



## Lecture 12- Routing & Static Routing

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### What is Routing?

Routing is the process of **selecting the best path** for data packets to travel from a **source network** to a **destination network**.

- ◆ Routing happens on **routers**.
- ◆ Routers read the **destination IP address** in a packet.
- ◆ Based on this IP, the router decides **where to forward the packet next**.
- 📌 Routers use a **Routing Table** to make this decision.



### Real-Life Example

Think of routing like **Google Maps** 🌐 :

- Source = Your home
- Destination = Your friend's house
- Router = Google Maps app
- Best path = Shortest / fastest road

When you open a website 🌐, routers guide your request through many networks until it reaches the correct server.

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### Types of Routing

Type	Description	Example
👤 Static Routing	Routes are manually configured	Small networks
🤝 Dynamic Routing	Routers share routes automatically	Large networks
💼 Default Routing	One route for unknown destinations	Internet access from LAN

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# Routing Protocols

Routing protocols are **rules** used by routers to **share routing information** and choose the best path.

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## 1 RIP (Routing Information Protocol)

- Oldest dynamic routing protocol 
- Type: **Distance Vector**
- Metric: **Hop Count**
- Maximum hops allowed: **15**

 Used only in very small networks

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## 2 OSPF (Open Shortest Path First)

- Type: **Link State**
- Metric: **Cost**
- Very fast convergence 
- Highly scalable

 Used in large enterprise networks

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## 3 EIGRP (Enhanced Interior Gateway Routing Protocol)

- Cisco proprietary 
- Type: **Hybrid (Distance Vector + Link State)**
- Metrics: Bandwidth, Delay
- Faster and more efficient than RIP & OSPF (Cisco-only networks)

## BGP (Border Gateway Protocol)

- Used on the **Internet** 
  - Type: **Path Vector**
  - Used between ISPs
  - Highly scalable but complex
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## Summary Table of Routing Protocols

Protocol Type	Use Case	Metric
RIP	Distance Vector	Small networks Hop Count
OSPF	Link State	Enterprise LANs Cost
EIGRP	Hybrid (Cisco)	Cisco enterprise Bandwidth, Delay
BGP	Path Vector	Internet / ISP Path Attributes

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## Types of Dynamic Routing Protocols

### IGP (Interior Gateway Protocol)

Used **inside one organization**.

Examples:

- RIP
- OSPF
- EIGRP
- IS-IS

 Fast convergence, low complexity

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## EGP (Exterior Gateway Protocol)

Used **between different organizations**.

Example:

- BGP (Only EGP used today)



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## What is an Autonomous System (AS)?

An **Autonomous System (AS)** is a group of networks managed by a **single organization**.

- ◆ Each company / ISP gets a unique **AS Number**.
- ◆ Routing inside same AS → **IGP**
- ◆ Routing between different AS → **EGP**

### Real-Life Analogy

- IGP = Local delivery trucks inside a city 
- EGP = National logistics company between cities 

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## What is Static Routing?

Static Routing is a routing method where routes are **manually configured** by a network administrator.

- ◆ Routers do not exchange routes automatically
- ◆ Admin defines the **exact path**

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### Key Features of Static Routing

- Manual configuration 
- No routing overhead 
- More secure 

- Not scalable ✗
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## ✓ When to Use Static Routing?

- Small networks
  - Backup routes
  - Test labs 🧪
  - When path never changes
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## 💻 Static Routing Command (Cisco IOS)

Router(config)# ip route [destination\_network] [subnet\_mask] [next\_hop\_ip]

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## Static Routing Lab

### Lab Topology

- 4 Routers (R1, R2, R3, R4) 
- 2 Switches 
- 2 PCs 

 Routers connected in **square topology**

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### IP Addressing Plan

#### PC Configuration

- PC1: 192.168.2.2 /24 | Gateway: 192.168.2.1
  - PC2: 192.168.4.2 /24 | Gateway: 192.168.4.1
- 

### Router Configurations

#### ◆ Router R1 Configuration

enable

configure terminal

hostname R1

interface g0/0

ip address 192.168.10.1 255.255.255.0

no shutdown

interface g0/1

ip address 192.168.40.1 255.255.255.0

no shutdown

```
interface g0/2
ip address 192.168.2.1 255.255.255.0
no shutdown
```

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#### ◆ Router R2 Configuration

```
enable
configure terminal
hostname R2
```

```
interface g0/0
ip address 192.168.10.2 255.255.255.0
no shutdown
```

```
interface g0/1
ip address 192.168.20.1 255.255.255.0
no shutdown
```

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#### ◆ Router R3 Configuration

```
enable
configure terminal
hostname R3
```

```
interface g0/0
ip address 192.168.30.1 255.255.255.0
no shutdown
```

```
interface g0/1  
ip address 192.168.40.2 255.255.255.0  
no shutdown
```

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#### ◆ Router R4 Configuration

```
enable  
configure terminal  
hostname R4
```

```
interface g0/0  
ip address 192.168.20.2 255.255.255.0  
no shutdown
```

```
interface g0/1  
ip address 192.168.30.2 255.255.255.0  
no shutdown
```

```
interface g0/2  
ip address 192.168.4.1 255.255.255.0  
no shutdown
```

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#### 📍 Static Route Configuration

##### 📍 On Router R1

```
ip route 192.168.4.0 255.255.255.0 192.168.10.2
```

### 📍 On Router R2

```
ip route 192.168.4.0 255.255.255.0 192.168.20.2
```

```
ip route 192.168.2.0 255.255.255.0 192.168.10.1
```

### 📍 On Router R4

```
ip route 192.168.2.0 255.255.255.0 192.168.20.1
```

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## 🔍 Verification Commands

### 💡 Check Interface Status

```
show ip interface brief
```

### 💡 Check Routing Table

```
show ip route
```

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## 📡 Connectivity Test (Ping)

### From PC1

```
ping 192.168.4.2
```

### From PC2

```
ping 192.168.2.2
```

✓ If ping replies received → **Static Routing is working successfully** 🎉

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## CHAPTER SUMMARY

### What is Routing?

Routing is the process of **deciding the best path** for data packets to travel from **source network to destination network**.

- ✓ Routing is done by **routers**
- ✓ Routers read **destination IP address**
- ✓ Routers use a **Routing Table** to forward packets

### Real-Life Example

Routing works like **Google Maps**:

- Source → Your home
- Destination → Friend's house
- Router → Google Maps
- Best Path → Shortest / fastest route

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### Types of Routing

Type	Description	Used In
 Static Routing	Manually configured routes	Small networks
 Dynamic Routing	Routes shared automatically	Large networks
 Default Routing	One route for all unknown networks	Internet access

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### Routing Protocols

Routing protocols help routers:

- Share routing information
- Choose the **best path**
- Update routing tables automatically

## 🔥 Dynamic Routing Protocols

### 1 RIP (Routing Information Protocol)

- Oldest protocol 🕒
- Type: **Distance Vector**
- Metric: **Hop Count**
- Max hops: **15** ✗
- Slow convergence

➡ Used only in very small networks

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### 2 OSPF (Open Shortest Path First)

- Type: **Link State**
- Metric: **Cost**
- Very fast convergence ⚡
- Highly scalable

➡ Used in large enterprise networks

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### 3 EIGRP

- Cisco proprietary 🔒
- Type: **Hybrid**
- Metrics: Bandwidth + Delay
- Faster than RIP & OSPF

➡ Used in Cisco-only networks

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### 4 BGP (Border Gateway Protocol)

- Used on the **Internet** 🌎

- Type: **Path Vector**
  - Used between ISPs
  - Highly scalable but complex
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## Routing Protocol Comparison

Protocol Type	Use Case	Metric
RIP	Distance Vector	Small networks Hop Count
OSPF	Link State	Enterprise LAN Cost
EIGRP	Hybrid	Cisco networks Bandwidth, Delay
BGP	Path Vector	Internet Path Attributes

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### IGP vs EGP

#### IGP (Interior Gateway Protocol)

Used **inside one organization**

- RIP
- OSPF
- EIGRP
- IS-IS

 Like local delivery inside a city

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#### EGP (Exterior Gateway Protocol)

Used **between organizations**

- BGP (only EGP today)

 Like national/international logistics

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## Autonomous System (AS)

An **Autonomous System** is a group of networks managed by **one organization**.

- ✓ Each AS has a unique **AS Number**
  - ✓ Same AS → IGP
  - ✓ Different AS → BGP
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## Static Routing Explained

### What is Static Routing?

Static Routing is when **network admin manually adds routes** in the router.

- ✓ No automatic route sharing
  - ✓ Admin decides the exact path
- 

### Features of Static Routing

-  Manual configuration
  -  No routing overhead
  -  More secure
  -  Not scalable
- 

### When to Use Static Routing?

- Small networks
  - Backup routes
  - Lab & testing 
  - When path never changes
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## Static Route Command

```
ip route destination_network subnet_mask next_hop_ip
```

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## Static Routing Lab – Explanation

### Topology

- 4 Routers (R1, R2, R3, R4)
  - 2 Switches
  - 2 PCs
  - Square topology 
- 

### IP Plan

- PC1 → 192.168.2.2 /24
  - PC2 → 192.168.4.2 /24
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### Static Routes Logic

Each router is told:

 “If destination is not directly connected, forward packet to next router”

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### Verification

Command	Purpose
show ip interface brief	Check interfaces
show ip route	Check routing table
ping	Test connectivity
 Successful ping = Routing working	

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## TEXT MIND MAP

### Routing

- └— Definition
  - └— Best path selection
  - └— Uses routing table
- |
- └— Types of Routing
  - └— Static
  - └— Dynamic
  - └— Default
- |
- └— Routing Protocols
  - └— RIP (Hop Count)
  - └— OSPF (Cost)
  - └— EIGRP (Bandwidth, Delay)
  - └— BGP (Path Vector)
- |
- └— IGP vs EGP
  - └— IGP → RIP, OSPF, EIGRP
  - └— EGP → BGP
- |
- └— Autonomous System
  - └— AS Number
  - └— Same AS → IGP
  - └— Different AS → BGP

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└— Static Routing

  └— Manual

  └— Secure

  └— Not scalable

  └— Used in small networks

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## Q & A

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### Q 1 What is routing?

**Answer:**

Routing is the process of selecting the best path for data packets to travel from source to destination using routers.

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### Q 2 What device performs routing?

**Answer:**

Routing is performed by **routers**, which forward packets based on destination IP address.

### Q 3 What is a routing table?

**Answer:**

A routing table is a database stored in a router that contains network paths and next-hop information.

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### Q 4 Difference between Static and Dynamic Routing?

Static	Dynamic
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Manual	Automatic
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No updates	Updates automatically
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Secure	Scalable
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Small networks	Large networks
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## **Q 5 What is RIP and its limitation?**

**Answer:**

RIP is a distance vector routing protocol using hop count as metric.

Its limitation is **maximum 15 hops**, making it unsuitable for large networks.

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## **Q 6 Why OSPF is better than RIP?**

**Answer:**

OSPF has:

- Faster convergence
- No hop limit
- Uses cost metric

So it is better for large enterprise networks.

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## **Q 7 What is EIGRP?**

**Answer:**

EIGRP is a Cisco proprietary hybrid routing protocol that uses bandwidth and delay for best path selection.

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## **Q 8 What is BGP and where is it used?**

**Answer:**

BGP is a path vector routing protocol used between ISPs on the Internet.

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## **Q 9 What is IGP?**

**Answer:**

IGP is used for routing **inside one organization** (example: RIP, OSPF, EIGRP).

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## **Q 10 What is EGP?**

**Answer:**

EGP is used for routing **between different organizations**, mainly BGP.

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## **Q 1 1** What is an Autonomous System?

**Answer:**

An Autonomous System is a group of networks under a single administrative control, identified by an AS number.

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## **Q 1 2** What is Static Routing?

**Answer:**

Static routing is manually configured routing where admin defines exact routes.

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## **Q 1 3** Advantages of Static Routing?

- Secure
- No overhead
- Simple
- Predictable



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## **Q 1 4** Disadvantages of Static Routing?

- Not scalable
- Manual updates required
- Not suitable for large networks

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## **Q 1 5** Static route command in Cisco?

ip route destination subnet\_mask next\_hop

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**Q 1 6 How do you verify routing?**

**Answer:**

Using:

- show ip route
  - show ip interface brief
  - ping command
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