

3.5.2 Routing Information Protocol

- The Routing Information Protocol (RIP) is one of the most widely used intradomain routing protocols based on the distance-vector routing algorithm we described earlier.
- RIP was started as part of the Xerox Network System (XNS), but it was the Berkeley Software Distribution (BSD) version of UNIX that helped make the use of RIP widespread.

Hop Count

- A router in this protocol basically implements the distance-vector routing algorithm.
- First, since a router in an AS needs to know how to forward a packet to different networks (subnets) in an AS, RIP routers advertise the cost of reaching different networks instead of reaching other nodes in a theoretical graph. In other words, the cost is defined between a router and the network in which the destination host is located.
- Second, to make the implementation of the cost simpler (independent from performance factors of the routers and links, such as delay, bandwidth, and so on), the cost is defined as the number of hops, which means the number of networks (subnets) a packet needs to travel through from the source router to the final destination host. Note that the network in which the source host is connected is not counted in this calculation because the source host does not use a forwarding table; the packet is delivered to the default router. Figure 3.5.2.1 shows the concept of hop count advertised by three routers from a source host to a destination host.
- In RIP, the maximum cost of a path can be 15, which means 16 is considered as infinity (no connection). For this reason, RIP can be used only in autonomous systems in which the diameter of the AS is not more than 15 hops.

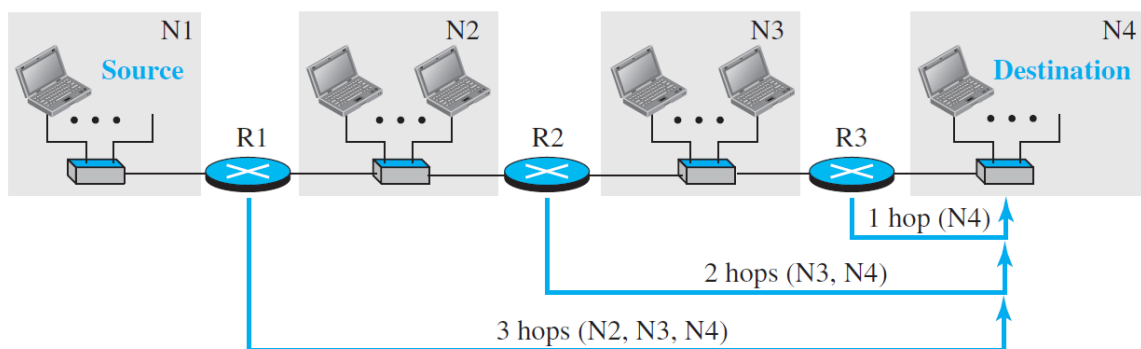


Figure 3.5.2.1 Hop counts in RIP

Forwarding Tables

- Although the distance-vector algorithm we discussed in the previous section is concerned with exchanging distance vectors between neighboring nodes, the routers in an autonomous system need to keep forwarding tables to forward packets to their destination networks.
- A forwarding table in RIP is a three-column table in which the first column is the address of the destination network, the second column is the address of the next router to which the packet should be forwarded, and the third column is the cost (the number of hops) to reach the destination network.

- Figure 3.5.2.2 shows the three forwarding tables for the routers in Figure 3.5.2.1. Note that the first and the third columns together convey the same information as does a distance vector, but the cost shows the number of hops to the destination networks.

Forwarding table for R1			Forwarding table for R2			Forwarding table for R3		
Destination network	Next router	Cost in hops	Destination network	Next router	Cost in hops	Destination network	Next router	Cost in hops
N1	—	1	N1	R1	2	N1	R2	3
N2	—	1	N2	—	1	N2	R2	2
N3	R2	2	N3	—	1	N3	—	1
N4	R2	3	N4	R3	2	N4	—	1

Figure 3.5.2.2 Forwarding Tables

- Although a forwarding table in RIP defines only the next router in the second column, it gives the information about the whole least-cost tree based on the second property of these trees, discussed in the previous section.
- For example, R1 defines that the next router for the path to N4 is R2; R2 defines that the next router to N4 is R3; R3 defines that there is no next router for this path. The tree is then $R1 \rightarrow R2 \rightarrow R3 \rightarrow N4$.
- A question often asked about the forwarding table is what the use of the third column is. The third column is not needed for forwarding the packet, but it is needed for updating the forwarding table when there is a change in the route, as we will see shortly.

RIP Implementation

- RIP is implemented as a process that uses the service of UDP on the well-known port number 520.
- In BSD, RIP is a daemon process (a process running in the background), named routed (abbreviation for route daemon and pronounced route-dee). This means that, although RIP is a routing protocol to help IP route its datagrams through the AS, the RIP messages are encapsulated inside UDP user datagrams, which in turn are encapsulated inside IP datagrams. In other words, RIP runs at the application layer, but creates forwarding tables for IP at the network layer.
- RIP has gone through two versions: RIP-1 and RIP-2. The second version is backward compatible with the first version; it allows the use of more information in the RIP messages that were set to 0 in the first version. We discuss only RIP-2 in this section.

RIP Messages

- Two RIP processes, a client and a server, like any other processes, need to exchange messages.
- RIP-2 defines the format of the message, as shown in Figure 3.5.2.3.
- Part of the message, which we call entry, can be repeated as needed in a message.
- Each entry carries the information related to one line in the forwarding table of the router that sends the message.

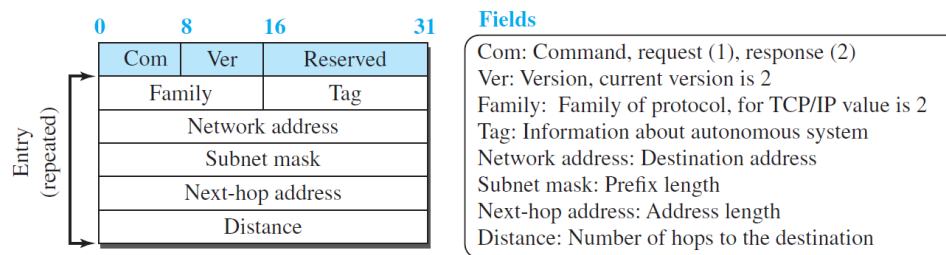


Figure 3.5.2.3 RIP Message Format

- RIP has two types of messages: request and response.
- A request message is sent by a router that has just come up or by a router that has some time-out entries. A request message can ask about specific entries or all entries.
- A response (or update) message can be either solicited or unsolicited. A solicited response message is sent only in answer to a request message. It contains information about the destination specified in the corresponding request message. An unsolicited response message, on the other hand, is sent periodically, every 30 seconds or when there is a change in the forwarding table.

RIP Algorithm

- RIP implements the same algorithm as the distance-vector routing algorithm we discussed in the previous section.
- However, some changes need to be made to the algorithm to enable a router to update its forwarding table:
 - Instead of sending only distance vectors, a router needs to send the whole contents of its forwarding table in a response message.
 - The receiver adds one hop to each cost and changes the next router field to the address of the sending router.
 - We call each route in the modified forwarding table **the received route** and each route in the old forwarding table **the old route**. The received router selects the old routes as the new ones except in the following three cases:
 - If the received route does not exist in the old forwarding table, it should be added to the route.
 - If the cost of the received route is lower than the cost of the old one, the received route should be selected as the new one.
 - If the cost of the received route is higher than the cost of the old one, but the value of the next router is the same in both routes, the received route should be selected as the new one. This is the case where the route was actually advertised by the same router in the past, but now the situation has been changed. *For example, suppose a neighbor has previously advertised a route to a destination with cost 3, but now there is no path between this neighbor and that destination. The neighbor advertises this destination with cost value infinity (16 in RIP). The receiving router must not ignore this value even though its old route has a lower cost to the same destination.*

- The new forwarding table needs to be sorted according to the destination route (mostly using the longest prefix first).

Timers in RIP

- RIP uses three timers to support its operation.
 - **The periodic timer**
 - It controls the advertising of regular update messages.
 - Each router has one periodic timer that is randomly set to a number between 25 and 35 seconds (to prevent all routers sending their messages at the same time and creating excess traffic).
 - The timer counts down; when zero is reached, the update message is sent, and the timer is randomly set once again.
 - **The expiration timer**
 - It governs the validity of a route.
 - When a router receives update information for a route, the expiration timer is set to 180 seconds for that particular route.
 - Every time a new update for the route is received, the timer is reset. If there is a problem on an internet and no update is received within the allotted 180 seconds, the route is considered expired and the hop count of the route is set to 16, which means the destination is unreachable.
 - Every route has its own expiration timer.
 - **The garbage collection timer**
 - It is used to purge a route from the forwarding table.
 - When the information about a route becomes invalid, the router does not immediately purge that route from its table. Instead, it continues to advertise the route with a metric value of 16.
 - At the same time, a garbage collection timer is set to 120 seconds for that route. When the count reaches zero, the route is purged from the table.
 - This timer allows neighbors to become aware of the invalidity of a route prior to purging.

Performance

- Update Messages.
 - The update messages in RIP have a very simple format and are sent only to neighbors; they are local.
 - They do not normally create traffic because the routers try to avoid sending them at the same time.
- Convergence of Forwarding Tables.
 - RIP uses the distance-vector algorithm, which can converge slowly if the domain is large, but, since RIP allows only 15 hops in a domain (16 is considered as infinity), there is normally no problem in convergence.

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- The only problems that may slow down convergence are count-to-infinity and loops created in the domain; use of poison-reverse and split-horizon strategies added to the RIP extension may alleviate the situation.
- Robustness.
 - Distance-vector routing is based on the concept that each router sends what it knows about the whole domain to its neighbors. This means that the calculation of the forwarding table depends on information received from immediate neighbors, which in turn receive their information from their own neighbors.
 - If there is a failure or corruption in one router, the problem will be propagated to all routers and the forwarding in each router will be affected.

Example

- Figure 3.5.2.4 shows a more realistic example of the operation of RIP in an autonomous system.
- First, the figure shows all forwarding tables after all routers have been booted.
- Then we show changes in some tables when some update messages have been exchanged.
- Finally, we show the stabilized forwarding tables when there is no more change.

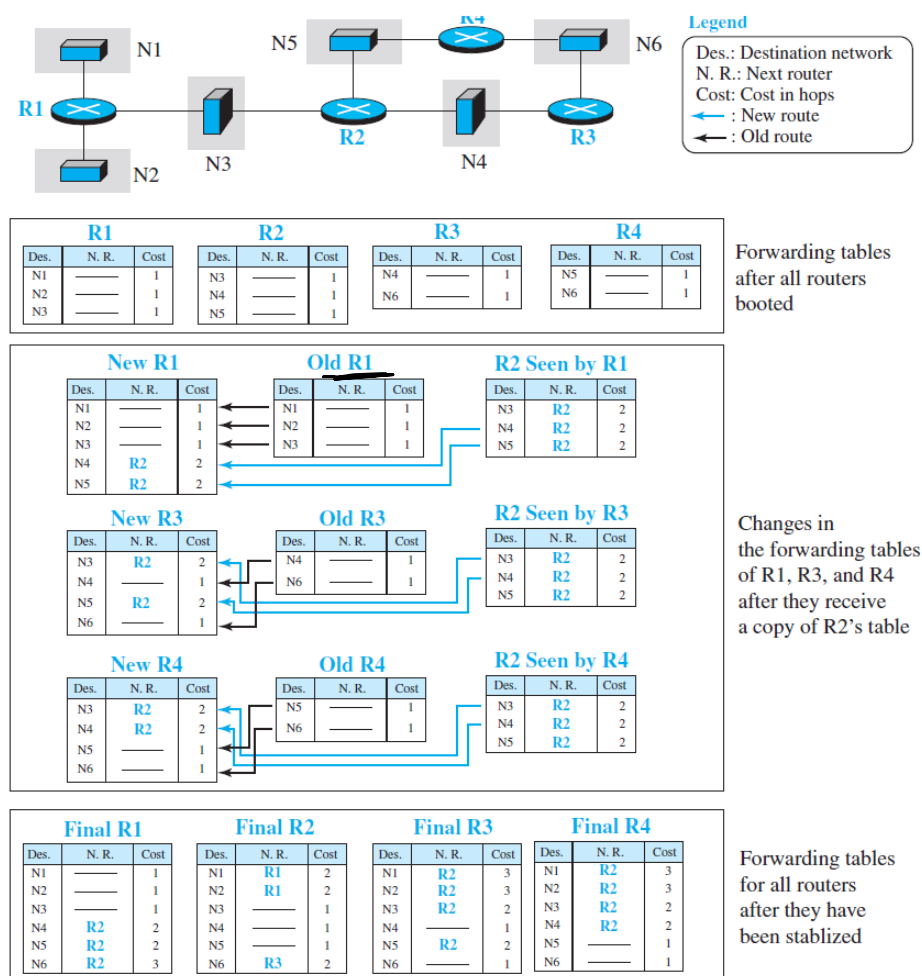


Figure 3.5.2.4 Example of autonomous system using RIP.