.1.1.104 netmask 0xffffffff broadcast 10.1.1.255
            nd6 options=201<PERFORMNUD,DAD>
            media: autoselect (1000baseT <full-duplex>)
            status: active

Mac_B$ networksetup -getinfo "USB 10/100/1000 LAN"
DHCP Configuration
IP address: 10.1.1.104
Subnet mask: 255.255.255.0
Router: 10.1.1.1
Client ID:
IPv6: Automatic
IPv6 IP address: none
IPv6 Router: none
Ethernet Address: 00:e0:4c:68:1f:26
```

```
Mac_B> netstat -rn
Routing tables

Internet:

Destination      Gateway          Flags    Netif  Expire
default          10.1.1.1        UGScg   en8
10.1.1/24        link#20        UCS     en8      !
10.1.1.1/32      link#20        UCS     en8      !
10.1.1.1          2:0:11:11:11:11 UHLWIir en8      385
10.1.1.104/32    link#20        UCS     en8      !
! lines omitted for brevity
```

```
Linux_C$ ifconfig
enp4s0f2: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 10.1.1.105 netmask 255.255.255.0 broadcast 10.1.1.255
        inet6 fe80::552d:e285:4347:bded prefixlen 64 scopeid 0x20<link>
            ether 80:fa:5b:04:de:8b txqueuelen 1000 (Ethernet)
            RX packets 4958 bytes 384498 (384.4 KB)
            RX errors 0 dropped 0 overruns 0 frame 0
            TX packets 16270 bytes 1320108 (1.3 MB)
            TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

Linux_C$ ip address
2: enp4s0f2: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP
    group default qlen 1000
        link/ether 80:fa:5b:04:de:8b brd ff:ff:ff:ff:ff:ff
        inet 10.1.1.105/24 brd 10.1.1.255 scope global dynamic noprefixroute enp4s0f2
            valid_lft 81056sec preferred_lft 81056sec
        inet6 fe80::552d:e285:4347:bded/64 scope link noprefixroute
            valid_lft forever preferred_lft forever
```

```
Linux_C$ netstat -rn
Kernel IP routing table
Destination      Gateway        Genmask        Flags   MSS Window irtt Iface
0.0.0.0          10.1.1.1      0.0.0.0        UG        0 0          0 enp4s0f2
10.1.1.0         0.0.0.0       255.255.255.0  U         0 0          0 enp4s0f2
! Lines omitted for brevity
```

```
Linux_C$ ip route
default via 10.1.1.1 dev enp4s0f2 proto dhcp metric 20100
10.1.1.0/24 dev enp4s0f2 proto kernel scope link src 10.1.1.105 metric 100
! Lines omitted for brevity
```

```
Windows_A> ipconfig /all
! Showing only the Ethernet adapter connected to subnet 10.1.1.0/24
Ethernet adapter Ethernet 5:

Connection-specific DNS Suffix . :
Description . . . . . : Realtek USB GbE Family Controller
Physical Address. . . . . : 00-E0-4C-69-08-47
DHCP Enabled. . . . . : No
Autoconfiguration Enabled . . . . : Yes
Link-local IPv6 Address . . . . : fe80::6878:1f3d:6223:f4db%6 (Preferred)
IPv4 Address. . . . . : 10.1.1.99 (Preferred)
Subnet Mask . . . . . : 255.255.255.0
Default Gateway . . . . . : 10.1.1.1
DHCPv6 IAID . . . . . : 100720716
DHCPv6 Client DUID. . . . . : 00-01-00-01-19-A0-DC-F0-24-FD-52-CB-50-C9
DNS Servers . . . . . : 208.67.222.222
                                         208.67.222.220
NetBIOS over Tcpip. . . . . : Enabled
```

```
Windows_A> ipconfig /all
! Showing only the Ethernet adapter connected to subnet 10.1.1.0/24
Ethernet adapter Ethernet 5:

Connection-specific DNS Suffix . :
Description . . . . . : Realtek USB GbE Family Controller
Physical Address. . . . . : 00-E0-4C-69-08-47
DHCP Enabled. . . . . : Yes
Autoconfiguration Enabled . . . . : Yes
Link-local IPv6 Address . . . . : fe80::6878:1f3d:6223:f4db%6 (Preferred)
Autoconfiguration IPv4 Address. . . : 169.254.244.219 (Preferred)
Subnet Mask . . . . . : 255.255.0.0
Default Gateway . . . . . :
DHCPv6 IAID . . . . . : 100720716
DHCPv6 Client DUID. . . . . : 00-01-00-01-19-A0-DC-F0-24-FD-52-CB-50-C9
DNS Servers . . . . . . . : fec0:0:0:ffff::1%1
                           fec0:0:0:ffff::2%1
                           fec0:0:0:ffff::3%1
NetBIOS over Tcpip. . . . . : Enabled
```

```
Windows_A> ipconfig /all
```

```
Ethernet adapter Ethernet 5:
```

```
    Connection-specific DNS Suffix . . .  
    Description . . . . . : Realtek USB GbE Family Controller  
    Physical Address . . . . . : 00-E0-4C-69-08-47  
    DHCP Enabled . . . . . : Yes  
    Autoconfiguration Enabled . . . . . : Yes  
    Link-local IPv6 Address . . . . . : fe80::6878:1f3d:6223:f4db%6 (Preferred)  
    IPv4 Address . . . . . : 10.1.1.103 (Preferred)  
    Subnet Mask . . . . . : 255.255.255.0  
    Lease Obtained . . . . . : Tuesday, October 25, 2022 7:54:17 AM  
    Lease Expires . . . . . : Wednesday, October 26, 2022 7:54:16 AM  
    Default Gateway . . . . . : 10.1.1.254  
    DHCP Server . . . . . : 10.1.12.2  
    DHCPv6 IAID . . . . . : 100720716  
    DHCPv6 Client DUID . . . . . : 00-01-00-01-19-A0-DC-F0-24-FD-52-CB-50-C9  
    DNS Servers . . . . . : 208.67.222.222  
                                208.67.222.220  
    NetBIOS over Tcpip . . . . . : Enabled
```

```
Windows_A> netstat -rn
```

```
IPv4 Route Table
```

```
=====
```

Active Routes:				
Network Destination	Netmask	Gateway	Interface	Metric
0.0.0.0	0.0.0.0	10.1.1.254	10.1.1.103	25
10.1.1.0	255.255.255.0	On-link	10.1.1.103	281

```
! Lines omitted for brevity
```

```
Mac_A$ ping 172.16.2.101
PING 172.16.2.101 (172.16.2.101): 56 data bytes
64 bytes from 172.16.2.101: icmp_seq=0 ttl=64 time=1.112 ms
64 bytes from 172.16.2.101: icmp_seq=1 ttl=64 time=0.673 ms
64 bytes from 172.16.2.101: icmp_seq=2 ttl=64 time=0.631 ms
64 bytes from 172.16.2.101: icmp_seq=3 ttl=64 time=0.674 ms
64 bytes from 172.16.2.101: icmp_seq=4 ttl=64 time=0.642 ms
64 bytes from 172.16.2.101: icmp_seq=5 ttl=64 time=0.656 ms
^C
--- 172.16.2.101 ping statistics ---
6 packets transmitted, 6 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 0.631/0.731/1.112/0.171 ms
```

```
R1# ping 172.16.2.101
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.2.101, timeout is 2 seconds:
.!!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 1/2/4 ms
R1# ping 172.16.2.101
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.2.101, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
```

```
R1# ping
Protocol [ip]:
Target IP address: 172.16.2.101
Repeat count [5]:
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 172.16.1.1
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose [none]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.2.101, timeout is 2 seconds:
Packet sent with a source address of 172.16.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
```

```
R1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)# ip domain lookup
R1(config)# ip domain name example.com
R1(config)# ip name-server 8.8.8.8 8.8.8.4
R1(config)# ^Z
R1#
R1# ping hostB
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.2.101, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/4 ms
```



```
Mac_A$ traceroute 172.16.2.101
traceroute to 172.16.2.101, 64 hops max, 52 byte packets
1 172.16.1.1 (172.16.1.1) 0.870 ms 0.520 ms 0.496 ms
2 172.16.4.2 (172.16.4.2) 8.263 ms 7.518 ms 9.319 ms
3 172.16.2.101 (172.16.2.101) 16.770 ms 9.819 ms 9.830 ms
```

```
R1# traceroute 172.16.2.101
Type escape sequence to abort.
Tracing the route to 172.16.2.101
VRF info: (vrf in name/id, vrf out name/id)
 1 172.16.4.2 0 msec 0 msec 0 msec
 2 172.16.2.101 0 msec 0 msec *
```

```
R1# traceroute
Protocol [ip]:
Target IP address: 172.16.2.101
Source address: 172.16.1.1
Numeric display [n]:
Timeout in seconds [3]:
Probe count [3]:
Minimum Time to Live [1]:
Maximum Time to Live [30]:
Port Number [33434]:
Loose, Strict, Record, Timestamp, Verbose [none]:
Type escape sequence to abort.
Tracing the route to 172.16.2.101
VRF info: (vrf in name/id, vrf out name/id)
 1 172.16.4.2 0 msec 0 msec 0 msec
 2 172.16.2.101 0 msec 0 msec *
```

```
R1# telnet 10.1.2.2
Trying 10.1.2.2 ... Open

User Access Verification

Username: wendell
Password:
R2>
R2> show ip interface brief
Interface          IP-Address      OK? Method Status      Protocol
GigabitEthernet0/0  unassigned      YES unset  administratively down down
GigabitEthernet0/1  10.1.3.2       YES manual up        up
GigabitEthernet0/2  10.1.2.2       YES manual up        up
GigabitEthernet0/3  unassigned      YES unset  administratively down down
```

```
R1# ssh -l wendell 10.1.2.2
```

Password:

```
R2>
```

Interface	IP-Address	OK?	Method	Status	Protocol
GigabitEthernet0/0	unassigned	YES	unset	administratively down	down
GigabitEthernet0/1	10.1.3.2	YES	manual	up	up
GigabitEthernet0/2	10.1.2.2	YES	manual	up	up
GigabitEthernet0/3	unassigned	YES	unset	administratively down	down

```
interface GigabitEthernet0/0/0
  ip address 10.1.1.1 255.255.255.0
!
interface GigabitEthernet0/0/1
  ip address 10.1.12.1 255.255.255.0
!
interface GigabitEthernet0/0/2
  ip address 10.1.13.1 255.255.255.0
!
interface GigabitEthernet0/0/3
  ip address 10.1.14.1 255.255.255.0
```

```
router ospf 1
  network 10.0.0.0 0.255.255.255 area 0
```

```
! R2 configuration next - one network command enables OSPF on both interfaces
interface GigabitEthernet0/0/0
  ip address 10.1.23.2 255.255.255.0
!
interface GigabitEthernet0/0/1
  ip address 10.1.12.2 255.255.255.0
!
router ospf 1
  network 10.0.0.0 0.255.255.255 area 0
```

```
! R3 configuration next - One network command per interface
interface GigabitEthernet0/0/0
  ip address 10.1.23.3 255.255.255.0
!
interface GigabitEthernet0/0/1
  ip address 10.1.13.3 255.255.255.0
!
router ospf 1
  network 10.1.13.3 0.0.0.0 area 0
  network 10.1.23.3 0.0.0.0 area 0
```

```
! R4 configuration next - One network command per interface with wildcard 0.0.0.255
interface GigabitEthernet0/0/0
  ip address 10.1.4.4 255.255.255.0
!
interface GigabitEthernet0/0/1
  ip address 10.1.14.4 255.255.255.0
!
router ospf 1
  network 10.1.14.0 0.0.0.255 area 0
  network 10.1.4.0 0.0.0.255 area 0
```

```
R1# show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
2.2.2.2	1	FULL/DR	00:00:37	10.1.12.2	GigabitEthernet0/0/1
3.3.3.3	1	FULL/DR	00:00:37	10.1.13.3	GigabitEthernet0/0/2
4.4.4.4	1	FULL/BDR	00:00:34	10.1.14.4	GigabitEthernet0/0/3

```
R1# show ip ospf database
```

```
OSPF Router with ID (1.1.1.1) (Process ID 1)
```

```
Router Link States (Area 0)
```

Link ID	ADV Router	Age	Seq#	Checksum	Link count
1.1.1.1	1.1.1.1	431	0x8000008F	0x00DCCA	5
2.2.2.2	2.2.2.2	1167	0x8000007F	0x009DA1	2
3.3.3.3	3.3.3.3	441	0x80000005	0x002FB1	1
4.4.4.4	4.4.4.4	530	0x80000004	0x007F39	2

```
Net Link States (Area 0)
```

Link ID	ADV Router	Age	Seq#	Checksum
10.1.12.2	2.2.2.2	1167	0x8000007C	0x00BBD5
10.1.13.3	3.3.3.3	453	0x80000001	0x00A161
10.1.14.1	4.4.4.4	745	0x8000007B	0x004449
10.1.23.3	3.3.3.3	8	0x80000001	0x00658F

```
R4# 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
! Additional legend lines omitted for brevity

Gateway of last resort is not set

  10.0.0.0/8 is variably subnetted, 9 subnets, 2 masks
O  10.1.1.0/24 [110/2] via 10.1.14.1, 00:27:24, GigabitEthernet0/0/1
C  10.1.4.0/24 is directly connected, GigabitEthernet0/0/0
L  10.1.4.4/32 is directly connected, GigabitEthernet0/0/0
O  10.1.12.0/24 [110/2] via 10.1.14.1, 00:27:24, GigabitEthernet0/0/1
O  10.1.13.0/24 [110/2] via 10.1.14.1, 00:25:15, GigabitEthernet0/0/1
C  10.1.14.0/24 is directly connected, GigabitEthernet0/0/1
L  10.1.14.4/32 is directly connected, GigabitEthernet0/0/1
O  10.1.23.0/24 [110/3] via 10.1.14.1, 00:27:24, GigabitEthernet0/0/1
```

```
R3# show running-config | section router ospf 1
router ospf 1
  network 10.1.13.3 0.0.0.0 area 0
  network 10.1.23.3 0.0.0.0 area 0
  router-id 3.3.3.3

R3# show ip protocols
*** IP Routing is NSF aware ***

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 3.3.3.3
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    10.1.13.3 0.0.0.0 area 0
    10.1.23.3 0.0.0.0 area 0
  Routing Information Sources:
    Gateway          Distance      Last Update
      1.1.1.1           110          02:05:26
      4.4.4.4           110          02:05:26
      2.2.2.2           110          01:51:16
  Distance: (default is 110)
```

```
R1# show ip ospf interface brief
```

Interface	PID	Area	IP Address/Mask	Cost	State	Nbrs	F/C
Gi0/0/0	1	0	10.1.1.1/24	1	DR	0/0	
Gi0/0/1	1	0	10.1.12.1/24	1	BDR	1/1	
Gi0/0/2	1	0	10.1.13.1/24	1	BDR	1/1	
Gi0/0/3	1	0	10.1.14.1/24	1	DR	1/1	

```
! R1 Configuration first
router ospf 1
 router-id 1.1.1.1
 network 10.1.0.0 0.0.255.255 area 0
```

```
! R2 Configuration next
!
interface Loopback2
 ip address 2.2.2.2 255.255.255.255
```

```
R1# show ip ospf  
Routing Process "ospf 1" with ID 1.1.1.1  
! lines omitted for brevity
```

```
router ospf 1
network 10.1.1.1 0.0.0.0 area 0
network 10.1.12.1 0.0.0.0 area 23
network 10.1.13.1 0.0.0.0 area 23
network 10.1.14.1 0.0.0.0 area 4
```

```
R1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)# router ospf 1
R1(config-router)# no network 10.0.0.0 0.255.255.255 area 0
R1(config-router)#
*Apr  8 19:35:24.994: %OSPF-5-ADJCHG: Process 1, Nbr 2.2.2.2 on GigabitEthernet0/0/1
from FULL to DOWN, Neighbor Down: Interface down or detached
*Apr  8 19:35:24.994: %OSPF-5-ADJCHG: Process 1, Nbr 3.3.3.3 on GigabitEthernet0/0/2
from FULL to DOWN, Neighbor Down: Interface down or detached
*Apr  8 19:35:24.994: %OSPF-5-ADJCHG: Process 1, Nbr 4.4.4.4 on GigabitEthernet0/0/3
from FULL to DOWN, Neighbor Down: Interface down or detached
R1(config-router)# interface g0/0/0
R1(config-if)# ip ospf 1 area 0
R1(config-if)# interface g0/0/1
R1(config-if)# ip ospf 1 area 0
R1(config-if)#
*Apr  8 19:35:52.970: %OSPF-5-ADJCHG: Process 1, Nbr 2.2.2.2 on GigabitEthernet0/0/1
from LOADING to FULL, Loading Done
R1(config-if)# interface g0/0/2
R1(config-if)# ip ospf 1 area 0
R1(config-if)#
*Apr  8 19:36:13.362: %OSPF-5-ADJCHG: Process 1, Nbr 3.3.3.3 on GigabitEthernet0/0/2
from LOADING to FULL, Loading Done
R1(config-if)# interface g0/0/3
R1(config-if)# ip ospf 1 area 0
R1(config-if)#
*Apr  8 19:37:05.398: %OSPF-5-ADJCHG: Process 1, Nbr 4.4.4.4 on GigabitEthernet0/0/3
from LOADING to FULL, Loading Done
R1(config-if)#

```

```
! First, with the new interface configuration
R1# show ip protocols
! ... beginning lines omitted for brevity
Routing for Networks:
Routing on Interfaces Configured Explicitly (Area 0):
GigabitEthernet0/0/0
GigabitEthernet0/0/1
GigabitEthernet0/0/2
GigabitEthernet0/0/3
Routing Information Sources:
  Gateway        Distance      Last Update
    4.4.4.4          110        00:09:30
    2.2.2.2          110        00:10:49
    3.3.3.3          110       05:20:07
Distance: (default is 110)
```

```
! For comparison, the old results with the use of the OSPF network command
R1# show ip protocols
! ... beginning lines omitted for brevity
Routing for Networks:
  10.1.0.0 0.0.255.255 area 0
! ... ending line omitted for brevity
```

```
! First, with the new interface configuration
R1# show ip ospf interface g0/0/1
GigabitEthernet0/0/0 is up, line protocol is up
  Internet Address 10.1.12.1/24, Area 0, Attached via Interface Enable
! Lines omitted for brevity

! For comparison, the old results with the use of the OSPF network command
R1# show ip ospf interface g0/0/1
GigabitEthernet0/0/0 is up, line protocol is up
  Internet Address 10.1.12.1/24, Area 0, Attached via Network Statement
! ... ending line omitted for brevity
```

```
R9# show ip ospf interface brief
```

Interface	PID	Area	IP Address/Mask	Cost	State	Nbrs	F/C
Gi0/0	1	0	10.1.1.1/24	1	DROTH	2/5	

```
router ospf 1
  router-id 1.1.1.1
!
interface gigabitEthernet0/0
  ip ospf 1 area 0
!
interface gigabitEthernet0/1
  ip ospf 1 area 0
```

```
R1# show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
2.2.2.2	1	2WAY/DROTHER	00:00:35	10.1.1.2	GigabitEthernet0/0
3.3.3.3	1	FULL/BDR	00:00:33	10.1.1.3	GigabitEthernet0/0
4.4.4.4	1	FULL/DR	00:00:35	10.1.1.4	GigabitEthernet0/0

```
R1# show ip ospf interface brief
```

Interface	PID	Area	IP Address/Mask	Cost	State	Nbrs	F/C
Gi0/1	1	0	10.1.11.1/24	1	DR	0/0	
Gi0/0	1	0	10.1.1.1/24	1	DROTH	2/3	

```
R1# show ip ospf interface g0/0
GigabitEthernet0/0 is up, line protocol is up
  Internet Address 10.1.1.1/24, Area 0, Attached via Interface Enable
  Process ID 1, Router ID 1.1.1.1, Network Type BROADCAST, Cost: 1
  Topology-MTID      Cost      Disabled      Shutdown      Topology Name
    0              1            no            no          Base
  Enabled by interface config, including secondary ip addresses
  Transmit Delay is 1 sec, State DROTHER, Priority 1
  Designated Router (ID) 4.4.4.4, Interface address 10.1.1.4
  Backup Designated router (ID) 3.3.3.3, Interface address 10.1.1.3
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:00
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 1/1/1, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 3, Adjacent neighbor count is 2
    Adjacent with neighbor 3.3.3.3 (Backup Designated Router)
    Adjacent with neighbor 4.4.4.4 (Designated Router)
  Suppress hello for 0 neighbor(s)
```

```

R1# configure terminal
Configuring from terminal, memory, or network [terminal]?
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)# interface g0/0
R1(config-if)# ip ospf priority 99
R1(config-if)# ^Z
R1#
R1# show ip ospf interface g0/0 | include Priority
Transmit Delay is 1 sec, State DROTHER, Priority 99

R1# show ip ospf neighbor
Neighbor ID      Pri  State            Dead Time     Address          Interface
2.2.2.2          1    2WAY/DROTHER   00:00:36     10.1.1.2        GigabitEthernet0/0
3.3.3.3          1    FULL/BDR       00:00:30     10.1.1.3        GigabitEthernet0/0
4.4.4.4          1    FULL/DR        00:00:37     10.1.1.4        GigabitEthernet0/0

R1# show ip ospf interface brief
Interface      PID  Area           IP Address/Mask   Cost  State Nbrs F/C
Gi0/1          1    0              10.1.11.1/24     1     DR    0/0
Gi0/0          1    0              10.1.1.1/24     1     DROTH 2/3

```

```

! Not shown: LAN fails, and then recovers, causing a new OSPF Election
R1# show ip ospf neighbor

Neighbor ID      Pri   State            Dead Time     Address          Interface
2.2.2.2           1    FULL/DROTHER    00:00:37     10.1.1.2        GigabitEthernet0/0
3.3.3.3           1    FULL/DROTHER    00:00:38     10.1.1.3        GigabitEthernet0/0
4.4.4.4           1    FULL/BDR       00:00:38     10.1.1.4        GigabitEthernet0/0

R1# show ip ospf interface brief
Interface    PID   Area          IP Address/Mask   Cost   State Nbrs F/C
Gi0/1        1     0             10.1.11.1/24     1      DR    0/0
Gi0/0        1     0             10.1.1.1/24      1      DR    3/3

```

```
R1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)# interface g0/0/1
R1(config-if)# ip ospf network point-to-point
R1(config-if)#

R1# show ip ospf interface g0/0/1
GigabitEthernet0/0/1 is up, line protocol is up
  Internet Address 10.1.12.1/24, Area 0, Attached via Interface Enable
  Process ID 1, Router ID 1.1.1.1, Network Type POINT_TO_POINT, Cost: 1
  Topology-MTID      Cost      Disabled      Shutdown      Topology Name
    0            4          no          no           Base
  Enabled by interface config, including secondary ip addresses
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:01
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 1/3/3, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 3
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 2.2.2.2
  Suppress hello for 0 neighbor(s)
```

```
R1# show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
2.2.2.2	0	FULL/-	00:00:39	10.1.12.2	GigabitEthernet0/0/1

! lines omitted for brevity

```
R1# show ip ospf interface brief
```

Interface	PID	Area	IP Address/Mask	Cost	State	Nbrs	F/C
Gi0/0/1	1	0	10.1.12.1/24	4	P2P	1/1	

! lines omitted for brevity

```
! First, make each interface passive directly
router ospf 1
  passive-interface GigabitEthernet0/0/0

! Or, change the default to passive, and make the other interfaces not be passive
router ospf 1
  passive-interface default
  no passive-interface GigabitEthernet0/0/1
  no passive-interface GigabitEthernet0/0/2
  no passive-interface GigabitEthernet0/0/3
```

```
R1# show ip ospf interface brief


| Interface | PID | Area | IP Address/Mask | Cost | State | Nbrs | F/C |
|-----------|-----|------|-----------------|------|-------|------|-----|
| Gi0/0/0   | 1   | 0    | 10.1.1.1/24     | 1    | DR    | 0/0  |     |
| Gi0/0/1   | 1   | 0    | 10.1.12.1/24    | 1    | BDR   | 1/1  |     |
| Gi0/0/2   | 1   | 0    | 10.1.13.1/24    | 1    | BDR   | 1/1  |     |
| Gi0/0/3   | 1   | 0    | 10.1.14.1/24    | 1    | DR    | 1/1  |     |



R1# show ip ospf interface g0/0/0
GigabitEthernet0/0/0 is up, line protocol is up
  Internet Address 10.1.1.1/24, Area 0, Attached via Network Statement
  Process ID 1, Router ID 1.1.1.1, Network Type BROADCAST, Cost: 1
  Topology-MTID      Cost      Disabled      Shutdown      Topology Name
          0           1           no           no           Base
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 1.1.1.1, Interface address 10.1.1.1
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
  No Hellos (Passive interface)
! Lines omitted for brevity
```

```
! Excerpt from a show running-config command on router R1
ip route 0.0.0.0 0.0.0.0 192.0.2.1
!
router ospf 1
  network 10.0.0.0 0.255.255.255 area 0
  router-id 1.1.1.1
    default-information originate
```

```
! The next command is from Router R1. Note the static code for the default route
```

```
R1# show ip route static
```

```
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
```

```
! Rest of the legend omitted for brevity
```

```
Gateway of last resort is 192.0.2.1 to network 0.0.0.0
```

```
S*      0.0.0.0/0 [254/0] via 192.0.2.1
```

```
! The next command is from router B1; notice the External route code for the default
```

```
B1# show ip route ospf
```

```
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
```

```
! Rest of the legend omitted for brevity
```

```
Gateway of last resort is 10.1.12.1 to network 0.0.0.0
```

```
O*E2    0.0.0.0/0 [110/1] via 10.1.12.1, 00:20:51, GigabitEthernet0/1/0
```

```
10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
```

```
O        10.1.3.0/24 [110/3] via 10.1.12.1, 00:20:51, GigabitEthernet0/1/0
```

```
O        10.1.13.0/24 [110/2] via 10.1.12.1, 00:20:51, GigabitEthernet0/1/0
```

```

R1# conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)# interface g0/0/1
R1(config-if)# ip ospf cost 4
R1(config-if)# interface g0/0/2
R1(config-if)# ip ospf cost 5
R1(config-if)# ^Z
R1#
R1# show ip ospf interface brief

```

Interface	PID	Area	IP Address/Mask	Cost	State	Nbrs	F/C
Gi0/0/0	1	0	10.1.1.1/24	1	DR	0/0	
Gi0/0/1	1	0	10.1.12.1/24	4	DR	1/1	
Gi0/0/2	1	0	10.1.13.1/24	5	BDR	1/1	
Gi0/0/3	1	0	10.1.14.1/24	1	DR	1/1	

```
R1# conf t
Enter configuration commands, one per line.  End with CNTL/Z.
! Link connected to router R2
R1(config)# interface g0/0/1
R1(config-if)# ip ospf hello-interval 5
! Link connected to router R3
R1(config)# interface g0/0/2
R1(config-if)# ip ospf dead-interval 20
! Link connected to router R4
R1(config)# interface g0/0/3
R1(config-if)# ip ospf hello-interval 5
R1(config-if)# ip ospf dead-interval 15
R1(config-if)# Ctrl-z
R1#
```

```
R1# show ip ospf interface g0/0/1 | include Hello
Timer intervals configured, Hello 5, Dead 20, Wait 20, Retransmit 5
Hello due in 00:00:02

R1# show ip ospf interface g0/0/2 | include Hello
Timer intervals configured, Hello 10, Dead 20, Wait 20, Retransmit 5
Hello due in 00:00:04

R1# show ip ospf interface g0/0/3 | include Hello
Timer intervals configured, Hello 5, Dead 15, Wait 15, Retransmit 5
Hello due in 00:00:03
```

```
R3# show ip route
Gateway of last resort is 172.20.15.5 to network 0.0.0.0

O*E2  0.0.0.0/0 [110/1] via 172.20.15.5, 00:04:56, GigabitEthernet0/1
      172.20.0.0/16 is variably subnetted, 12 subnets, 4 masks
S       172.20.90.9/32 [1/0] via 172.20.11.1
O IA    172.20.88.0/23 [110/3] via 172.20.12.2, 00:03:44, GigabitEthernet0/0/2
O IA    172.20.80.0/20 [110/3] via 172.20.13.3, 00:04:55, GigabitEthernet0/0/3
O IA    172.20.0.0/16 [110/6] via 172.20.14.4, 00:02:14, GigabitEthernet0/0/4
```

```
R3# show ip route
Gateway of last resort is 172.20.15.5 to network 0.0.0.0

O*E2  0.0.0.0/0 [110/1] via 172.20.15.5, 00:04:56, GigabitEthernet0/1
      172.20.0.0/16 is variably subnetted, 12 subnets, 4 masks
S       172.20.90.9/32 [1/0] via 172.20.11.1
O IA    172.20.88.0/23 [110/3] via 172.20.12.2, 00:03:44, GigabitEthernet0/0/2
O IA    172.20.80.0/20 [110/3] via 172.20.13.3, 00:04:55, GigabitEthernet0/0/3
O IA    172.20.0.0/16 [110/6] via 172.20.14.4, 00:02:14, GigabitEthernet0/0/4
```

```
router ospf 1
  router-id 1.1.1.1
!
interface gigabitEthernet0/0
  ip address 10.1.1.1 255.255.255.0
  ip ospf 1 area 0
!
interface gigabitEthernet0/1
  ip address 10.1.11.1 255.255.255.0
  ip ospf 1 area 0
```

```
router ospf 1
  router-id 2.2.2.2
!
interface gigabitEthernet0/0
  ip address 10.1.1.2 255.255.255.0
  ip ospf 1 area 1
!
interface gigabitEthernet0/1
  ip address 10.1.22.2 255.255.255.0
  ip ospf 1 area 1
```

```
! Next, on R3: R3 lists the RID of 1.1.1.1
!
R3# show ip ospf
Routing Process "ospf 1" with ID 1.1.1.1
Start time: 00:00:37.136, Time elapsed: 02:20:37.200
! lines omitted for brevity
```

```
! Back to R1: R1 also uses RID 1.1.1.1
R1# show ip ospf
Routing Process "ospf 1" with ID 1.1.1.1
Start time: 00:01:51.864, Time elapsed: 12:13:50.904
! lines omitted for brevity
```

```
*May 29 00:01:25.679: %OSPF-4-DUP_RTRID_NBR: OSPF detected duplicate router-id
1.1.1.1 from 10.1.1.3 on interface GigabitEthernet0/0
```

```
R1# show ip ospf interface G0/0
GigabitEthernet0/0 is up, line protocol is up
    Internet Address 10.1.1.1/24, Area 0, Attached via Network Statement
    Process ID 1, Router ID 1.1.1.1, Network Type BROADCAST, Cost: 1
    Topology-MTID  Cost  Disabled  Shutdown  Topology Name
        0          1        no        no      Base
    Transmit Delay is 1 sec, State DR, Priority 1
    Designated Router (ID) 1.1.1.1, Interface address 10.1.1.1
    No backup designated router on this network
    Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
! lines omitted for brevity
```

```
! Moving on to R4 next
!
R4# show ip ospf interface Gi0/0
GigabitEthernet0/0 is up, line protocol is up
    Internet Address 10.1.1.4/24, Area 0, Attached via Network Statement
    Process ID 4, Router ID 10.1.44.4, Network Type BROADCAST, Cost: 1
    Topology-MTID  Cost  Disabled  Shutdown  Topology Name
        0          1        no        no      Base
    Transmit Delay is 1 sec, State DR, Priority 1
    Transmit Delay is 1 sec, State DR, Priority 1
    Designated Router (ID) 10.1.44.4, Interface address 10.1.1.4
    No backup designated router on this network
    Timer intervals configured, Hello 5, Dead 20, Wait 20, Retransmit 5
! lines omitted for brevity
```

```

R5# show ip ospf neighbor
Neighbor ID      Pri   State        Dead Time     Address          Interface
2.2.2.2           1    FULL/DR      00:00:35     10.1.12.2       GigabitEthernet0/1
3.3.3.3           1    FULL/DR      00:00:33     10.1.13.3       GigabitEthernet0/2

R5# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R5(config)# router ospf 1
R5(config-router)# shutdown
R5(config-router)# ^Z
*Mar 23 12:43:30.634: %OSPF-5-ADJCHG: Process 1, Nbr 2.2.2.2 on GigabitEthernet0/1
from FULL to DOWN, Neighbor Down: Interface down or detached
*Mar 23 12:43:30.635: %OSPF-5-ADJCHG: Process 1, Nbr 3.3.3.3 on GigabitEthernet0/2
from FULL to DOWN, Neighbor Down: Interface down or detached

R5# show ip ospf interface brief
Interface      PID      Area        IP Address/Mask      Cost      State Nbrs F/C
Gi0/1           1        0            10.1.12.1/24        1        DOWN  0/0
Gi0/2           1        0            10.1.13.1/24        1        DOWN  0/0

R5# show ip ospf
Routing Process "ospf 1" with ID 5.5.5.5
Start time: 5d23h, Time elapsed: 1d04h
Routing Process is shutdown
! lines omitted for brevity

R5# show ip ospf neighbor
R5#
R5# show ip ospf database
      OSPF Router with ID (3.3.3.3) (Process ID 1)
R5#

```

```
R1# show running-config interface g0/0/1
! Neighboring router R2 defaults to network type broadcast
interface GigabitEthernet0/0/1
  ip address 10.1.12.1 255.255.255.0
  ip ospf network point-to-point
  ip ospf 1 area 0

R1# show running-config interface g0/0/2
! Neighboring router R3 defaults to IP MTU 1500
interface GigabitEthernet0/0/2
  ip address 10.1.13.1 255.255.255.0
  ip mtu 1600
  ip ospf 1 area 0

R1# show running-config interface g0/0/3
! Neighboring router R4 is also configured for OSPF priority 0
interface GigabitEthernet0/0/3
  ip address 10.1.14.1 255.255.255.0
  ip ospf priority 0
  ip ospf 1 area 0
```

```
R1# show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
4.4.4.4	0	2WAY/DROTHER	00:00:38	10.1.14.4	GigabitEthernet0/0/3
3.3.3.3	0	EXCHANGE/DROTHER	00:00:38	10.1.13.3	GigabitEthernet0/0/2
2.2.2.2	0	FULL/ -	00:00:39	10.1.12.2	GigabitEthernet0/0/1

```
R1#
```

```
*Nov  2 21:38:34.046: %OSPF-5-ADJCHG: Process 1, Nbr 3.3.3.3 on GigabitEthernet0/0/2  
from EXCHANGE to DOWN, Neighbor Down: Too many retransmissions
```

```
R1# show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
4.4.4.4	0	2WAY/DROTHER	00:00:31	10.1.14.4	GigabitEthernet0/0/3
3.3.3.3	0	DOWN/DROTHER	-	10.1.13.3	GigabitEthernet0/0/2
2.2.2.2	0	FULL/ -	00:00:34	10.1.12.2	GigabitEthernet0/0/1

```
R1# show ip route ospf
! Legend omitted for brevity

Gateway of last resort is not set

    10.0.0.0/8 is variably subnetted, 14 subnets, 2 masks
O        10.1.4.0/24 [110/20] via 10.1.14.4, 00:00:17, GigabitEthernet0/0/3
O        10.1.23.0/24 [110/20] via 10.1.13.3, 00:00:20, GigabitEthernet0/0/2
                                         [110/20] via 10.1.12.2, 00:00:23, GigabitEthernet0/0/1
```

```
R1# 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
i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
+ - replicated route, % - next hop override

Gateway of last resort is 172.16.13.3 to network 0.0.0.0

```
O*E2 0.0.0.0/0 [110/1] via 172.16.13.3, 00:04:56, GigabitEthernet0/1
    172.16.0.0/16 is variably subnetted, 12 subnets, 4 masks
S      172.16.10.4/32 [1/0] via 172.16.12.2
O IA    172.16.10.0/26 [110/3] via 172.16.13.3, 00:04:56, GigabitEthernet0/0/1
O IA    172.16.10.0/23 [110/6] via 172.16.12.2, 00:04:56, GigabitEthernet0/0/0
O IA    172.16.11.0/26 [110/3] via 172.16.13.3, 00:04:56, GigabitEthernet0/0/1
! Non-overlapping routes omitted for brevity
```

```
R1# show ip route 172.16.10.1
Routing entry for 172.16.10.0/26
  Known via "ospf 1", distance 110, metric 3, type inter area
  Last update from 172.16.13.3 on GigabitEthernet0/0/1, 00:44:09 ago
  Routing Descriptor Blocks:
    * 172.16.13.3, from 3.3.3.3, 00:44:09 ago, via GigabitEthernet0/0/1
      Route metric is 3, traffic share count is 1
```

```
R1# 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, m - OMP
      n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      H - NHRP, G - NHRP registered, g - NHRP registration summary
      o - ODR, P - periodic downloaded static route, l - LISP
      a - application route
      + - replicated route, % - next hop override, p - overrides from PfR
      & - replicated local route overrides by connected
! Lines omitted for brevity
```

2345:1111:2222:3333:4444:5555:6666:AAAA

2000:1:2:3:4:5:6:A

FE80::1

2340:1111:AAAA:0001:1234:5678:9ABC:1234

2100:0000:0000:0001:0000:0000:0000:0056

2222:1111:0:1:A:B:C:D/64

2222:1111:0:1:A:B:C:D /64

2000:1234:5678:9ABC:1234:5678:9ABC:1111/64

2000:1234:5678:9ABC:0000:0000:0000:0000/64

2000:1234:5678:9ABC:1234:5678:9ABC:1111/56

2000:1234:5678:9A00:0000:0000:0000:0000/56

```
ipv6 unicast-routing
!
interface GigabitEthernet0/0/0
    ipv6 address 2001:DB8:1111:1::1/64
!
! Below, note the expanded address. IOS will abbreviate the address for you.
interface GigabitEthernet0/0/1
    ipv6 address 2001:0db8:1111:0012:0000:0000:0000:0001/64
```

```
ipv6 unicast-routing
!
interface GigabitEthernet0/0/0
    ipv6 address 2001:DB8:1111:2::2/64
!
interface GigabitEthernet0/0/1
    ipv6 address 2001:db8:1111:12::2/64
```

```
! The first interface is in subnet 1
R1# show ipv6 interface GigabitEthernet 0/0/0
GigabitEthernet0/0/0 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::11FF:FE11:1111
  No Virtual link-local address(es):
    Global unicast address(es):
      2001:DB8:1111:1::1, subnet is 2001:DB8:1111:1::/64
  Joined group address(es):
    FF02::1
    FF02::2
    FF02::1:FF00:1
    FF02::1:FF11:1111
  MTU is 1500 bytes
  ICMP error messages limited to one every 100 milliseconds
  ICMP redirects are enabled
  ICMP unreachables are sent
  ND DAD is enabled, number of DAD attempts: 1
  ND reachable time is 30000 milliseconds (using 30000)
  ND advertised reachable time is 0 (unspecified)
  ND advertised retransmit interval is 0 (unspecified)
  ND router advertisements are sent every 200 seconds
  ND router advertisements live for 1800 seconds
  ND advertised default router preference is Medium
  Hosts use stateless autoconfig for addresses.
```

```
R1# show ipv6 interface brief
GigabitEthernet0/0/0      [up/up]
  FE80::11FF:FE11:1111
  2001:DB8:1111:1::1
GigabitEthernet0/0/1      [up/up]
  FE80::32F7:DFF:FE29:8568
  2001:DB8:1111:12::1
GigabitEthernet0/0/2      [administratively down/down]
  unassigned
GigabitEthernet0/0/3      [administratively down/down]
  unassigned
```

```
R1# show ipv6 route connected
IPv6 Routing Table - default - 5 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
      B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
      I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
      EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination
      NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
      OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
      a - Application, m - OMP
C  2001:DB8:1111:1::/64 [0/0]
    via GigabitEthernet0/0/0, directly connected
C  2001:DB8:1111:12::/64 [0/0]
    via GigabitEthernet0/0/1, directly connected
```

```
ipv6 unicast-routing
!
! The ipv6 address command below lists a prefix, not the full address
interface GigabitEthernet0/0/0
    mac-address 0200.1111.1111
    ipv6 address 2001:DB8:1111:1::/64 eui-64
!
interface GigabitEthernet0/0/1
    ipv6 address 2001:DB8:1111:12::/64 eui-64

R1# show ipv6 interface brief
GigabitEthernet0/0/0      [up/up]
    FE80::11FF:FE11:1111
    2001:DB8:1111:1:0:11FF:FE11:1111
GigabitEthernet0/0/1      [up/up]
    FE80::32F7:DFF:FE29:8568
    2001:DB8:1111:12:32F7:DFF:FE29:8568
GigabitEthernet0/0/2      [administratively down/down]
    unassigned
GigabitEthernet0/0/3      [administratively down/down]
    unassigned
```

```
R1# show interfaces g0/0/0
GigabitEthernet0/0/0 is up, line protocol is up
    IPv6 is enabled, link-local address is FE80::11FF:FE11:1111
        No Virtual link-local address(es):
        Global unicast address(es):
            2001:DB8:1111:1:0:11FF:FE11:1111, subnet is 2001:DB8:1111:1::/64 [EUI/TEN]
    ! Lines omitted for brevity
    ! Next command gathered seconds later...
R1# show interfaces g0/0/0
GigabitEthernet0/0/0 is up, line protocol is up
    IPv6 is enabled, link-local address is FE80::11FF:FE11:1111
        No Virtual link-local address(es):
        Global unicast address(es):
            2001:DB8:1111:1:0:11FF:FE11:1111, subnet is 2001:DB8:1111:1::/64 [EUI]
    ! Lines omitted for brevity
```

```
! This interface uses DHCP to learn its IPv6 address
interface GigabitEthernet0/0/0
    ipv6 address dhcp
!
! This interface uses SLAAC to learn its IPv6 address
interface GigabitEthernet0/0/1
    ipv6 address autoconfig
```

```
R1# show ipv6 interface brief
GigabitEthernet0/0/0      [up/up]
  FE80::11FF:FE11:1111
  2001:DB8:1111:1:0:11FF:FE11:1111
GigabitEthernet0/0/1      [up/up]
  FE80::32F7:DFF:FE29:8568
  2001:DB8:1111:12:32F7:DFF:FE29:8568
GigabitEthernet0/0/2      [administratively down/down]
  unassigned
GigabitEthernet0/0/3      [administratively down/down]
  unassigned
```

```
R1# show ipv6 interface GigabitEthernet 0/0/0
GigabitEthernet0/0/0 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::11FF:FE11:1111
    No Virtual link-local address(es):
    Global unicast address(es):
      2001:DB8:1111:1::1, subnet is 2001:DB8:1111:1::/64
    Joined group address(es):
      FF02::1
      FF02::2
      FF02::5
      FF02::6
      FF02::1:FF00:1
      FF02::1:FF11:1111
! Lines omitted for brevity
```

```
R1# show ipv6 interface GigabitEthernet 0/0/0
GigabitEthernet0/0/0 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::11FF:FE11:1111
    No Virtual link-local address(es):
    Global unicast address(es):
      2001:DB8:1111:1::1, subnet is 2001:DB8:1111:1::/64
    Joined group address(es):
      FF02::1
      FF02::2
      FF02::5
      FF02::1:FF00:1
      FF02::1:FF11:1111
! Lines omitted for brevity
```

```
R1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)# interface gigabitEthernet 0/0/0
R1(config-if)# ipv6 address 2001:1:1:1::1/64
R1(config-if)# ipv6 address 2001:1:1:2::99/128 anycast
R1(config-if)# ^Z
R1#

R1# show ipv6 interface g0/0/0
GigabitEthernet0/0/0 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::11FF:FE11:1111
    No Virtual link-local address(es):
    Global unicast address(es):
      2001:1:1:1::1, subnet is 2001:1:1:1::/64
      2001:1:1:2::99, subnet is 2001:1:1:2::99/128 [ANY]
    ! Lines omitted for brevity
R1# show ipv6 interface brief g0/0/0
GigabitEthernet0/0/0 [up/up]
  FE80::11FF:FE11:1111
  2001:1:1:1::1
  2001:1:1:2::99
```

```
R1# show ipv6 neighbors
```

IPv6 Address	Age	Link-layer Addr	State	Interface
2001:DB8:1111:1::a	0	0200.aaaa.aaaa	REACH	Gi0/0/0
2001:DB8:1111:1:9EA:93AC:F7CE:D39F	0	3c8c.f8eb.710d	REACH	Gi0/0/0
2001:DB8:1111:1:706A:5FDF:AA40:E576	16	3c8c.f8eb.710d	STALE	Gi0/0/0
2001:DB8:1111:1:70D0:AE1F:4786:907D	0	80fa.5b04.de8b	STALE	Gi0/0/0
2001:DB8:1111:1:7C6B:7B02:DB5C:873F	16	3c8c.f8eb.710d	STALE	Gi0/0/0
2001:DB8:1111:1:90A1:C742:1B11:6F10	0	00e0.4c68.1f26	STALE	Gi0/0/0
2001:DB8:1111:1:BD2C:9AA4:83E2:6D8F	16	3c8c.f8eb.710d	STALE	Gi0/0/0
FE80::AAAA:AAAA	0	0200.aaaa.aaaa	REACH	Gi0/0/0
FE80::184C:56F9:FD3B:D6E7	0	00e0.4c68.1f26	REACH	Gi0/0/0
FE80::552D:E285:4347:BDED	0	80fa.5b04.de8b	DELAY	Gi0/0/0
FE80::706A:5FDF:AA40:E576	0	3c8c.f8eb.710d	REACH	Gi0/0/0
FE80::FF:FE01:2	0	2436.dad9.9281	REACH	Gi0/0/1
FE80::72EA:1AFF:FE9A:D301	0	70ea.1a9a.d301	REACH	Gi0/0/2

```
C:\Users\Wendell> netsh
netsh> interface ipv6
netsh interface ipv6> show neighbors
Interface 7: En0

Internet Address                               Physical Address   Type
-----
fe80::11ff:fe11:1111                         02-00-11-11-11-11  Reachable (Router)
ff02::1                                         33-33-00-00-00-01  Permanent
ff02::2                                         33-33-00-00-00-02  Permanent
ff02::1:ff11:1111                             33-33-ff-11-11-11  Permanent
! Lines omitted for brevity
! Next line shows a Powershell command

PS C:\Users\Wendell> get-NetNeighbor -AddressFamily IPv6
ifIndex IPAddress                               LinkLayerAddress     State      PolicyStore
----- -----
49      ff02::1:ff11:1111                       33-33-FF-11-11-11  Permanent  ActiveStore
49      fe80::11ff:fe11:1111                     02-00-11-11-11-11  Reachable  ActiveStore
49      ff02::2                                     33-33-00-00-00-02  Permanent  ActiveStore
49      ff02::1                                     33-33-00-00-00-01  Permanent  ActiveStore
! Lines omitted for brevity
```

```
R1# show ipv6 routers
Router FE80::FF:FE01:2 on GigabitEthernet0/0/1, last update 2 min
  Hops 64, Lifetime 1800 sec, AddrFlag=0, OtherFlag=0, MTU=1500
  HomeAgentFlag=0, Preference=Medium
  Reachable time 0 (unspecified), Retransmit time 0 (unspecified)
  Prefix 2001:DB8:1111:12::/64 onlink autoconfig
    Valid lifetime 2592000, preferred lifetime 604800
Router FE80::72EA:1AFF:FE9A:D301 on GigabitEthernet0/0/2, last update 0 min
  Hops 64, Lifetime 1800 sec, AddrFlag=0, OtherFlag=0, MTU=1500
  HomeAgentFlag=0, Preference=Medium
  Reachable time 0 (unspecified), Retransmit time 0 (unspecified)
  Prefix 2001:DB8:1111:13::/64 onlink autoconfig
    Valid lifetime 2592000, preferred lifetime 604800
```

```
Mac% netstat -rnf inet6
default          fe80::11ff:fe11:1111%en8      UGcg        en8
2001:db8:1111:1::/64    link#20                UC          en8
fe80::11ff:fe11:1111%en8  2:0:11:11:11:11   UHLWIir    en8
! Lines omitted for brevity
```

```
Windows PC> netsh
netsh> interface ipv6
netsh interface ipv6> show route

Publish  Type      Met     Prefix          Index  Gateway/Interface Name
-----  -----  -----  -----  -----
No       Manual    256    ::/0            49      fe80::11ff:fe11:1111
No       Manual    256    2001:db8:1111:1::/64  49      Ethernet 6
! Lines omitted for brevity
```

```
interface GigabitEthernet0/0/0
    ipv6 dhcp relay destination 2001:DB8:1111:2::8

R1# show ipv6 interface g0/0/0
GigabitEthernet0/0/0 is up, line protocol is up
    IPv6 is enabled, link-local address is FE80::11FF:FE11:1111
    No Virtual link-local address(es):
    Global unicast address(es):
        2001:DB8:1111:1::1, subnet is 2001:DB8:1111:1::/64
    Joined group address(es):
        FF02::1
        FF02::2
        FF02::5
        FF02::6
        FF02::1:2
        FF02::1:FF00:1
        FF02::1:FF11:1111
! Lines omitted for brevity
```

```
C:\Users\Wendell> netsh
netsh> interface ipv6
netsh interface ipv6> show address

Interface 7: Wi-Fi

          Addr Type  DAD State   Valid Life Pref. Life Address
-----  -----
Temporary Preferred  6d23h57m58s  23h49m3s  2001:db8:1111:1:c1cd:7a44:45a5:58f1
Public     Preferred    infinite   infinite  2001:db8:1111:1:f1f5:5cbb:f395:6c51
Other      Preferred    infinite   infinite  fe80::f1f5:5cbb:f395:6c51%7
```

```
Mac% ifconfig en8
en8: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=6467<RXCSUM,TXCSUM,VLAN_MTU,TSO4,TSO6,CHANNEL_IO,PARTIAL_
CSUM,ZEROINVERT_CSUM>
        ether 00:e0:4c:68:1f:26
        inet6 fe80::184c:56f9:fd3b:d6e7%en8 prefixlen 64 secured scopeid 0x14
        inet6 2001:db8:1111:1:106a:dd3e:8e22:a6fb prefixlen 64 autoconf secured
        inet6 2001:db8:1111:1:ec69:15f9:b4fc:fe2c prefixlen 64 autoconf temporary
        inet 192.168.1.120 netmask 0xffffffff broadcast 192.168.1.120
        nd6 options=201<PERFORMNUD,DAD>
            media: autoselect (1000baseT <full-duplex>)
            status: active
Mac% ifconfig -al inet6
! Only interface en8 shown for brevity
en8: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=6467<RXCSUM,TXCSUM,VLAN_MTU,TSO4,TSO6,CHANNEL_IO,PARTIAL_
CSUM,ZEROINVERT_CSUM>
        inet6 fe80::8ad:f140:a952:9a46%en8 prefixlen 64 secured scopeid 0xc
        inet6 2001:db8:1111:1:106a:dd3e:8e22:a6fb prefixlen 64 autoconf secured
pltime 604654 vftime 2591854
        inet6 2001:db8:1111:1:a968:a6d9:7fbf:38a6 prefixlen 64 autoconf temporary
pltime 85782 vftime 604654
        nd6 options=201<PERFORMNUD,DAD>
```

```

! An IPv6 ping, PC A pings R1's address in the same subnet
Linux_A:$ ping6 2001:db8:1111:1::1
PING 2001:db8:1111:1::1 (2001:db8:1111:1::1) 56 data bytes
64 bytes from 2001:db8:1111:1::1: icmp_seq=1 ttl=64 time=1.26 ms
64 bytes from 2001:db8:1111:1::1: icmp_seq=2 ttl=64 time=1.15 ms
^C
--- 2001:db8:1111:1::1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001 ms
rtt min/avg/max/mdev = 1.156/1.210/1.263/0.062 ms

! An IPv6 ping next, ping of PC B from PC A
Linux_A:$ ping6 2001:db8:1111:2::b
PING 2001:db8:1111:2::b (2001:db8:1111:2::b) 56 data bytes
64 bytes from 2001:db8:1111:2::b: icmp_seq=1 ttl=64 time=2.33 ms
64 bytes from 2001:db8:1111:2::b: icmp_seq=2 ttl=64 time=2.59 ms
64 bytes from 2001:db8:1111:2::b: icmp_seq=3 ttl=64 time=2.03 ms
^C
--- 2001:db8:1111:2::b ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2003 ms
rtt min/avg/max/mdev = 2.039/2.321/2.591/0.225 ms

! An IPv4 ping next, for comparison - ping of PC B from PC A
Linux_A:$ ping 10.1.2.22
PING 10.1.3.22 (10.1.2.22) 56 data bytes
64 bytes from 10.1.2.22: icmp_seq=1 ttl=64 time=2.45 ms
64 bytes from 10.1.2.22: icmp_seq=2 ttl=64 time=2.55 ms
64 bytes from 10.1.2.22: icmp_seq=3 ttl=64 time=2.14 ms
^C
--- 10.1.3.22 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2014 ms
rtt min/avg/max/mdev = 2.04/2.318/2.604/0.224 ms

```

```
Linux_A:$ traceroute6 2001:db8:1111:2::b
traceroute to 2001:db8:1111:2::b (2001:db8:1111:2::b) from 2001:db8:1111:1::a,
  30 hops max, 24 byte packets
1  2001:db8:1111:1::1 (2001:db8:1111:1::1)  0.794 ms  0.648 ms  0.604 ms
2  2001:db8:1111:12::2 (2001:db8:1111:12::2)  1.606 ms  1.49 ms  1.497 ms
3  2001:db8:1111:2::b (2001:db8:1111:2::b)  2.038 ms  1.911 ms  1.899 ms
```

```
R1# ping
Protocol [ip]: ipv6
Target IPv6 address: 2001:db8:1111:2::b
Repeat count [5]:
Datagram size [100]:
Timeout in seconds [2]:
Extended commands? [no]: yes
Source address or interface: GigabitEthernet0/0/0
UDP protocol? [no]:
Verbose? [no]:
Precedence [0]:
DSCP [0]:
Include hop by hop option? [no]:
Include destination option? [no]:
Sweep range of sizes? [no]:
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:1111:2::b, timeout is 2 seconds:
Packet sent with a source address of 2001:DB8:1111:1::1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 0/1/4 ms
R1# traceroute 2001:db8:1111:2::b
Type escape sequence to abort.
Tracing the route to 2001:DB8:1111:2::b

1 2001:DB8:1111:12::2 4 msec 0 msec 0 msec
2 2001:DB8:1111:2::b 0 msec 4 msec 0 msec
```

```
R2# show ipv6 neighbors
```

IPv6 Address	Age	Link-layer Addr	State	Interface
2001:DB8:1111:2::B	0	0200.bbbb.bbbb	STALE	Gi0/0/0
FE80::BBFF:FEBB:BBBB	0	0200.bbbb.bbbb	STALE	Gi0/0/0
FE80::FF:FE01:1	0	2436.dadf.5681	REACH	Gi0/0/1

```
ipv6 unicast-routing
!
! Unused interfaces omitted
!
interface GigabitEthernet0/0/0
  ipv6 address 2001:DB8:1111:1::1/64
!
interface Serial0/0/1
  ipv6 address 2001:db8:1111:12::1/64
!
interface GigabitEthernet0/0/2
  ipv6 address 2001:db8:1111:13::1/64
```

```
R1# show ipv6 route
IPv6 Routing Table - default - 7 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
      B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
      H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
      IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO
      ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
      RL - RPL, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
      OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
      la - LISP alt, lr - LISP site-registrations, ld - LISP dyn-eid
      LA - LISP away, a - Application
C  2001:DB8:1111:1::/64 [0/0]
    via GigabitEthernet0/0/0, directly connected
L  2001:DB8:1111:1::1/128 [0/0]
    via GigabitEthernet0/0/0, receive
C  2001:DB8:1111:12::/64 [0/0]
    via Serial0/0/1, directly connected
L  2001:DB8:1111:12::1/128 [0/0]
    via Serial0/0/1, receive
C  2001:DB8:1111:13::/64 [0/0]
    via GigabitEthernet0/0/2, directly connected
L  2001:DB8:1111:13::1/128 [0/0]
    via GigabitEthernet0/0/2, receive
L  FF00::/8 [0/0]
    via Null0, receive
```

```
R1# show ipv6 route local
! Legend omitted for brevity

L  2001:DB8:1111:1::1/128 [0/0]
    via GigabitEthernet0/0/0, receive
L  2001:DB8:1111:4::1/128 [0/0]
    via Serial0/0/1, receive
L  2001:DB8:1111:5::1/128 [0/0]
    via GigabitEthernet0/0/2, receive
L  FF00::/8 [0/0]
    via Null0, receive
```

```
! Static route on router R1
R1(config)# ipv6 route 2001:db8:1111:2::/64 s0/0/1
```

```
! Static route on router R2
R2(config)# ipv6 route 2001:db8:1111:1::/64 s0/0/0
```

```
R1# show ipv6 route static
! Legend omitted for brevity
S 2001:DB8:1111:2::/64 [1/0]
    via Serial0/0/1, directly connected
```

```
R1# show ipv6 route 2001:db8:1111:2::b
Routing entry for 2001:DB8:1111:2::/64
Known via "static", distance 1, metric 0
Route count is 1/1, share count 0
Routing paths:
    directly connected via Serial0/0/1
Last updated 00:01:29 ago
```

```
!  
R1(config)# ipv6 route 2001:db8:1111:3::/64 2001:DB8:1111:13::3
```

```
R1# show ipv6 route static
! Legend omitted for brevity
S  2001:DB8:1111:3::/64 [1/0]
    via 2001:DB8:1111:13::3

R1# show ipv6 route 2001:db8:1111:3::33
Routing entry for 2001:DB8:1111:3::/64
    Known via "static", distance 1, metric 0
    Route count is 1/1, share count 0
    Routing paths:
        2001:DB8:1111:13::3
            Route metric is 0, traffic share count is 1
            Last updated 00:07:43 ago
```

```
R1# show ipv6 route connected
! Lines omitted to reveal route to the subnet between R1 and R3
C 2001:DB8:1111:13::/64 [0/0]
    via GigabitEthernet0/0/2, directly connected

R1# show ipv6 static detail
IPv6 Static routes Table - default
Codes: * - installed in RIB, u/m - Unicast/Multicast only
Codes for []: P - permanent I - Inactive permanent
U - Per-user Static route
N - ND Static route
M - MIP Static route
P - DHCP-PD Static route
R - RHI Static route
V - VxLan Static route
* 2001:DB8:1111:3::/64 via 2001:DB8:1111:13::3, distance 1
    Resolves to 1 paths (max depth 1)
    via GigabitEthernet0/0/2
```

```
R1# show running-config | include ipv6 route
ipv6 route 2001:DB8:1111:3::/64 GigabitEthernet0/0/2 2001:DB8:1111:13::3

R1# show ipv6 route | section 2001:DB8:1111:3::/64
S 2001:DB8:1111:3::/64 [1/0]
    via 2001:DB8:1111:13::3, GigabitEthernet0/0/2

R1# show ipv6 static detail
! Legend omitted
* 2001:DB8:1111:3::/64 via 2001:DB8:1111:13::3, GigabitEthernet0/0/2, distance 1
```

```
R1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)# ipv6 route 2001:db8:1111:3::/64 fe80::ff:fe01:3
% Interface has to be specified for a link-local nexthop
R1(config)# ipv6 route 2001:db8:1111:3::/64 fe80::ff:fe00:2 g0/0/2
^
% Invalid input detected at '^' marker.

R1(config)# ipv6 route 2001:db8:1111:3::/64 g0/0/2 fe80::ff:fe01:3
R1(config)#^Z
```

```
R1# show ipv6 route static
! Legend omitted for brevity

S  2001:DB8:1111:3::/64 [1/0]
    via FE80::FF:FE00:2, GigabitEthernet0/0/2

R1# show ipv6 route 2001:db8:1111:3::33
Routing entry for 2001:DB8:1111:3::/64
Known via "static", distance 1, metric 0
Route count is 1/1, share count 0
Routing paths:
    FE80::FF:FE00:2, GigabitEthernet0/0/2
        Route metric is 0, traffic share count is 1
        Last updated 00:01:01 ago
```

```
! Forward out R3's G0/0/1 local interface to R1's G0/0/2 LLA FE80::FF:FE02:1.  
R3(config)# ipv6 route ::/0 g0/0/1 fe80::ff:fe02:1
```

```
R3# show ipv6 route
IPv6 Routing Table - default - 6 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
      B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
      I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
      EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination
      NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
      OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
      a - Application, m - OMP

S ::/0 [1/0]
  via FE80::FF:FE02:1, GigabitEthernet0/0/1

C 2001:DB8:1111:3::/64 [0/0]
  via GigabitEthernet0/0/0, directly connected

L 2001:DB8:1111:3::3/128 [0/0]
  via GigabitEthernet0/0/0, receive

C 2001:DB8:1111:13::/64 [0/0]
  via GigabitEthernet0/0/1, directly connected

L 2001:DB8:1111:13::3/128 [0/0]
  via GigabitEthernet0/0/1, receive

L FF00::/8 [0/0]
  via Null0, receive

R3# show ipv6 route ::/0
Routing entry for ::/0
  Known via "static", distance 1, metric 0
  Route count is 1/1, share count 0
  Routing paths:
    FE80::FF:FE02:1, GigabitEthernet0/0/1
      Route metric is 0, traffic share count is 1
      Last updated 00:04:04 ago
```

```
! The first command shows the host route, and the second shows the network route.  
! Both use next-hop GUA and outgoing interface for clarity.  
R1# configure terminal  
Enter configuration commands, one per line. End with CNTL/Z.  
R1(config)# ipv6 route 2001:db8:1111:d::4/128 g0/0/1 2001:db8:1111:12::2  
R1(config)# ipv6 route 2001:db8:1111:d::/64 g0/0/2 2001:db8:1111:13::3  
R1(config)#^Z  
R1#
```

```
R1# show ipv6 route static
! Legend omitted
S  2001:DB8:1111:D::/64 [1/0]
    via 2001:DB8:1111:13::3, GigabitEthernet0/0/2
S  2001:DB8:1111:D::4/128 [1/0]
    via 2001:DB8:1111:12::2, GigabitEthernet0/0/1

R1# show ipv6 route 2001:db8:1111:d::4
Routing entry for 2001:DB8:1111:D::4/128
Known via "static", distance 1, metric 0
Route count is 1/1, share count 0
Routing paths:
2001:DB8:1111:12::2, GigabitEthernet0/0/1
    Route metric is 0, traffic share count is 1
    Last updated 00:02:28 ago

R1# show ipv6 route 2001:db8:1111:d::3
Routing entry for 2001:DB8:1111:D::/64
Known via "static", distance 1, metric 0
Route count is 1/1, share count 0
Routing paths:
2001:DB8:1111:13::3, GigabitEthernet0/0/2
    Route metric is 0, traffic share count is 1
    Last updated 00:00:43 ago
```

```
ipv6 route 2001:DB8:9:33::/64 2001:DB8:9:12::2 ! Step 1: Wrong prefix
ipv6 route 2001:DB8:9:3::/64 FE80::2 ! Step 2A: Missing outgoing interface
ipv6 route 2001:DB8:9:3::/64 G0/0/0 FE80::2 ! Step 2B: Wrong interface on R1
ipv6 route 2001:DB8:9:3::/64 G0/0/1 FE80::1 ! Step 2C: Wrong neighbor link local
ipv6 route 2001:DB8:9:3::/64 2001:DB8:9:12::3 ! Step 3A: Wrong neighbor address
ipv6 route 2001:DB8:9:3::/64 G0/0/1 ! Step 4A: Also needs next-hop
```

```
R1# show running-config
! lines omitted for brevity
interface Serial0/0/0
    ip address 172.16.4.1 255.255.255.0
    clock rate 2000000
!
interface Serial0/0/1
    ip address 172.16.5.1 255.255.255.0
    clock rate 128000

! lines omitted for brevity

R1# show controllers serial 0/0/1
Interface Serial0
Hardware is PowerQUICC MPC860
DCE V.35, clock rate 128000
idb at 0x8169BB20, driver data structure at 0x816A35E4
! Lines omitted for brevity
```

```
R1# show interfaces s0/0/1
Serial0/0/1 is up, line protocol is up
    Hardware is WIC MBRD Serial
    Description: link to R3
    Internet address is 10.1.13.1/24
    MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
        reliability 255/255, txload 1/255, rxload 1/255
    Encapsulation HDLC, loopback not set
```

```
ip dhcp excluded-address 172.16.1.1 172.16.1.50
ip dhcp excluded-address 172.16.2.1 172.16.2.100
!
ip dhcp pool subnet-left
  network 172.16.1.0 255.255.255.0
  dns-server 172.16.1.12
  default-router 172.16.1.1
  lease 0 23 59
  domain-name example.com
  next-server 172.16.2.5
!
ip dhcp pool subnet-right
  network 172.16.2.0 /24
  dns-server 172.16.1.12
  default-router 172.16.2.1
  lease 1 2 3
  next-server 172.16.2.5
```

```
R2# show ip dhcp binding
Bindings from all pools not associated with VRF:
IP address          Client-ID/          Lease expiration      Type
                  Hardware address/
                  User name
172.16.1.51        0063.6973.636f.2d30.   Oct 12 2012 02:56 AM  Automatic
                  3230.302e.3131.3131.
                  2e31.3131.312d.4661.
                  302f.30
172.16.2.101       0063.6973.636f.2d30.   Oct 12 2012 04:59 AM  Automatic
                  3230.302e.3232.3232.
                  2e32.3232.322d.4769.
                  302f.30
R2# show ip dhcp pool subnet-right
Pool subnet-right :
Utilization mark (high/low)    : 100 / 0
Subnet size (first/next)       : 0 / 0
Total addresses                : 254
Leased addresses               : 1
Pending event                  : none
1 subnet is currently in the pool :
Current index     IP address range           Leased addresses
172.16.2.102      172.16.2.1      - 172.16.2.254      1
```

```
R1# show ip interface g0/0
GigabitEthernet0/0 is up, line protocol is up
  Internet address is 182.16.1.1/24
  Broadcast address is 255.255.255.255
  Address determined by non-volatile memory
  MTU is 1500 bytes
  Helper address is 172.16.2.11
! Lines omitted for brevity (about 20 lines)
```

```
*Oct 16 19:28:59.220: %DHCPD-4-DECLINE_CONFLICT: DHCP address conflict: client  
0063.6973.636f.2d30.3230.302e.3034.3034.2e30.3430.342d.4769.302f.30      declined  
172.16.2.102.
```

```
R2# show ip dhcp conflict
```

IP address	Detection method	Detection time	VRF
172.16.2.102	Gratuitous ARP	Oct 16 2012 07:28 PM	

```
R1# show ipv6 route
IPv6 Routing Table - default - 4 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
      B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
      H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
      IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO
      ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
      O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
      ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, la - LISP alt
      lr - LISP site-registrations, ld - LISP dyn-eid, a - Application
ND ::/0 [2/0]
  via FE80::22FF:FE22:2222, Serial0/0/0
NDp 2001:DB8:1:12::/64 [2/0]
  via Serial0/0/0, directly connected
L 2001:DB8:1:12:32F7:DFF:FE29:8560/128 [0/0]
  via Serial0/0/0, receive
! lines omitted for brevity
```

```
SW2# show spanning-tree vlan 20 root
```

Vlan	Root ID	Cost	Time	Age	Dly	Root Port
VLAN0020	32788 1833.9d7b.0e80	4	2	20	15	Gi0/2

```
SW2# show spanning-tree vlan 20
```

VLAN0020

Spanning tree enabled protocol ieee

Root ID Priority 32788

Address 1833.9d7b.0e80

Cost 4

Port 26 (GigabitEthernet0/2)

Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32788 (priority 32768 sys-id-ext 20)

Address 1833.9d7b.1380

Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Aging Time 15 sec

Interface Role Sts Cost Prio.Nbr Type

Gi0/1 Desg FWD 4 128.25 P2p

Gi0/2 Root FWD 4 128.26 P2p

```

SW1# show etherchannel summary
Flags: D - down          P - bundled in port-channel
      I - stand-alone   S - suspended
      H - Hot-standby (LACP only)
      R - Layer3         L - Layer2
      U - in use         F - failed to allocate aggregator

      M - not in use, minimum links not met
      u - unsuitable for bundling
      w - waiting to be aggregated
      d - default port

Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
-----+-----+-----+
1      Po1 (SD)     PAgP        Fa0/14(I)  Fa0/15(I)

SW1# show interfaces status | include Po|14|15
Port      Name          Status       Vlan      Duplex  Speed Type
Fa0/14    connected    301        a-full   a-100  10/100BaseTX
Fa0/15    connected    301        a-full   a-100  10/100BaseTX
Po1       notconnect   unassigned  auto     auto

```

```
SW1# show mac address-table dynamic
```

Mac Address Table

Vlan	Mac Address	Type	Ports
1	0200.AAAA.AAAA	DYNAMIC	Gi0/2
2	0200.BBBB.BBBB	DYNAMIC	Gi0/1

```
SW2# show mac address-table dynamic
```

Mac Address Table

Vlan	Mac Address	Type	Ports
1	0200.AAAA.AAAA	DYNAMIC	Gi0/2
2	0200.BBBB.BBBB	DYNAMIC	Gi0/1

```
SW1# show mac address-table dynamic
```

Mac Address Table

Vlan	Mac Address	Type	Ports
1	0200.AAAA.AAAA	DYNAMIC	Po2
2	0200.BBBB.BBBB	DYNAMIC	Po1

```
SW2# show mac address-table dynamic
```

Mac Address Table

Vlan	Mac Address	Type	Ports
1	0200.AAAA.AAAA	DYNAMIC	Po1
2	0200.BBBB.BBBB	DYNAMIC	Po3

```
Yosemite# configure terminal
Yosemite(config)# interface Fa0/0
Yosemite(config-if)# ip address 10.2.1.1 255.255.255.0
Yosemite(config-if)# interface S0/1
Yosemite(config-if)# ip address 10.1.4.1 255.255.255.252
```

```
Albuquerque# show ip route
! Legend omitted for brevity

  10.0.0.0/8 is variably subnetted, 14 subnets, 3 masks
D      10.2.1.0/24 [90/2172416] via 10.1.4.1, 00:00:34, Serial0/0
D      10.2.2.0/24 [90/2172416] via 10.1.4.1, 00:00:34, Serial0/0
D      10.2.3.0/24 [90/2172416] via 10.1.4.1, 00:00:34, Serial0/0
D      10.2.4.0/24 [90/2172416] via 10.1.4.1, 00:00:34, Serial0/0
D      10.3.4.0/24 [90/2172416] via 10.1.6.2, 00:00:56, Serial0/1
D      10.3.5.0/24 [90/2172416] via 10.1.6.2, 00:00:56, Serial0/1
D      10.3.6.0/24 [90/2172416] via 10.1.6.2, 00:00:56, Serial0/1
D      10.3.7.0/24 [90/2172416] via 10.1.6.2, 00:00:56, Serial0/1
C      10.1.1.0/24 is directly connected, FastEthernet0/0
L      10.1.1.1/32 is directly connected, FastEthernet0/0
C      10.1.6.0/30 is directly connected, Serial0/1
L      10.1.6.1/32 is directly connected, Serial0/1
C      10.1.4.0/30 is directly connected, Serial0/0
L      10.1.4.1/32 is directly connected, Serial0/0
```