Chapter 10:
Dynamic Routing Protocols

Introduction

- **When do we using dynamic routing?**
  - If any of below three conditions is false, dynamic routing is used
    - The network is small
    - There is a single connection point to other network
    - No redundant routes
- **Dynamic Routing**
  - It occurs when routers talk to adjacent routers, informing each other of what networks each router is currently conneted to
  - What's the routing daemon
    - The process is running protocol, communicating with its neighbor routers
    - It updates the kernel's routing table with information it retrieves from neighbor routers.

Dynamic Routing

- **The use of dynamic routing does not change the way the kernel performs routing at the IP layer (called *routing mechanism*).**
- **The daemon adds a *routing policy* to the system, choosing which routers to place into the kernel's routing table.**
  - If the daemon finds multiple routes to a destination, the daemon choose the best one to insert into the kernel's table
  - If the daemon finds that a link has gone down, it can delete the affected routes or alternate routes that bypass the problem.
- **Each autonomous system (AS) can select its own routing protocol to communicate between the routers in that AS (called *interior gateway protocol*, IGP, or *intradomain routing protocol*).**
  - The most popular IGP: *Routing Information Protocol* (*RIP*)
  - A newest IGP: *Open Shortest Path First protocol* (*OSPF*)
- **Routing between the routers in different ASs: *exterior gateway protocol* (EGP)**
  - e.g., Border Gateway Protocol (BGP)

Unix Routing Daemons

- **Routing Daemons in Unix System:**
  - Unix systems often run the routing daemon named *routed*: using only RIP.
  - An alternative program is *gated* that supports both IGPs and EGPs

Daemon	Interior Gateway Protocol			Exterior Gateway Protocol	
	HELLO	RIP	OSPF	EGP	BGP
routed		V1			
gated, Version 2	•	V1		•	V1
gated, Version 3	•	V1, V2	V2	•	V2, V3

Figure 10.1 Routing protocols supported by routed and gated.

- **RIP (Routing Information Protocol) message format**

Figure 10.2 RIP message encapsulated within a UDP datagram.

RIP: Routing Information Protocol

- **Format of a RIP message**

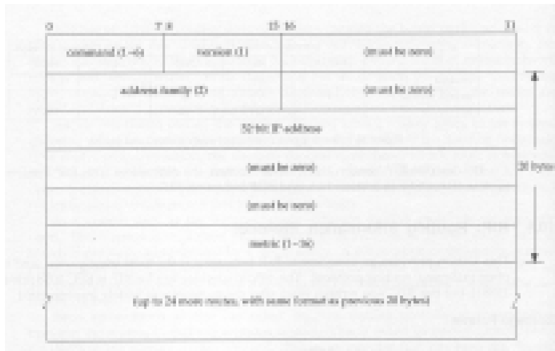


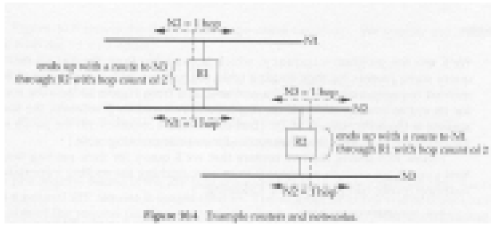
Figure 10.2 Format of a RIP message.

RIP: Routing Information Protocol (Cont.)

- **Normal Operation**
  - The well-know port number for RIP is UDP port 520
  - Initialization: The daemon send a request packet out each interface, asking for the other router's complete routing table
  - Request received: If we have a route to the specified address, set the metric to our value, else set the metric to 16
  - Response received: The response is validated and may update the routing table
  - Regular routing updates: Every 30 seconds, routing table is sent to every neighbor router
  - Triggered updates: Only those entries that have changed must be transmitted
  - A route has not been updated for 3-min, metric is set to infinity (16)

RIP: Route Metrics

- The metrics used by RIP are hop counts.The hop count for all directly connected interfaces is 1



- The metric to N1 for R2 is 2, as is the metric to N3 for R1
- The router selects the path within the AS from a router to a network with the smallest hop count and ignores the other paths
- maximum number of hops between hosts is 15

Drawbacks of RIP

- RIP has no knowledge of subnet addressing
- It takes a long time to stabilize after the failure of a router or a link
- A maximum of 15 for the metric limits sometime is not enough
- Example 1
  - ripquery tries to send one of the undocumented requests (name “poll”, a command of 5)
  - If no response is received in 5 seconds, the standard RIP request is issued (command of 1)

```
sun % ripquery -n netb
504 bytes from netb (140.252.1.183):     first message contains 504 bytes
                                         lots of other lines deleted
        140.252.1.0, metric 1            the top Ethernet in Figure 10.5
        140.252.13.0, metric 1           the bottom Ethernet in Figure 10.5
244 bytes from netb (140.252.1.183):     second message with remaining 244 bytes
                                         lots of other lines deleted
```

RIP Example

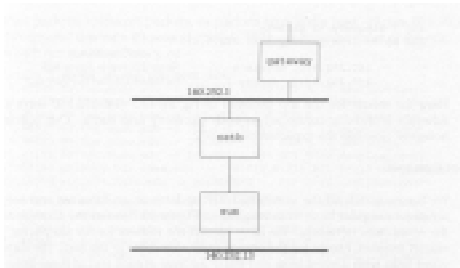
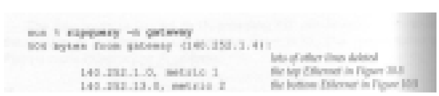


Figure 10.5 Two routers netb and gateway that we'll query for their routing tables.

```
sun % tcpdump -s600 -i sl0
1  0.0                         sun.2879 > netb.route: rip-poll 24
2  5.014702 (5.0147)           sun.2879 > netb.route: rip-req 24
3  5.560427 (0.5457)           netb.route > sun.2879: rip-resp 25:
4  5.710251 (0.1498)           netb.route > sun.2879: rip-resp 12:
```

Figure 10.6 tcpdump output while running ripquery program.

RIP Example (Cont.)

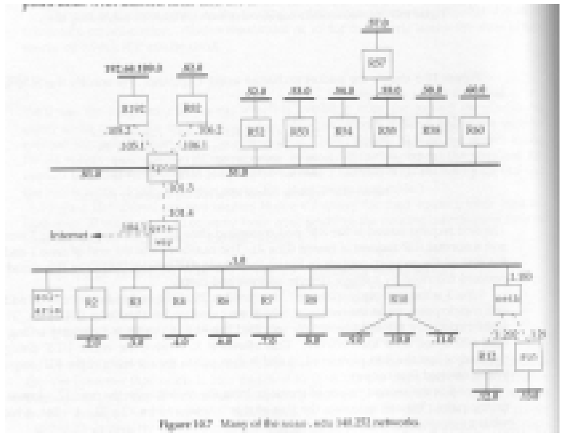


```
sun % ripquery -n gateway
504 bytes from gateway (140.252.1.4):
                                      lots of other lines deleted
        140.252.1.0, metric 1         the top Ethernet in Figure 10.5
        140.252.13.0, metric 2        the bottom Ethernet in Figure 10.5
```

- ❖ Here the metric in 140.252.1.0 stays at 1, since that Ethernet is directly connected to both gateway and netb
- ❖ Our subnet 140.252.13.0 has the expected metric of 2

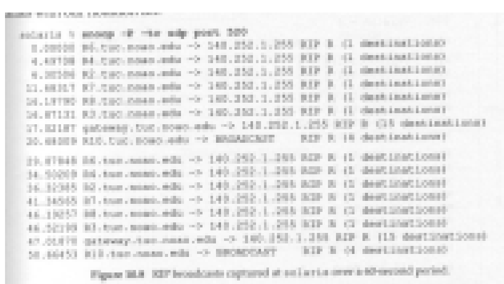
- ❑ **Example 2**
  - ❖ We'll run the Solaris 2.x program *snoop*, which is similar to tcpdump, on the host solaris
  - ❖ Figure 10.8 shows the packets captured during a 60-second period

RIP Example (Cont.)

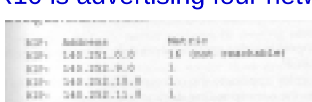


Network & System Lab, NSYSU

RIP Example (Cont.)



- Why R10 is advertising four networks ?



Network & System Lab, NSYSU

RIP Example (Cont.)

- The router *gateway* advertises 15 routes. We can run snoop with the -v flag and see the entire contents of the RIP message

```
solaris % snoop -P -v -Tr udp port 520 host gateway
                                        many lines deleted
RIP:  Opcode = 2 (route response)
RIP:  Version = 1

RIP:  Address          Metric

RIP:  140.252.101.0    1
RIP:  140.252.104.0    1

RIP:  140.252.51.0     2
RIP:  140.252.81.0     2
RIP:  140.252.105.0    2
RIP:  140.252.106.0    2

RIP:  140.252.52.0     3
RIP:  140.252.53.0     3
RIP:  140.252.54.0     3
RIP:  140.252.55.0     3
RIP:  140.252.58.0     3
RIP:  140.252.60.0     3
RIP:  140.252.82.0     3
RIP:  192.68.189.0     3

RIP:  140.252.57.0     4
```

Figure 10.9 RIP response from gateway.

Department of Computer Science and Engineering
NATIONAL SUN YAT-SEN UNIVERSITY

RIP Version 2

- **Compare RIP and RIP-2**

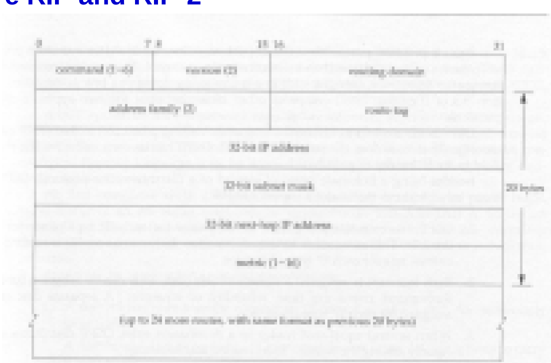


Figure 10.10 Format of a RIP-2 message.

- RIP-2 supports multicasting.This can reduce the load on hosts that not listening for RIP-2 messages

Department of Computer Science and Engineering
NATIONAL SUN YAT-SEN UNIVERSITY

OSPF: Open Shortest Path First

- **The difference of OSPF and RIP**
  - OSPF is a link-state protocol, RIP is a distance-vector protocol
    - The distance-vector means each router updates from its neighbors
    - In a link-state protocol,each router actively tests the status of its link to each of its neighbors, sends this information to its other neighbors, which then propagate it throughout the AS.
  - A link-state protocol will always converge faster than a distance-vector protocol
- **Features of OSPF that superior to RIP**
  - OSPF can calculate a separate set of routes for each IP TOS
  - Each interface is assigned a dimensionless cost
  - OSPF distributes traffic equally among the routes (load balancing)
  - OSPF supports subnets
  - PPP links between routers do not need an IP address at each end

BGP: Border Gateway Protocol

  - A cleartext password can be specified, similar to the RIP-2 scheme
  - OSPF uses multicasting instead of broadcasting to reduce the load

- **Local traffic and transit traffic**
  - Local traffic in an AS either originates or terminates in that AS
  - Anything else is called transit traffic
  - A major goal of BGP is to reduce transit traffic
- **Category of an AS**
  - A *stub* AS has only a single connection to one other AS
  - A *multihomed* AS has connections to more than one other AS
  - A *transit* AS has connections to more than one other AS and is designed, to carry both local and transit traffic

BGP: Border Gateway Protocol (Cont.)

- BGP allows for policy-based routing
- BGP uses TCP as its transport protocol
- BGP is a distance vector protocol
- BGP detects the failure of either the link or the host by sending keepalive message to its neighbor on a regular basis

- **What's CIDR?**
  - CIDR is a way to prevent explosion in the size of the Internet routing tables. It is also called *supernetting*
  - The basic concept in CIDR is to allocate multiple IP addresses in a way that allows *summarization* into a smaller number of routing table entries
- **Three features are needed to allow this summarization**
  - Multiple IP addresses must share the same high-order bits

CIDR: Classless Interdomain Routing

- The routing tables and routing algorithms must be extended to base their routing decisions on a 32-bit IP address and a 32-bit mask
- The routing protocols being used must be extended to carry the 32-bit mask in addition to the 32-bit address

- **CIDR uses the technique whereby the best match is always the one with the *longest match*: the one with the greatest number of one bits in the 32-bit mask.**
- **The term "classless" is because routing decisions are now made based on masking operations of entire 32-bit IP address.**
  - Whether the IP address is class A, B, or C makes no difference.
- **CIDR will slow down the growth of the Internet routing tables**