Route Summarization

Route summarization is a method to consolidate a group of networks into a single network with the main objective of reducing the routing table size and complexity. Let's take a look at the following example:

Without route summarization, R2 has to have specific routes in its routing table to reach the three stub networks connected to R1. With route summarization, R2 can only have a summary route to reach all R1’s stub networks. R1 will locally determine which interface to use to route the packet. To determine a summary route use the following procedure:

1. Identify the network with the highest and lowest IP addresses, 8.8.8.32/28 and 8.8.8.0/28 on R1.
2. Convert to binary the octet where the IPs start to differ.
   - 8.8.8.32 -> 8.8.8.0010 0000
   - 8.8.8.0  -> 8.8.8.0000 0000
3. Determine up to where both IPs match and convert to decimal considering the remaining bits to the right equal zero, X=0.
   - 8.8.8.00XX XXXX -> 8.8.8.0000 0000 -> 8.8.8.0
4. Count all bits where both IPs match to determine the subnet mask.
   - 24 + 2 = 26
5. Create your summarized network, which is composed using step 3 and 4’s results.
   - 8.8.8.0/26

Let’s repeat the procedure for R2:

1. 8.8.9.48/30 and 8.8.8.0/26.
2. 8.8.0000 1001.0011 0000 and 8.8.0000 1000.0000 0000
3. 8.8.0000 100X.XXXX XXXX -> 8.8.0001 0000.0000 0000 -> 8.8.8.0
4. 16 + 7 = 23
5. 8.8.8.0/23

Network 8.8.8.0/23 can be used to summarize all four network behind R2.
Route summarization is very useful. However, there are cases where it might create some problems. For example, networks connected to R1 are summarized into 8.8.8.0/26. This summary also includes either network 8.8.8.24/29 or networks 8.8.8.24/30 and 8.8.8.28/30, which actually do not exist on this example. So, an IP packet with destination address 8.8.8.25 may unnecessary travel all the way to R1 to be discarded. This situation is explained below.

Good network planning should always be accomplished to help successful network summarization. Ideally all networks should be continuous or as continuous as possible like the ones shown on this example. It would be very difficult or unpractical to summarize discontinuous networks like; 10.1.55.0/24 and 200.26.58.28/30 for instance. The summarized network will include too many combinations making unpractical to summarize them.

The truncated configurations below allow static routing between R1 and R2 without summarization.

```
R2
!
hostname R2
!
interface Serial0/0/0
  ip address 8.8.9.50 255.255.255.252
duplex auto
speed auto
!
ip classless
ip route 8.8.8.0 255.255.255.240 Serial0/0/0
ip route 8.8.8.32 255.255.255.240 Serial0/0/0
ip route 8.8.8.16 255.255.255.248 Serial0/0/0
!
```
**R1**

! hostname R1

! interface Serial0/0/0
   ip address 8.8.9.49 255.255.255.252
duplex auto
speed auto

! interface FastEthernet0/1
   ip address 8.8.8.14 255.255.255.240
duplex auto
speed auto

! interface FastEthernet1/0
   ip address 8.8.8.22 255.255.255.248
duplex auto
speed auto

! interface FastEthernet1/1
   ip address 8.8.8.46 255.255.255.240
duplex auto
speed auto

! Notice that only static routes have been created at R2.
Let see what happens on R1 when pinging 8.8.8.1 from R2,
An IP packet coming from 8.8.9.50 to 8.8.8.1 is routed based on the routing information base (RIB). The action taken by R1 is to forward the packet. The same process takes place on the reversed direction.

When trying to ping an IP address on network 8.8.8.24/29 (i.e. 8.8.8.26) nothing happens on R1 because there is no route on R2 to reach such a network. Basically, R2 flagged the packet as unroutable and drop it without leaving any R2's interface. This is an advantage of not using route summarization.

Let's now configure network summarization on R2. R1 keeps the same configuration. By the way, specific routes have to be manually removed from routing table on R2 using the `no ip route` command.

Notice that, this is the same action taken by R1 when no network summarization was configured on R2.
When trying to ping an IP on network 8.8.8.24/29 (i.e. 8.8.8.26) R1 drops the IP packet because there is no route based on the RIB. It also sends a message back to R2 to let it know that the host is unreachable. This is an disadvantage of using route summarization. There was unnecessary traffic flow between R1 and R2 over the serial link.

**R1**

*IP: s=8.8.9.50 (Serial0/0/0), d=8.8.8.26 len 128, unroutable*

*IP: tableid=0, s=8.8.9.49 (Serial0/0/0), d=8.8.9.50 (Serial0/0/0), routed via RIB*

*IP: s=8.8.9.49 (local), d=8.8.9.50 (Serial0/0/0), len 156, sending*

*ICMP: dst (8.8.8.26) host unreachable sent to 8.8.9.50*