Université Constantine 2
جامعة قسنطينة 2

Network Management

– Course 2 –

Chapter 2 : TCP/IP addressing and routing (2/2)

Introduction

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Concerned Students :

Faculty/Institute	Department	Level	Speciality
NTIC	TLSI	License 3	G.L.

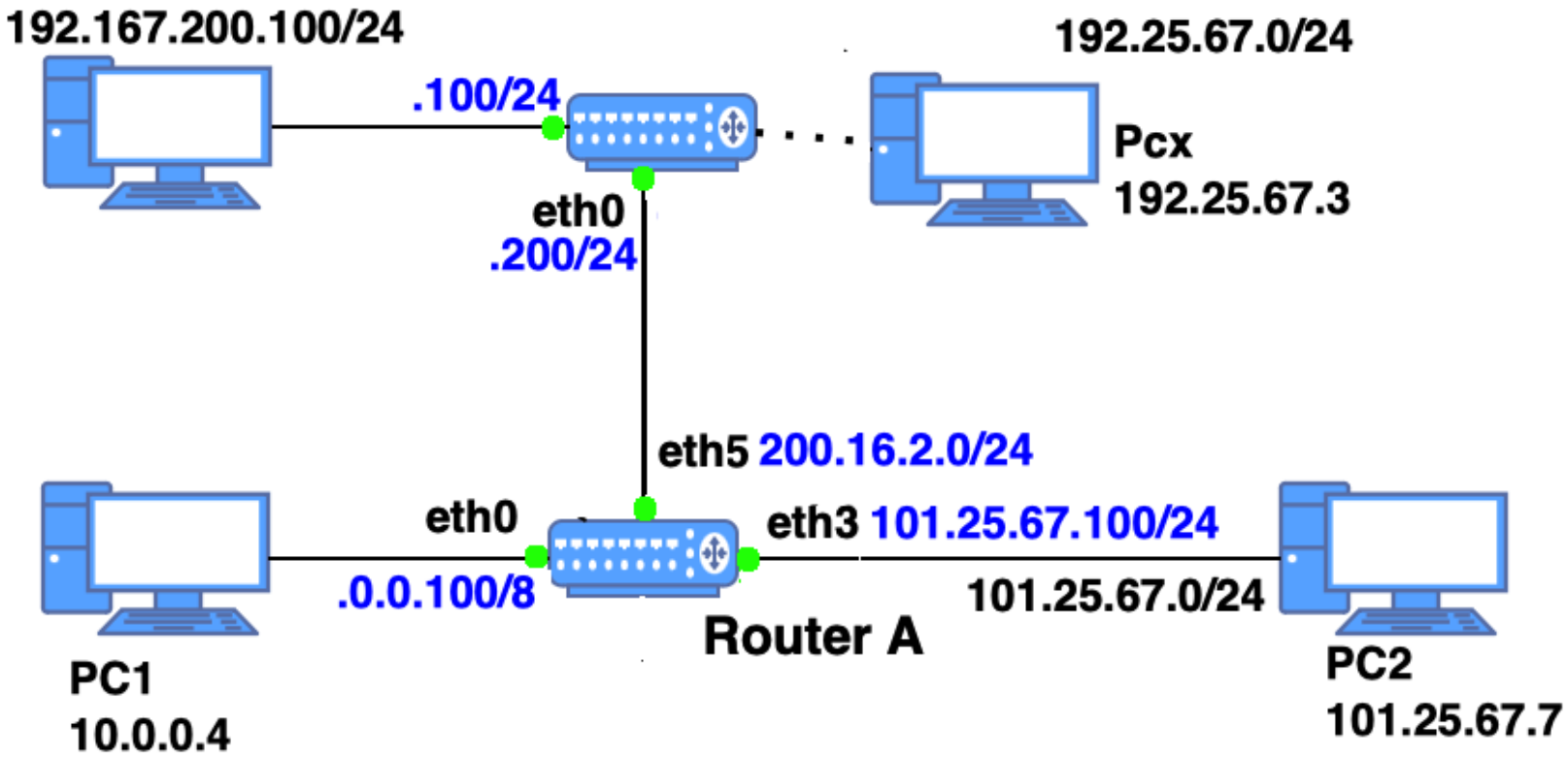
Objectives

- Presentation of routing in IP networks,
- Introduction of some dynamic routing strategies and their metrics,
- Introduction to the RIP routing protocol.

Data Routing

- **Convey information:** ensure the transport of data units from the source to a destination designated by its address.
- This process requires the **developing techniques** to decide which *route* to follow. All of these techniques are called *routing*.
- each node, receiving a packet, will decide **locally** to which next node the packet will be forwarded.
- Thus, from **close to close**, the transfer of the packet will be ensured from the source to the destination.

Data Routing



Routing Definition

- The routing operation consists of the *configuration* and the *information* of the **routing table** used by the nodes of a network.
- The rules used by routers and the types of information exchanged for these tables, constitute the *routing protocol*.
- The choice of a path is most often made on a criterion of *minimum cost*.

Routing Table

This is an example of a routing table:

Network Destination	Netmask	Gateway	Interface	Metric
10.0.0.0	255.0.0.0	—	eth0	0
101.25.67.0	255.255.255.0	—	eth3	0
192.25.67.0	255.255.255.0	200.16.2.200	eth5	10
192.167.200.0	255.255.255.0	200.16.2.200	eth5	1
default	0.0.0.0	200.16.2.200	eth5	0

Routing Table

An entry in a routing table is usually a route to a specific network. The basic components of each entry in the routing table are:

1. **Destination address**: this refers to the IP address of the destination network.
2. **Subnet mask/Netmask**: It's used to map the destination address to the right network.
3. **Gateway/Next Hop**: this refers to the next IP address (router) to which the packet is forwarded.
4. **Interface**: refers to the outgoing interface that connects to the destination.
5. **Metric**: this assigns a value to each route to ensure that optimal routes are chosen for sending packets. It is the cost to get to the destination network. If multiple routes exist, the route with the lowest metric is chosen.

Routing problem

- The major problem in routing is the **taking into account changes** in the state of the network due to:
  - of **failures**,
  - a **high traffic**,
  - the **process mobility** (for *wifi* or *ad-hoc* networks), ...
- Hence the existence of several routing *strategies* and *techniques*.

Types de Routage

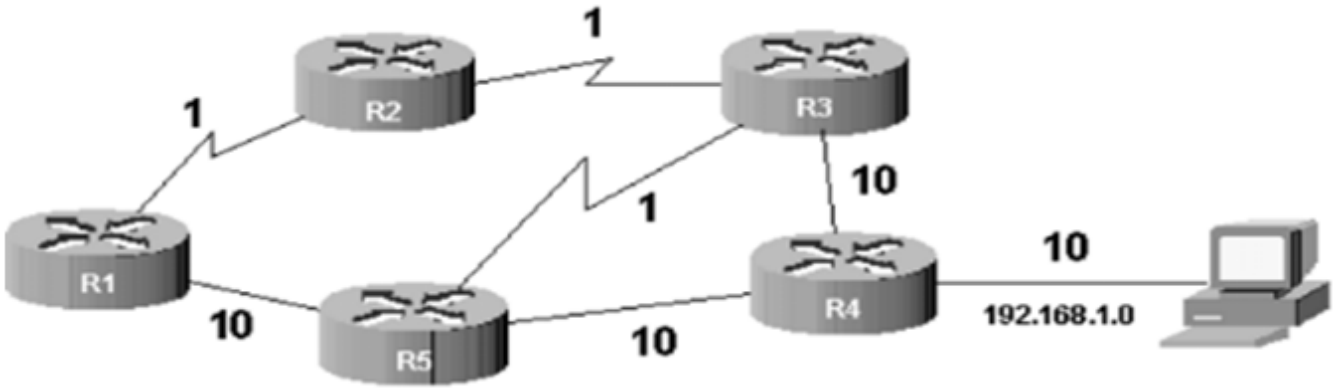
There are two main classes of routing:

- **Static**: The routing tables are permanently configured in each node by the network manager.
  - ▶ Efficient in small networks, few changes.
- **Dynamic**: The routing tables evolve according to the current state of the network (topology, load, node down, ...).
  - ▶ Efficient in large networks, lots of addresses and lots of changes.

Routing table management is generally **distributed** → Each node updates its routing table.

Shortest Path Routing

- Static,
- each table is constructed using shortest path calculation algorithms between two nodes a *weighted graph* representing the network (Ex. Dijkstra's algorithm).



Shortest Path Routing

Advantages:

- Easy implementation,
- Forwarding of packets is guaranteed.

Disadvantages:

- Not optimal,
- No fault management.

Flooding algorithm

In this algorithm, each node send every incoming packet through every outgoing link except the one it arrived on
Thus, after a while, he is informed by all his neighbors.

Advantages:

- Very robust system,
- Shortest path is always found.

Disadvantages:

- mechanisms must be implemented to avoid overload of the network and the loopback.

Adaptive Routing

- Routing tables are dynamically modified to adapt to changes in traffic or network topology.
- These modifications vary depending on the metric used (number of hops, bandwidth,...) and/or
- The nature of the source (locally from neighboring routers, or from all routers).

Advantages:

- Path always **optimal**,
- Robust system.

Disadvantages:

- No guarantee of packet delivery,
- Consumption of **bandwidth** at the expense of data,
- No mechanisms to ensure the **consistency** of data,
- No mechanisms to handle **convergence** problems.

Distance Vector Adaptive Routing

An example of **AR** (also called **Bellman-Ford** routing), an algorithm used in *ARPAnet* and for the *RIP* protocol on the Internet.

Principle: each router must know its neighbors and the cost to reach them and so it can:

1. Maintain a distance vector indicating the best distance to reach each router and the corresponding output line.
2. Update of the vector based on information received from its neighbors.
3. Periodically send its distance vector to all neighbors.

– Convergence problem.

Adaptive routing by link state information

Allows to mitigate the problem of the slowness of the convergence of the algorithm with distance vector. This is the algorithm used today.

Principle: Each router **A** must:

1. Discover neighboring routers,
2. Calculate the transit time to reach each neighbor,
3. Build a packet containing, for each neighbor **X** of **A**, the cost for the link *A*-*X*, then send this packet to all routers,
4. Calculate the shortest path to each router (Dijkstra) using a cost matrix built using packets received from other routers.

Examples:

These are examples of dynamic protocols:

- **RIP**: Routing Information Protocol (Number of Hops)
- **OSPF**: Open Shortest Path First (Bandwidth, Cost*)
- **IGRP**: Interior Gateway Routing Protocol (Delay, Reliability, Bandwidth)
- **EIGRP**: Enhanced Interior Gateway Routing Protocol (Delay, Reliability, Bandwidth)
- **ISIS** or **IS-IS**: Intermediate System to Intermediate System (Cost)

*Cost: a value that can vary from 1 to 65535 with no particular meaning.

RIP: Routing Information Protocol

- **RIP** is known as a program that implements it: **routed**.
- The program **routed** was carried out at the *Berkeley* University of California:
- A router *RIP* transmits to its neighbors the network addresses it knows (either the addresses of its interfaces, or the addresses discovered via other routers) as well as the distance to reach them.
- These **address/distance** pairs are called **distance vectors**.
- The metric used by *RIP* is the **number** of routers to traverse (**hop** or **hops**) before reaching a network.

General RIP Algorithm

- When initializing the router,
  1. it determines the network address and its interfaces
  2. each sends a full or partial RIP table request to neighboring routers.
- Upon receiving a request, a router sends its table according to the request.
- When receiving a response, it updates its table if necessary. Two cases can arise:
  1. for a new route, it increments the distance, verifies that it is strictly less than 15 and immediately broadcasts the corresponding distance vector;
  2. for an existing route but with a lower distance, the table is updated. The new distance and, possibly, the address of the router if it differs are integrated into the table.
- RIP considers a router that hasn't heard from for *three minutes* to be **down**.

RIP on Linux

1. The command:
   - Router♯ **ip route show**

   displays an initial routing table.

2. These commands allow you to statically configure the router:
   - Router♯ **route add -net** ip1 **netmask** mask **gw** ip2
   - Router♯ **route add default gw** ip

3. Activate RIP by:
   - Router(RIP)(config)♯ **router rip**
   - Router(RIP)(config-router)♯ **redistribute connected**

RIP Routing Table

Destination	Gateway	Genmask	Metric	Ref	Use	Interface
192.168.1.0	*	255.255.255.0	0	0	0	eth0
127.0.0.0	*	255.0.0.0	0	0	0	lo
100.0.0.0	192.168.1.254	255.0.0.0	1	0	0	eth0
default	192.168.1.254	0.0.0.0	1	0	0	eth0

-**Destination**: route destination address
-**Gateway**: IP address of the gateway to reach the route, * otherwise
-**Genmask**: mask to use.
-**Metric**: route metric cost (0 by default)
-**Ref**: number of routes depending on this one,
-**Use**: usage count in routing table
-**Interface**: interface *eth0*, *eth1*, *lo*.

Conclusion

This course aimed to:

- Introduce the basics of the routing mechanism in TCP/IP networks.
- Present some dynamic routing strategies and the RIP protocol in some detail.

References

- CCNA Exploration 4.0 /**Routing Protocols and Concepts**/Instructor Handbook,
- Configuration, implementation and administration of Internet and Intranet servers under Linux.
- **Basics of Linux system administration**. Sébastien Namèche (sebastiennameche.fr)
- **Linux network administration**. Source: http://en.wikibooks.org/w/index.php?oldid=171613 Contributors: Michael Witrant, Tavernier

Some useful links

- http://technet.microsoft.com/fr-fr/library
- http://www.linux-france.org/prj/edu/archinet/systeme