

Help for Network Administrators

IP Routing



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Ravi Malhotra

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by Ravi Malhotra

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[C]

Dynamic Routing

After the public library, our Canadian visitor jumps into a taxi to go crash at a friend's place in Brooklyn. "Go over the Brooklyn Bridge," she tells the driver. They head downtown. Suddenly, the driver slams on his brakes and makes an abrupt turn. Cars all around jam on their brakes, and pedestrians run hither and thither. "The radio said it is an hour to go over the bridge! We will take the tunnel!" the driver shouts to the back seat. This is an example of dynamic routing in a transportation system. What is dynamic routing in IP networks? Dynamic routing protocols allow each router to automatically discover one or more paths to each destination in the network. When the network topology changes, such as when new paths are added or when paths go out of service, dynamic routing protocols automatically adjust the contents of the routing table to reflect the new network topology.

Dynamic routing relies on (frequent!) updates to discover changes in network topology. In the example in Figure 1-3, when the path $R3 \rightarrow R4$ is added to the network it can be automatically discovered by a routing protocol, such as RIP, EIGRP, or OSPF.

The routing protocols in use today are based on one of two algorithms: *Distance Vector* or *Link State*. Distance Vector (DV) algorithms broadcast routing information to all neighboring routers. In other words, each router tells all of its neighbors the routes it knows. When a router receives a route (from a neighbor) that is not in its routing table, it adds the route to its table; if the router receives a route that is already in its routing table, it keeps the *shorter* route in its table. DV algorithms are sometimes also described as routing by rumor: bad routing information propagates just as quickly as good information. Link State algorithms operate on a different paradigm. First, each router constructs its own topological map of the entire network, based on updates from neighbors. Next, each router uses Dijkstra's algorithm to compute the *shortest* path to each destination in this graph. Both DV and Link State algorithms are described in further detail in the chapters that follow.

In the previous paragraph, we spoke of the "shorter" or "shortest" path in the context of both DV and Link State algorithms. Since a router may know of multiple paths to a destination, each routing protocol must provide a mechanism to discover the "shorter" or "shortest" path based on one or more of the following criteria: number of hops, delay, throughput, traffic, reliability, etc. A *metric* is usually attached to this combination; lower metric values indicate "shorter" paths. For each routing protocol discussed in the chapters that follow, we will describe how the route metric is computed.

A network under a single administrative authority is described as an *autonomous system* (AS) in routing parlance. *Interior gateway protocols* (IGPs) are designed to support the task of routing internal to an AS. IGPs have no concept of political boundaries

then proceed to the indicated platforms. Similarly, a routing table must contain at least two pieces of information: the destination network and the next hop toward that destination. This reflects a fundamental paradigm of IP routing: hop-by-hop routing. In other words, a router does not know the full path to a destination, but only the next hop to reach the destination.

Departures		
Time	Destination	Track number
9:18	New Haven	17
9:21	Cos Cob	22
9:24	Valhalla	11
9:31	Dover Plains	19
9:42	Bronxville	12

Figure 1-4. Destinations and track numbers at Grand Central Terminal

Routes are installed in the routing table as they are learned through the mechanisms we have been discussing: directly connected networks, static routes, and dynamic routing protocols. A typical routing table in a Cisco router looks like this:

```
Router>show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

2    177.130.0.0/30 is subnetted, 2 subnets
   C      177.130.17.152 is directly connected, Serial1
   C      177.130.17.148 is directly connected, Serial0
3    10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
4    S      10.0.0.0/8 [1/0] via 160.4.115.74
5    S      10.254.101.0/24 [1/0] via 160.4.101.4
6    162.162.0.0/24 is subnetted, 2 subnets
   O IA    162.162.101.0 [110/3137] via 11.175.238.4, 02:16:02, Ethernet0
           [110/3137] via 11.175.238.3, 02:16:02, Ethernet0
   O IA    162.162.253.0 [110/3127] via 11.175.238.4, 02:25:43, Ethernet0
           [110/3127] via 11.175.238.3, 02:25:43, Ethernet0
7    O E2 192.188.106.0/24 [110/20] via 11.175.238.33, 20:49:59, Ethernet0
...
```

Note that the first few lines of the output attach a code to the source of the routing information: “C” and “S” denote “connected” and “static”, respectively, as we saw earlier, “I” denotes IGRP, etc. This code is prepended to each routing entry in the routing table, signifying the source of that route.