Note for Instructors

- These presentations are the result of a collaboration among the instructors at St. Clair College in Windsor, Ontario.
- Thanks must go out to Rick Graziani of Cabrillo College. His material and additional information was used as a reference in their creation.
- If anyone finds any errors or omissions, please let me know at:
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RIP Version 2 (RIPv2)

RIPv1 Limitations

- RIPv1 (a classful routing protocol) is used as an example, so we can see how RIPv2 (a classless routing protocol) does not have these same limitations.
- Classful routing protocols have three major limitations:
  - Does not support discontiguous networks.
  - Does not support VLSM.
  - Does not support CIDR.
RIPv1 Limitations - Discontiguous Networks

RIPv1 is a **CLASSFUL** routing protocol and does not include the subnet mask.

```
R2# sh ip route
<output omitted>

Gateway of last resort is set to 10.0.0.0

C  10.0.0.0/16 is subnetted, 1 subnets
R  10.1.0.0/16 is directly connected, FastEthernet0/0
R  172.30.0.0/16 [120/1] via 209.165.200.294, 00:00:08, Serial10/0/1
    [120/1] via 209.165.200.230, 00:00:08, Serial10/0/0
C  209.165.200.0/30 is subnetted, 2 subnets
C    209.165.200.228 is directly connected, Serial10/0/0
C    209.165.200.232 is directly connected, Serial10/0/1
```

- **Auto Summary is ON**
- **RIPv1 - No Subnet Mask**
- **172.30.0.0/16**
- **172.30.0.0/16**

R2 will load balance.
RIPv1 Limitations - Discontiguous Networks

- Solution:
  - Use RIPv2 to include the subnet mask.
  - Turn off auto summarization.
- How do we do that?

```
R2>en
R2#conf t
R2 (config)#router rip
R2 (config-router)#version 2
R2 (config-router)#no auto-summary
R2 (config-router)#
```

Auto Summary and RIPv2

- By default, RIPv2 automatically summarizes networks at major network boundaries, just like RIPv1.
- R1 and R3 will still advertise the summarized routes for their networks.
- R2 will still have the summarized route for 172.30.0.0/16 with the same two equal cost paths.
- Auto-summary must be disabled.
RIPv1 Limitations - Discontiguous Networks

R2 now has the proper routes.

R2 will load balance

RIPv2

RIPv1

RIPv1 Limitations - Discontiguous Networks

R2 now has the proper routes.
RIPv1 Limitations – No VLSM

- **RIPv1 does not support VLSM:**
  - To illustrate it, we will be adding Loopback Interfaces.
  - **Loopback Interface:**
    - Software-only interface.
    - Used to emulate a physical interface.
    - Can be assigned an IP address.
    - Can be pined.
    - Subnet can be advertised in routing updates.
    - Useful in a lab environment to create additional networks without having to add more physical interfaces.
  - *More in chapter 11.*

---

R2# sh ip route
<output omitted>

Gateway of last resort is not set
C  10.0.0.0/16 is subnetted, 1 subnets
R  10.1.0.0 is directly connected, FastEthernet0/0
R  172.30.0.0/16 [120/1] via 172.16.1.2, 00:00:08, Serial1/0/1
    [120/1] via 172.16.1.2, 00:00:08, Serial1/0/0
    209.165.200.0/30 is subnetted, 2 subnets
C  209.165.200.228 is directly connected, Serial1/0/0
C  209.165.200.232 is directly connected, Serial1/0/1

R2 will load balance

Auto Summary is ON
RIPv1 - No Subnet Mask
RIPv1 Limitations – No VLSM

RIPv1

Gateway of last resort is not set

10.0.0.0/16 is subnetted, 1 subnets
C 10.1.0.0 is directly connected, FastEthernet0/0
R 172.30.0.0/16 [120/1] via 209.165.200.234, 00:00:20, Serial0/0
R 172.30.1.0/24 [120/1] via 209.165.200.234, 00:00:20, Serial0/0
R 172.30.2.0/24 [120/1] via 209.165.200.234, 00:00:20, Serial0/0
R 172.30.100.0/24 [120/1] via 209.165.200.234, 00:00:20, Serial0/0
R 172.30.110.0/24 [120/1] via 209.165.200.234, 00:00:20, Serial0/0
R 172.30.200.0/24 [120/1] via 209.165.200.234, 00:00:20, Serial0/0
209.165.200.0/30 is subnetted, 2 subnets
C 209.165.200.232 is directly connected, Serial0/0/0
C 209.165.200.232 is directly connected, Serial0/0/1

RIPv2

Gateway of last resort is not set

10.0.0.0/16 is subnetted, 1 subnets
C 10.1.0.0 is directly connected, FastEthernet0/0
R 172.30.0.0/16 [120/1] via 209.165.200.234, 00:00:08, Serial0/0/0
R 172.30.1.0/24 [120/1] via 209.165.200.234, 00:00:08, Serial0/0/0
R 172.30.2.0/24 [120/1] via 209.165.200.234, 00:00:08, Serial0/0/0
R 172.30.100.0/24 [120/1] via 209.165.200.234, 00:00:08, Serial0/0/0
R 172.30.110.0/24 [120/1] via 209.165.200.234, 00:00:08, Serial0/0/0
R 172.30.200.0/24 [120/1] via 209.165.200.234, 00:00:08, Serial0/0/0
209.165.200.0/30 is subnetted, 2 subnets
C 209.165.200.232 is directly connected, Serial0/0/0
C 209.165.200.232 is directly connected, Serial0/0/1

Auto Summary is OFF
RIPv2 – Subnet Mask
RIPv1 Limitations – No CIDR

- RIPv1 does not support CIDR:
  - To illustrate it, we will be adding a static summary route to R2 and telling R2 to redistribute that route to other routers in the network.
  - Static Summary Route:
    - This route is a summary of all of the 192.168.0.0/24 networks.
    - The **null0** argument lets us add the route without affecting any interface.

```
R2#conf t
R2(config)#ip route 192.168.0.0 255.255.0.0 null0
```

- Redistribution:
  - For now, just realize that this summary route will cause problems with RIPv1 because **192.168.0.0/16 is not a major classful address** and includes all of the /24 versions of 192.168.0.0/16.

```
R2 (config)#router rip
R2 (config-router)#redistribute static
```
RIPv1 Limitations – No CIDR

R2: Static Route appears in the routing table.

Auto Summary is ON.
RIPv1 – No Subnet Mask

Static Route NOT redistributed to R3

Auto Summary is ON.
RIPv1 – No Subnet Mask
RIPv1 Limitations – No CIDR

- Static Route NOT redistributed to R3:
  - The static route 192.168.0.0 has a /16 mask.
  - What class is it? – Class C
  - RIPv1 is a CLASSFUL routing protocol.
    - The mask does not match the class or a subnet of the class.
    - RIPv1 will not include this route in its updates to other routers.
  - RIPv1 and other classful routing protocols cannot support CIDR routes that are summarized routes with a smaller subnet mask than the classful mask of the route.

RIPv1 Limitations – No CIDR

```
R3#sh ip route
<output omitted>

Gateway of last resort is not set

    10.0.0.0/16 is subnetted, 1 subnets
     R    10.1.0.0 [120/1] via 209.165.200.233, 00:00:14, Serial0/0/1
     R    172.30.0.0/16 is variably subnetted, 6 subnets, 2 masks
          172.30.1.0/24 [120/2] via 209.165.200.233, 00:00:14, Serial0/0/1
          172.30.2.0/24 [120/2] via 209.165.200.233, 00:00:14, Serial0/0/1
     C    172.30.100.0/24 is directly connected, FastEthernet0/0
     C    172.30.110.0/24 is directly connected, Loopback0
     C    172.30.200.0/26 is directly connected, Loopback1
     C    172.30.200.32/26 is directly connected, Loopback2
     R    192.168.0.0/16 [120/1] via 209.165.200.233, 00:00:09, Serial0/0/1
        209.165.200.0/30 is subnetted, 2 subnets
          R   209.165.200.2/28 [120/1] via 209.165.200.233, 00:00:14, Serial0/0/1
          C   209.165.200.32/32 is directly connected, Serial0/0/1
```

Auto Summary is OFF

RIPv2 – Subnet Mask
Enabling and Verifying RIPv2

- By default, when a RIP process is configured on a Cisco router, it is running RIPv1.
- Even though the router only sends RIPv1 messages, it can interpret both RIPv1 and RIPv2 messages.
- A RIPv1 router will just ignore the RIPv2 fields in the route entry.

```
R2>en
R2#conf t
R2(config)#router rip
R2(config-router)#version 2
```

Verifying: **ip protocols** command.

```
R2# show ip protocols
<output omitted>
Default version control: send version 1, receive any version
Interface         Send  Recv  Triggered RIP Key-chain
Serial0/0/0        1       2
Serial0/0/1        1       2
Automatic network summarization is in effect
<output omitted>
```

```
R2# show ip protocols
Routing Protocol is "rip"
    Sending updates every 30 seconds, next due in 1 seconds
    Invalid after 180 seconds, hold down 180, flushed after 240
    Outgoing update filter list for all interfaces is
    Incoming update filter list for all interfaces is
    Redistributing: static, ip
Default version control: send version 2, receive version 2
Interface         Send  Recv  Triggered RIP Key-chain
Serial0/0/0        2       2
Serial0/0/1        2       2
Automatic network summarization is in effect
<output omitted>
```
Verifying RIPv2 Updates

RIPv2 Fully Converged Network:

```
Router(config)# router rip
Router(config-router)# version 2
```

```
R1# show ip route
<output omitted>
```

```
   10.0.0.0/16 is subnetted, 1 subnets
   R 10.1.0.0 [120/1] via 209.165.200.229, 00:00:02, Serial10/0/0
   R 172.30.200.32/28 [120/2] via 209.165.200.229, 00:00:00, Serial10/0/0
   C 172.30.2.0/24 is directly connected, Loopback0
   C 172.30.1.0/24 is directly connected, FastEthernet0/0
   R 172.30.100.0/24 [120/2] via 209.165.200.229, 00:00:01, Serial10/0/0
   R 172.30.110.0/24 [120/2] via 209.165.200.229, 00:00:01, Serial10/0/0
   R 192.168.0.0/16 [120/1] via 209.165.200.229, 00:00:02, Serial10/0/0
   R 209.165.200.0/30 is subnetted, 2 subnets
   R 209.165.200.232 [120/1] via 209.165.200.229, 00:00:02, Serial10/0/0
   C 209.165.200.228 is directly connected, Serial10/0/0
```
Verifying RIPv2 Updates

- **RIPv2 Fully Converged Network:**

```plaintext
Router#conf t
Router(config)# router rip
Router(config-router)#version 2
Router(config-router)#no auto-summary

Router# show ip route
<output omitted>
10.0.0.0/16 is subnetted, 1 subnets
R 10.1.0.0 [120/1] via 209.165.200.233, 00:00:02, Serial0/0/1
  172.30.0.0/16 is variably subnetted, 6 subnets, 2 masks
  C 172.30.200.32/28 is directly connected, Loopback2
  C 172.30.200.16/28 is directly connected, Loopback1
R 172.30.2.0/24 [120/2] via 209.165.200.233, 00:00:01, Serial0/0/1
  R 172.30.110.0/24 [120/2] via 209.165.200.233, 00:00:01, Serial0/0/1
  C 172.30.100.0/24 is directly connected, FastEthernet0/0
  C 172.30.110.0/24 is directly connected, Loopback0
R 192.168.0.0/16 [120/1] via 209.165.200.233, 00:00:02, Serial0/0/1
  209.165.200.0/30 is subnetted, 2 subnets
  C 209.165.200.232 is directly connected, Serial0/0/1
  R 209.165.200.228 [120/1] via 209.165.200.233, 00:00:02, Serial0/0/1
```

- **Using the `debug` command, the update process can be verified.**

```plaintext
R2# debug ip rip
RIP: received v2 update from 209.165.200.234 on Serial0/0/1
  172.30.100.0/24 via 0.0.0.0 in 1 hops
  172.30.110.0/24 via 0.0.0.0 in 1 hops
  172.30.200.16/28 via 0.0.0.0 in 1 hops
RIP: sending v2 update to 224.0.0.9 via Serial0/0/0 (209.165.200.229)
RIP: build update entries
  10.1.0.0/16 via 0.0.0.0, metric 1, tag 0
  172.30.100.0/24 via 0.0.0.0, metric 2, tag 0
  172.30.110.0/24 via 0.0.0.0, metric 2, tag 0
  172.30.200.16/28 via 0.0.0.0, metric 2, tag 0
  172.30.200.32/28 via 0.0.0.0, metric 2, tag 0
  192.168.0.0/16 via 0.0.0.0, metric 1, tag 0
  209.165.200.232/30 via 0.0.0.0, metric 1, tag 0
```
Verifying RIPv2 Updates

Finally, remember that updates under RIPv2 are sent as a multicast to address 224.0.0.9.

RIPv1 sends updates as a broadcast (255.255.255.255).

In general:
- Multicasts can take up less bandwidth on the network.
- Multicasting updates require less processing by devices that are not RIP enabled.

RIP Version 2 (RIPv2)

Verifying and Troubleshooting RIPv2
Verifying and Troubleshooting RIPv2

- **Begin with the basics:**
  - Make sure all of the links (interfaces) are up and operational.
  - Check the cabling.
  - Check to make sure you have the correct IP address and subnet mask on each interface.
  - Remove any unnecessary configuration commands that are no longer necessary or have been replaced by other commands.

- **show ip route** command:

  ```
  Router# show ip route
  <output omitted>
  Gateway of last resort is not set
  
  10.0.0.0/16 is subnetwork, 1 subnets
  R  10.1.0.0/16 [209.165.200.229, 00:00:02, Serial0/0/0]
  172.30.0.0/16 is subnetwork, 6 subnets, 2 masks
  C  172.30.1.0/24 is directly connected, FastEthernet0/0
  C  172.30.2.0/24 is directly connected, Loopback0
  R  172.30.100.0/24 [209.165.200.229, 00:00:01, Serial0/0/0]
  R  172.30.110.0/24 [209.165.200.229, 00:00:01, Serial0/0/0]
  R  172.30.200.16/28 [209.165.200.229, 00:00:01, Serial0/0/0]
  R  172.30.200.32/28 [209.165.200.229, 00:00:01, Serial0/0/0]
  R  192.168.0.0/16 [209.165.200.229, 00:00:02, Serial0/0/0]
  209.165.200.0/30 is subnetwork, 2 subnets
  R  209.165.200.128 [209.165.200.229, 00:00:02, Serial0/0/0]
  C  209.165.200.228 is directly connected, Serial0/0/0
  ```

  First command to check for convergence. Look for 'expected' routes.
Verifying and Troubleshooting RIPv2

• **show ip interface brief** command:

```text
RI# show ip interface brief
 Interface        IP-Address    OK? Method Status        Protocol
 FastEthernet0/0   172.30.1.1   YES  NVRAM      up      up
 FastEthernet0/1   172.30.2.1   YES  NVRAM      up      up
 Serial10/0/0      209.165.200.230 YES  NVRAM      up      up
 Serial10/0/1      unassigned  YES  NVRAM      down     down
```

If a network is missing from the routing table, it is often because an interface is down or incorrectly configured.

The **show ip interface brief** command quickly verifies the status of all interfaces.

---

Verifying and Troubleshooting RIPv2

• **show ip protocols** command:

```text
RI# show ip protocols
Routing Protocol is “rip”
Sending updates every 30 seconds, next due in 29 seconds
Invalid after 180 seconds, hold down 180, flushed after 720
Outgoing update filter list for all interfaces is not.
Incoming update filter list for all interfaces is not.
Redistributing: rip
Default version control: send version 2, receive version 2
Interface    Send  Recv  Triggered RIP Key-chain
 FastEthernet0/0  2  2
 FastEthernet0/1  2  2
 Serial10/0/0  2  2
Automatic network summarization is not in effect
Maximum path: 4
Routing for Networks:
  172.30.0.0
  209.165.200.0
Routing Information Sources:
Gateway  Distance  Last Update
  209.165.200.229  120  00:00:18
Distance: (default is 120)
```
Verifying and Troubleshooting RIPv2

- **debug ip rip** command:

```plaintext
R2# debug ip rip
RIP: received v2 update from 209.165.200.234 on Serial0/0/1
  172.30.100.0/24 via 0.0.0.0 in 1 hops
  172.30.110.0/24 via 0.0.0.0 in 1 hops
  172.30.200.16/28 via 0.0.0.0 in 1 hops
RIP: sending v2 update to 224.0.0.9 via Serial0/0/0 (209.165.200.229)
RIP: build update entries
  10.1.0.0/16 via 0.0.0.0, metric 1, tag 0
  172.30.100.0/24 via 0.0.0.0, metric 2, tag 0
  172.30.110.0/24 via 0.0.0.0, metric 2, tag 0
  172.30.200.16/28 via 0.0.0.0, metric 2, tag 0
```

An excellent command to use to examine the contents of the routing updates that are sent and received by a router.

There can be times when a route is received by a router but is not added to the routing table.

---

Verifying and Troubleshooting RIPv2

- **ping** command:

```plaintext
R2# ping 172.30.2.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.2.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/20/20 ms
R2# ping 172.30.100.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.100.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/20/20 ms
```

An easy way to test end-to-end connectivity.
Verifying and Troubleshooting RIPv2

• **show running-config** command:
  ```
  Ri# show running-config
  !
  hostname R1
  !
  interface FastEthernet0/0
  ip address 172.30.1.1 255.255.255.0
  !
  interface FastEthernet0/1
  ip address 172.30.2.1 255.255.255.0
  !
  interface Serial0/0/0
  ip address 209.165.200.230 255.255.255.252
  clock rate 64000
  !
  <output omitted>
  router rip
  version 2
  network 172.30.0.0
  network 209.165.200.0
  no auto-summary
  ```

Common RIPv2 Issues:

- **Version:**
  - Although RIPv1 and RIPv2 can be made compatible with additional commands beyond the scope of this course, RIPv1 does not support discontiguous subnets, VLSM, or CIDR supernet routes.

- **Automatic Summarization:**
  - If there is a need or expectation for sending specific subnets and not just summarized routes, make sure that automatic summarization has been disabled with the `no auto-summary` command.
Verifying and Troubleshooting RIPv2

- **Common RIPv2 Issues:**
  - **Network Statements:**
    - Incorrectly configured or missing network statements configured with the `network` command.
    - The `network` command does two things:
      - It enables the routing protocol to send and receive updates on any local interfaces that belong to that network.
      - It includes the configured network in its routing updates to its neighboring routers.
    - A missing or incorrect network statement will result in missed routing updates and routing updates not being sent or received on an interface.