
Networkforyou
Welcome
To
Network for you
Introduction to
Routing Protocol
Networkforyou

Introduction to Routing Protocol:

Before routing protocol let see Routed Protocols.

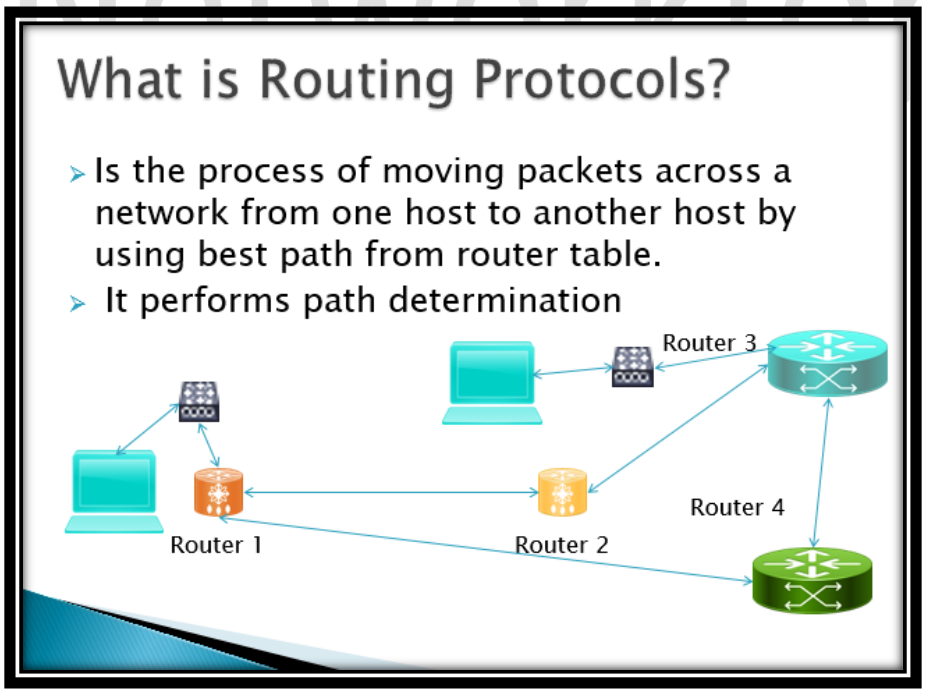
Routed Protocols:

- Routed Protocols are the actual data that is transferred from router to router.
- Like IP V4 and IP V6 is example for Routed protocols.
- Routed Protocol is used to send user data from one network to another network.
- Routed Protocol carries user traffic such as file transfers, emails or web traffic etc.
- It used between router to direct user traffic and it is also known as Network Protocols.

Routing: Forwarding of Packet from one network to another network.

Routing Protocols:

- Routing Protocols are used by routers to exchange information about known networks.
- Routers will initially only know the existence of directly connected or attached networks.
- With the use of routing protocols routers learn different network information from different router and make communication with them.

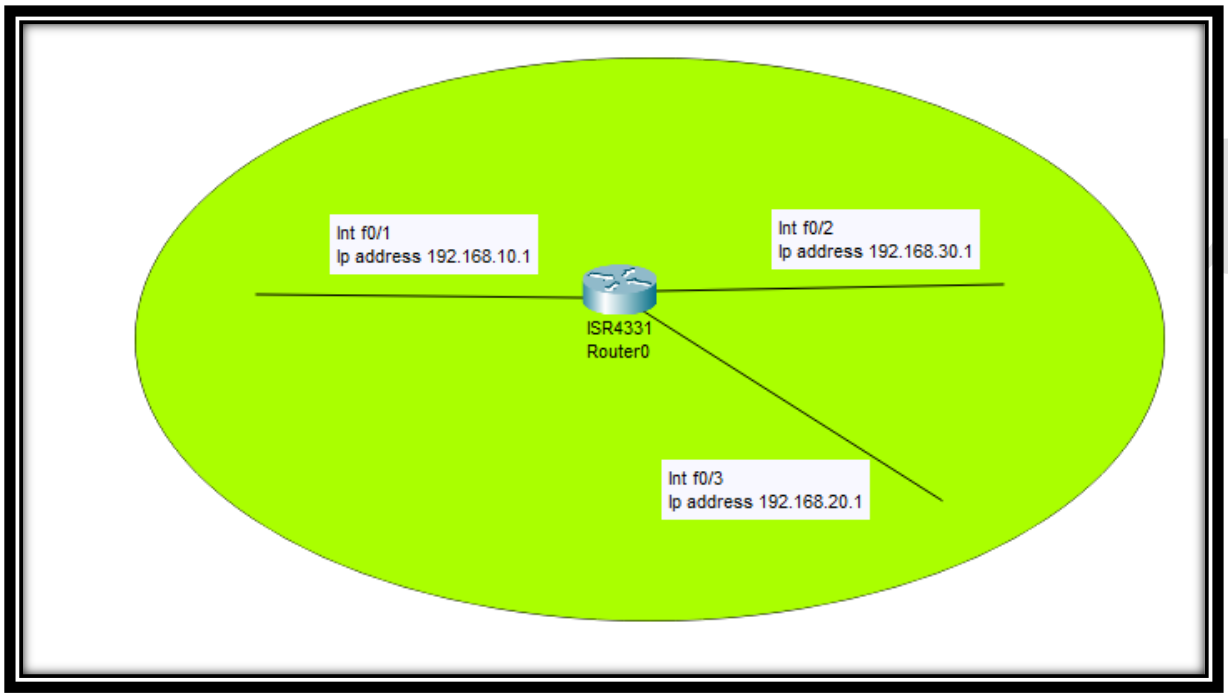


Routed Protocol	Routing Protocols
IP, IPV4, IPV6	RIP V1, RIPV2, OSPF, EIGRP, BGP, ISIS

A Router has two main functions

1. Determining the best path to available networks
2. Forwarding traffic to those networks.

- The best available path to a destination network is listed in a router's routing table and will be used for forwarding traffic.
- A routing table consists of directly connected networks and router configured statically by the administrator or dynamically learned through a routing protocol.
- The first thing we do in router is configures IP address on the routers interfaces.



Interface FastEthernet 0/1
Ip address 192.168.10.1 255.255.255.0

Interface FastEthernet 0/2
Ip address 192.168.30.1 255.255.255.0

Interface FastEthernet 0/3
Ip address 192.168.20.1 255.255.255.0

- When we do IP address configure on interfaces it will automatically add route to corresponding path in the routing table. I.e. connected routes into the routing table.
- Because we configure that ip address to that interfaces so router know that this ip 192.168.10.1 /24 is connected to fastethernet 0/1
- We can see that by sh ip route command.

Example:
Router # sh ip route
C 192.168.10.0 /24 is directly connected, FastEthernet 0/1
C 192.168.30.0 /24 is directly connected, FastEthernet 0/2
C 192.168.20.0 /24 is directly connected, FastEthernet 0/3

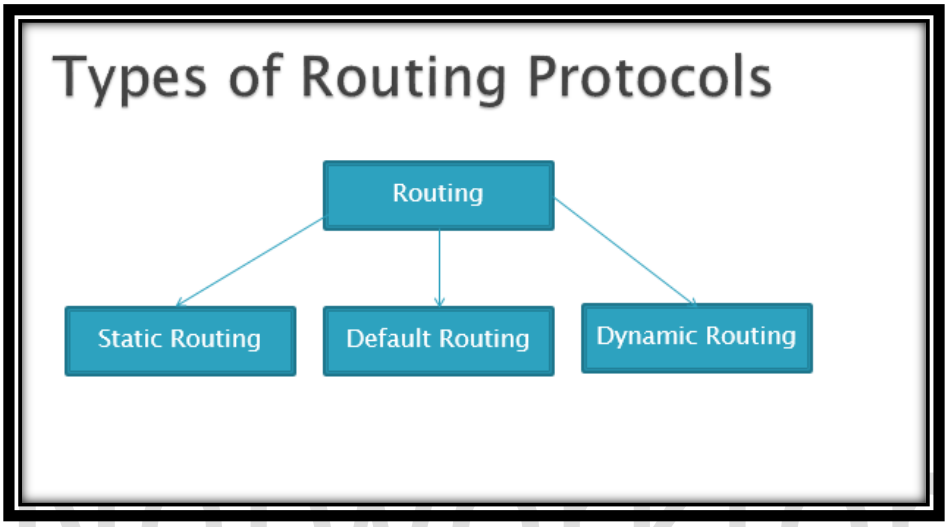
- If any traffic for the 192.168.10.0/24 network is received in another interface on the router, it will forward it out interface FastEthernet 0/1.
- As soon as we configure IP address on interface router start routing traffic for this interfaces as it is directly connected.
- From IOS 15 onwards, Local routes will also be added to the routing table
- Local routes always have a /32 mask and show the IP address configured on the interface.
- We can see that by sh ip route.

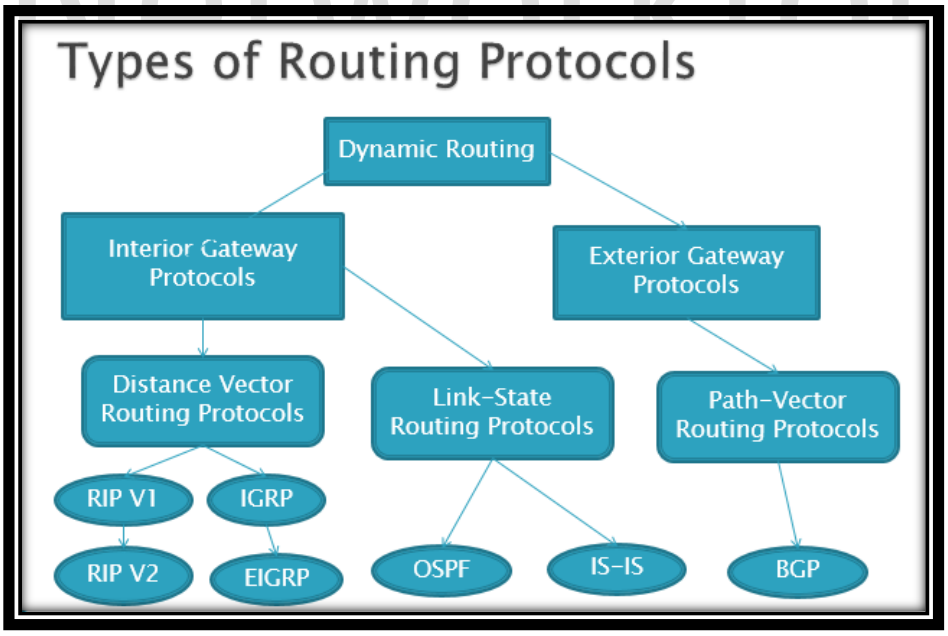
Example:
Router# sh ip route
L 192.168.10.1 /32 is directly connected, FastEthernet 0/1
L 192.168.30.1 /32 is directly connected, FastEthernet 0/2
L 192.168.20.1 /32 is directly connected, FastEthernet 0/3

If we want to trace route then we can use traceroute 192.168.10.1

Type of Routing:

1. Static Routing.
2. Default Routing
3. Dynamic Routing.





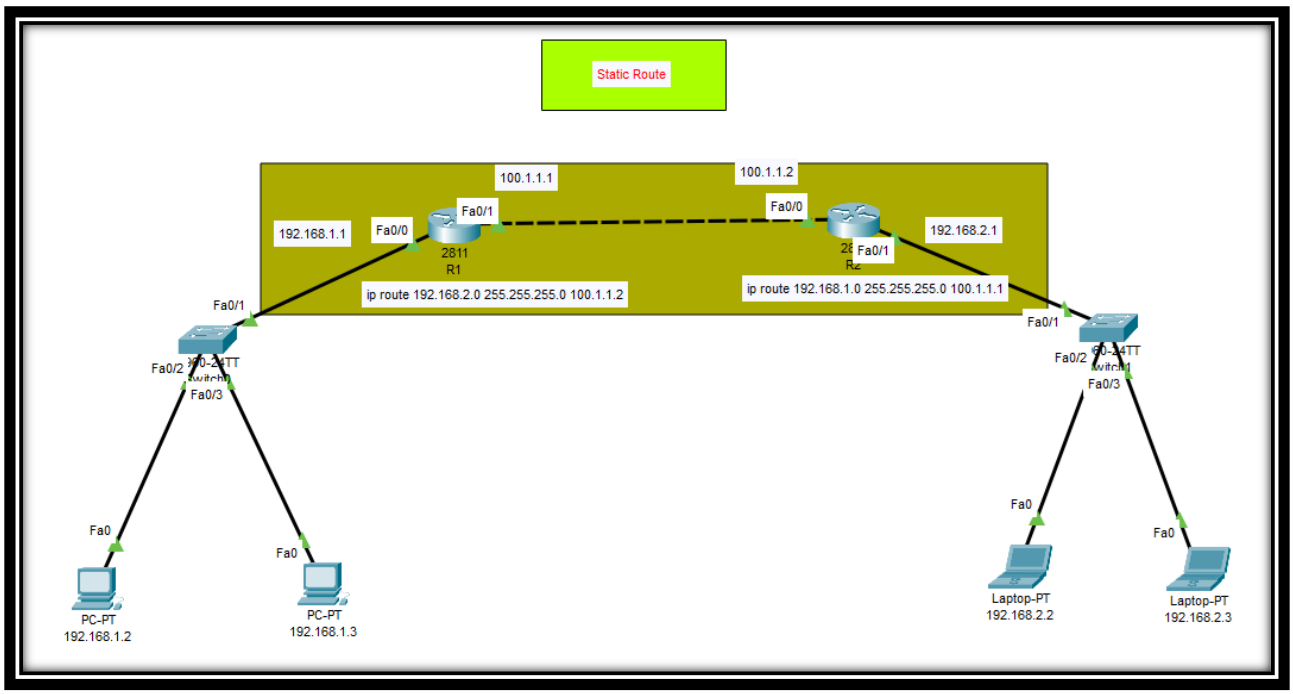
Static Routing:

- It is configured by administrator manually.
- It is secure and fast.
- In this we should know destination Network ID.
- Generally it use in small organizations with a network of 10-15 routers.
- Administrative Distance (AD) value 1.
- Static routing not able to support VLSM it is only support class full Network.

Configuration of Static Route:

Router(config)# ip route <Destination Network ID> <Destination Subnet Mask> <Next-hop IP address >

Lab 1 on Static Routing:



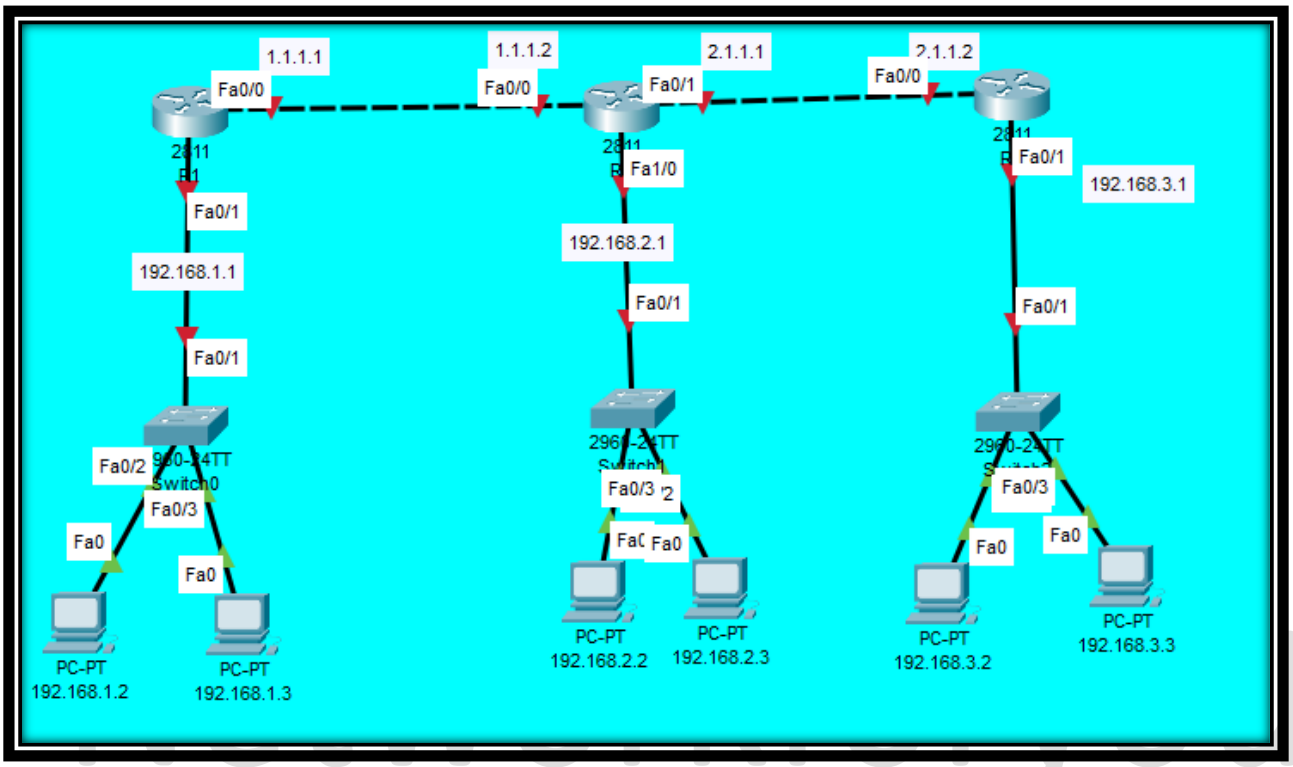
For R1:

ip route 192.168.2.0 255.255.255.0 100.1.1.2

For R2:

ip route 192.168.1.0 255.255.255.0 100.1.1.1

Lab 2 on Static Routing:



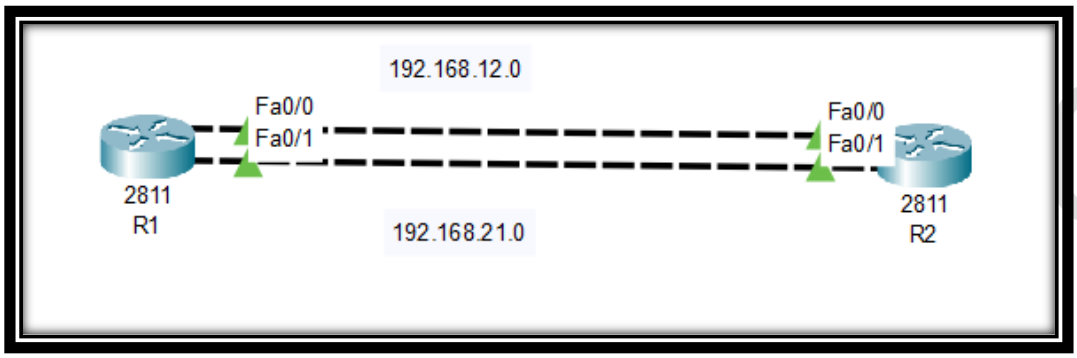
Configuration:

Router R1 Configuration	Router R2 Configuration	Router R3Configuration
En Config t Hostname R1 Int f0/0 Ip add 1.1.1.1 255.0.0.0 No sh Int f0/1 Ip add 192.168.1.1 255.255.255.0 No sh Ip route 2.0.0.0 255.0.0.0 1.1.1.2 Ip route 192.168.2.0	En Config t Hostname R2 Int f0/0 Ip add 1.1.1.2 255.0.0.0 No sh Int f1/0 Ip add 192.168.2.1 255.255.255.0 No sh Int f0/1 Ip add 2.1.1.1 255.0.0.0	En Config t Hostname R3 Int f0/0 Ip add 2.1.1.2 255.0.0.0 No sh Int f0/1 Ip add 192.168.3.1 255.255.255.0 No sh Ip route 1.0.0.0 255.0.0.0 2.1.1.1 Ip route 192.168.2.0

255.255.255.0 1.1.1.2 Ip route 192.168.3.0 255.255.255.0 1.1.1.2	No sh Ip route 192.168.3.0 255.255.255.0 2.1.1.2 Ip route 192.168.1.0 255.255.255.0 1.1.1.1	255.255.255.0 2.1.1.1 Ip route 192.168.1.0 255.255.255.0 2.1.1.1

Floating Static Routes:

- If we want to use a static route as a backup route, we have to change its AD value.
- To make static route as a backup route and it is knows as floating static route.
- Floating static routes are used for redundancy in-case an interface fails.
- A Floating static route is a route that has a higher administrative distance then the current route in a routing table.
- Think of how a router works for a second; The routes that have a lower administrative distance number will be the ones installed into the routing table whereas higher AD numbers will not.



R1 configuration	R2 Configuration
en config t hostname R1 int f0/0 ip add 192.168.12.1 255.255.255.0 no sh int f0/1 ip add 192.168.21.1 255.255.255.0 no sh ip route 8.0.0.0 255.0.0.0 192.168.12.2 130	en config t hostname R2 int f0/0 ip add 192.168.12.2 255.255.255.0 no sh int f0/1 ip add 192.168.21.2 255.255.255.0 no sh int lo 0

ip route 8.0.0.0 255.0.0.0 192.168.21.2 130 Router rip version 2 no auto-summary network 192.168.12.0	ip add 8.8.8.8 255.0.0.0 Router rip version 2 no auto-summary network 192.168.12.0 network 8.0.0.0

```
R1#sh ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

R    8.0.0.0/8 [120/1] via 192.168.12.2, 00:00:04, FastEthernet0/0
C    192.168.12.0/24 is directly connected, FastEthernet0/0
C    192.168.21.0/24 is directly connected, FastEthernet0/1
```



```
R1(config)#int f0/0
R1(config-if)#sh

R1(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to administratively down

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

R1(config-if)#do sh ip ro
R1(config-if)#do sh ip ro
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

S    8.0.0.0/8 [130/0] via 192.168.21.2
C    192.168.21.0/24 is directly connected, FastEthernet0/1
```

Default Routing:

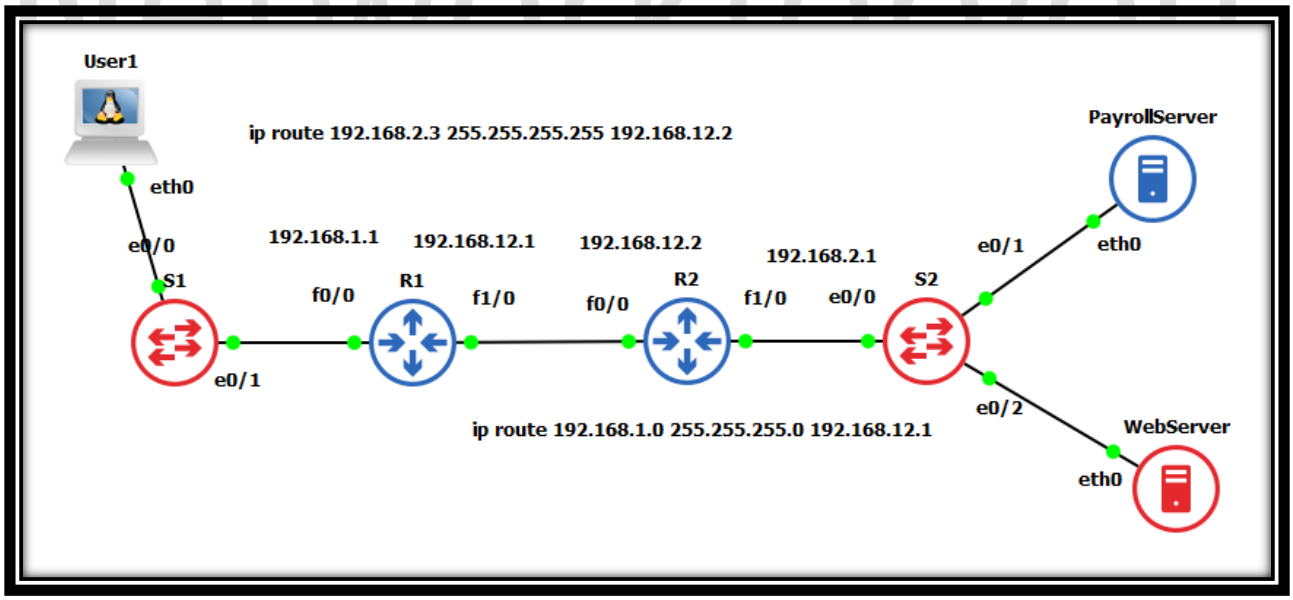
- It is manually configure single route for the entire destination.
- Default route is use to go Internet.
- Default route is use for unknown destination.
- Default routing last preferred route in the routing table.
- When there is no entry for the destination network in routing table then router will forward the traffic to it default route.
- Default route help to reduce the routing table size.
- A Default Route also known as the gateway of last resort and it is a special type of static route.

Configuration for Default Route:

R1(config)# ip route 0.0.0.0 0.0.0.0 <Next-hop IP address>

Host Route:

- It is where destination address is specific devices IP with a subnet mask of /32 for IPV4 and /128 for IPV6.
- A host route is used to route traffic to a specific host.



R1 Configuration	R2 Configuration
en config t hostname R1 int f0/0 ip add 192.168.1.1 255.255.255.0 no sh int f1/0 ip add 192.168.12.1 255.255.255.0 no sh ip route 192.168.2.3 255.255.255.255 192.168.12.2	en config t hostname R2 int f0/0 ip add 192.168.12.2 255.255.255.0 no sh int f1/0 ip add 192.168.2.1 255.255.255.0 no sh ip route 192.168.1.0 255.255.255.0 192.168.12.1

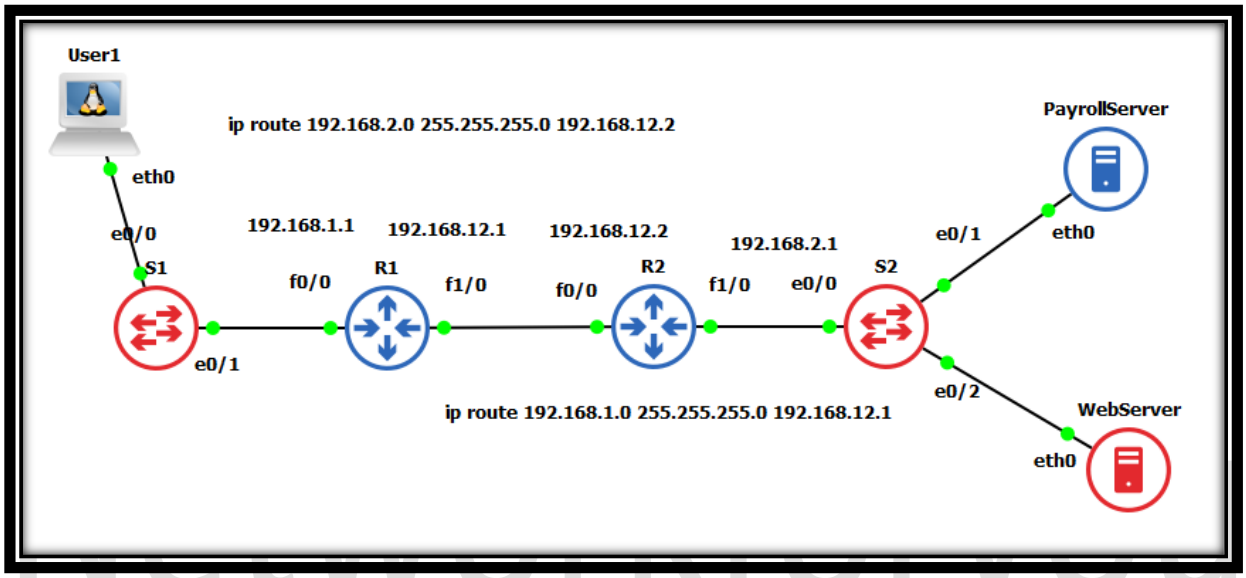
```
R1#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - 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

Gateway of last resort is not set

C    192.168.12.0/24 is directly connected, FastEthernet1/0
C    192.168.1.0/24 is directly connected, FastEthernet0/0
     192.168.2.0/32 is subnetted, 1 subnets
S       192.168.2.3 [1/0] via 192.168.12.2
```

```
root@User1:~# ping 192.168.2.2
PING 192.168.2.2 (192.168.2.2) 56(84) bytes of data.
From 192.168.1.1 icmp_seq=1 Destination Host Unreachable
From 192.168.1.1 icmp_seq=2 Destination Host Unreachable
From 192.168.1.1 icmp_seq=3 Destination Host Unreachable
From 192.168.1.1 icmp_seq=4 Destination Host Unreachable
^Z
[3]+  Stopped                 ping 192.168.2.2
root@User1:~# ping 192.168.2.3
PING 192.168.2.3 (192.168.2.3) 56(84) bytes of data.
64 bytes from 192.168.2.3: icmp_seq=1 ttl=62 time=37.1 ms
64 bytes from 192.168.2.3: icmp_seq=2 ttl=62 time=42.9 ms
64 bytes from 192.168.2.3: icmp_seq=3 ttl=62 time=45.7 ms
64 bytes from 192.168.2.3: icmp_seq=4 ttl=62 time=45.0 ms
```

Network Route:

- If we want to allow all networks we can use this route.
- It is opposite of Host route.

Network Route Lab:



R1 Configuration	R2 Configuration
en config t hostname R1 int f0/0 ip add 192.168.1.1 255.255.255.0 no sh int f1/0 ip add 192.168.12.1 255.255.255.0 no sh ip route 192.168.2.0 255.255.255.0 192.168.12.2	en config t hostname R2 int f0/0 ip add 192.168.12.2 255.255.255.0 no sh int f1/0 ip add 192.168.2.1 255.255.255.0 no sh ip route 192.168.1.0 255.255.255.0 192.168.12.1

```
R1#sh ip route
Codes: 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

Gateway of last resort is not set

C    192.168.12.0/24 is directly connected, FastEthernet1/0
C    192.168.1.0/24 is directly connected, FastEthernet0/0
S    192.168.2.0/24 [1/0] via 192.168.12.2
```

Dynamic Routing Protocols:

- When a routing protocol is used, routers automatically advertise their best paths to known networks to each other
- Router uses this information to calculate their own best path to the known destinations.
- When any state of the network changes or update or any link going down or new subnet is add the routers update each other.
- Router will automatically calculate a new best path and update the routing table if the network changes.
- The routers automatically advertise available subnets to each other without the administrator having to manually enter every route on every router.
- If a subnet is added or removed the routers will automatically discover that and update their routing tables.
- If the best path to a subnet goes down routers automatically discover that and will calculate a new path if one is available.

Routing Protocol Types:

- Interior gateway protocols (IGPs).
- Exterior gateway protocols (EGPs).
- IGPs are used for routing traffic within an organization (within company).
- EGPs are used for routing traffic between organizations over the Internet. (Out the company)
- The only EGP in use today is BGP (Border Gateway Protocol).

Interior gateway protocols can be dividing into two main types:

- Distance Vector routing protocols.
- Link State Routing Protocols.

Distance Vector routing protocols:

- Distance vector routing protocols works with Bellman Ford algorithm.
- Distance vector routing protocols periodic updates.
- It is Class full routing protocol.
- Full Routing tables are exchanged.
- Updates are through broadcast.

Example: RIP 1, RIP 2.

Link State Routing Protocols:

- Link State routing protocols works with Dijkstra algorithm
- Link State routing protocols updates links state
- It is Class Less routing protocol
- It will exchange only missing routes
- Updates are through multicast

Example: OSPF, ISIS

- **All of the IGPs do the same Job, which is to advertise routes within an organization and determine the best paths**
- An organization will typically pick one of the IGPs.
- If an organization has multiple IGPs in effect, information can be redistributed between them.
- A router may receive multiple possible paths to get to a destination network only the best path will make into the routing table & be used.

The different IGPs use different methods to calculate the best path to destination network.

Metric:

- Each possible path will be assigned a 'Metric' value by the routing protocol which indicates how preferred the path is.
- The lowest metric value is preferred
- Distance vector routers advertise to each other the networks they know about, and their metric to get to each of them.
- Link state Routers advertises all the links in their area of the network to each other.
- Each router will take this information and then make an independent calculation of its own best path to get to each destination.
- If the best path to a destination is lost it will be removed from the routing table and replaced with the next best route.
- RIP uses Hop count as the Metric.

- The Maximum hop count by default is 15. Paths which are more than 15 hops away are marked as unreachable.

Protocols	Metric
Static	Administrator decides
OSPF	Cost
RIP	Hop Counts
EIGRP	Bandwidth and Delay
BGP	Path Counts

OSPF Metric - Cost:

- OSPF uses 'Cost' as the metric, which is automatically derived from interface bandwidth by default.
- You can manually configure the cost to links if you want to manipulate the path.

EIGRP Metric:

- EIGRP used the bandwidth and delay of links to calculate the metric.

We have RIP V1 and RIP V2 let see below both.

Routing Information Protocol V1 (RIP V1):

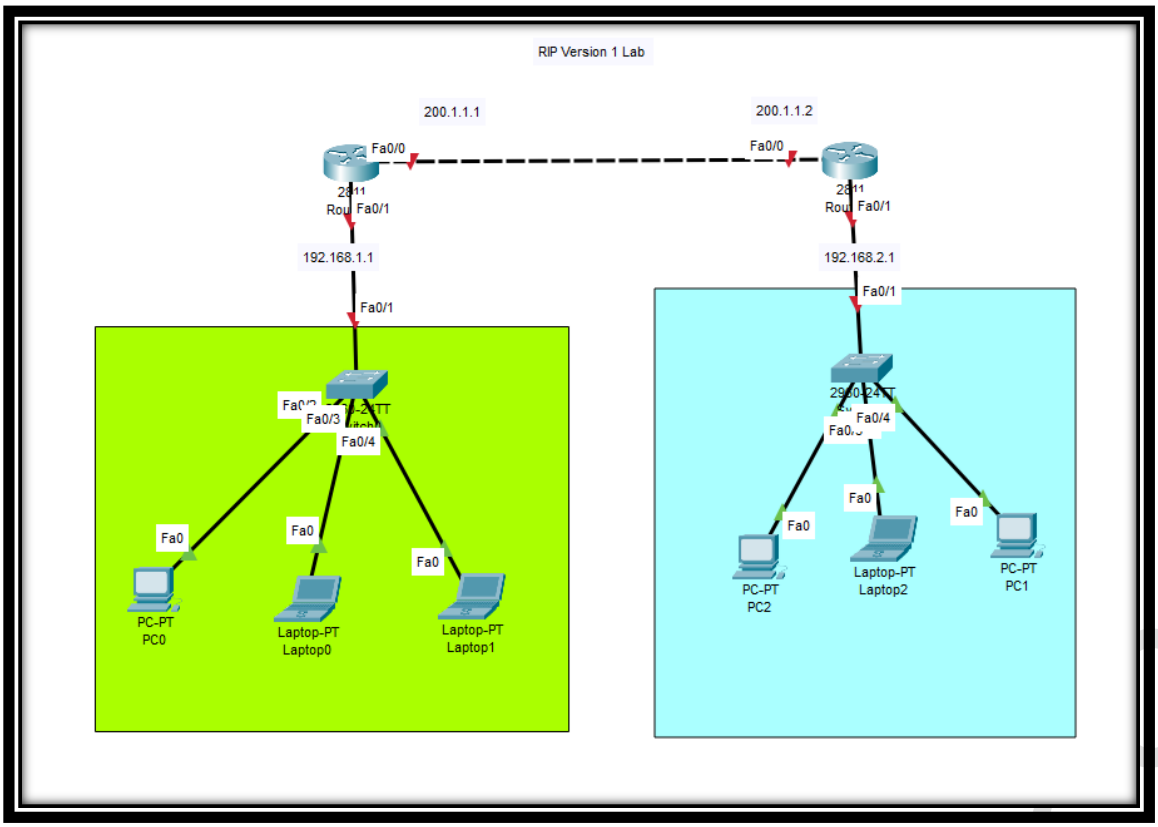
- RIP is Open Standard
- Class full
- Updates are broadcasted (255.255.255.255)
- Metric is Hop Count (Maximum hop count 15)
- Administrative distance is 120
- Used for small network
- Exchange entire routing table for every 30 seconds.
- Update timer is 30 sec, Invalid timer is 180 sec, Flush timer is 240 sec

Configuration command for RIP Version 1:

R1(Config)# router rip

R1(config)# network <Network ID>

RIP Version 1 Lab:



RIP V1 Configuration:

R1Configuration	R2 Configuation
En Config t Hostname R1 Int f0/0 Ip add 200.1.1.1 255.255.255.0 No sh Int f0/1 Ip add 192.168.1.1 255.255.255.0 No sh Router rip Network 200.1.1.0	En Config t Hostname R2 Int f0/0 Ip add 200.1.1.2 255.255.255.0 No sh Int f0/1 Ip add 192.168.2.1 255.255.255.0 No sh Router rip Network 200.1.1.0

Network 192.168.1.0	Network 192.168.2.0

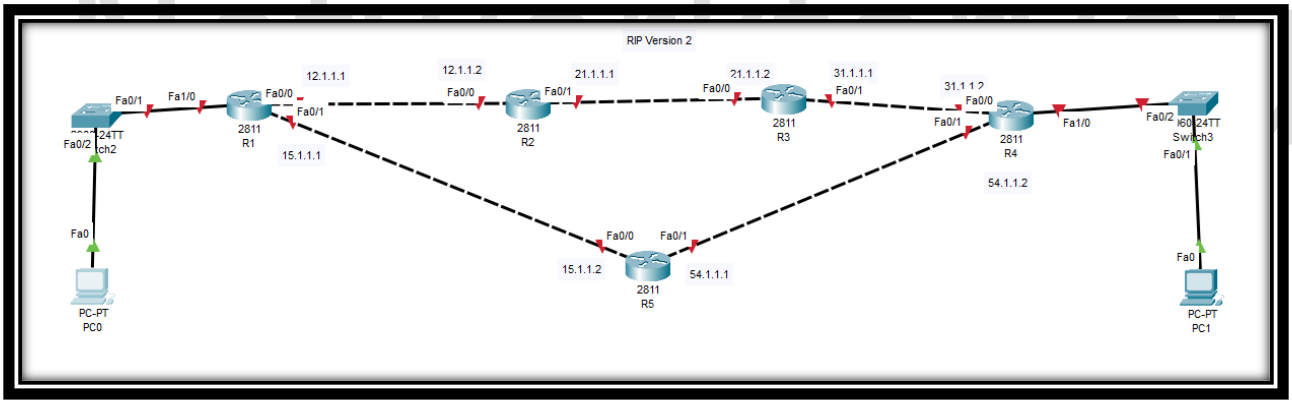
Routing Information Protocol V2(RIP V2):

- RIP V2 is class less routing protocol.
- Supports authentication
- Uses Multi cast address 224.0.0.9
- Supports VLSM.

Configuration command for RIP Version 2:

R1(Config)# router rip
R1(Config)# version 2
R1(config)# no auto-summary
R1(config)# network <Network ID>

RIP Version 2 Lab:



Lab Configuration:

R1 Configuration	R2 Configuration
en config t hostname R1 int f0/0 ip add 12.1.1.1 255.0.0.0 no sh	en config t hostname R2 int f0/0 ip add 12.1.1.2 255.0.0.0 no sh

int f0/1 ip add 15.1.1.1 255.0.0.0 no sh int f1/0 ip add 192.168.1.1 255.255.255.0 no sh router rip version 2 no auto-summary network 12.0.0.0 network 15.0.0.0 network 192.168.1.0	int f0/1 ip add 21.1.1.1 255.0.0.0 no sh router rip version 2 no auto-summary network 12.0.0.0 network 21.0.0.0
R3 Configuration	**R4 Configuration**
en config t hostname R3 int f0/1 ip add 31.1.1.1 255.0.0.0 no sh int f0/0 ip add 21.1.1.2 255.0.0.0 no sh router rip version 2 no auto-summary network 31.0.0.0 network 21.0.0.0	en config t hostname R4 int f0/0 ip add 31.1.1.2 255.0.0.0 no sh int f0/1 ip add 54.1.1.2 255.0.0.0 no sh int f1/0 ip add 192.168.2.1 255.255.255.0 no sh router rip version 2 no auto-summary network 31.0.0.0 network 54.0.0.0 network 192.168.2.0
R5 Configuration	en config t hostname R5

	int f0/0 ip add 15.1.1.2 255.0.0.0 no sh int f0/1 ip add 54.1.1.1 255.0.0.0 no sh router rip version 2 no auto-summary network 15.0.0.0 network 54.0.0.0

traceroute

Loopback Interfaces:

- Lookback Interface are logical interfaces.
- It allows us to assign an IP address to a router or L3 switch, which is not tied to a physical interface
- And it will not go down. It is always up.
- It is logical interfaces and it is not physical.

Example:

```
int loopback 0
ip add 8.8.8.8 255.0.0.0
```

Wildcard Mask:

- Wildcard mask is a mask of bits that indicates which parts of an IP address are available for examination.
- Generally, we say wild card mask is opposite subnet mask.

How we can calculate wildcard mask?

- Let calculate wild card mask for Class C as we know subnet mask for Class C is 255.255.255.0
- To Calculate Wildcard mask, we need to subscribe subnet mask from Global Subnet mask.

Example:
255.255.255.255 ---- This is Global subnet mask
255.255.255.0 ---- This is Class C subnet mask

0.0.0.255 ---------- This is Wild card mask for Class C