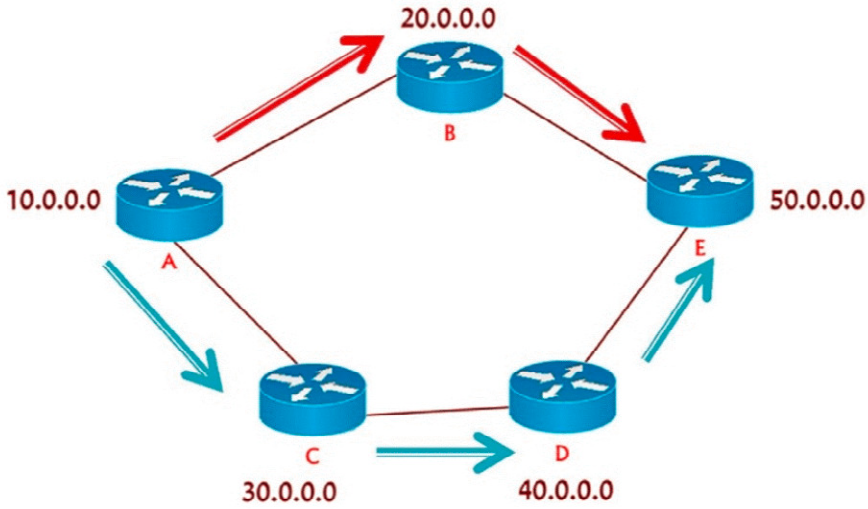
Routing

- Forwarding of packets from one network to another network .
- choosing the best path from the routing table.



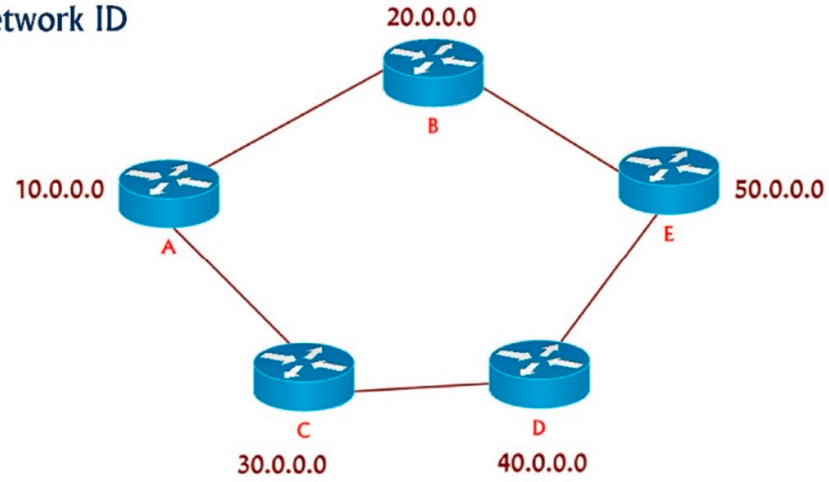
Best path selection is based on the type of routing we are using (static /Dynamic)

Types of Routing

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

Static Routing

- Best path is configured manually by Administrator
- Mandatory need of Destination Network ID
- It is Secure & fast



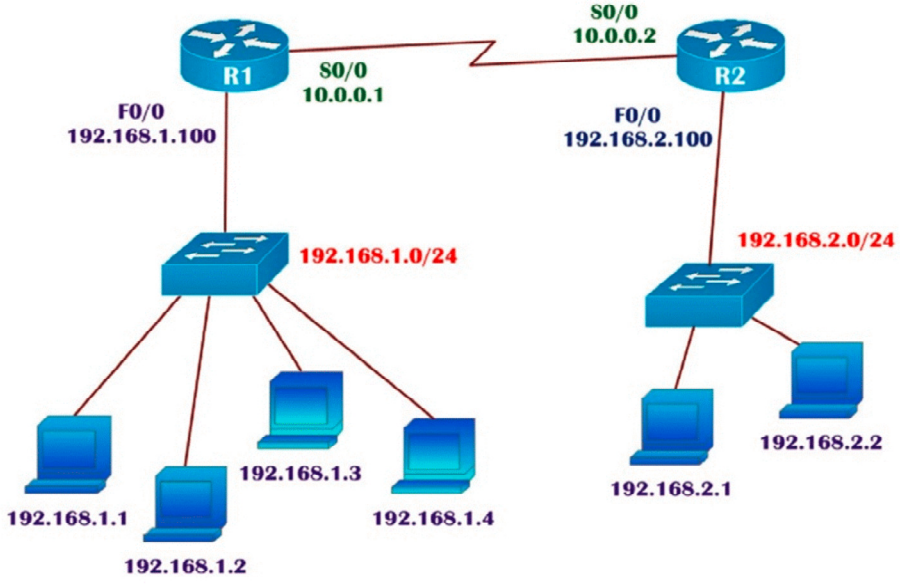
Disadvantages

- Everything to manually
- Used for small network.
- Network change effect complete network.

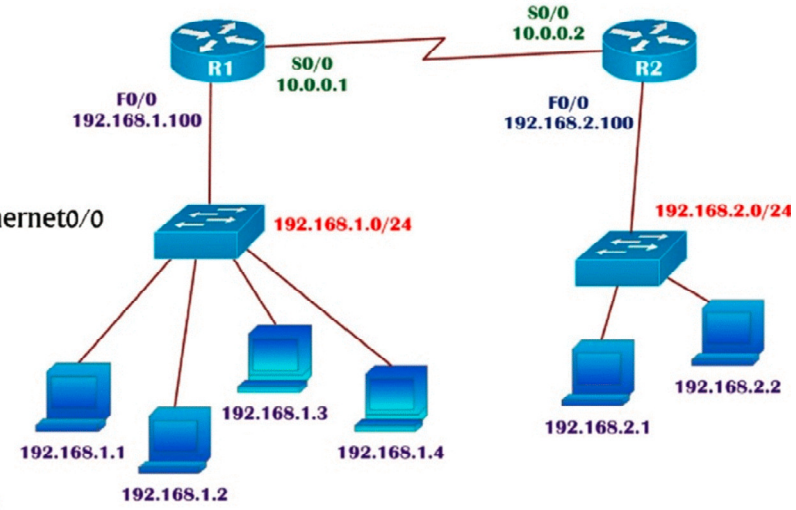
Configuring Static Route

Router(config)#

ip route <Destination Network ID> <Destination Subnet Mask> <Next-hop IP address >



Verification before static Routing



R-1#show ip route

C 10.0.0.0/8 is directly connected, Serial0/0

C 192.168.1.0/24 is directly connected, FastEthernet0/0

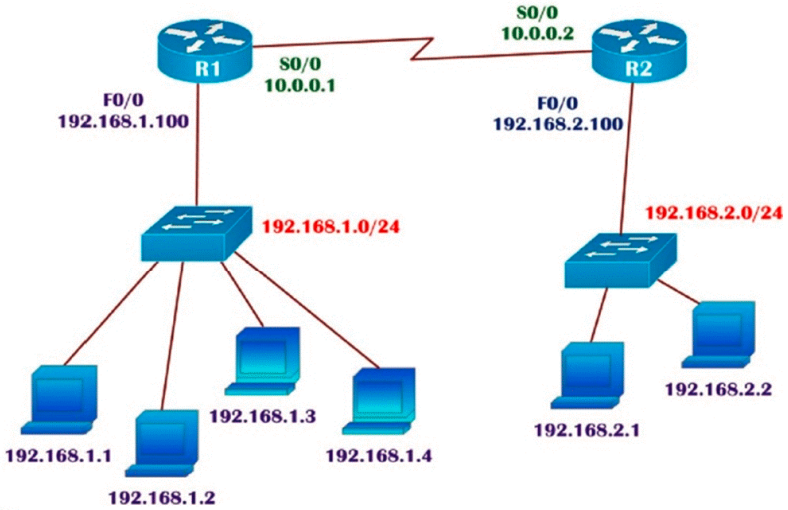
PC>ping 192.168.2.1

Pinging 192.168.2.1 with 32 bytes of data:

Reply from 192.168.1.100: Destination host unreachable.
Reply from 192.168.1.100: Destination host unreachable.
Reply from 192.168.1.100: Destination host unreachable.
Reply from 192.168.1.100: Destination host unreachable.

Static Routing – 2 routers

R-1(config)# ip route 192.168.2.0 255.255.255.0 10.0.0.2



R-1#sh ip route

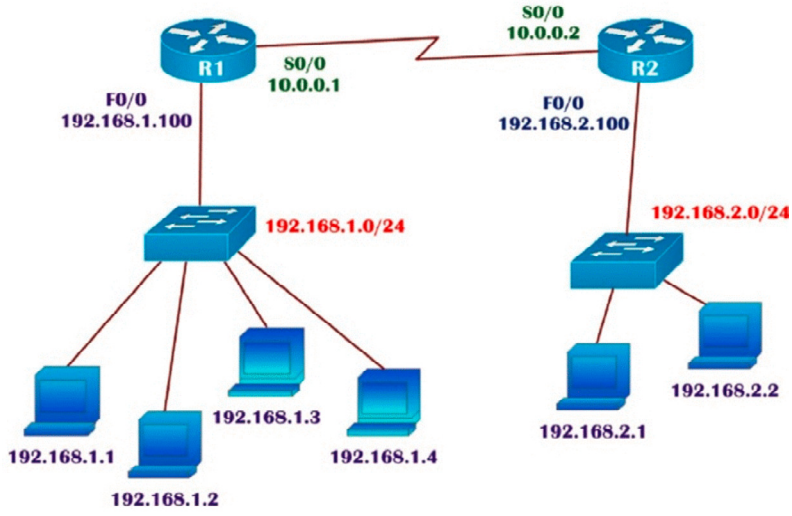
Gateway of last resort is not set

C 10.0.0.0/8 is directly connected, Serial0/0

C 192.168.1.0/24 is directly connected, FastEthernet0/0

S 192.168.2.0/24 [1/0] via 10.0.0.2

R-2(config)#ip route 192.168.1.0 255.255.255.0 10.0.0.1



R-2#show ip route

Gateway of last resort is not set

C 10.0.0.0/8 is directly connected, Serial0/0

S 192.168.1.0/24 [1/0] via 10.0.0.1

C 192.168.2.0/24 is directly connected, FastEthernet0/0

Ping & tracert

PC>ping 192.168.2.1

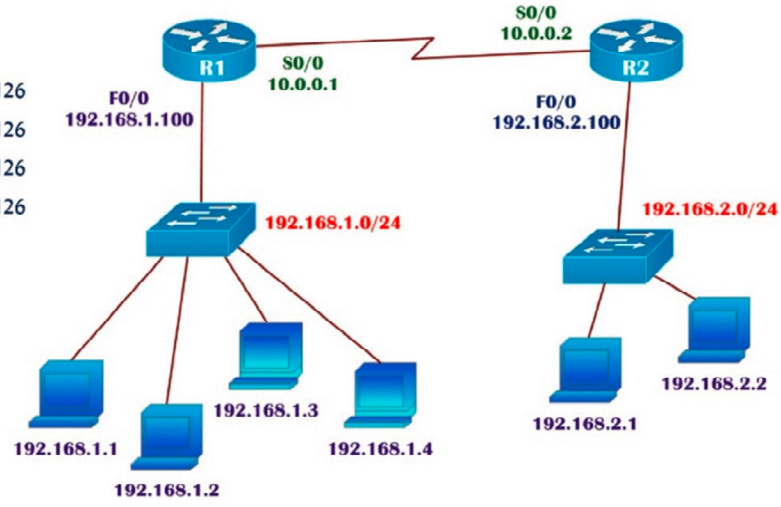
Pinging 192.168.2.1 with 32 bytes of data:

Reply from 192.168.2.1: bytes=32 time=20ms TTL=126

Reply from 192.168.2.1: bytes=32 time=20ms TTL=126

Reply from 192.168.2.1: bytes=32 time=21ms TTL=126

Reply from 192.168.2.1: bytes=32 time=21ms TTL=126

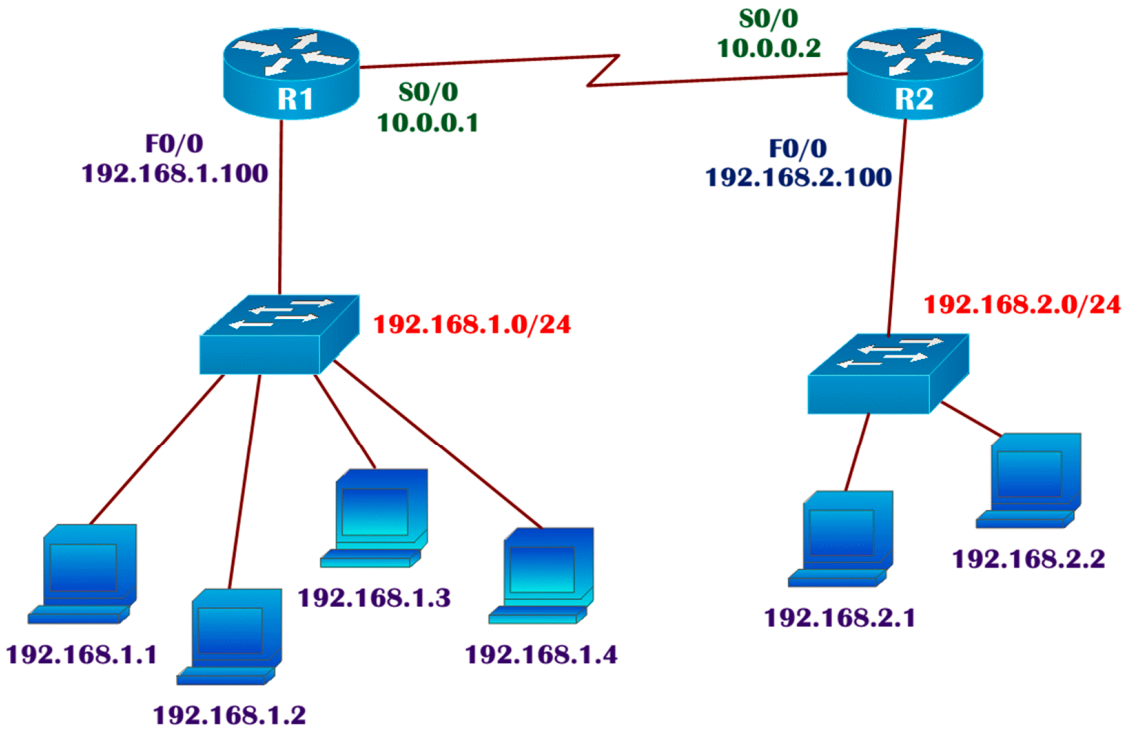


PC>tracert 192.168.2.1

Tracing route to 192.168.2.1 over a maximum of 30 hops:

1	44 ms	9 ms	10 ms	192.168.1.100
2	13 ms	13 ms	12 ms	10.0.0.2
3	17 ms	22 ms	20 ms	192.168.2.1

LAB: STATIC ROUTING



TASK:

- Configure Static routing
- Verify Routing table and reachability between the LAN's (using PING and TRACE commands)

R-1#show ip route

Gateway of last resort is not set

C 10.0.0.0/8 is directly connected, Serial0/0

C 192.168.1.0/24 is directly connected, FastEthernet0/0

R-2#show ip route

Gateway of last resort is not set

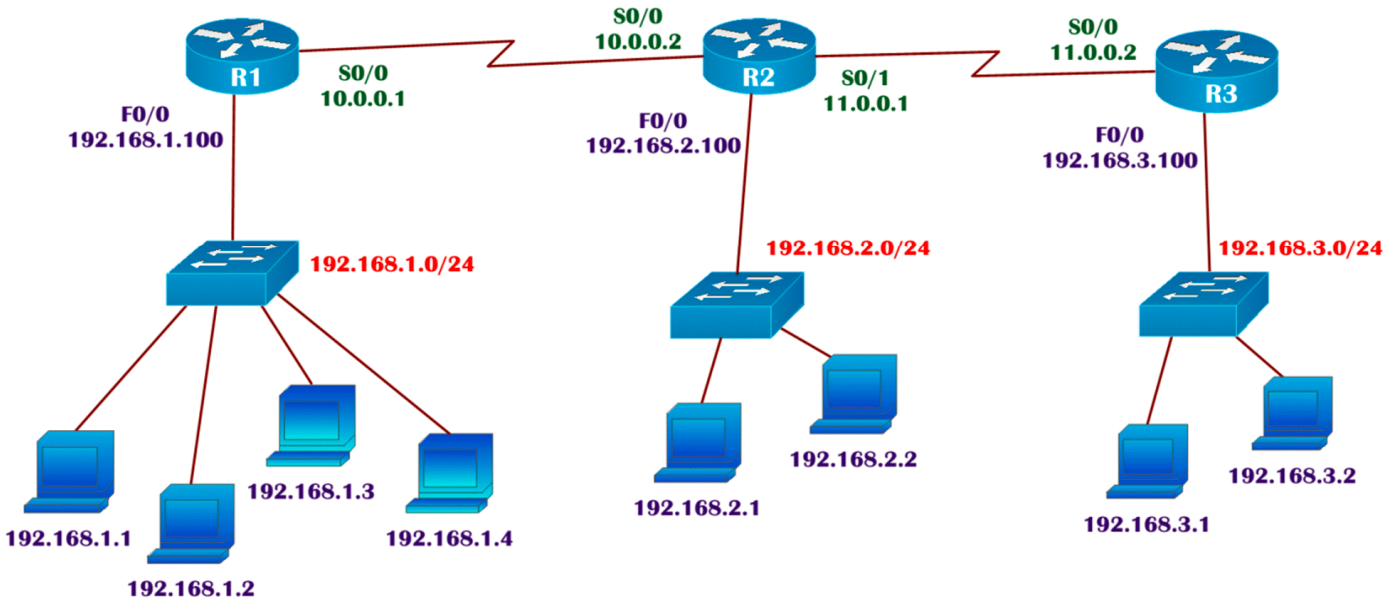
C 10.0.0.0/8 is directly connected, Serial0/0

C 192.168.2.0/24 is directly connected, FastEthernet0/0

NOTE:

- The above routing table displays only the networks which are directly connected
- By default router don't know about the networks which are not directly connected and that the reason there is no reachability between the two LAN's
- So to provide reachability we need to implement any type of the routing

LAB: STATIC ROUTING USING THREE ROUTERS



TASK:

- Configure Static routing
- Verify Routing table and reachability between the LAN's (using PING and TRACE commands)

R-1#sh ip route

Gateway of last resort is not set
C 10.0.0.0/8 is directly connected, Serial0/0
C 192.168.1.0/24 is directly connected, FastEthernet0/0

R-2#sh ip route

Gateway of last resort is not set
C 10.0.0.0/8 is directly connected, Serial0/0
C 11.0.0.0/8 is directly connected, Serial0/1
C 192.168.2.0/24 is directly connected, FastEthernet0/0

R-3#sh ip route

Gateway of last resort is not set
C 11.0.0.0/8 is directly connected, Serial0/0
C 192.168.3.0/24 is directly connected, FastEthernet0/0

Router- 1

R-1(config)# ip route 192.168.2.0 255.255.255.0 10.0.0.2

R-1(config)# ip route 192.168.3.0 255.255.255.0 10.0.0.2

R-1(config)# ip route 11.0.0.0 255.0.0.0 10.0.0.2

Router – 2

R-2(config)# ip route 192.168.1.0 255.255.255.0 10.0.0.1

R-2(config)# ip route 192.168.3.0 255.255.255.0 11.0.0.2

Router – 3

R-3(config)# ip route 192.168.2.0 255.255.255.0 11.0.0.1

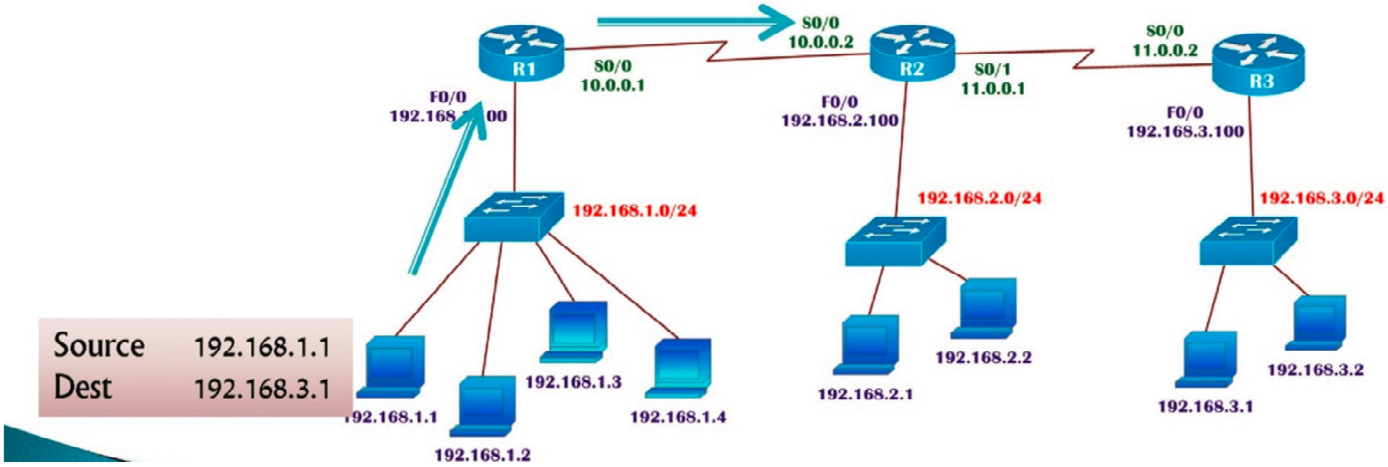
R-3(config)# ip route 192.168.1.0 255.255.255.0 11.0.0.1

R-3(config)# ip route 10.0.0.0 255.0.0.0 11.0.0.1

Routing lookup

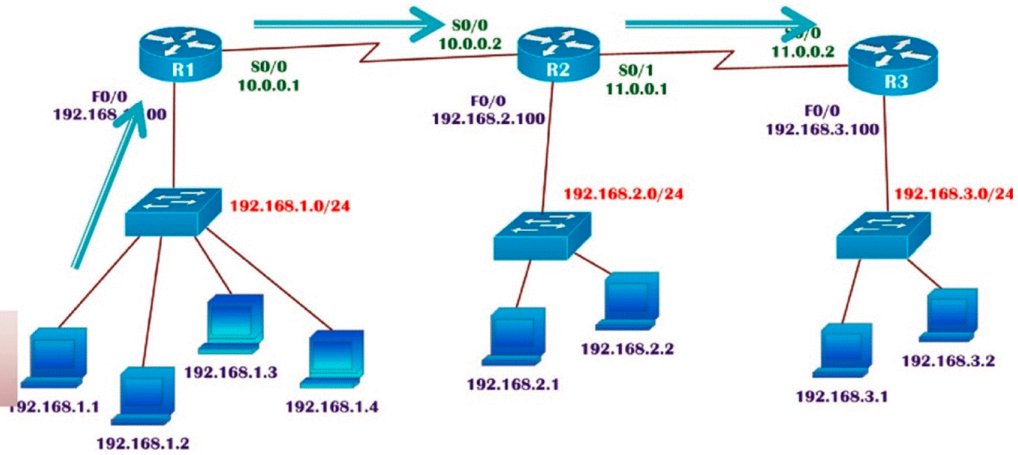
R-1#sh ip route

C 10.0.0.0/8 is directly connected, Serial0/0
S 11.0.0.0/8 [1/0] via 10.0.0.2
C 192.168.1.0/24 is directly connected, FastEthernet0/0
S 192.168.2.0/24 [1/0] via 10.0.0.2
S 192.168.3.0/24 [1/0] via 10.0.0.2



R-2#sh ip route

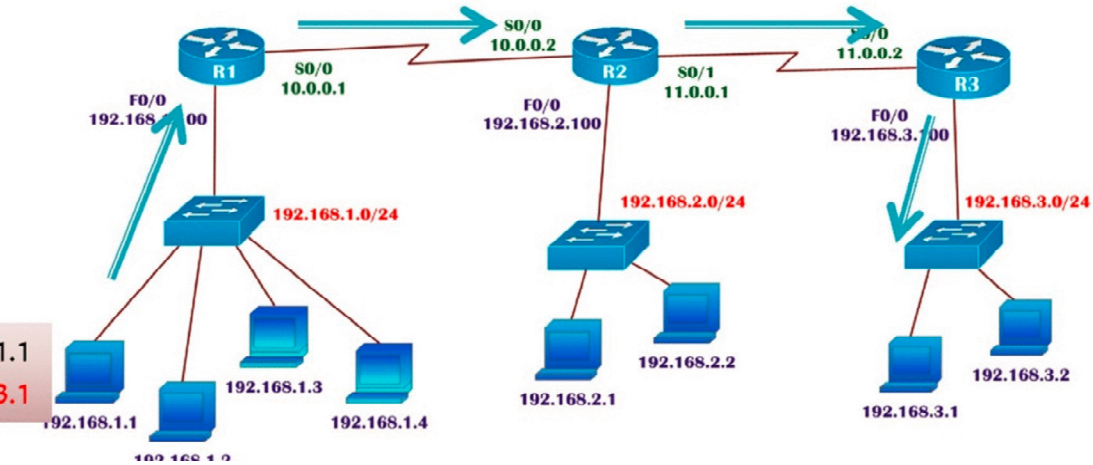
C 10.0.0.0/8 is directly connected, Serial0/0
C 11.0.0.0/8 is directly connected, Serial0/1
S 192.168.1.0/24 [1/0] via 10.0.0.1
C 192.168.2.0/24 is directly connected, FastEthernet0/0
S 192.168.3.0/24 [1/0] via 11.0.0.2



Source 192.168.1.1
Dest 192.168.3.1

R-3#sh ip route

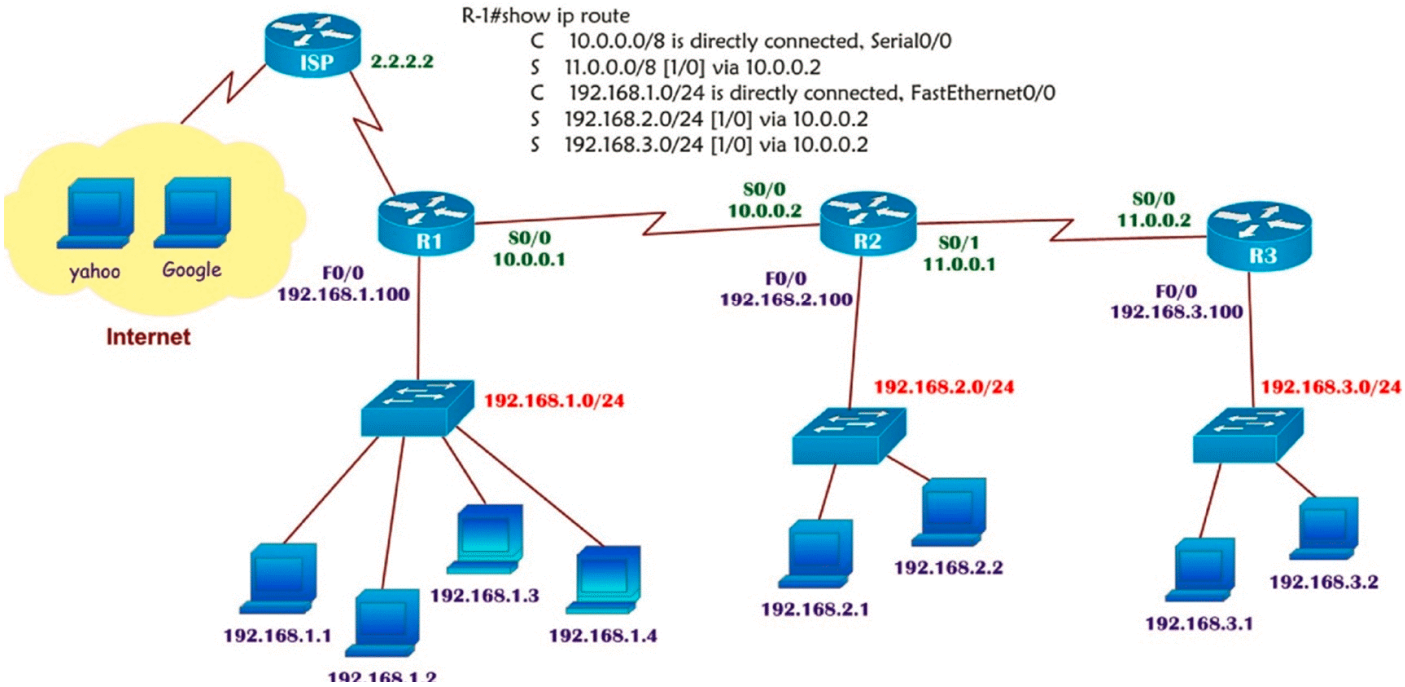
S 10.0.0.0/8 [1/0] via 11.0.0.1
C 11.0.0.0/8 is directly connected, Serial0/0
S 192.168.1.0/24 [1/0] via 11.0.0.1
S 192.168.2.0/24 [1/0] via 11.0.0.1
C 192.168.3.0/24 is directly connected, FastEthernet0/0



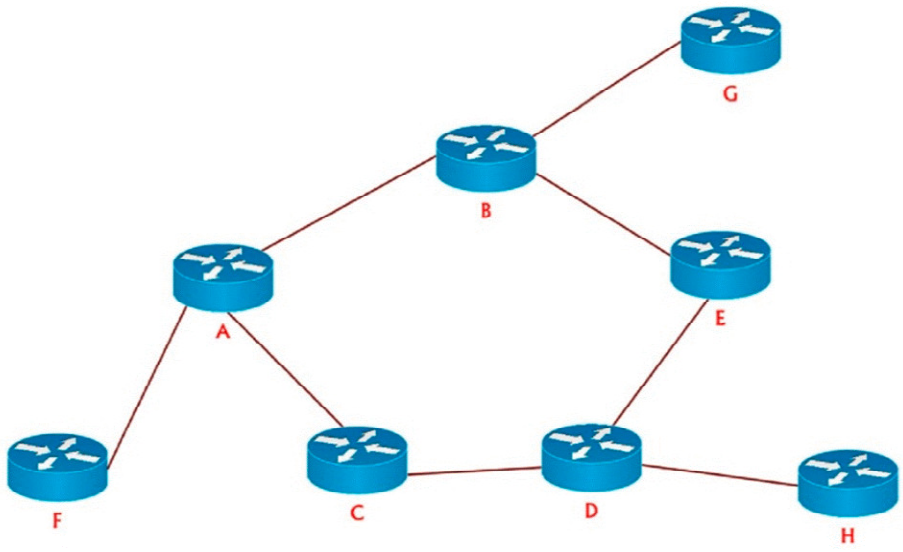
Source 192.168.1.1
Dest 192.168.3.1

Default Routing

Used to route traffic for unknown destinations (internet)



Also can be used at end locations.(optional)



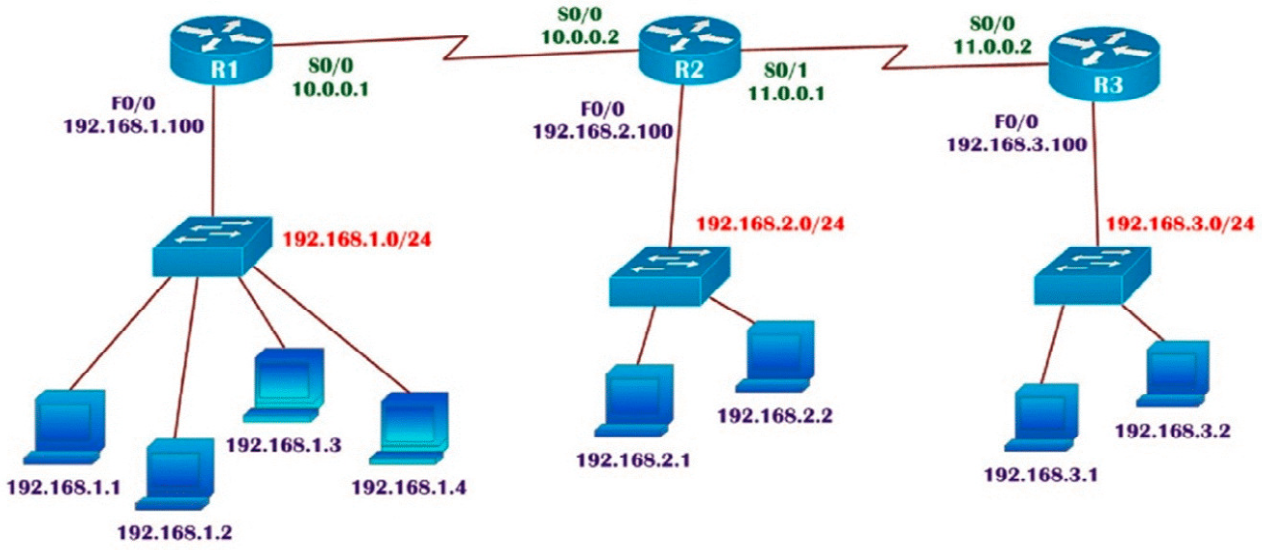
Default Routing (contd)

- It is the last preferred routing
- Default routes help in reducing the size of your routing table.
- R-1(config)#ip route 0.0.0.0 0.0.0.0 10.0.0.2

LAB: Verifying Default Route

Task:

- Design topology
- Basic IP addressing (up up)
- R1 and R3 configured with default routes (common next-hop for all destinations)
- R2 using static routing



R-1(config)#**ip route** 0.0.0.0 0.0.0.0 10.0.0.2

R-2(config)#**ip route** 192.168.1.0 255.255.255.0 10.0.0.1

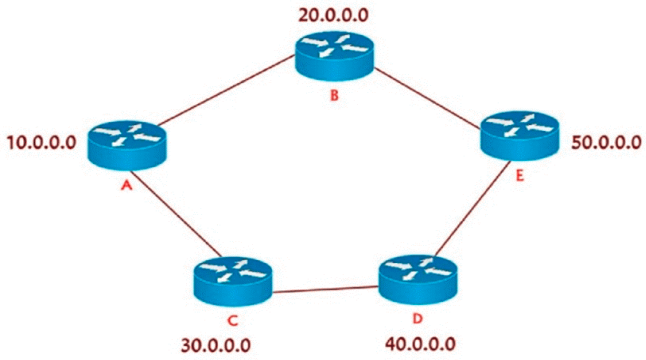
R-2(config)#**ip route** 192.168.3.0 255.255.255.0 11.0.0.2

R-3(config)# **ip route** 0.0.0.0 0.0.0.0 11.0.0.1

Dynamic Routing

RIP, EIGRP, OSPF

Dynamic Routing



Advantages of Dynamic over static :

- No need of manual configuration (unlike static routing)
- Learns about other networks via advertisements (of directly connected networks)
- Automatically select the best route. (builds routing table)
- Updates the topology changes dynamically.
- No need to know the destination networks. (others network)
- Administrative work is reduced
- Applicable for large organizations.

Types of Dynamic Routing Protocols

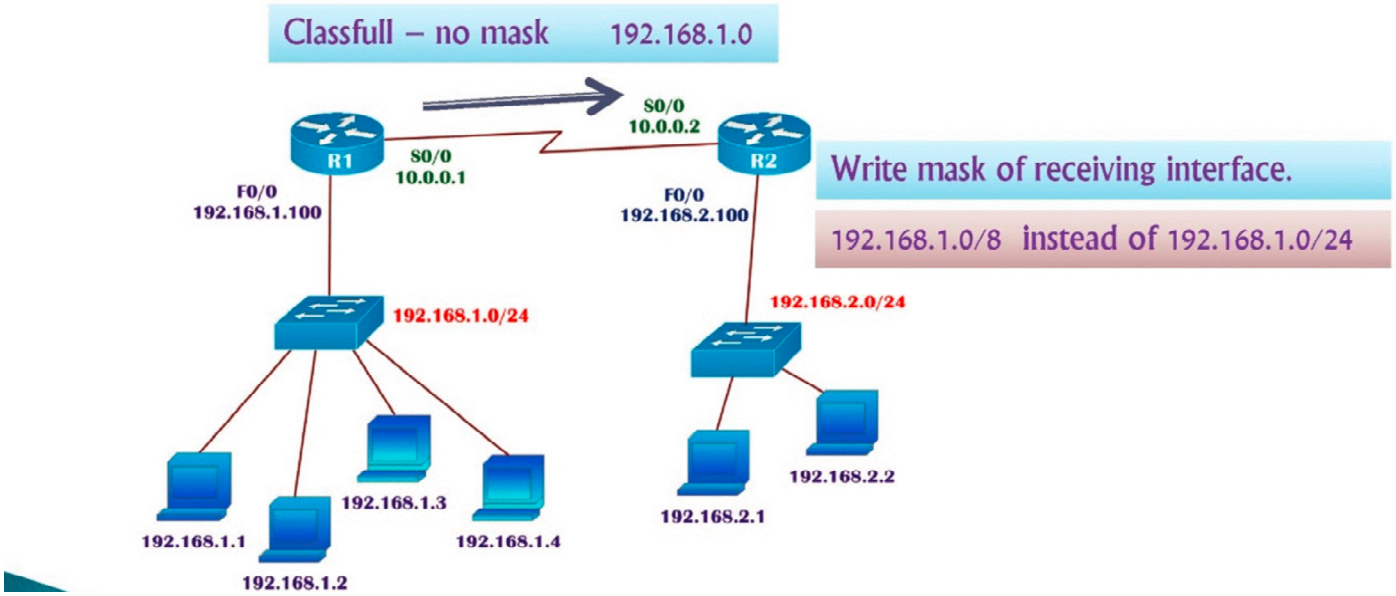
- **Distance Vector Protocol**
- **Link State Protocol**
- **Hybrid Protocol**

Types of Dynamic Routing Protocols

Distance Vector	Link State	Hybrid (Advance Distance vector)
Works with Bellman Ford algorithm	Works with Dijkstra algorithm	Works with DUAL algorithm
Periodic updates	Incremental updates Link state updates	Incremental updates
Full Routing tables are exchanged	Missing routes are exchanged	Missing routes are exchanged
Classful routing protocol	Classless routing protocol	Classless routing protocol
Updates are through broadcast	Updates are through multicast	Updates are through multicast
Example: RIP v1, RIPv2, IGRP	Example : OSPF, IS-IS	Example : EIGRP
Less overhead	More overhead	Less overhead
Easy to configure	Difficult to configure	Easy to configure

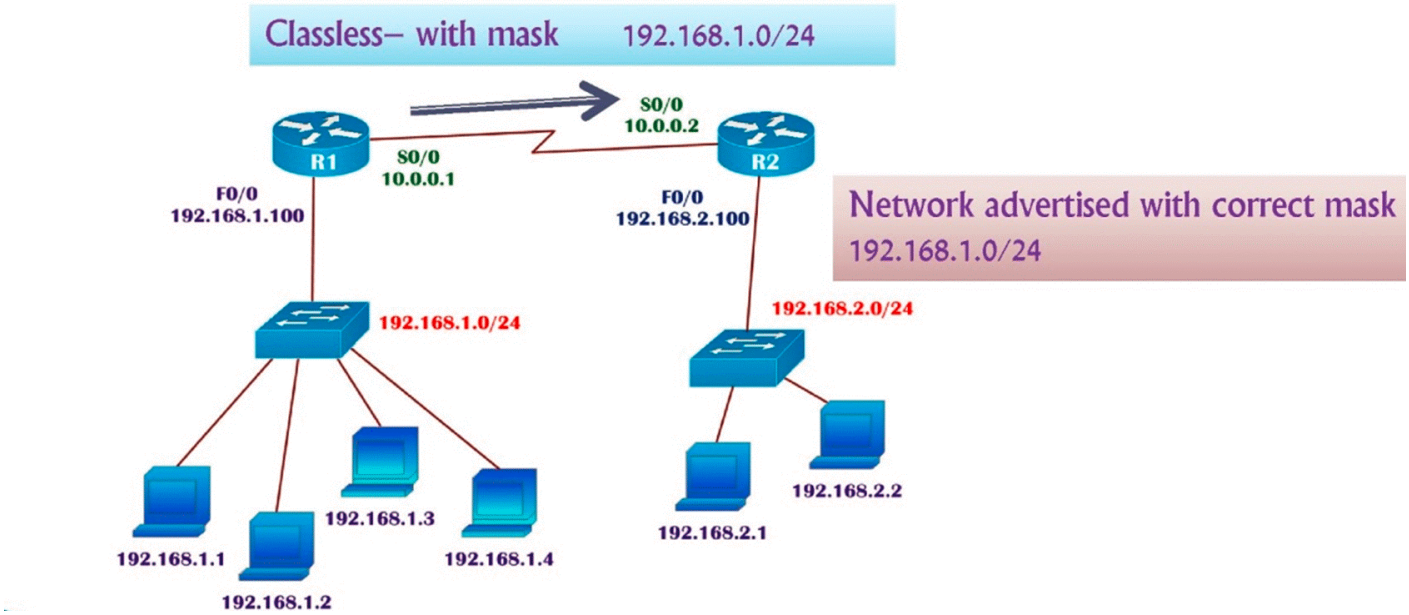
Classfull protocols

- Classful routing protocol do not carry the subnet mask information along with updates
- which means that all devices in the network must use the same subnet mask (FLSM or default same class)
  - Ex : RIPv1 , IGRP



Classless protocols

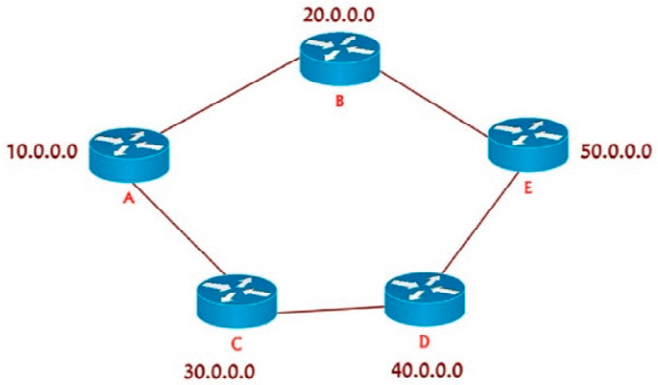
- Classless routing protocol carry the subnet mask information along with updates
- That's why they support sub networks(VLSM and FLSM) and default networks also
  - Ex : RIPv2 , EIGRP , OSPF, IS-IS



Routing Information Protocol

(RIP)

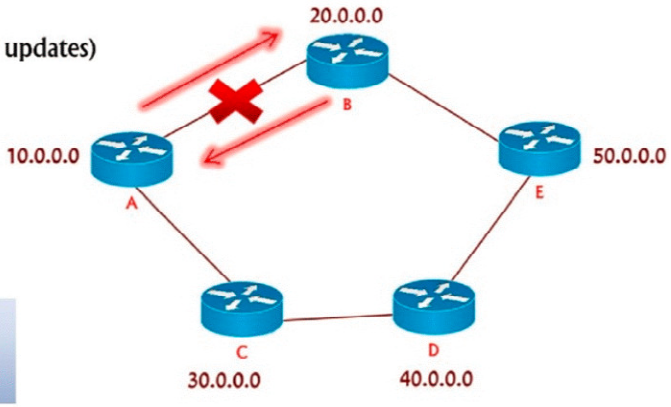
- Open Standard Protocol (Cisco/ non-cisco)
- Classfull routing protocol (not carry subnetmask)
- Updates are broadcasted via 255.255.255.255
- Metric : Hop count
- Load Balancing up to 4 equal paths
- Max Hop counts = 15 / Max routers = 16
- Applicable for small organizations
- Administrative distance is 120
- Exchange entire routing table for every 30 seconds. (periodic updates)

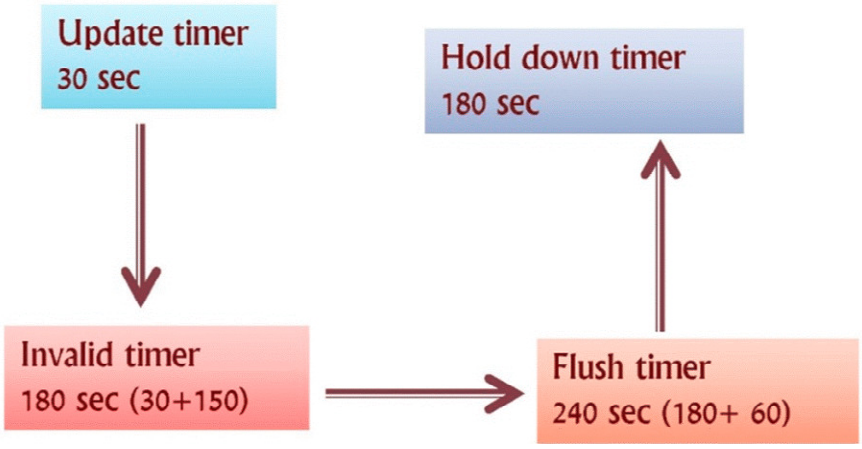


Rip Timers

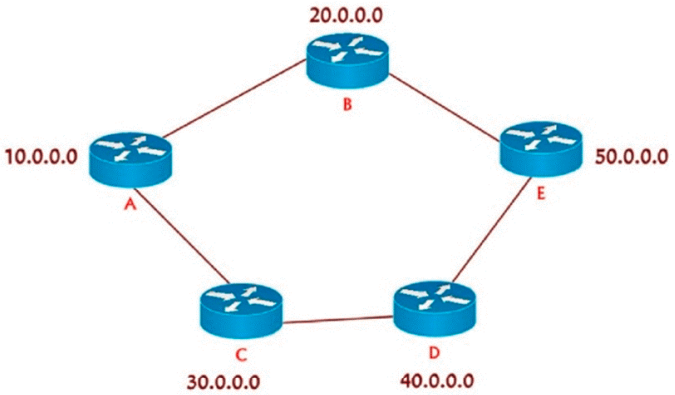
Update Timer :

- Exchange entire routing table for every 30 seconds. (periodic updates)





Rip Timers



Update timer : 30 sec

- Time between consecutive updates

Invalid timer : 180 sec

- Time a router waits to hear updates
- The route is marked unreachable if there is no update during this interval.

Flush timer : 240 sec

- Time before the invalid route is removed from the routing table

Hold Down timer : 180 Sec

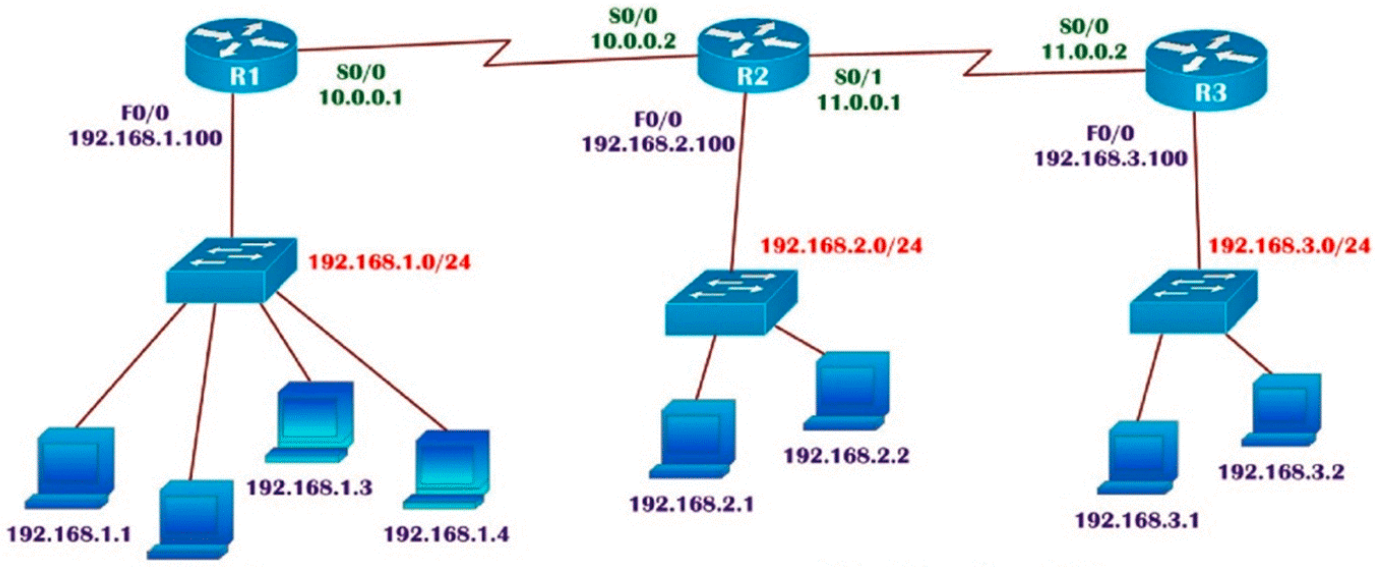
- Stabilizes routing information and helps preventing routing loops during periods when the topology is converging on new information.

RIPv1

- Classful routing protocol (not carry mask)
- Updates via broadcasts (255.255.255.255)
- No support for authentication.

RIPv2

- Classless routing protocol (carry mask)
- Updates via multicast address 224.0.0.9
- Supports authentication



Configuring RIP v1

```
Router(config)# router rip
Router(config-router)# network <Network ID>
```

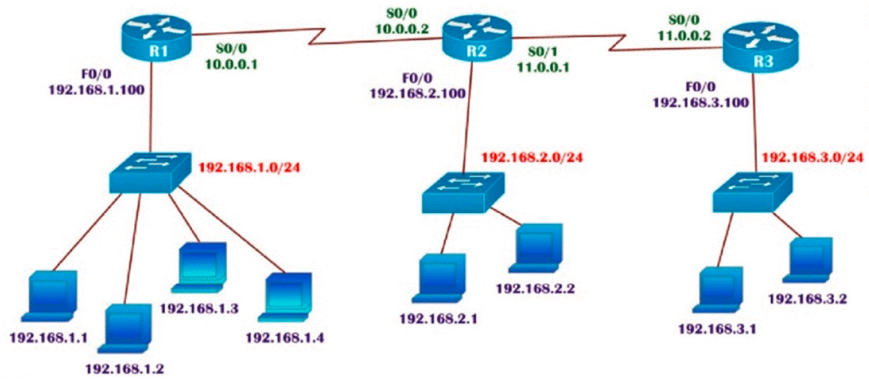
Configuring RIP v2

```
Router(config)# router rip
Router(config-router)# network <Network ID>
Router(config-router)# version 2
```

LAB : Routing using RIPv2

R-1(config)#**router rip**
R-1(config-router)#**network 192.168.1.0**
R-1(config-router)#**network 10.0.0.0**
R-1(config-router)#**version 2**

R-2(config)#**router rip**
R-2(config-router)#**network 192.168.2.0**
R-2(config-router)#**network 10.0.0.0**
R-2(config-router)#**network 11.0.0.0**
R-2(config-router)#**version 2**



R-3(config)#**router rip**
R-3(config-router)#**network 192.168.3.0**
R-3(config-router)#**network 11.0.0.0**
R-3(config-router)#**version 2**

RIPv2 Verification commands

R-1#sh ip route

Gateway of last resort is not set
C 10.0.0.0/8 is directly connected, Serial0/0
R 11.0.0.0/8 [120/1] via 10.0.0.2, 00:00:03, Serial0/0
C 192.168.1.0/24 is directly connected, FastEthernet0/0
R 192.168.2.0/24 [120/1] via 10.0.0.2, 00:00:03, Serial0/0
R 192.168.3.0/24 [120/2] via 10.0.0.2, 00:00:03, Serial0/0

PC>ping 192.168.3.1

Pinging 192.168.3.1 with 32 bytes of data:
Reply from 192.168.3.1: bytes=32 time=20ms TTL=126
Reply from 192.168.3.1: bytes=32 time=20ms TTL=126
Reply from 192.168.3.1: bytes=32 time=21ms TTL=126
Reply from 192.168.3.1: bytes=32 time=21ms TTL=126

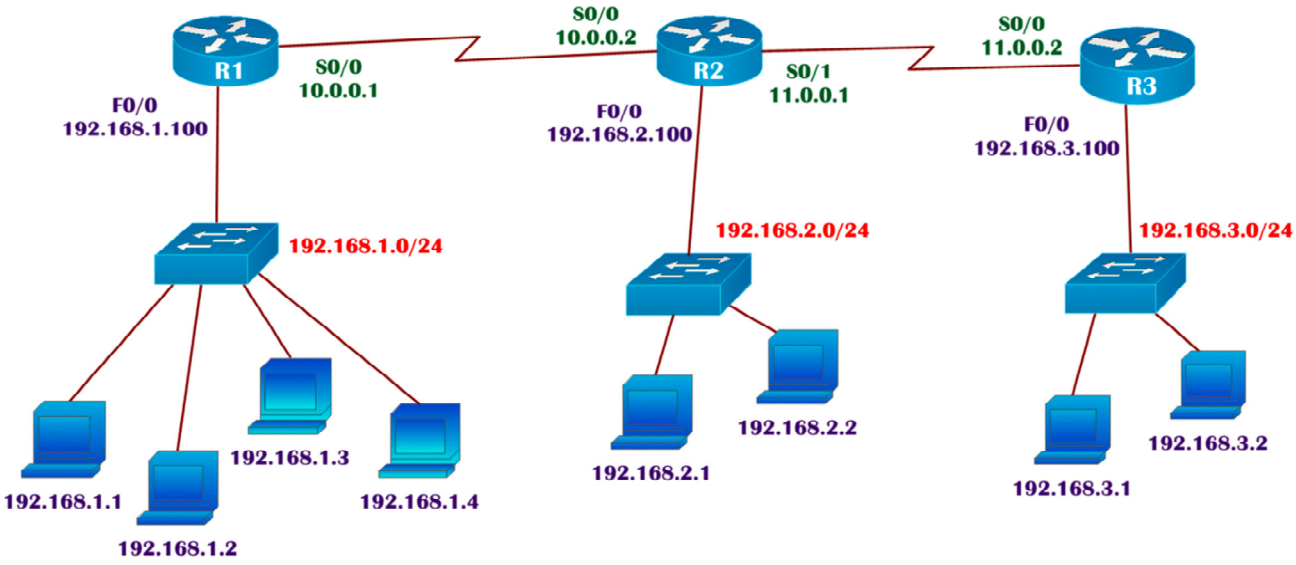
Advantages of RIP

- Easy to configure
- No design constraints (unlike OSPF)
- Less overhead

Disadvantage of RIP

- Bandwidth utilization is very high as broadcast for every 30 seconds (periodic updates)
- Works only on hop count (not consider BW)
- Applicable for small organizations (maximum hop counts = 15)
- Slow convergence (240 sec)

LAB: DYNAMIC ROUTING USING RIPV2



Administrative Distance

- Trust worthiness of the information received by the router.
- The Number is between 0 and 255
- Less value is more preferred routing

Default administrative distances

Directly Connected = 0

Static Route = 1

IGRP = 100

EIGRP = 90

OSPF = 110

RIP = 120

Autonomous System Number

- is a collection of networks under a common administrative domain.
- A unique number identifying the Routing domain of the routers (one organization).
- Ranges from 1- 65535
  - Public AS (in between multiple SP) 1 – 64512
  - Private AS (same SP) 64513 – 65535

Routing Protocol Classification

IGP

- Interior Gateway Protocol
- used to communicate within same autonomous system
- RIP, IGRP, EIGRP, OSPF, IS-IS

EGP

1. Exterior Gateway Protocol
2. used to communicate between two or more autonomous system
3. Border Gateway Protocol (BGP)