Operating Systems and Networks

Networks Part: Project 2

Network Security Group
ETH Zürich

Dynamic Routing with RIP

RIP is a routing protocol based on the Bellman-Ford algorithm (distance-vector routing).

Destination are associated with a metric (cost), which is—usually, but not always—the hop-count.

Several technics are used to avoid routing loops:

- maximum cost of 15
- "split-horizon with poisoned reverse" mechanism
- triggered updates

Distance-Vector Routing

The protocol uses vectors (arrays) of distances/costs to reach other nodes in the network.

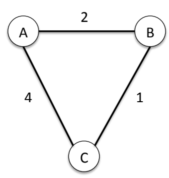
As opposed to link-state routing, routers send route advertisements only to neighbors. These advertisements are sent both periodically and under certain other conditions.

When an advertisement is received by a router, its internal routing table is updated.

One of the most well-known algorithms (in particular, the one used by RIP) is Bellman-Ford.

Distance-Vector Routing Example (1)

The routing tables are initialized with the distances to immediate neighbors.



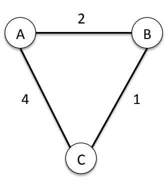
From A	Via A	Via B	Via C
To A	–	–	–
To B	–	2	
To C	–		4

From B	Via A	Via B	Via C
To A	2	–	
To B	–	–	–
To C		–	1

From C	Via A	Via B	Via C
To A	4		–
To B		1	–
To C	–	–	–

Distance-Vector Routing Example (2)

All nodes broadcast distance vectors to their neighbors and then update their routing table.



From A	Via A	Via B	Via C
To A	–	–	–
To B	–	**2**	5
To C	–	**3**	4

From B	Via A	Via B	Via C
To A	**2**	–	5
To B	–	–	–
To C	6	–	**1**

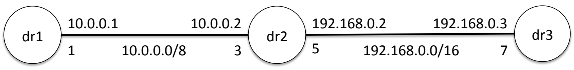
From C	Via A	Via B	Via C
To A	4	**3**	–
To B	6	**1**	–
To C	–	–	–

Some Differences (1)

There are a few subtle differences between the previous theoretical example and your assignment:

- Destinations are not necessarily other nodes in the topology graph. If the destination is a network, it will usually be represented by an edge.
- The virtual network system that we use (LVNS) allows to set asymmetrical costs to a link, i.e., a cost can be assigned to each interface.
- For each destination, only one entry (the one with the lowest cost) is kept.

Some Differences (2)



For example, *dr1*'s routing table should include:

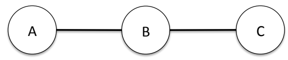
destination	mask	gateway	cost
10.0.0.0	255.0.0.0	0.0.0.0	1
192.168.0.0	255.255.0.0	10.0.0.2	6

Split Horizon

A router should not claim reachability for a destination network to the neighbor(s) from which the route was learned.

In the simple split-horizon scheme, routers completely omit routes learned from neighbors in the updates they send to these neighbors.

Objective: avoiding routing loops



Split Horizon with Poisoned Reverse

Instead of omitting certain routes in the updates, the cost is set to infinity. In the case of RIP, infinity equals to 16.

"If two routers have routes pointing at each other, advertising reverse routes with a metric of 16 will break the loop immediately. If the reverse routes are simply not advertised, the erroneous routes will have to be eliminated by waiting for a timeout." [RFC 2453]

Objective: avoiding routing loops, more safely and quickly compared to the simple split-horizon scheme (at the cost of increasing the size of advertisements)

Triggered Updates

Whenever a router changes the cost associated with a route in its routing table, an advertisement is sent immediately.

Objective: avoiding larger routing loops, by accelerating the convergence to an infinite cost in such loops.

Timers

- `RIP_ADVERT_INTERVAL_SEC`: periodic update timer
  An unsolicited message containing the complete routing table is sent to every neighbor.
- `RIP_TIMEOUT_SEC`: route timeout
  Upon expiration of this timeout, the route is no longer valid, but it is retained in the routing table so that neighbors can be notified that the route has been dropped.
- `RIP_GARBAGE_SEC`: garbage-collection timer
  Upon expiration of the garbage-collection timer, the route is finally removed from the routing table.

Tips

Here are a few other tips that you might find useful:

- If an update does not change the cost of a specific route, it should not trigger the transmission of an advertisement for that route. However, the timeout should still be updated.

- If a cost is equal to or greater than infinity (i.e., 16 for RIP), then the corresponding destination should be considered as unreachable.

Getting Started

1. Get a Linux distribution
2. Install the g++ compiler
3. Compile the project with:

   ```
   make
   ```

4. Run the LVNS server, for example, with an existing topology:

   ```
   ./lvns -t complex.topo
   ```

5. Run the dynamic routing instances, one by one:

   ```
   ./dr -v dr1
   …
   ```

   or all at once:

   ```
   ./launch_dr.sh 5
   ```

LVNS Commands

To obtain the set of all possible LVNS commands that you can use to create and manipulate topologies, just type:

```
./lvns
```

then

```
help
```

Evaluation

We will run your code with the topologies that were provided + other topologies that we will create.

Then, we will look at the resulting routing table.