Routing Information Protocol

Week 7 – Internetworking

Objectives

- Overview of RIP
- Advantages and Disadvantages
- Populating Routing Tables
- Convergence
- Routing Loop
- Mechanisms to prevent Routing Loops
- Anatomy of a Routing Loop – Fault Preventing Route Loop Back (optional)

Overview

- RIP is an old protocol (RFC2453)
  - It supports classless networks,
- It is **a distance vector protocol**.
- It is based on the Bellman-Ford algorithm, which it uses to compute the cost for a route.
- The algorithm **uses hop count as the metric for stating the cost** to a network.
  - E.g., the destination is 2 hops away, 4 hops away etc.
  - RIP does not consider variables such as bandwidth, load, and reliability.

Advantages of using RIP

- Supported on the widest variety of networking platforms
- Acceptable for use in smaller networks
- Easy to configure
- Good for networks with few or no redundant paths
- Good for networks with similar speed networks links

Disadvantages of using RIP

- Maximum hop count is 15
  - If the cost shows as 16 hops
  - The destination is unreachable

- Prone to looping due to slow convergence

- Chatty protocol – sends entire route table periodically – every 30 seconds by default
  - Uses a significant portion of the available bandwidth

Versions of RIP

Version One

- Class-based routing
- Limited support for classless addressing
- You shouldn’t ever see this

Versions of RIP

Version 2 (RFC 2453)

- Auto-summarisation is on by default,
  - Remember CIDR (aka supernetting)?
- Multicast is used rather than broadcast to communicate with neighbouring routers.
  - They listen on multicast address 224.0.0.9 for RIPv2 updates. Reducing the processing on network hosts that don’t care about RIP traffic
- RIPv2 supports simple password authentication

Advertising Routes (1)

- **Step 1** – When the router is first booted a routing table is created containing only the directly connected networks and any statically added route.
- **Step 2** – After it initialises, the router will send its routing table to its immediate neighbouring routers through all its interfaces.
- **Step 3** – RIP see neighbouring routers as one sharing a common interface link, it shares its routing table every 30 seconds.

Advertising Routes (2)

- **Step 4** – A variability can be introduced so not all updates are triggered at the same instant
  - this is called jitter.
- **Step 5** – An RIP router can be configured to not advertise updates unnecessarily

Learning Routes (1)

- Once a new route has been discovered, the router adds it to the routing table.
- The router then advertises the newly learnt route to other connected routers.
- Every router learns the path to every network advertised by RIP.
- Changes or failures are also advertised to the neighbouring routers.

Learning Routes (2)

- The time it takes to update all the routes is called **convergence time**
- Once all the routing tables (of all routers) are updated the network is considered **converged**
- The routers continue to broadcast their entire routing table every 30 seconds, hence chatty protocol
  - The design means that the protocol is “bandwidth hungry”.

Information that RIP keeps about a route

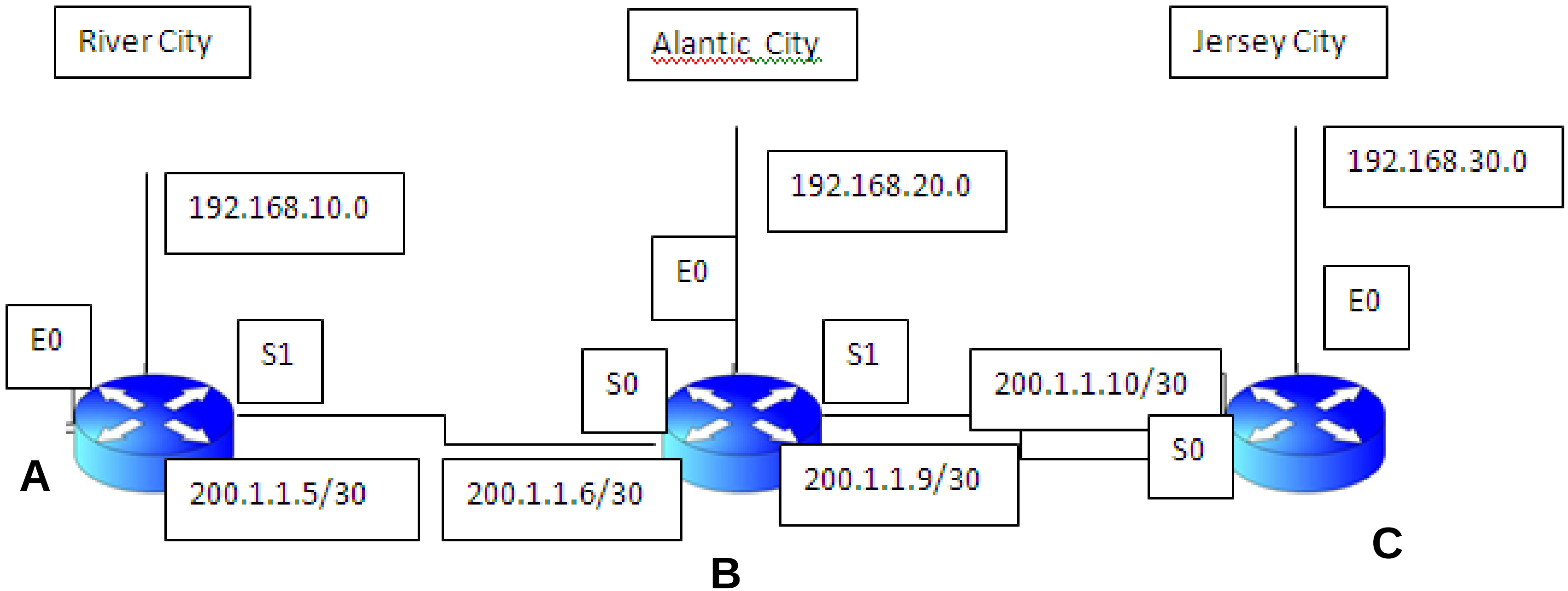
Extract from a routing table:

C	192.168.10.0	/24	(0/0) is directly connected, Ethernet0
	200.1.1.0	/30	is subnetted 2 subnetts
C	200.1.1.4		(0/0) is directly connected Serial1
R	200.1.18		(120/1) via 200.1.1.6, 00.01.05, Serial1
R	192.168.20.0	/24	(120/1) via 200.1.1.6, 00.01.05, Serial1
R	192.168.30.0	/24	(120/2) via 200.1.1.6, 00.01.05, Serial1

- Above shows that 3 routes have been learnt,
  - each has an administrative distance value 120 (the default for RIP).
- Two routes are 1 hop away and one is 2 hops away

- Most protocol routing table will look similar, but they keep other information in other databases.

Network


River City
Alantic City
Jersey City
192.168.10.0
192.168.20.0
192.168.30.0
E0
S1
S0
E0
S1
200.1.1.10/30
E0
S0
A
200.1.1.5/30
200.1.1.6/30
200.1.1.9/30
C
B

Routing Tables

Routing table for Router A				
network	mask	Next hop	int	a/m
192.168.10.0	/24	direct	E0	0/0
200.1.1.4	/30	direct	S1	0/0

Routing table for Router B				
network	mask	Next hop	int	a/m
192.168.20.0	/24	direct	E0	0/0
200.1.1.4	/30	direct	S0	0/0
200.1.1.8	/30	direct	S1	0/0
192.168.10.0	**/24**	**200.1.1.5**	**S0**	**120/1**

Routing table for Router C				
network	mask	Next hop	int	a/m
192.168.30.0	/24	direct	E0	0/0
200.1.1.8	/30	direct	S0	0/0

Fully Converged Routers

Routing table for Router A				
network	mask	Next hop	int	a/m
192.168.10.0	/24	direct	E0	0/0
200.1.1.4	/30	direct	S1	0/0
192.168.20.0	**/24**	**200.1.1.6**	**S1**	**120/1**
192.168.30.0	**/24**	**200.1.1.6**	**S1**	**120/2**
200.1.1.8	**/30**	**200.1.1.6**	**S1**	**120/1**

Routing table for Router B				
network	mask	Next hop	int	a/m
192.168.20.0	/24	direct	E0	0/0
200.1.1.4	/30	direct	S0	0/0
200.1.1.8	/30	direct	S1	0/0
192.168.10.0	**/24**	**200.1.1.5**	**S0**	**120/1**
192.168.30.0	**/24**	**200.1.1.10**	**S1**	**120/1**

Routing table for Router C				
network	mask	Next hop	int	a/m
192.168.30.0	/24	direct	E0	0/0
200.1.1.8	/30	direct	S0	0/0
192.168.10.0	**/24**	**200.1.1.9**	**S0**	**120/2**
192.168.20.0	**/24**	**200.1.1.9**	**S0**	**120/1**
200.1.1.4	**/30**	**200.1.1.9**	**S0**	**120/1**

Populating Routing Tables

- Once the directly connected route information is gained, the router on 192.168.10.0 network would not know how to reach 192.168.20.0 or 192.168.30.0 network.
- There are 0 hops to directly connected networks.
- Router A sent its route table to router B.
- Router B has installed router A's networks into its routing table.
- Router B also bumped the hop count for the learned network by one resulting in a hop count 1.
- Router B ignored the advertisement about 200.1.1.5 because it already has an entry for that network with a lower metric

RIP Routing Timers

- **Update Timer**
  - dictates the interval routing updates.
  - Happens every 30 second unless otherwise configured.
- **Invalid Timer**
  - If a specific route is not heard from within a specified amount of time (180s) the routers assume it is no longer available
- **Flush Timer**
  - If a route is not heard from for default 90s after invalid timer then router informs neighbours that route should be flushed

How to prevent routing loop backs

- Fundamentally the speed of convergence needs to be efficient to avoid routing loops.

- Here is a list of RIP prevention techniques built into distance vector routing:
  - Maintain only the best routes e.g. the lowest metric
  - Using routes with the lowest metric can speed up routing, but also as fewer router are used this limits the amount of problems that can arise.
  - Timeout directly connected routes immediately upon failure
  - This happens as soon as the keep-alive’s detect a dead link
    - Route poisoning
    - Split horizon
    - Triggered updates
    - Poison reverse
    - Maximum hop count 15 hops

Split Horizon

- Advertising a route back to the router that told you about the route in the first place is a mistake.
- Therefore, a rule stating 'never to advertise a route back to the link you learned the route from' but would include it in advertising the route to other neighbouring nodes.
- This is called split horizon – this is a simple loop-prevention technique which would have prevent the situation as detailed in the following up example.

Hold Down Timer

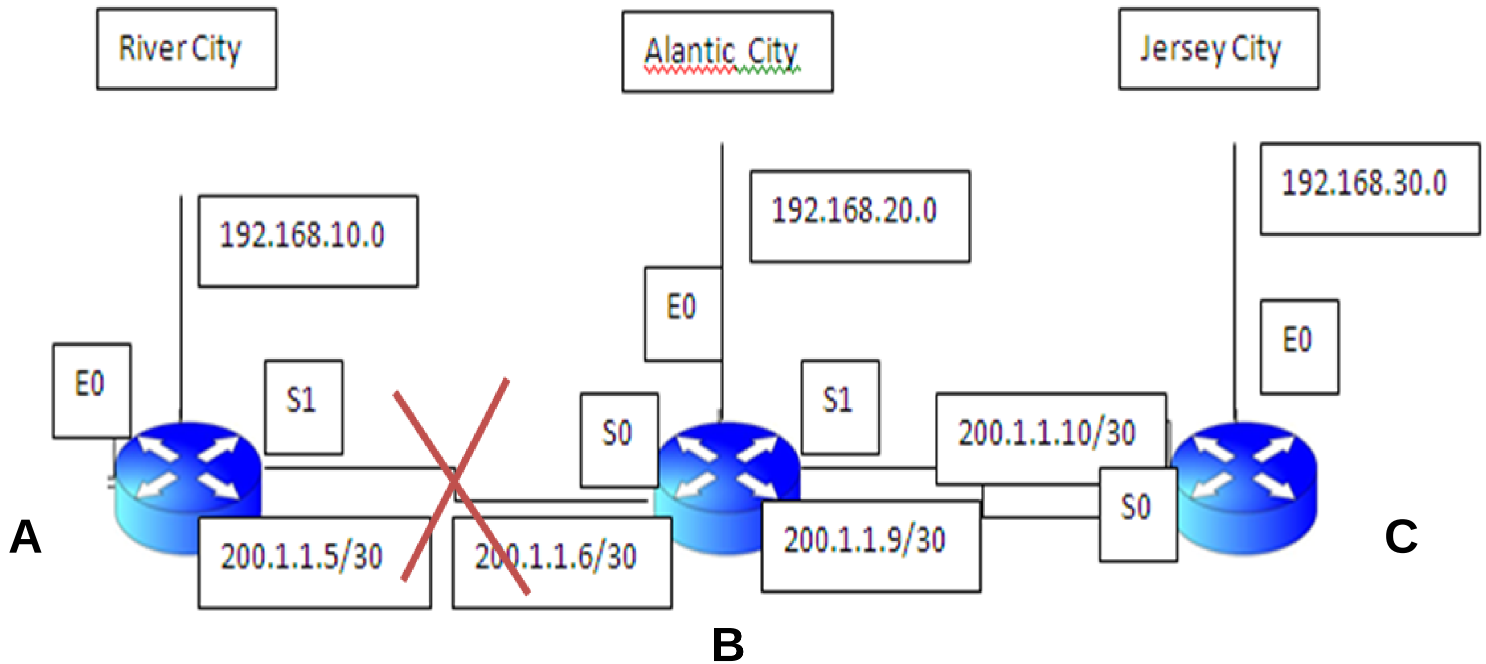
- The hold down timer helps to stabilise route tables and avoid loop backs.
  - The fundamental rule is "Once an entry in a route table is updated (added, changed or deleted), ignore any updates about the route until the hold-down timer expires".
  - The RIP value for the hold down timer is 180 secs.
- The hold down timer acts as a buffer when network conditions change rapidly.
  - For example, a link was temperamental and was connected then disconnected intermittently. This would cause an enormous amount of network traffic to communicate the continuing changing states of the network.
  - This network situation is known as route flapping. In this case the hold down timer 'freezes' the route in its current state for the duration of 180 secs, even if it continues to change. Once the timer expires the router will react to the updates again.

Trigger Update

- Trigger update is a complementary rule to route poisoning making it even more effective. Here router B will not wait for the full 30 secs updates to tell router C about the poisoned route. The update is 'triggered' once the route is poisoned.

- This update only includes poisoned route information to be acted upon, therefore speeding up convergence. Though this is additional traffic on the system is warrants the overhead. This mechanism is used for all changes to the network topology.

The Anatomy of a Routing Loop – Fault



Routing Tables A and B

Routing table for Router A				
network	mask	Next hop	int	a/m
192.168.10.0	/24	direct	E0	0/0
~~200.1.1.4~~	~~/30~~	~~direct~~	~~S1~~	~~0/0~~
~~**192.168.20.0**~~	~~**/24**~~	~~**200.1.1.6**~~	~~**S1**~~	~~**120/1**~~
~~**192.168.30.0**~~	~~**/24**~~	~~**200.1.1.6**~~	~~**S1**~~	~~**120/2**~~
~~**200.1.1.8**~~	~~**/30**~~	~~**200.1.1.6**~~	~~**S1**~~	~~**120/1**~~

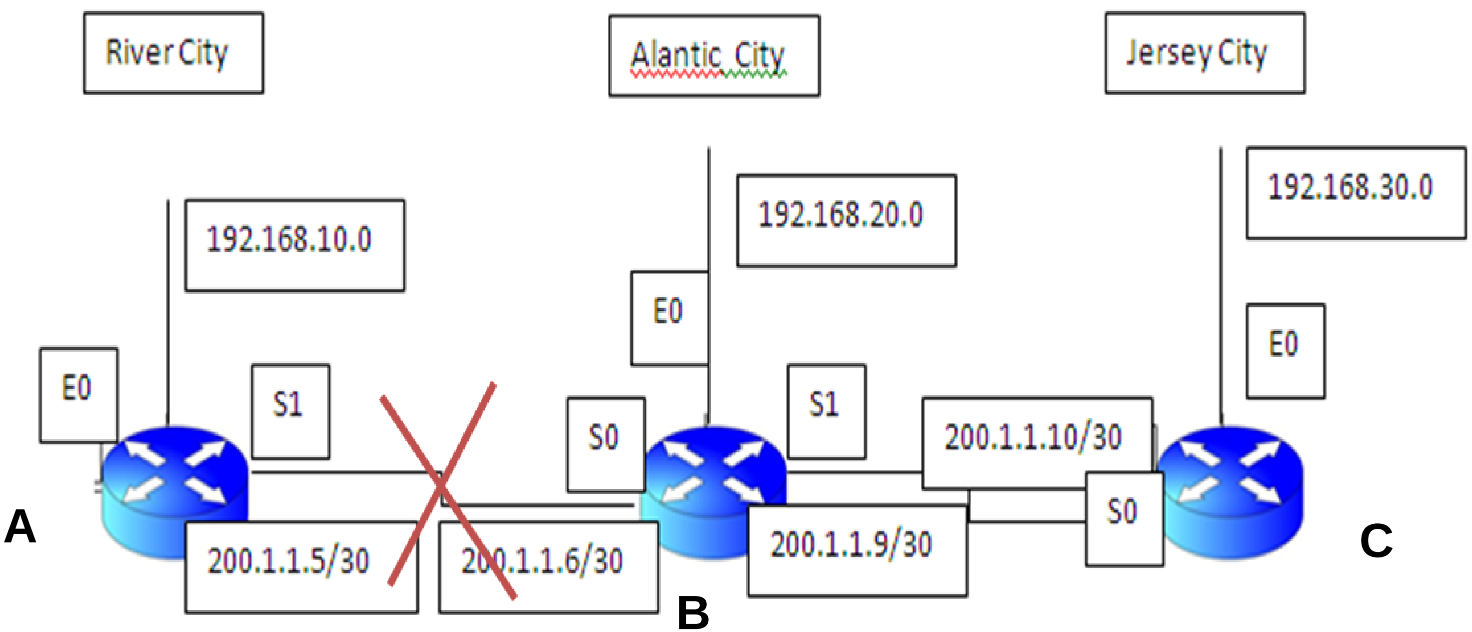
Routing table for Router B				
network	mask	Next hop	int	a/m
192.168.20.0	/24	direct	E0	0/0
~~200.1.1.4~~	~~/30~~	~~direct~~	~~S0~~	~~0/0~~
200.1.1.8	/30	direct	S1	0/0
~~**192.168.10.0**~~	~~**/24**~~	~~**200.1.1.5**~~	~~**S0**~~	~~**120/1**~~
192.168.30.0	**/24**	**200.1.1.10**	**S1**	**120/1**

Routing Table

- The route to 200.1.1.4/30 has been removed from the routing tables,
  - Directly connected networks that fail are removed immediately.
- As both routers have lost a directly connected link any routes depending on the link are marked invalid and advertised as such
- As you can see from router C's routing table, C is not aware of the problem yet but 192.168.10.0 and 192.168.20.0 has the invalid timer running on them.

Routing Table C

Routing table for Router C				
network	mask	Next hop	int	a/m
192.168.30.0	/24	direct	E0	0/0
200.1.1.8	/30	direct	S0	0/0
192.168.10.0	/24	200.1.1.9	S0	120/2
192.168.20.0	/24	200.1.1.9	S0	120/1
200.1.1.4	/30	200.1.1.9	S0	120/1



Problem!

- Routers A and B knew that the connection was down as they use a Keep-alive packet for directly connected networks, to check if the links to directly connected links are up.
- The default keep alive period is 10 secs, allowing A and B to detected a problem with 2001.1.5 and then removed it from the respective routing tables.
- Any routes that are dependent on 200.1.1.5 would also be marked as invalid, without using the invalid timer. The flush timer would still be used to advertise that the routes are unreachable and the metric would be set to 16, until the flush expires.

- At this point router C does not know that any routes are unreachable. It is expected that router C will get this information after the respective timers have run their course.
- But router C has an entry to 200.1.1.5 and 192.168.10.0 through router B.
- Before router B sends this on to its neighbour's router C sends a periodic update telling router B about routes it thought were dead.
- Now Router B thinks this is a new path to the missing network!
- It accepts the new information from C and increments the metrics by 1.

Routing table for Router B				
network	mask	Next hop	int	a/m
192.168.20.0	/24	direct	E0	0/0
200.1.1.4	**/30**	**200.1.1.10**	**S1**	**0/0**
200.1.1.8	/30	direct	S1	0/0
192.168.10.0	**/24**	**200.1.1.10**	**S1**	**120/1**
192.168.30.0	/24	200.1.1.10	S1	120/1

Routing table for Router C				
network	mask	Next hop	int	a/m
192.168.30.0	/24	direct	E0	0/0
200.1.1.8	/30	direct	S0	0/0
192.168.10.0	/24	200.1.1.9	S0	120/2
192.168.20.0	/24	200.1.1.9	S0	120/1
200.1.1.4	/30	200.1.1.9	S0	120/1

- Router B now lists a RIP learned route to the 200.1.1.5 via serial 1
- Now a looping route has been created – router B has replaced the invalid routes to 192.168.10.0 and 200.1.1.5 with routes to the same network via router C
- Router B still thinks the way to the networks is via router B. Therefore each router would send a packet requiring 200.1.1.5 or 192.168.10.0 to the other to be routed there, basically ping pong the packet back and forth

Summary

- Overview
- Advantages and Disadvantages
- Populating Routing Tables
- Convergence
- Anatomy of a Routing Loop – Fault Preventing Route Loop Back
- Routing Timers