Distance Vector Routing Protocols
Objectives

- Identify the characteristics of distance vector routing protocols.
- Describe the network discovery process of distance vector routing protocols using Routing Information Protocol (RIP).
- Describe the processes to maintain accurate routing tables used by distance vector routing protocols.
- Identify the conditions leading to a routing loop and explain the implications for router performance.
- Recognize that distance vector routing protocols are in use today
Why dynamic routing protocol
Distance Vector Routing Protocols

- Examples of Distance Vector routing protocols:
  - Routing Information Protocol (RIP) v1,2
  - Interior Gateway Routing Protocol (IGRP)
  - Enhanced Interior Gateway Routing Protocol (EIGRP)
Distance Vector Routing Protocols

- Distance Vector Technology

**The Meaning of Distance Vector:**

- A router using distance vector routing protocols knows 2 things:
  - **Distance** to final destination
  - **Vector, or direction,** traffic should be directed

---

**Diagram:**

- **Distance = How Far**
- **Vector = Direction**

For R1, 172.16.3.0/24 is one hop away (distance). It can be reached through R2 (vector).
Distance Vector Routing Protocols

Characteristics of Distance Vector routing protocols:

- Periodic updates
- Broadcast updates
- Entire routing table is included into routing update
Distance Vector Routing Protocols

- **Routing Protocol Algorithm:**
  - Defined as *a procedure for accomplishing a certain task*

  **Purpose of Routing Algorithms**
  1. Send and Receive Updates
  2. Calculate best path; install routes
  3. Detect and react to topology changes

```
<table>
<thead>
<tr>
<th>Network</th>
<th>Interface</th>
<th>Hop</th>
</tr>
</thead>
<tbody>
<tr>
<td>172.16.1.0/24</td>
<td>Fa0/0</td>
<td>0</td>
</tr>
<tr>
<td>172.16.2.0/24</td>
<td>S0/0/0</td>
<td>0</td>
</tr>
</tbody>
</table>
```

```
<table>
<thead>
<tr>
<th>Network</th>
<th>Interface</th>
<th>Hop</th>
</tr>
</thead>
<tbody>
<tr>
<td>172.16.2.0/24</td>
<td>S0/0/0</td>
<td>0</td>
</tr>
<tr>
<td>172.16.1.0/24</td>
<td>S0/0/0</td>
<td>1</td>
</tr>
</tbody>
</table>
```
Distance Vector Routing Protocols

Routing Protocol Characteristics

- Criteria used to compare routing protocols includes
  - Time to convergence
  - Scalability
  - Resource usage
  - Implementation & maintenance
# Distance Vector Routing Protocols

## Advantages & Disadvantages of Distance Vector Routing Protocols

<table>
<thead>
<tr>
<th>Advantages:</th>
<th>Disadvantages:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Simple implementation and maintenance.</strong> The level of knowledge required to deploy and later maintain a network with distance vector protocol is not high.</td>
<td><strong>Slow convergence.</strong> The use of periodic updates can cause slower convergence. Even if some advanced techniques are used, like triggered updates which are discussed later, the overall convergence is still slower compared to link state routing protocols.</td>
</tr>
<tr>
<td><strong>Low resource requirements.</strong> Distance vector protocols typically do not need large amounts of memory to store the information. Nor do they require a powerful CPU. Depending on the network size and the IP addressing implemented, they also typically do not require a high level of link bandwidth to send routing updates. However, this can become an issue if you deploy a distance vector protocol in a large network.</td>
<td><strong>Limited scalability.</strong> Slow convergence may limit the size of the network because larger networks require more time to propagate routing information.</td>
</tr>
<tr>
<td><strong>Routing loops.</strong> Routing loops can occur when inconsistent routing tables are not updated due to slow convergence in a changing network.</td>
<td></td>
</tr>
</tbody>
</table>
Network Discovery

- Router initial start up
  - *Initial network discovery*
    - Directly connected networks are initially placed in routing table
Network Discovery

- **Initial Exchange** of Routing Information
  - If a routing protocol is configured then
    - Routers will exchange routing information

- Routing updates received from other routers
  - Router checks update for new information
    - If there is new information:
      - Metric is updated
      - New information is stored in routing table
Network Discovery

- Exchange of Routing Information

  - Router convergence is reached when
    - All routing tables in the network contain the same network information
  - Routers continue to exchange routing information
    - If no new information is found then Convergence is reached
Network Discovery

- **Convergence must be reached** before a network is considered completely operable.

- Speed of achieving convergence consists of 2 interdependent categories:
  - Speed of broadcasting routing information
  - Speed of calculating routes
Routing Table Maintenance

- **Periodic Updates**: RIPv1 & RIPv2

  These are *time intervals* in which a router sends out its entire routing table.
Routing Table Maintenance

- RIP uses 4 timers
  - Update timer
  - Invalid timer
  - Hold-down timer
  - Flush timer
Routing Table Maintenance

- **Invalid Timer:** If an update has not been received to refresh an existing route after 180 seconds (the default), the route is marked as invalid by setting the metric to 16. The route is retained in the routing table until the flush timer expires.

- **Flush Timer:** By default, the flush timer is set for 240 seconds, which is 60 seconds longer than the invalid timer. When the flush timer expires, the route is removed from the routing table.
Update, holddown & flush timers

- Update about certain network
- Update about certain network
- Update about certain network

- Invalid timer
- Holddown timer
- Flush timer

180 sec
Routing Table Maintenance

- EIRPG routing updates are
  - Partial updates (The Update Contain only the changed Routes)
  - Triggered by topology changes (Once a change happen, Update is sent)
  - Bounded (Update sent only to Routers who need it)
  - Non periodic
Routing Table Maintenance

- **Triggered Updates**
  - Conditions in which triggered updates are sent
    - Interface changes state
    - Route becomes unreachable
    - Route is placed in routing table
Routing Loops

- **Routing loops** are a condition in which a packet is continuously transmitted within a series of routers without ever reaching its destination.

See animation 4.4.1.1
Routing Loops

- **Routing loops** may be caused by:
  - Incorrectly configured static routes
  - Incorrectly configured route redistribution
  - Slow convergence
  - Incorrectly configured discard routes

- **Routing loops** can create the following issues:
  - Excess use of bandwidth
  - CPU resources may be strained
  - Network convergence is degraded
  - Routing updates may be lost or not processed in a timely manner
Routing Loops problems

- **Count to Infinity**

  This is a routing loop whereby packets bounce infinitely around a network.
Routing Loops problems

- **Distance Vector routing protocols** set a specified metric value to indicate infinity

Once a router “counts to infinity” it marks the route as unreachable
Routing Loops

- Preventing loops with holddown timers
  - Holddown timers allow a router to not accept any changes to a route for a specified period of time.
  - Point of using holddown timers
  - Allows routing updates to propagate through network with the most current information. Holddown timers are used to prevent regular update messages from inappropriately reinstating a route that may have gone bad.
Routing Loops

- Holddown Timer. This timer stabilizes routing information and helps prevent routing loops during periods when the topology is converging on new information. Once a route is marked as unreachable (Invalid), it must stay in holddown long enough for all routers in the topology to learn about the unreachable network. By default, the holddown timer is set for 180 seconds.
Update, holddown & flush timers

Last update about certain network

180 sec
Invalid timer

180 sec
Holddown timer

180 sec
Flush timer
Update, holddown & flush timers

Update about the same network with metric=16

Last update about certain network

- Invalid timer: 180 sec
- Holddown timer: 180 sec
- Flush timer: 180 sec
Routing Loops

- The **Split Horizon Rule** is used to prevent routing loops

- **Split Horizon rule:**
  
  A router should not advertise a network through the interface from which the update came.

---

**Split Horizon Rule for 10.4.0.0**

R2 only advertises 10.3.0.0 and 10.4.0.0 to R1.
R2 only advertises 10.2.0.0 and 10.1.0.0 to R3.

R1 only advertises 10.1.0.0 to R2.

R3 only advertises 10.4.0.0 to R2.

---

<table>
<thead>
<tr>
<th>Network</th>
<th>Interface</th>
<th>Hop</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.0.0</td>
<td>Fa0/0</td>
<td>0</td>
</tr>
<tr>
<td>10.2.0.0</td>
<td>S0/0/0</td>
<td>0</td>
</tr>
<tr>
<td>10.3.0.0</td>
<td>S0/0/0</td>
<td>1</td>
</tr>
<tr>
<td>10.4.0.0</td>
<td>S0/0/0</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Network</th>
<th>Interface</th>
<th>Hop</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.2.0.0</td>
<td>S0/0/0</td>
<td>0</td>
</tr>
<tr>
<td>10.3.0.0</td>
<td>S0/0/1</td>
<td>0</td>
</tr>
<tr>
<td>10.1.0.0</td>
<td>S0/0/0</td>
<td>1</td>
</tr>
<tr>
<td>10.4.0.0</td>
<td>S0/0/1</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Network</th>
<th>Interface</th>
<th>Hop</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.3.0.0</td>
<td>S0/0/1</td>
<td>0</td>
</tr>
<tr>
<td>10.4.0.0</td>
<td>Fa0/0</td>
<td>0</td>
</tr>
<tr>
<td>10.2.0.0</td>
<td>S0/0/1</td>
<td>1</td>
</tr>
<tr>
<td>10.1.0.0</td>
<td>S0/0/1</td>
<td>2</td>
</tr>
</tbody>
</table>
Routing Loops

- **Split horizon with poison reverse**

  The rule states that once a router learns of an unreachable route through an interface, advertise it as unreachable back through the same interface.
Route poisoning & Poison reverse

- **Route poisoning**: sending update about the unreachable network with setting the metric (hop count) to 16

- **Poison reverse**: after receiving the poisoned update the router will suspend the split horizon rule and send the same poisoned update again across the same interface then resume split horizon rule again
Routing Loops

- **IP & TTL**
  - **Purpose of the TTL field**
    The TTL field is found in an IP header and is used to prevent packets from endlessly traveling on a network.
  - **How the TTL field works**
    - TTL field contains a numeric value
      The numeric value is decreased by one by every router on the route to the destination.
      If numeric value reaches 0 then Packet is discarded.
Routing Protocols Today

- Factors used to determine whether to use RIP or EIGRP include
  - Network size
  - Compatibility between models of routers
  - Administrative knowledge

Distance Vector Routing Protocols Compared

<table>
<thead>
<tr>
<th>Speed of Convergence</th>
<th>Ripv1</th>
<th>Ripv2</th>
<th>IGRP</th>
<th>EIGRP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Slow</td>
<td>Slow</td>
<td>Slow</td>
<td>Fast</td>
</tr>
<tr>
<td>Scalability – size of network</td>
<td>Small</td>
<td>Small</td>
<td>Small</td>
<td>Large</td>
</tr>
<tr>
<td>Use of VLSM</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Resource usage</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Implementation and maintenance</td>
<td>Simple</td>
<td>Simple</td>
<td>Simple</td>
<td>Complex</td>
</tr>
</tbody>
</table>
Routing Protocols Today

- **RIP**
  - **Features of RIP:**
    - Supports split horizon & split horizon with poison reverse
    - Capable of load balancing
    - Easy to configure
    - Works in a multi vendor router environment
Routing Protocols Today

- **EIGRP**
  - **Features of EIGRP:**
    - Triggered updates
    - EIGRP hello protocol used to establish neighbor adjacencies
    - Supports VLSM & route summarization
    - Use of topology table to maintain all routes
    - Classless distance vector routing protocol
    - Cisco proprietary protocol