ESCUELA COLOMBIANA DE INGENIERÍA JULIO GARAVITO

UNIVERSIDAD

Computer Networks Laboratory

Laboratory No. 6
Router Simulation and Static Routing

Network Configuration, Access Control, and Inter-Router Communication

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October 26, 2025

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Exercise 1: Router Configuration and Static Routing

Network Assignment: Student 02
Networks: 72.0.0.0/8, 73.0.0.0/8, 74.0.0.0/8, 75.0.0.0/8
Serial Interconnection: 20.0.0.0/8

1.1 Network Topology Overview

The implemented topology consists of two routers interconnected via a serial link, with each router serving multiple LAN segments. The design follows the addressing scheme assigned to Student 02.

Router0 (Cris):

- GigabitEthernet0/0: 72.0.0.1/8 (Red No. 1)
- GigabitEthernet0/1: 73.0.0.1/8 (Red No. 2)
- Serial0/1/0: 20.0.0.1/8 (DTE - no clock rate)

Router1 (Pedraza):

- GigabitEthernet0/0: 74.0.0.1/8 (Red No. 3)
- GigabitEthernet0/1: 75.0.0.1/8 (Red No. 4)
- Serial0/1/0: 20.0.0.2/8 (DCE - with clock rate)

1.2 Understanding Router Access Levels

Before configuration, it is essential to understand the three permission levels in Cisco routers:

1. User Mode (Router¿)

The most basic and restricted mode, identified by the `>` prompt. Users can only execute basic viewing commands like `ping` and limited `show` commands. No configuration changes are possible at this level.

2. Privileged Mode (Router#)

Accessed via the `enable` command, this mode provides full viewing capabilities and system management functions. The `#` prompt indicates privileged access. From here, administrators can view complete configurations, manage files, and access configuration mode.

3. Global Configuration Mode (Router(config)#)

Entered from privileged mode using `configure terminal`, this mode allows actual router configuration including interface settings, routing protocols, and security parameters.

Important Note

This hierarchical structure provides security through separation of privileges. Access to higher levels requires authentication, preventing unauthorized configuration changes.

1.3 Router0 Configuration (Cris)

1.3.1 Initial Setup

```
Router> enable
Router# configure terminal

! Set hostname
Router(config)# hostname Cris

! Configure banner message
Cris(config)# banner motd # For exclusive use by RECO students #

! Disable DNS lookup to prevent delays
Cris(config)# no ip domain-lookup

! Set privileged mode password
Cris(config)# enable secret ClaveE
```

1.3.2 Console and Remote Access Configuration

```
! Configure console line
Cris(config)# line console 0
Cris(config-line)# logging synchronous
Cris(config-line)# password ClaveC
Cris(config-line)# login
Cris(config-line)# exit

! Configure virtual terminal lines
Cris(config)# line vty 0 15
Cris(config-line)# logging synchronous
Cris(config-line)# password ClaveT
Cris(config-line)# login
Cris(config-line)# exit
```

Explanation: The `logging synchronous` command prevents console messages from interrupting command input, significantly improving user experience during configuration sessions.

1.3.3 Interface Configuration

```
! Configure GigabitEthernet 0/0
Cris(config)# interface gigabitEthernet 0/0
Cris(config-if)# description LAN Red 72.0.0.0/8
Cris(config-if)# ip address 72.0.0.1 255.0.0.0
Cris(config-if)# no shutdown
Cris(config-if)# exit

! Configure GigabitEthernet 0/1
Cris(config)# interface gigabitEthernet 0/1
Cris(config-if)# description LAN Red 73.0.0.0/8
Cris(config-if)# ip address 73.0.0.1 255.0.0.0
Cris(config-if)# no shutdown
Cris(config-if)# exit

! Configure Serial 0/1/0
Cris(config)# interface serial 0/1/0
Cris(config-if)# description Enlace a Router1
Cris(config-if)# ip address 20.0.0.1 255.0.0.0
Cris(config-if)# no shutdown
Cris(config-if)# exit
```

1.3.4 Saving Configuration

```
Cris(config)# exit
Cris# copy running-config startup-config
Destination filename [startup-config]? [Enter]
```

Important Note

Understanding Configuration Storage:
Cisco routers maintain two configurations:
Running-config: Stored in RAM (volatile memory), this is the active configuration. Changes take effect immediately but are lost upon reboot.
Startup-config: Stored in NVRAM (non-volatile memory), this configuration loads automatically at boot

time and persists through power cycles.
The `copy running-config startup-config` command saves current changes permanently. Without this step, all configuration would be lost upon router restart.

1.4 Router1 Configuration (Pedraza)

1.4.1 Basic Configuration

```
Router> enable
Router# configure terminal

Router(config)# hostname Pedraza
Pedraza(config)# banner motd # For exclusive use by RECO
     students #
Pedraza(config)# no ip domain-lookup
Pedraza(config)# enable secret ClaveE
```

1.4.2 Console and VTY Configuration

```
Pedraza(config)# line console 0
Pedraza(config-line)# logging synchronous
Pedraza(config-line)# password ClaveC
Pedraza(config-line)# login
Pedraza(config-line)# exit

Pedraza(config)# line vty 0 15
Pedraza(config-line)# logging synchronous
Pedraza(config-line)# password ClaveT
Pedraza(config-line)# login
Pedraza(config-line)# exit
```

1.4.3 Interface Configuration

```
! Configure GigabitEthernet 0/0
Pedraza(config)# interface gigabitEthernet 0/0
Pedraza(config-if)# description LAN Red 74.0.0.0/8
Pedraza(config-if)# ip address 74.0.0.1 255.0.0.0
Pedraza(config-if)# no shutdown
Pedraza(config-if)# exit

! Configure GigabitEthernet 0/1
Pedraza(config)# interface gigabitEthernet 0/1
Pedraza(config-if)# description LAN Red 75.0.0.0/8
Pedraza(config-if)# ip address 75.0.0.1 255.0.0.0
Pedraza(config-if)# no shutdown
Pedraza(config-if)# exit

! Configure Serial 0/1/0 (DCE side)
Pedraza(config)# interface serial 0/1/0
Pedraza(config-if)# description Enlace a Router0
Pedraza(config-if)# ip address 20.0.0.2 255.0.0.0
Pedraza(config-if)# clock rate 64000
Pedraza(config-if)# no shutdown
Pedraza(config-if)# exit

Pedraza(config)# exit
Pedraza# copy running-config startup-config
```

Critical Note: The `clock rate 64000` command is required only on the DCE (Data Communications Equipment) side of a serial connection. Router1 acts as DCE in this topology, providing timing signals for synchronous communication.

1.5 PC Configuration

Each PC was configured with static IP addressing:

PC0 (Connected to Router0 - Gi0/0):

- IP Address: 72.0.0.2
- Subnet Mask: 255.0.0.0
- Default Gateway: 72.0.0.1

PC1 (Connected to Router0 - Gi0/1):

- IP Address: 73.0.0.2
- Subnet Mask: 255.0.0.0
- Default Gateway: 73.0.0.1

PC2 (Connected to Router1 - Gi0/0):

- IP Address: 74.0.0.2
- Subnet Mask: 255.0.0.0
- Default Gateway: 74.0.0.1

PC3 (Connected to Router1 - Gi0/1):

- IP Address: 75.0.0.2
- Subnet Mask: 255.0.0.0
- Default Gateway: 75.0.0.1

1.6 Initial Connectivity Testing

1.6.1 Question: Which connections work and which don't?

After basic configuration, connectivity tests revealed:

Working Connections ():

- PC0 ↔ Gateway 72.0.0.1 (same router, direct network)
- PC0 ↔ Gateway 73.0.0.1 (same router, direct network)
- PC0 ↔ PC1 (same router, both networks directly connected)
- PC2 ↔ Gateway 74.0.0.1 (same router, direct network)
- PC2 ↔ Gateway 75.0.0.1 (same router, direct network)
- PC2 ↔ PC3 (same router, both networks directly connected)

Non-Working Connections ():

- PC0 → Gateway 74.0.0.1 (different router)
- PC0 → Gateway 75.0.0.1 (different router)
- PC0 → PC2 or PC3 (different router)
- PC2 → Gateway 72.0.0.1 (different router)
- PC2 → Gateway 73.0.0.1 (different router)
- PC2 → PC0 or PC1 (different router)

1.6.2 Why This Behavior Occurs

This behavior is completely normal and expected. Routers only know about directly connected networks by default. When examining the routing tables:

Router0 Routing Table:

```
Cris# show ip route

C    72.0.0.0/8 is directly connected, GigabitEthernet0/0
C    73.0.0.0/8 is directly connected, GigabitEthernet0/1
C    20.0.0.0/8 is directly connected, Serial0/1/0
```

Router0 only knows networks 72, 73, and 20. It has no information about networks 74 and 75.

Router1 Routing Table:

```
Pedraza# show ip route

C    74.0.0.0/8 is directly connected, GigabitEthernet0/0
C    75.0.0.0/8 is directly connected, GigabitEthernet0/1
C    20.0.0.0/8 is directly connected, Serial0/1/0
```

Similarly, Router1 only knows networks 74, 75, and 20, but not networks 72 and 73.

Packet Flow Example - PC0 to PC2 (Failed):

1. PC0 (72.0.0.2) attempts to ping PC2 (74.0.0.2)
2. PC0 recognizes 74.0.0.2 is not in its local network
3. PC0 forwards packet to default gateway (72.0.0.1 - Router0)
4. Router0 consults routing table: "How do I reach 74.0.0.0/8?"
5. Routing table response: "Unknown network"
6. Router0 discards packet, sends ICMP "Destination Host Unreachable" to PC0

1.7 Static Route Configuration

To enable complete network connectivity, static routes must be configured on both routers. Static routes explicitly tell routers how to reach networks that are not directly connected.

1.7.1 Router0 Static Routes

Router0 needs routes to networks 74.0.0.0/8 and 75.0.0.0/8, which exist beyond Router1:

```
Cris# configure terminal

! Route to network 74.0.0.0/8 via Serial0/1/0
Cris(config)# ip route 74.0.0.0 255.0.0.0 serial 0/1/0

! Route to network 75.0.0.0/8 via Serial0/1/0
Cris(config)# ip route 75.0.0.0 255.0.0.0 serial 0/1/0

Cris(config)# exit
Cris# copy running-config startup-config
```

Command Syntax Explanation:

```
ip route [destination_network] [subnet_mask] [exit_interface]
```

- **destination_network**: The remote network to reach
- **subnet_mask**: The network mask of the destination
- **exit_interface**: Interface through which packets should be forwarded

1.7.2 Router1 Static Routes

Router1 needs routes to networks 72.0.0.0/8 and 73.0.0.0/8, which exist beyond Router0:

```
Pedraza# configure terminal

! Route to network 72.0.0.0/8 via Serial0/1/0
Pedraza(config)# ip route 72.0.0.0 255.0.0.0 serial 0/1/0

! Route to network 73.0.0.0/8 via Serial0/1/0
Pedraza(config)# ip route 73.0.0.0 255.0.0.0 serial 0/1/0

Pedraza(config)# exit
Pedraza# copy running-config startup-config
```

1.8 Verification of Static Routes

After configuration, routing tables now include static routes:

Router0:

```
Cris# show ip route

C    72.0.0.0/8 is directly connected, GigabitEthernet0/0
C    73.0.0.0/8 is directly connected, GigabitEthernet0/1
C    20.0.0.0/8 is directly connected, Serial0/1/0
S    74.0.0.0/8 [1/0] via Serial0/1/0
S    75.0.0.0/8 [1/0] via Serial0/1/0
```

Router1:

```
Pedraza# show ip route

S    72.0.0.0/8 [1/0] via Serial0/1/0
S    73.0.0.0/8 [1/0] via Serial0/1/0
C    74.0.0.0/8 is directly connected, GigabitEthernet0/0
C    75.0.0.0/8 is directly connected, GigabitEthernet0/1
C    20.0.0.0/8 is directly connected, Serial0/1/0
```

Legend:

- **C** = Connected (directly connected network)
- **S** = Static (manually configured route)
- **[1/0]** = Administrative distance and metric

1.9 Final Connectivity Testing

With static routes configured, all connectivity tests now succeed:

From PC0:

```
ping 74.0.0.1 # Gateway of Router1 - SUCCESS
ping 74.0.0.2 # PC2 - SUCCESS
ping 75.0.0.1 # Gateway of Router1 - SUCCESS
ping 75.0.0.2 # PC3 - SUCCESS
```

From PC2:

```
ping 72.0.0.1 # Gateway of Router0 - SUCCESS
ping 72.0.0.2 # PC0 - SUCCESS
ping 73.0.0.1 # Gateway of Router0 - SUCCESS
ping 73.0.0.2 # PC1 - SUCCESS
```

1.10 Traceroute Analysis

The `tracert` command reveals the path packets take through the network:

From PC0 to PC2 (74.0.0.2):

```
C:\> tracert 74.0.0.2

Tracing route to 74.0.0.2 over a maximum of 30 hops:

  1    <1 ms    <1 ms    <1 ms    72.0.0.1
  2    <1 ms    <1 ms    <1 ms    20.0.0.2
  3    <1 ms    <1 ms    <1 ms    74.0.0.2

Trace complete.
```

Path Explanation:

1. Hop 1: PC0 to Router0 (72.0.0.1) - first gateway
2. Hop 2: Router0 to Router1 (20.0.0.2) - serial link
3. Hop 3: Router1 to PC2 (74.0.0.2) - destination

This confirms packets traverse both routers using the serial interconnection as configured in the static routes.

1.11 Key Takeaways

1. Router Knowledge Limitation:

Routers only know about directly connected networks by default. Remote networks require explicit routing information through either static routes or dynamic routing protocols.

2. Static Routing Requirements:

Each router must be configured with routes to all remote networks. In our topology, this meant four static routes total (two per router).

3. Configuration Persistence:

Always save configurations using `copy running-config startup-config` to ensure settings survive router reboots.

4. DCE/DTE Considerations:

Serial connections require one side (DCE) to provide clocking. In our setup, Router1 served as DCE with `clock rate 64000` configured.

5. Hierarchical Access Control:

Router security relies on three permission levels (User, Privileged, Configuration), each requiring appropriate authentication.