- Classful vs. Classless Routing -

Classful vs Classless routing protocols

Classful routing protocols do not send subnet mask information with their routing updates. A router running a classful routing protocol will react in one of two ways when receiving a route:

- If the router has a directly connected interface belonging to the same **major network**, it will apply the same subnet mask as that interface.
- If the router *does not* have any interfaces belonging to the same major network, it will apply the *classful* subnet mask to the route.

Belonging to same "major network" simply indicates that they belong to the same "classful" network. For example:

- 10.3.1.0 and 10.5.5.0 belong to the same major network (10.0.0.0)
- 10.1.4.5 and 11.1.4.4 *do not* belong to the same major network
- 192.168.1.1 and 192.168.1.254 belong to the same major network (192.168.1.0)
- 192.168.1.5 and 192.167.2.5 *do not* belong to the same major network.

Take the following example (assume the routing protocol is classful):

Router A   Router B   10.2.5.0/16

If Router B sends a routing update to Router A, it will *not* include the subnet mask for the 10.2.0.0 network. Thus, Router A must make a decision.

If Router A has a directly connected interface that belongs to the same major network (10.0.0.0), it will use the subnet mask of that interface for the route. For example, if Router A has an interface on the 10.4.0.0/16 network, it will apply a subnet mask of /16 to the 10.2.0.0 network.

If Router A *does not* have a directly connected interfacing belonging to the same major network, it will apply the classful subnet mask of /8. This can obviously cause routing difficulties.

When using classful routing protocols, the subnet mask must remain consistent throughout your entire network.

Classful vs Classless routing protocols (continued)

Classless routing protocols *do* send the subnet mask with their updates. Thus, Variable Length Subnet Masks (VLSMs) are allowed when using classless routing protocols.

Examples of *classful* routing protocols include RIPv1 and IGRP.

Examples of *classless* routing protocols include RIPv2, EIGRP, OSPF, and IS-IS.

The IP Classless Command

The preceding section described how classful and classless protocols differ when sending *routing updates.* Additionally, the router itself can operate either "classfully" or "classlessly" when actually *routing data*.

When a "classful" router has an interface connected to a major network, *it believes it knows all routes connected to that major network.*

For example, a router may have an interface attached to the 10.1.5.0/24 network. It may also have routes from a routing protocol, also for the 10.x.x.x network.

However, if the classful router receives a packet destined for a 10.x.x.x subnet that is *not* in the routing table, it will *drop* that packet, ***even if there is a default route***.

Again, a classful router believes it knows all possible destinations in a major network.

To configure your router in "classful" mode:
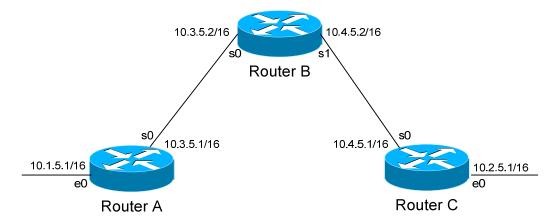
> **Router(config)#** *no ip classless*

To configure your router in "classless" mode (this is default in IOS 12.0 and greater):

> **Router(config)#** *ip classless*

(Reference: http://www.cisco.com/en/US/tech/tk365/technologies_tech_note09186a0080094823.shtml)

Limitations of Classful Routing Example

The following section will illustrate the limitations of classful routing, using RIPv1 as an example. Consider the following diagram:

This particular scenario will work when using RIPv1, despite the fact that we've subnetted the major 10.0.0.0 network. Notice that the subnets are contiguous (that is, they belong to the same major network), and use the same subnet mask.

When Router A sends a RIPv1 update to Router B via Serial0, it will not include the subnet mask for the 10.1.0.0 network. However, because the 10.3.0.0 network is in the same major network as the 10.1.0.0 network, it will **not summarize** the address. The route entry in the update will simply state "10.1.0.0".

Router B will accept this routing update, and realize that the interface receiving the update (Serial0) belongs to the same major network as the route entry of 10.1.0.0. It will then apply the subnet mask of its Serial0 interface to this route entry.

Router C will similarly send an entry for the 10.2.0.0 network to Router B. Router B's routing table will thus look like:
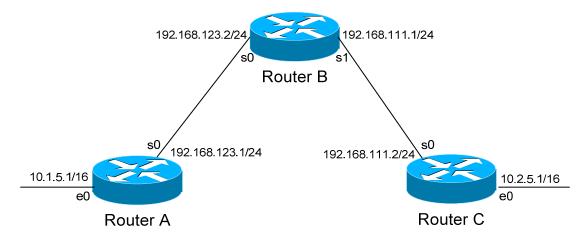
```
RouterB#  show ip route

Gateway of last resort is not set

        10.0.0.0/16 is subnetted, 4 subnets
C     10.3.0.0 is directly connected, Serial0
C     10.4.0.0 is directly connected, Serial1
R     10.1.0.0 [120/1] via 10.3.5.1, 00:00:00, Serial0
R     10.2.0.0 [120/1] via 10.4.5.1, 00:00:00, Serial1
```

Limitations of Classful Routing Example

Consider the following, slightly altered, example:

We'll assume that RIPv1 is configured correctly on all routers. Notice that our networks are no longer contiguous. Both Router A and Router C contain *subnets* of the 10.0.0.0 major network (10.1.0.0 and 10.2.0.0 respectively).
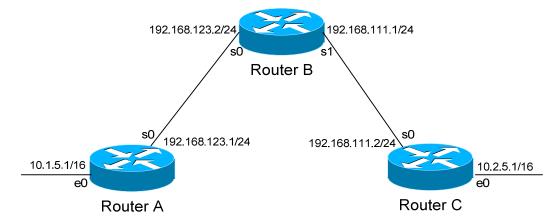
Separating these networks now are two Class C subnets (192.168.123.0 and 192.168.111.0).

Why is this a problem? Again, when Router A sends a RIPv1 update to Router B via Serial, it will not include the subnet mask for the 10.1.0.0 network. Instead, Router A will consider itself a **border** router, as the 10.1.0.0 and 192.168.123.0 networks *do not* belong to the same major network. Router A will **summarize** the 10.1.0.0/16 network to its classful boundary of 10.0.0.0/8.

Router B will accept this routing update, and realize that it does not have a directly connected interface in the 10.x.x.x scheme. Thus, it has no subnet mask to apply to this route. Because of this, Router B will install the summarized 10.0.0.0 route into its routing table.

Router C, similarly, will consider itself a border router between networks 10.2.0.0 and 192.168.111.0. Thus, Router C will *also* send a summarized 10.0.0.0 route to Router B.

Limitations of Classful Routing Example

Router B's routing table will then look like:

RouterB# *show ip route*

```
Gateway of last resort is not set

C     192.168.123.0 is directly connected, Serial0
C     192.168.111.0 is directly connected, Serial1
R     10.0.0.0 [120/1] via 192.168.123.1, 00:00:00, Serial0
                [120/1] via 192.168.111.2, 00:00:00, Serial1
```

That's right, Router B now has two *equal* metric routes to get to the summarized 10.0.0.0 network, one through Router A and the other through Router C. Router B will now *load balance* all traffic to *any* 10.x.x.x network between routers A and C. Suffice to say, this is not a good thing. ☺

It gets better. Router B then tries to send routing updates to Router A and Router C, including the summary route of 10.0.0.0/8. Router A's routing table looks like:

RouterA# *show ip route*

```
Gateway of last resort is not set

C     192.168.123.0 is directly connected, Serial0
       10.0.0.0/16 is subnetted, 1 subnet
C     10.1.0.0 is directly connected, Ethernet0
```

Router A will receive the summarized 10.0.0.0/8 route from Router B, and will reject it. This is because it already has the summary network of 10.0.0.0 in its routing table, and it's directly connected. Router C will respond exactly the same, and the 10.1.0.0/16 and 10.2.0.0/16 networks will never be able to communicate.

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