Chapter 4: Routing Fundamentals Route Summarization
Book Title: Guide to Network Defense and Countermeasures
Printed By: Andrew Kornrumpf (akornrumpf0001@kctcs.edu)

Route Summarization

Route summarization (The process of shortening the network identifier in a subnet mask to allow one network route to represent multiple network routes. (Also called *supernetting*.)) (also called **supernetting** (See *route summarization*.)) allows service providers to assign addresses in a classless fashion and make more efficient use of available Internet addresses. IPv6 will eventually provide many more IP addresses, but IPv4 will not be phased out overnight. Until then, better ways to use IPv4 addresses are needed.

For example, to provide an organization with 2000 IP addresses, eight traditional Class C networks must be used (see Table 4-1).

Table 4-1

Eight Traditional Class C Networks

Traditional Class C address range	Subnet mask	CIDR prefix
194.28.0.1–194.28.0.254	255.255.255.0	/24
194.28.1.1–194.28.1.254	255.255.255.0	/24
194.28.2.1–194.28.2.254	255.255.255.0	/24
194.28.3.1–194.28.3.254	255.255.255.0	/24
194.28.4.1–194.28.4.254	255.255.255.0	/24
194.28.5.1–194.28.5.254	255.255.255.0	/24

Traditional Class C address range	Subnet mask	CIDR prefix
194.28.6.1–194.28.6.254	255.255.255.0	/24
194.28.7.1–194.28.7.254	255.255.255.0	/24

Table 4-1 lists both the subnet mask and Classless Interdomain Routing (CIDR) notation. Both show that the first three octets (24 bits) of the IP addresses represent the network identifier and that the last octet represents the host identifier. To provide packet-forwarding services to all these networks, the routers would need to have each route represented individually in their routing tables. Currently, Internet routers contain about 400,000 routes.

You can follow the daily changes of Internet routes at www.cidrreport.org/as2.0/#General_Status.

Route summarization allows you to create a single routing table entry that would represent all these routes. To summarize routes, convert the IP addresses to binary and then count the number of bits that are common to all networks. Table 4-2 demonstrates this process.

Table 4-2

Determination of Matching Network Bits in Each Class C Network

Class C network	Binary representation (common network bits in bold)
194.28.0.*x*	**11000010.00011100.00000**000.*x*
194.28.1.*x*	**11000010.00011100.00000**001.*x*
194.28.2.*x*	**11000010.00011100.00000**010.*x*
194.28.3.*x*	**11000010.00011100.00000**011.*x*
194.28.4.*x*	**11000010.00011100.00000**100.*x*

Class C network	Binary representation (common network bits in bold)
194.28.5.*x*	**11000010.00011100.00000**101.*x*
194.28.6.*x*	**11000010.00011100.00000**110.*x*
194.28.7.*x*	**11000010.00011100.00000**111.*x*

Because all eight networks have the same first 21 bits, a single entry in a routing table for 194.28.0.0/21 would summarize all eight networks. If the first 21 bits of a packet's destination address matched the first 21 bits of a network address listed in Table 4-2, the packet would be sent to a predetermined router where the Internet meets your network: your border router. Thus, while your network routers could easily handle these eight networks, the Internet routers would only need to know one route to reach them all. With route summarization, Internet routers need about half the routing table entries (currently about 220,000) compared to all the networks to which packets can be delivered.

A concept related to route summarization is **variable length subnet masking (VLSM)** (A means of allocating IP addressing according to the network's needs that involves applying masks of varying sizes to the same network. This method creates subnets within subnets and multiple divisions of an IP network.) . VLSM uses subnet masks of different lengths on the same network to assign network addresses based on need instead of using a generic masking scheme. For example, you might have a Class C network divided into subnets, with each one supporting 62 hosts. In reality, only 15 to 20 hosts are attached to each subnet, so the additional addresses are wasted. With VLSM, you can divide the network into subnets of varying sizes to support your users but make better use of your available addresses, instead of using the network-wide classful routing.

This can be especially useful when setting the endpoint addresses for links between branch offices. Instead of using 62 host addresses to provide the subnet between the branch routers—a subnet in which only two addresses are needed—you can use VLSM to allocate only two addresses to the branch-to-branch link and use the other 60 addresses to divide among other subnets.

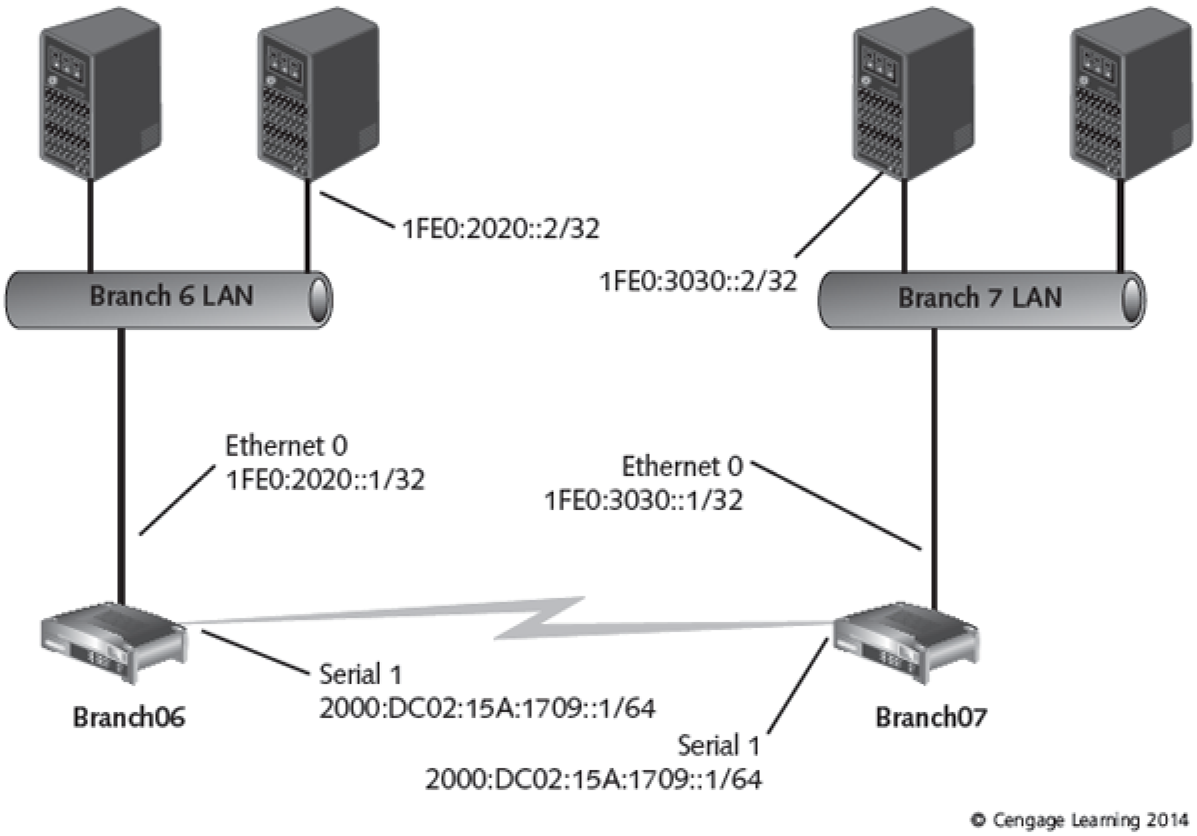
IPv6 Routing

As you learned in Chapter 2, IPv6 is gradually replacing IPv4. Microsoft operating systems now ship with IPv6 enabled by default. The routing protocols have been updated: RIP has upgraded to the IPv6-compliant RIPng. Similarly, OSPFv3, EIGRP for IPv6, and IS-IS for IPv6 are all IPv6 compliant. The U.S. government has mandated that all of its agencies must deploy IPv6 on their public Web sites before September 30, 2012, and that they must upgrade their entire internal infrastructure to IPv6 before September 30, 2014.

Cisco routers and others are now capable of supporting IPv6. The following example examines the configuration of the Branch06 router in Figure 4-2.

Figure 4-2

IPv6 addressing in branch networks



The Branch06 router connects the Branch 6 LAN to the Branch 7 LAN. The hosts on the Branch 6 LAN are in the IPv6 network with the prefix of 1FE0:2020, as indicated by the 32-bit mask. The addressed host has a link-local (private) IP address of 1FE0:2020::2/32, and the Branch06 router has an Ethernet 0 address on the same network, 1FE0:2020::1/32. The Branch06 router also has a connection through Serial 1 to the router at the Branch 7 LAN. This WAN network uses global unicast addresses (public) with the 64-bit prefix of 2000:DC02:15A:1709. The Branch06 router's WAN address is 2000:DC02:15A:1709::1/64.

You would take the following steps to address the Branch06 router. First, you would enable IPv6 on the router using the following command:

```
Branch06(config)#ipv6 unicast-routing
```

The following commands configure Ethernet 0:

```
Branch06(config)#interface FastEthernet 0/0
Branch06(config-if)#ipv6 address 1FE0:2020::1/32
Branch06(config-if)#no shutdown
Branch06(config-if)#exit
```

The following commands configure Serial 1:

After this, you could easily install the dynamic routing protocol RIPng because no more "network" statements would be required, as in RIPv1 and v2.

The tag "RIPng" can be any combination of letters and numbers; the tag is used to identify the RIP process. Then RIP is applied to each interface that will participate in RIP routing.

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