Router

- A router provides connectivity between different IP subnets
- An IP address must be configured on the interfaces in each subnet

interface FastEthernet0/0
ip address 192.168.0.1 255.255.255.0
no shutdown

interface FastEthernet0/1
ip address 192.168.1.1 255.255.255.0
no shutdown

show ip route - in order to see the routing table of a Router

Switch

- A Layer 2 Switch is not IP routing aware.
- It does however support a single IP address for management.
- The IP address and subnet mask is configured on the Switched Virtual Interface (SVI) for the default VLAN 1
- A default gateway also needs to be configured to allow connectivity to other subnets

Switch(config)# interface vlan 1
Switch(config-if)# ip address 192.168.0.10 255.255.255.0
Switch(config-if)# no shutdown
Switch(config-if)# exit
Switch(config)# ip default-gateway 192.168.0.1

Hostname
A descriptive hostname makes it easier to identify the device.
Eg. NY-F1-SW1

Switch(config)# hostname SW1
SW1(config)#

Interface descriptions can aid troubleshooting

SW1(config)# interface FastEthernet 0/1
SW1(config-if)# description Link to R1

Router & Switch

- Interface speed and duplex is set to ‘auto’ by default
- Both sides of a link should auto-negotiate to full duplex and the fastest available speed
- Best practice is to manually set the speed and duplex on ports which are connected to another network infrastructure device or server
- It is very important to set matching speed and duplex settings on both sides of the link

SW1(config)# interface FastEthernet 0/1
SW1(config-if)# duplex full
SW1(config-if)# speed 100

SW1# show running-config
SW1# show ip interface brief
SW1# show run interface vlan 1
SW1# show interface vlan 1
SW1# show version

CDP Cisco Discovery Protocol

- Cisco Discovery Protocol (CDP) is a Cisco proprietary Layer 2 protocol.
- It is used to share information with other directly connected Cisco equipment, such as the operating system version and IP address.
- This aids in troubleshooting by allowing administrators to map out how Cisco devices are connected to each other.
- It is enabled by default on most Cisco equipment.

- It works at Layer 2 so it is not necessary for the device to have an IP address.

Switch(config)# cdp run
Switch(config)# no cdp run
Switch(config-if)# no cdp enable
Switch# show cdp
Switch# show cdp neighbors
Switch# show cdp neighbors detail

LLDP Link Layer Discovery Protocol

LLDP (Link Layer Discovery Protocol) is an open standard protocol which provides similar information to CDP.
Differences with CDP:

- Depending on the switch and version it may be disabled by default
- It is only supported on physical interfaces
- It can only discover up to one device per port
- It can discover Linux servers

Switch(config)# lldp run
Switch(config)# no lldp run
Switch(config-if)# no lldp transmit
Switch(config-if)# no lldp receive
Switch# show lldp
Switch# show lldp neighbors
Switch# show lldp neighbors detail

Cisco Device Memory

Cisco routers and switches have 4 built-in memory locations:

- ROM – Read Only Memory
- Flash – newer devices use removable CompactFlash
- NVRAM – Non-Volatile RAM
- RAM – Random Access Memory
- An external USB device can also be used

Factory Reset

To factory reset a router or switch: *write erase*

This will erase the startup-config
Reload to boot up with a blank configuration
The Setup Wizard will run

The Config Register

- The configuration register can be used to change the way the router
- boots
- Use the *config-register* command in global configuration mode or *confreg* at the rommon prompt
- Eg *config-register 0x2142*

- 0x2102: boot normally (default)
- 0x2120: boot into rommon
- 0x2142: ignore contents of NVRAM (startup-config)

Router Password Recovery Procedure

- Press the break sequence (Ctrl-Break) at power on to break into rommon prompt
- *confreg 0x2142* to ignore the startup-config on boot
- The startup-config is still there with the full configuration including the unknown enable secret, but the router does not use it when it boots
- *reset* to reload
- The router will bootup with no configuration. Type no to bypass the setup wizard
- Enter enable mode. You will not be prompted for the enable secret as it is not in the running configuration
- Copy the startup config to the running config
- This will copy the entire previous configuration into the running config including the unknown enable secret. You are already in enable mode so you do not need to know what it is.
- Enter a new *enable secret* in global configuration mode to overwrite the old one. This will go into the running config

- *config-register 0x2102* so the router will boot normally on the next restart
- *copy run start* to save the configuration. This will merge the new enable password into the existing startup-config

Backing up the System Image and Config

- Copies of the device's IOS system image and configuration can be saved to Flash, FTP, TFTP or USB
- If you copy a config file into the running-config, it will be merged with the current configuration
- To replace a configuration, factory reset and then copy the new configuration into the startup-config

copy flash tftp
copy running-config tftp
copy startup-config usb

Upgrading the IOS System Image

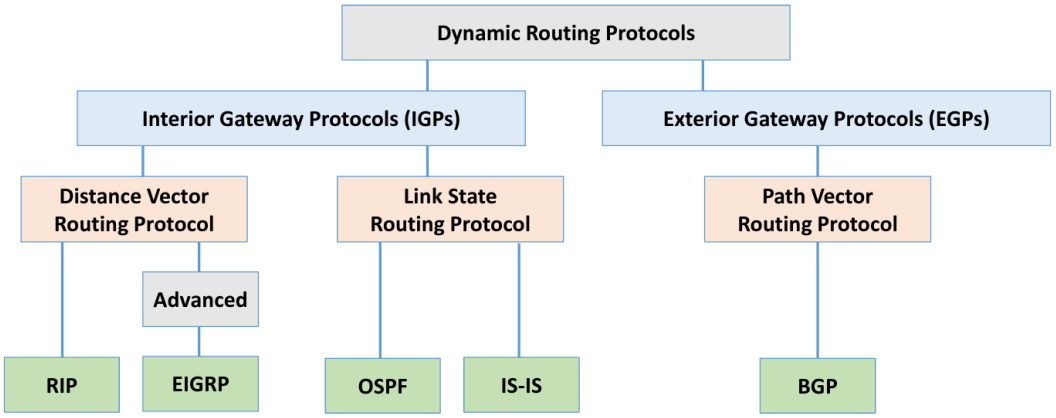
- IOS software images can be downloaded from: https://software.cisco.com/
- After downloading the software, copy to the device's Flash using TFTP: *copy tftp flash*
- Delete the old system image or use the *boot system* command

Static Routers - Routers

ip route 10.0.1.0 255.255.255.0 10.0.0.1

Default gateway - *ip route 0.0.0.0 0.0.0.0 ADDRESS*

Dynamic Routing Protocols Types



RIP: Routing Information Protocol
EIGRP: Enhanced Interior Gateway Routing Protocol
OSPF: Open Shortest Path First
IS-IS: Intermediate System – Intermediate System
BGP: Border Gateway Protocol

FLACKBOX
www.flackbox.com

Routing protocols can be split into two main types:

1. Interior gateway protocols (IGPs)
2. Exterior gateway protocols (EGPs)

Interior gateway protocols are used for routing within an organisation
Exterior gateway protocols are used for routing between organisations over the Internet
The only EGP in use today is BGP (Border Gateway Protocol)

Interior gateway protocols can be split into two main types:

1. Distance Vector routing protocols
2. Link State routing protocols

Distance Vector Routing Protocol

- In Distance Vector protocols, each router sends its directly connected neighbours a list of all its known networks along with its own distance to each of those networks
- Distance vector routing protocols do not advertise the entire network topology
- A router only knows its directly connected neighbours and the lists of networks those neighbours have advertised. It doesn't have detailed topology information beyond its directly connected neighbours
- Distance Vector routing protocols are often called 'Routing by rumour'

Link State Routing Protocol

- In Link State routing protocols, each router describes itself and its interfaces to its directly connected neighbours
- This information is passed unchanged from one router to another
- Every router learns the full picture of the network including every router, its interfaces and what they connect to

Command to check Ip protocol in use for a router: *show ip protocols*

Rip

- The Routing Information Protocol (RIP) is a Distance Vector routing protocol
- It uses hop count as its metric
- The maximum hop count is 15
- It will perform Equal Cost Multi Path, for up to 4 paths by default

router rip
version 2
no auto-summary
network 10.0.0.0
The 'network' command should reference a classful network. No subnet mask is specified

To watch live and debug use: *debug ip rip*

To find rip config:
show run | section rip
show run | begin rip

To show the info Rip has found:
sh ip rip database

RIP will automatically summarise routes to the classful boundary by default

For example, 192.168.10.1/30 will be advertised as 192.168.10.0/24
172.16.10.1/30 will be advertised as 172.16.0.0/16
This is almost never desirable

So:
R1(config)#router rip
R1(config-router)#no auto-summary

Manual summarisation gives you control of exactly how you summarise
The individual summarised routes are not advertised - only their summary route
R2(config-router)# interface f1/0
R2(config-if)# ip summary-address rip 10.0.0.0 255.255.0.0

Default Route Injection (no need to manually set default route on each of the routers)

In our example R4 is connected to the Internet
R4(config)#ip route 0.0.0.0 0.0.0.0 203.0.113.2
R4(config)#router rip
R4(config-router)#default-information originate

EIGRP

- EIGRP (Enhanced Interior Gateway Routing Protocol) is an Advanced Distance Vector routing protocol
- It supports large networks
- It has very fast convergence time
- It supports bounded updates where network topology change updates are only sent to routers affected by the change
- Messages are sent using multicast
- EIGRP will automatically perform equal cost load balancing on up to 4 paths by default
- This can be increased up to 16 paths
- EIGRP can also be configured to perform unequal cost load balancing

R1(config)#router eigrp 100

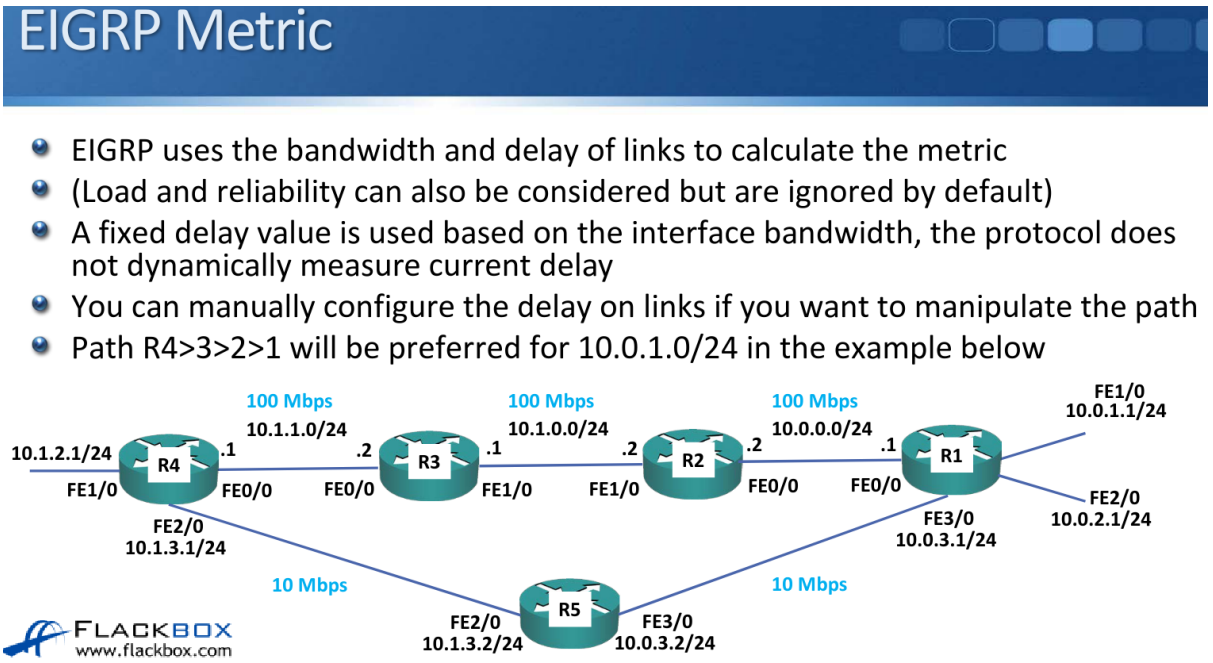
'100' in this example is the Autonomous System (AS), meaning an independent administrative domain. EIGRP routers need to have the same Autonomous System number to peer with each other.

R1(config)#router eigrp 100
R1(config-router)#network 10.0.0.0 0.0.255.255

- EIGRP routers identify themselves using an EIGRP Router ID which is in the form of an IP address.
- This will default to being the highest IP address of any loopback interfaces configured on the router, or the highest other IP address if a loopback does not exist.
- Loopback interfaces never go down so the Router ID will not change.
- You can also manually specify the Router ID.
- Best practice is to use a Loopback or manually set the Router ID

R1(config-router)#eigrp router-id 2.2.2.2

EIGRP Verification:
R1#show run | section eigrp
R1#show ip eigrp interfaces
R2#show ip eigrp neighbors



OSPF

R1(config)#router ospf 1
R1(config-router)# network 10.0.0.0 0.0.255.255 area 0
The network command means:

- Look for interfaces with an IP address which falls within this range.

- Enable OSPF on those interfaces – send out and listen for OSPF hello messages, and peer with adjacent OSPF routers.
- Advertise the network and mask which is configured on those interfaces.

OSPF Verification – show run | section ospf
R1#sh run | section ospf
R1#show ip protocols

OSPF Verification – show ip ospf interface brief
R2#show ip ospf interface brief

OSPF Verification - show ip ospf neighbor
R2#show ip ospf neighbor

OSPF Verification - show ip ospf database
R2#show ip ospf database

OSPF Verification - show ip route
R2#show ip route

OSPF Router ID
- OSPF routers identify themselves using an OSPF Router ID which is in the form of an IP address.
- This will default to being the highest IP address of any loopback interfaces configured on the router, or the highest other IP address if a loopback does not exist.
- Loopback interfaces never go down so the Router ID will not change.
- You can also manually specify the Router ID.
- Best practice is to use a Loopback or manually set the Router ID.

Router ID manual config

R1(config-router)#router ospf 1
R1(config-router)#router-id 2.2.2.2
% OSPF: Reload or use "clear ip ospf process" command, for this to take effect
R1#clear ip ospf process
R1#show ip protocols

Passive interface config
R1(config)#router ospf 1
R1(config-router)#passive-interface loopback 0

R1(config-router)#passive-interface f2/0
OR
R1(config)#router ospf 1
R1(config-router)#passive-interface default
R1(config-router)#no passive-interface f0/0
R1(config-router)#no passive-interface f1/0
R1(config-router)#no passive-interface f3/0

Default Route Injection
R4(config)#ip route 0.0.0.0 0.0.0.0 203.0.113.2
R4(config)#router ospf 1
R4(config-router)#default-information originate

Bandwidth vs Speed/Clock

- The 'bandwidth' setting on an interface does not affect the physical transmission rate – that is set by the 'speed' or 'clock rate'
- If you set a bandwidth of 50 Mbps on a FastEthernet interface, it will still transmit at 100 Mbps

OSPF Cost

- The cost is automatically derived from the interface bandwidth
- Cost = Reference Bandwidth / Interface Bandwidth
- The default reference bandwidth is 100 Mbps
- FastEthernet link cost defaults to 1 (100 / 100)
- T1 link cost defaults to 64 (100 / 1.544)

OSPF treats all interfaces of 100 Mbps or faster as equal
FastEthernet, Gigabit Ethernet, 10 Gigabit Ethernet etc. all default to a cost of 1
This can cause undesirable routing in modern networks

R1(config)#router ospf 1
R1(config-router)#auto-cost reference-bandwidth 100000 (100Gbps)

Manipulating the OSPF Metric (Cont.)

- If you want to use a different path, you can manipulate this by manually changing the bandwidth or OSPF cost on interfaces

- It is recommended to use cost because the bandwidth setting can affect many features other than OSPF (such as QoS)

OSPF Metric - Bandwidth

R1#show interface serial1/0
Serial1/0 is administratively down, line protocol is down
Hardware is M4T
MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
reliability 255/255, txload 1/255, rxload 1/255
!
R1(config)#interface serial1/0
R1(config-if)#bandwidth 768
!
R1#show interface serial1/0
Serial1/0 is administratively down, line protocol is down
Hardware is M4T
MTU 1500 bytes, BW 768 Kbit/sec, DLY 20000 usec,
reliability 255/255, txload 1/255, rxload 1/255

OSPF Metric - Cost

A manually configured OSPF cost overrides the value
automatically derived from the bandwidth

R1(config)#interface FastEthernet 0/0
R1(config-if)#ip ospf cost 50

R1#show ip ospf interface FastEthernet 0/0

DR and BDR

- A DR Designated Router and BDR Backup Designated Router are elected
- The router with the highest priority becomes DR, and the router with the 2nd highest priority becomes BDR
- Default priority is 1, the higher the better (0 - 255)
- Highest Router ID is used in case of a tie
- On multiaccess segments such as Ethernet, the routers elect the DR and BDR at the 2-Way stage
- There is no election on point to point links

R1(config)#interface FastEthernet 0/0
R1(config-if)#ip ospf priority 100
R4(config)#interface FastEthernet 0/0
R4(config-if)#ip ospf priority 0

R4#clear ip ospf process

OSPF Router Types - ABRs
An ABR has the following characteristics:

- It separates LSA flooding zones.
- It becomes the primary point for area address summarization.
- It functions regularly as the source for default routes.
- It maintains the LSDB for each area with which it is connected.
- The ideal design is to have each ABR connected to two areas only, the backbone and another area, with three areas being the upper limit

R2(config)#router ospf 1
R2(config-router)#network 10.1.0.0 0.0.255.255 area 0
R2(config-router)#network 10.0.0.0 0.0.255.255 area 1
R2(config-router)#area 0 range 10.1.0.0 255.255.0.0
R2(config-router)#area 1 range 10.0.0.0 255.255.0.0

Loopbacks

config t
interface loopback 0

Passive Interface

The passive-interface command has the same effect on our routing protocols which is to prevent routing updates.

For OSPF and EIGRP, the command stops hello packets from being sent. Therefore, it will not discover any neighbors which results in prevention of routing updates, both outgoing and incoming.

For RIP, the command will disable the interface from sending multicast updates. However, it is still able to receive incoming updates.

router rip
passive-interface f0/0
network 203.0.113.0

Troubleshoot

1. **Layer 1**
    - ***a.*** *Show ip interface brief*
    - ***b.*** *Show interface*
2. **Layer 2**
    - *a.* *Show arp*
    - *b.* *Show mac address-table*
3. **Layer 4**
    - *a.* *Telnet*
4. **Dns**
    - *a.* *nslookup*
    - *b.* *Ping by FQDN*