



Lecture 9 – Basics of Router & Router Memory



What is a Router?

A **router** is a networking device used to **connect different networks** and **forward data packets** between them using IP addresses.

- ◆ Routers work at **Layer 3 (Network Layer)** of the OSI Model.



Daily Life Example

Think of a router like a **traffic police officer**  :

- It checks the destination address
- Decides the best path
- Forwards data to the correct network



Cisco Router Operating System (IOS)

Cisco routers use an operating system called **IOS (Internetwork Operating System)**.

- ◆ **Key Points**

- IOS controls how the router works
- Handles routing, security, and interfaces
- Latest IOS series currently used: **17.x**



Example:

Just like Windows or Linux controls a computer, **Cisco IOS controls a router**.

Router Storage & Files

Flash Memory (Acts like Hard Disk)

Flash memory stores important router files.

- ◆ Stores:

- Cisco IOS (Operating System)
- VLAN.dat (VLAN configuration file)

- Example:

If **Flash memory fails**, the router **cannot load IOS** and will not start properly.

BIOS / ROM Concept in Router

ROM (Read Only Memory)

ROM is a **fixed memory chip** on the router motherboard.

- ◆ Characteristics:

- Software stored here **never changes**
- Similar to **BIOS in a computer**
- First memory used when router powers ON

- ◆ Functions:

- Runs POST (Power On Self Test)
- Checks hardware components
- Starts boot process

- Daily Life Example:

ROM is like a **doctor checkup**  before starting a journey.

Router Memories

Cisco routers have **4 main types of memory**, each with a different purpose.

1. ROM (Read Only Memory)

- ◆ Fixed memory on motherboard
- ◆ Cannot be modified
- ◆ Runs POST process
- ◆ Works like BIOS

- Example:

When router is powered ON → ROM checks CPU, RAM, interfaces.

2. Flash Memory

- ◆ Non-volatile memory
- ◆ Stores Cisco IOS
- ◆ Stores VLAN.dat file
- ◆ IOS version example: **15.7 / 17.x**

- Example:

If IOS file is corrupted → router cannot boot normally.



3. NVRAM (Non-Volatile RAM)

- ◆ Stores **Startup Configuration**
- ◆ Data remains even after power OFF
- ◆ Contains:
 - Hostname
 - Passwords
 - Interface IP configuration

- Example:

Router name saved → reboot router → same name appears.

4. RAM / VRAM (Volatile Memory)

- ◆ Stores **Running Configuration**

- ◆ Temporary memory

- ◆ Data lost after restart

- Example:

Configure IP address but do not save → restart router → configuration lost 

Running Configuration vs Startup Configuration

Feature	Running Config	Startup Config
---------	----------------	----------------

Stored In	RAM	NVRAM
-----------	-----	-------

Nature	Temporary	Permanent
--------	-----------	-----------

After Reboot Lost		Saved 
-------------------	---	---

Real Life Example of Router Memories

Imagine a router like a **mobile phone**:

- ROM → Bootloader / BIOS
 - Flash → Android / iOS system
 - NVRAM → Saved settings (WiFi name, password)
 - RAM → Apps currently running
-

Router Booting Process (Step-by-Step)

When router is powered ON:

1 ROM turns ON first

- Runs POST (Power On Self Test)
- Checks hardware components

2 POST successful

- Router looks for IOS in Flash memory

3 IOS loaded from Flash to RAM

- Router OS becomes active

4 NVRAM checked

- Startup configuration found

5 Startup Config copied to RAM

- Becomes Running Configuration

6 Router becomes fully operational

 Daily Life Example:

Like starting a car  :

- Engine check
- Load system
- Apply saved settings
- Ready to drive

★ Why Router Memory Knowledge is Important?

- ✓ Helps in troubleshooting
- ✓ Important for CCNA exams
- ✓ Understand boot failures
- ✓ Helps during password recovery



Summary (Quick Revision)

- Cisco router uses **IOS**
 - Flash stores **IOS & VLAN.dat**
 - ROM runs **POST process**
 - NVRAM stores **Startup Config**
 - RAM stores **Running Config**
 - Configuration must be saved to avoid data loss
-

KM



1 SUMMARY



A Router is a **Layer 3 (Network Layer)** device that connects **multiple networks** and forwards data using **IP addresses** .

Cisco routers use an operating system called **IOS (Internetwork Operating System)** which controls routing, security, and interfaces.

Routers have **four important types of memory**, and each memory has a **specific role**:

- ◆ **ROM** – Starts the router, runs POST
- ◆ **Flash** – Stores Cisco IOS
- ◆ **NVRAM** – Stores Startup Configuration
- ◆ **RAM** – Stores Running Configuration

During booting :

1. Router starts from **ROM**
2. POST is performed
3. IOS is loaded from **Flash to RAM**
4. Startup Config copied from **NVRAM to RAM**
5. Router becomes operational 

Understanding router memory is **very important** for:

- ✓ CCNA exams
 - ✓ Troubleshooting
 - ✓ Password recovery
 - ✓ Boot failure issues
-

2 CONCLUSION

A router is the **brain of a network**, and its memories work together like a **computer system** .

Each memory (ROM, Flash, NVRAM, RAM) has a **fixed responsibility**, and without understanding them, **real-world networking troubleshooting is impossible**.

Knowing:

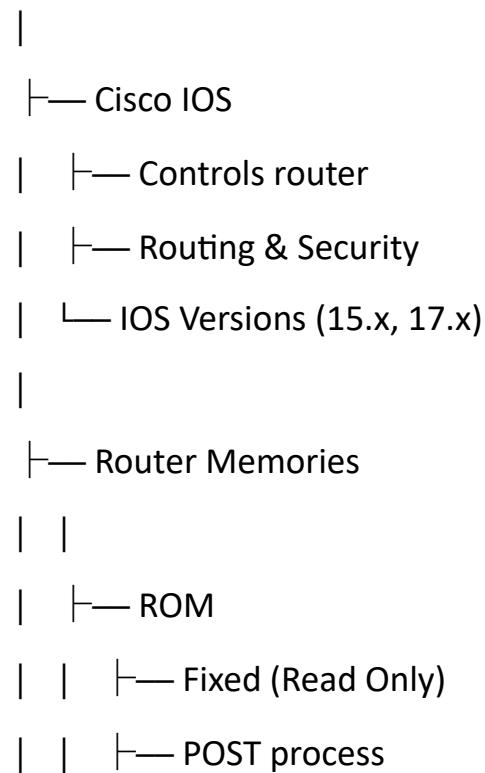
- ✓ Where IOS is stored
- ✓ Where configuration is saved
- ✓ What happens during reboot

...clearly shows that the candidate has **practical + conceptual networking knowledge**, not just theory .

 This chapter builds the foundation of routing, boot process, and configuration management.

3 MIND MAP

Router (Layer 3)



```
| | └ Boot process start
| |
|   | └ Flash
|   |   | └ Non-Volatile
|   |   | └ Stores IOS
|   |   |   | └ VLAN.dat
|   |   |
|   |   | └ NVRAM
|   |   |   | └ Startup Config
|   |   |   | └ Permanent
|   |   |   | └ Hostname, Passwords
|   |   |
|   |   | └ RAM
|   |   |   | └ Running Config
|   |   |   | └ Volatile
|   |   |   | └ Active Processes
|
└ Boot Process
    | └ ROM → POST
    | └ IOS from Flash → RAM
    | └ Startup Config from NVRAM → RAM
    └ Router Ready
```



Q & A

- ◆ Q1. What is a router?

Answer:

A router is a **Layer 3 networking device** that connects **different networks** and forwards data packets based on **IP addresses**.

Example:

Connecting office LAN to the Internet.

- ◆ Q2. On which OSI layer does a router work?

Answer:

A router works on **Layer 3 – Network Layer**.

Because it uses **IP addresses**, not MAC addresses.

- ◆ Q3. What is Cisco IOS?

Answer:

Cisco IOS (Internetwork Operating System) is the **operating system of Cisco routers**.

- ✓ Controls routing
- ✓ Manages interfaces
- ✓ Provides security

Just like Windows/Linux for a computer.

- ◆ Q4. Where is Cisco IOS stored?

Answer:

Cisco IOS is stored in **Flash Memory**.

- ✓ Flash is **non-volatile**
- ✓ IOS remains even after power OFF

◆ Q5. What is ROM in a router? 

Answer:

ROM (Read Only Memory) is a **fixed memory** on the router motherboard.

Functions:

- ✓ Runs POST
 - ✓ Starts boot process
 - ✓ Checks hardware
-  Works like **BIOS in a PC**.
-

◆ Q6. What is POST? 

Answer:

POST (Power On Self Test) checks:

- ✓ CPU
- ✓ RAM
- ✓ Interfaces

If POST fails → router will not boot.



◆ Q7. What is Flash memory used for? 

Answer:

Flash memory stores:

- ✓ Cisco IOS
- ✓ VLAN.dat file

 If Flash fails, router cannot load IOS.

◆ Q8. What is NVRAM? 

Answer:

NVRAM stores the **Startup Configuration**.

Includes:

- ✓ Hostname
 - ✓ Passwords
 - ✓ IP addresses
 - ✓ Data remains after reboot.
-

◆ Q9. What is RAM in a router? 🔌

Answer:

RAM stores the **Running Configuration** and active processes.

- ✗ Volatile memory
 - ✗ Data lost after reboot
-

◆ Q10. Difference between Running Config & Startup Config? 🔄

Feature	Running Config	Startup Config
Stored In	RAM	NVRAM
Nature	Temporary	Permanent
After Reboot	Lost ✗	Saved ✓

◆ Q11. What happens if configuration is not saved? ✗

Answer:

If configuration is not saved:

- ✓ Router reboot → all changes lost
- ✓ Running config is erased

👉 Use command:
copy running-config startup-config

◆ Q12. Explain router booting process step by step 

Answer:

- 1 Router powers ON
 - 2 ROM runs POST
 - 3 IOS loaded from Flash to RAM
 - 4 Startup config copied from NVRAM to RAM
 - 5 Router becomes operational 
-

◆ Q13. Which memory is used first when router starts? 

Answer:

ROM is the first memory used when router powers ON.

◆ Q14. Can we modify ROM? 

Answer:

 No.

ROM is **read-only and fixed**.

◆ Q15. Why router memory knowledge is important? 

Answer:

- ✓ Troubleshooting boot issues
- ✓ Password recovery
- ✓ CCNA exams
- ✓ IOS recovery

 Shows **real networking knowledge**.
