7.4.4 Routing Optimization Facts

Several commonly used methods for optimizing network routing include configuring the following:

- Administrative distance values
- Route summarization
- Redundant default gateway routers

The *administrative distance* is a number assigned to a source of routing information (such as a static route or a specific routing protocol). The router uses this value to select the source of information to use when multiple routes to a destination exist. A smaller number indicates a more trusted route. The following table shows the default administrative values for a Cisco router:

Route Source	Administrative Distance
Connected interface	0
Static route	1
EIGRP summary route	5
EIGRP internal route	90
IGRP	100
OSPF	110
RIP	120
EIGRP external route	170

You can modify how routes are selected by modifying the administrative distance associated with a source.

Routers can use multiple routing protocols to learn about routes to other networks. Additionally, there might be multiple paths between any two points. When making routing decisions, the router uses the following criteria for choosing between multiple routes:

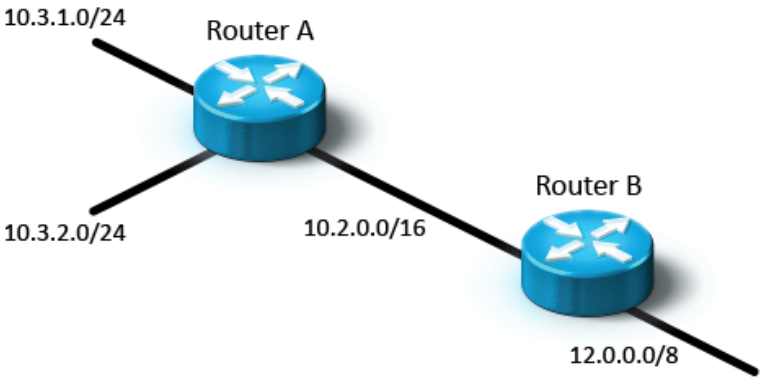
1. If a router has learned of two routes to a single network through different routing protocols (such as RIP and OSPF), it will choose the route with the lowest administrative distance (OSPF in this example).
2. If a router has learned of two routes through the same protocol (e.g., two routes through EIGRP), the router will choose the route that has the best cost as defined by the routing metric (for EIGRP, the link with the highest bandwidth and least delay will be used).

Another way to optimize routing is to implement *route summarization*. Route summarization groups contiguous networks that use the same routing path, advertising a single route as the destination for the grouped subnets. Keep in mind that summarization:

- Reduces the size of the routing table. A single route to the summarized network takes the place of multiple routes to individual subnets.
- Speeds convergence. The accessibility of each subnet address is indicated by the accessibility of the summarized address.
- Retains all necessary routing information, so all networks are still reachable after summarization.
- Can happen in one of two ways:

Method	Description
Automatic	With automatic summarization, the router identifies adjacent networks and calculates the summarized route. ▪ Auto-summarization is supported on classless and classful routing protocols. ▪ Auto-summarization uses the default class boundary to summarize routes. ▪ RIP (version 1 and version 2) and EIGRP support auto-summarization; OSPF does not. ▪ For RIPv2 and EIGRP, you can disable automatic summarization.
Manual	With manual summarization, an administrator identifies the summarized route to advertise. The specified route includes the summarized subnet address with the subnet mask that includes all summarized subnets.

Automatic summarization sends route summaries along class boundaries on a network of a different classful network only when advertising those routes. Consider the following graphic:



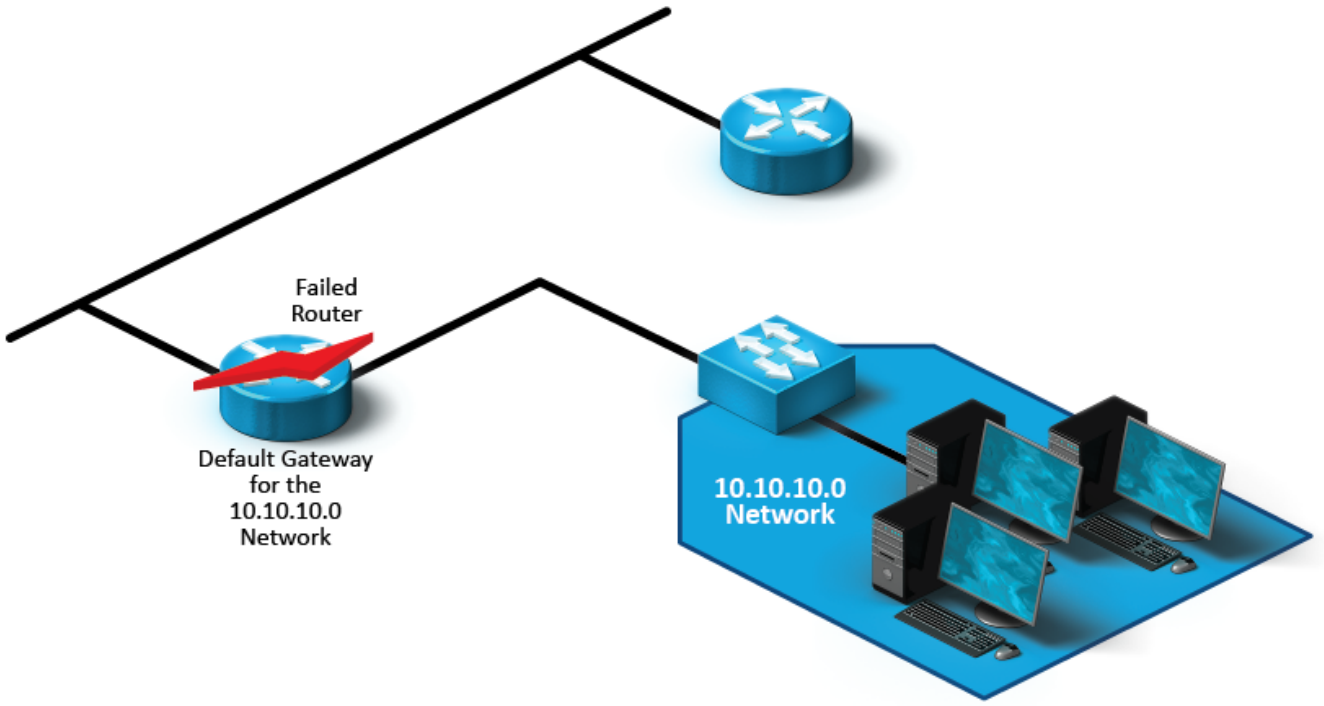
If both routers were using automatic summarization in this example:

- Router A would not automatically summarize routes from the 10.3.1.0/24 or the 10.3.2.0/24 networks when advertising those networks to Router B. This is because subnet 10.2.0.0/16, which connects the two routers, is in the same classful network (10.0.0.0/8) as the subnets connected to Router A.
- Router B would automatically summarize all routes as 10.0.0.0/8 when advertising routes on the 12.0.0.0/8 network. This is because the network is a different classful network than the 10.0.0.0/8 network.

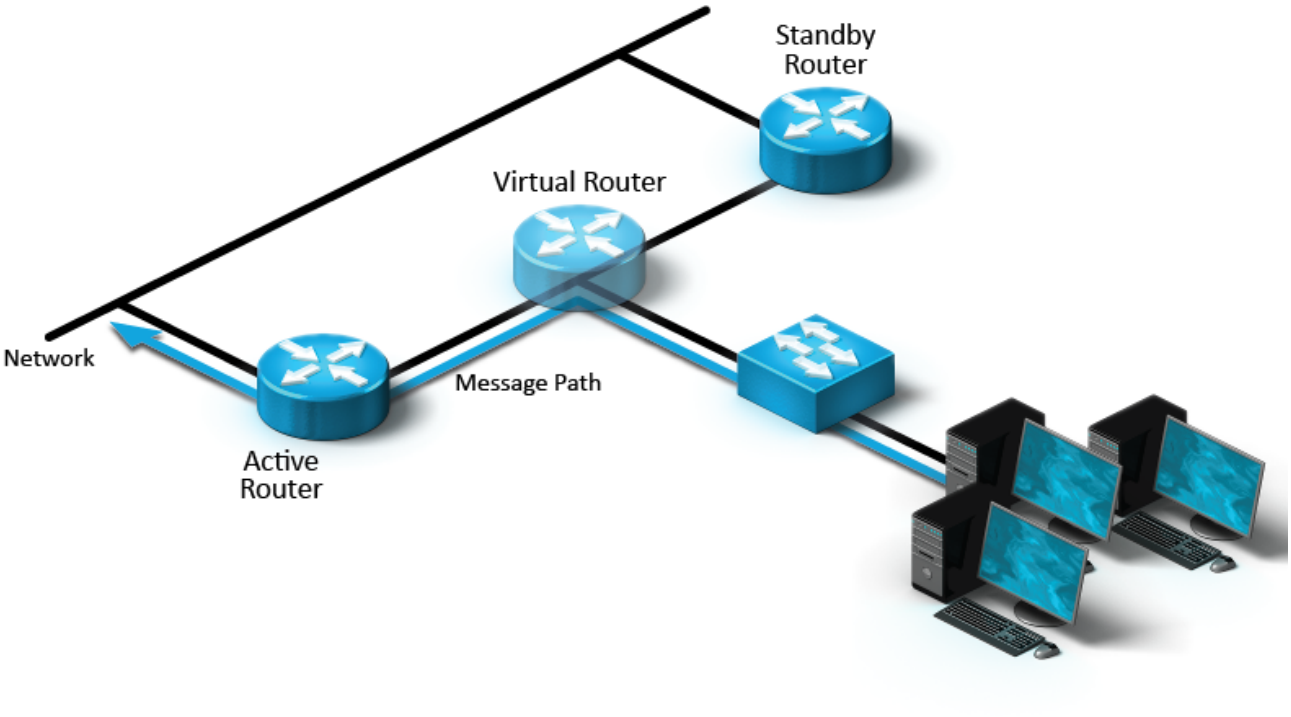
Route summarization can also be used to advertise multiple classful network addresses as a single summarized route. For example, the subnets 192.168.1.0/24 through 192.168.255.0/24 could be summarized as the single route 192.168.0.0/16.

Network hosts are typically configured with a single default gateway (the first-hop router) to allow them to communicate outside the local subnet. However, if the default gateway were to fail, the hosts would be limited to communicating only within the subnet, effectively disconnecting the hosts from the rest of the network. This is shown in the figure below. Even if there is a redundant router that could serve as a replacement gateway, there is no dynamic way for hosts to switch to a redundant default gateway IP address. To use the redundant router in this situation, users must statically change their default gateway address, which requires them to:

- Realize that the router is down.
- Know the IP address of the redundant router.
- Know how to manually change the IP address of their default gateway.



The *First Hop Redundancy Protocol* (FHRP) is a fault-tolerant approach that ensures hosts can communicate outside their local subnet. FHRP allows hosts to dynamically switch between the main router and one or more redundant routers should an outage occur. By doing this, FHRP protects against a single point of failure. Using FHRP, a group of two or more routers actively manage a single virtual router MAC address and IP address (as seen below) as their default router address. This configuration ensures that if a router fails, a backup router takes responsibility as the default gateway. With FHRP, LAN clients send traffic to the virtual router, and the physical router handles the forwarding of that traffic. The difference between the virtual and physical routers is transparent to clients.



FHRP is not an actual protocol. Instead, it identifies a family of protocols. FHRP includes the following:

- Hot Standby Router Protocol (HSRP)
- Virtual Router Redundancy Protocol (VRRP)
- Gateway Load Balancing Protocol (GLBP)