

Ministry of Higher Education and Scientific Researches
Al-Mansour University College
Department of Computer Technology Engineering
Fourth Class



Computer Networks Protocols

Lecture Four: Network Layer (Routing Protocols)

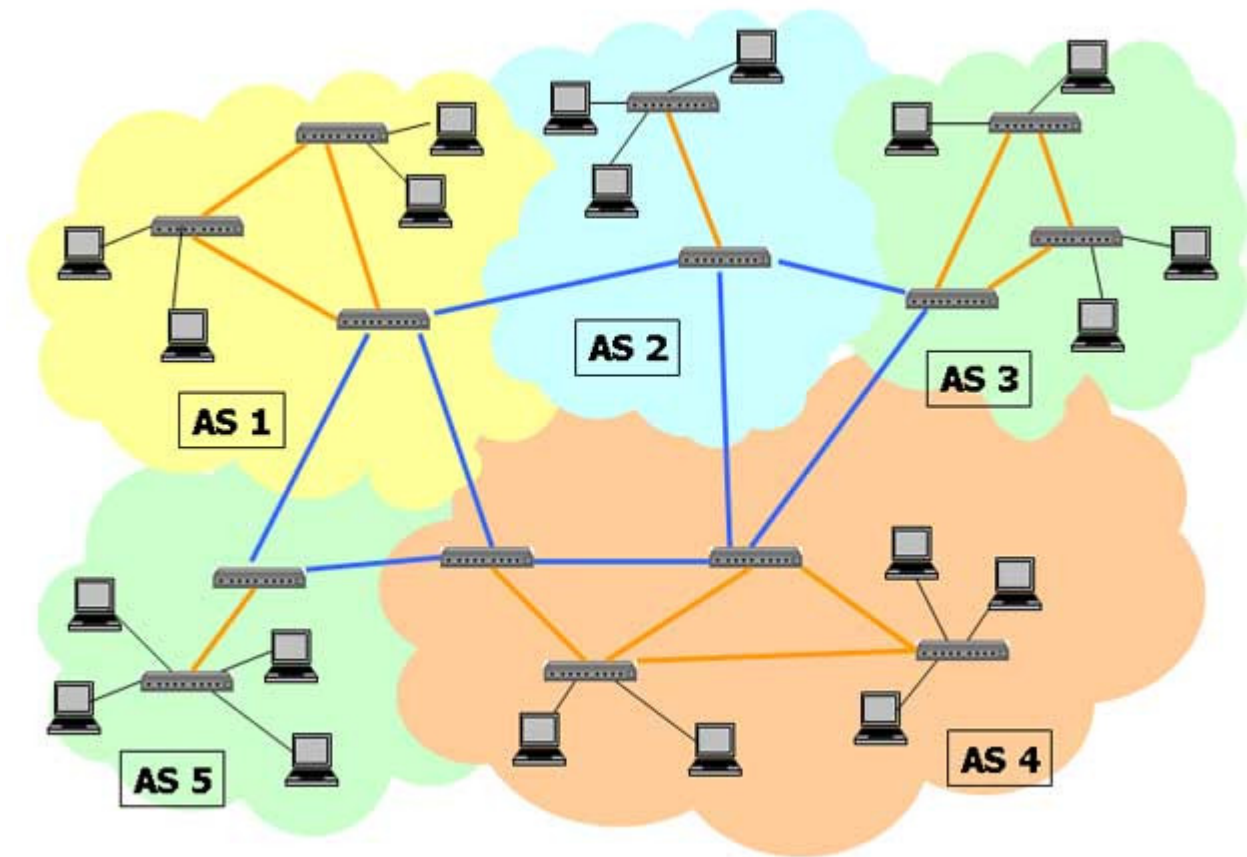
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Routing Protocols

- A **routing protocol** is a combination of **rules and a procedure that lets** routers in the internet inform each other of **changes**.
- **Routing metric**: a method by which routing algorithms determines that one route is better than another route, Metric may be (*hop count, bandwidth, delay, or load*)

Interior Versus Exterior Routing Protocols

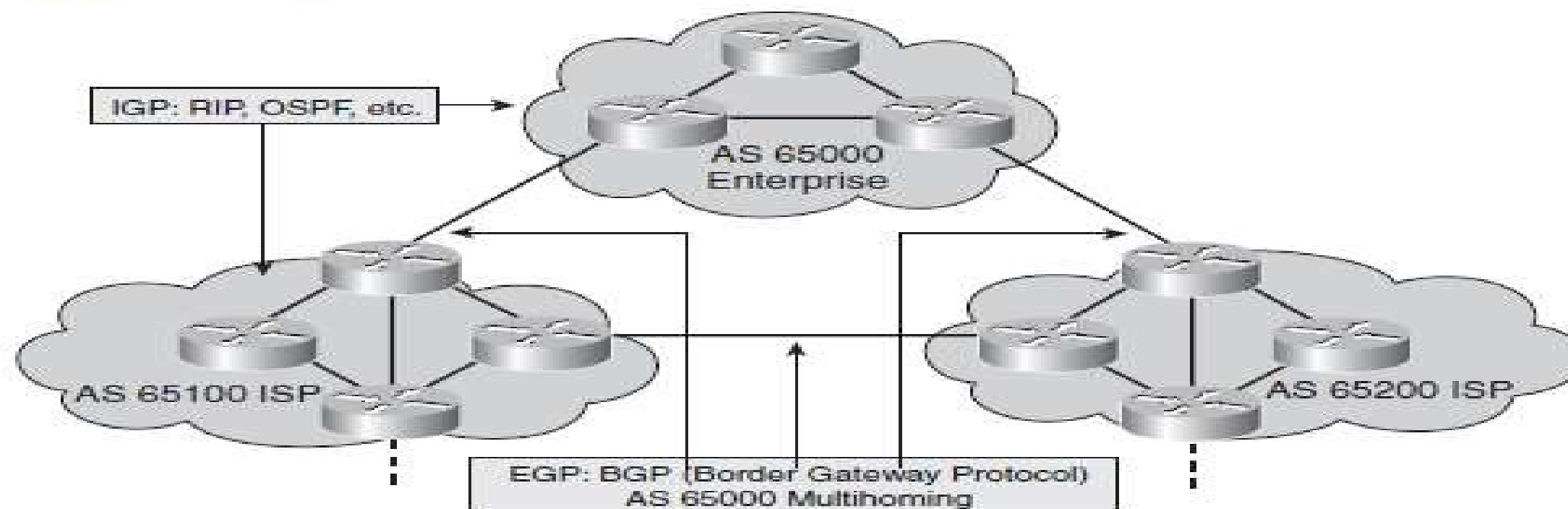
An autonomous system (AS), also known as a domain, is a **collection of routers** that are **under a common administration**, such as a company's internal network or an Internet service provider's (ISP's) network.



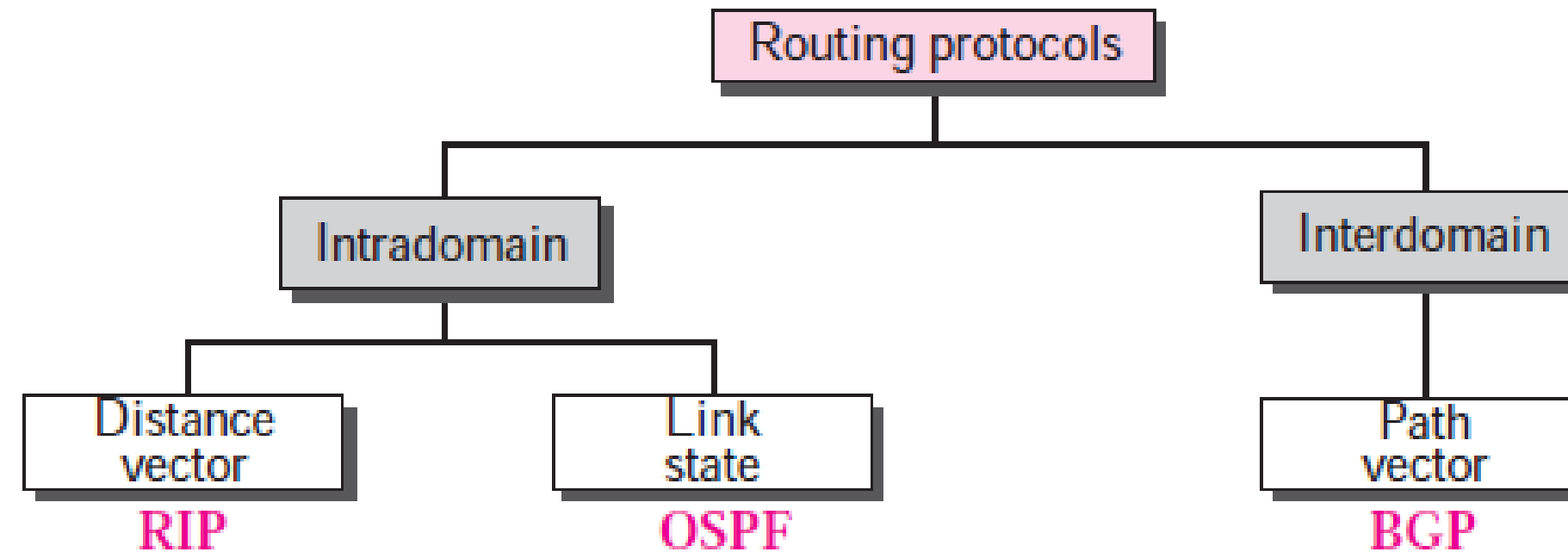
Because the Internet is based on the AS concept, two types of routing protocols are required:

Interior Gateway Protocols (IGP)	Exterior Gateway Protocols (EGP)
Intra-AS (inside an AS) routing protocols.	Inter-AS (between AS) routing protocols.
Examples of IGPs include: Routing Information Protocol (RIP) RIP version 2 (RIPv2), Open Shortest Path First (OSPF), and Enhanced Interior Gateway Routing Protocol (EIGRP).	Border Gateway Protocol (BGP) is the only widely used EGP protocol on the Internet. BGP version 4 (BGP-4) is considered the acceptable version of BGP on the Internet.
use less-complicated metrics to ease configuration and speed up the decisions about best routing paths for faster convergence	Slower to converge and more complex to configure.

Interior Protocols Are Used Inside and Exterior Protocols Are Used Between Autonomous Systems



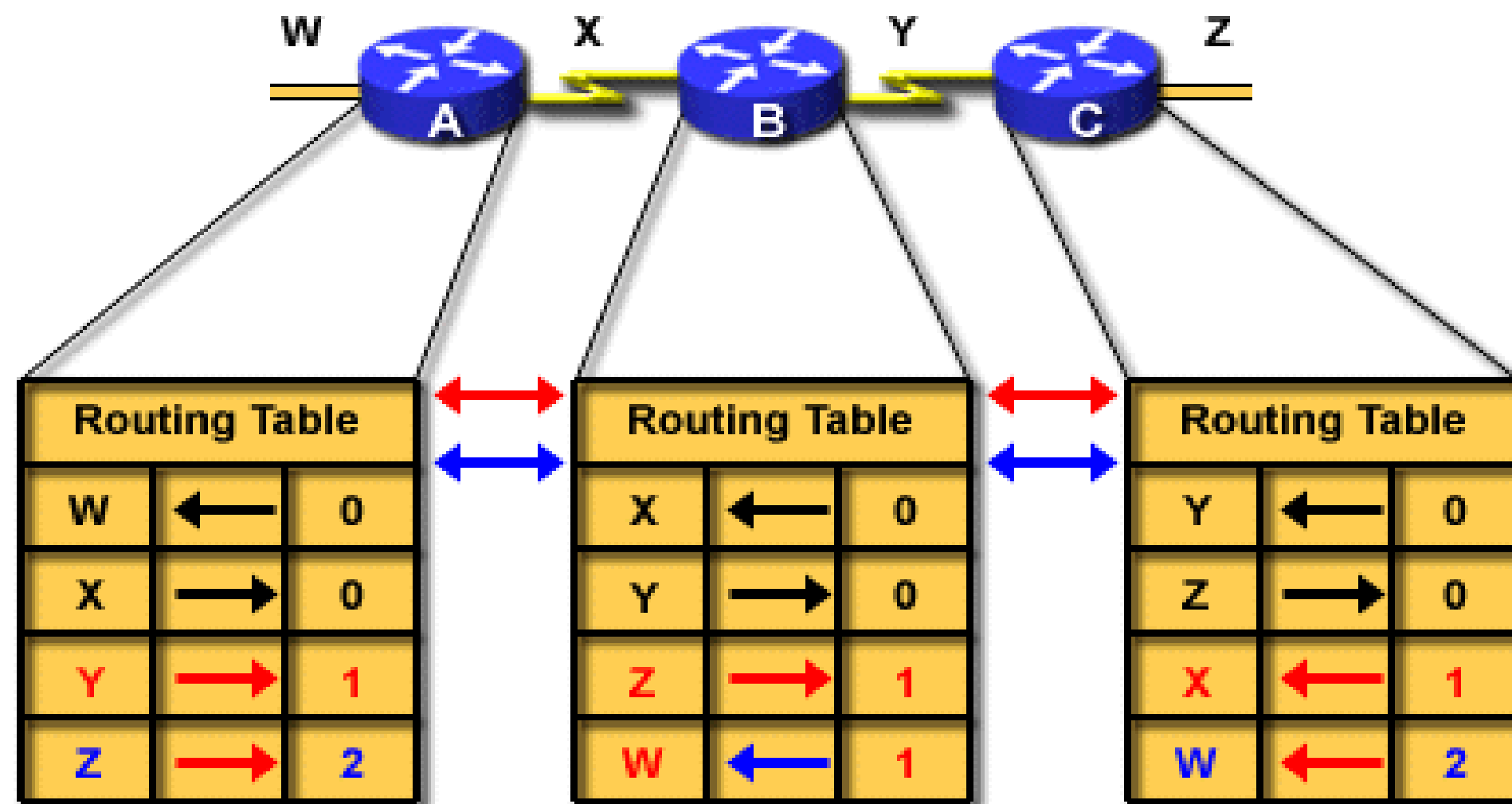
Popular routing protocols



RIP (Routing Information Protocol)

- RIP is a routing protocol **for exchanging routing table information between routers**.
- It is a very simple protocol based on **distance vector routing (DVR)**.
- simple **intra-domain** protocol
- Uses **hop count** as a path selection **metric**. (RIP **prevents routing loops** by implementing a **limit on the number of hops** allowed in a path from the source to a destination. The maximum number of hops allowed for RIP is 15. This hop limit, however, also limits the size of networks that RIP can support, a hop count of 16 is considered an infinite distance, in other words the route is considered unreachable.
- **Three types of timers**.

Distance Vector Network Discovery



- Routers discover the best path to destinations from each neighbor

RIP Protocol Timers

Routing-update timer (periodic timer)

- The **periodic timer** controls the advertising of **regular update** messages.
- By default, routers send updates **every 30 seconds**.

Route timeout (*Expiration Timer*)

- If there is a **problem** on an internet and **no update** is received within the allotted 180 s, the route is considered expired and the hop count of the route is set to 16, which means the **destination is unreachable**.

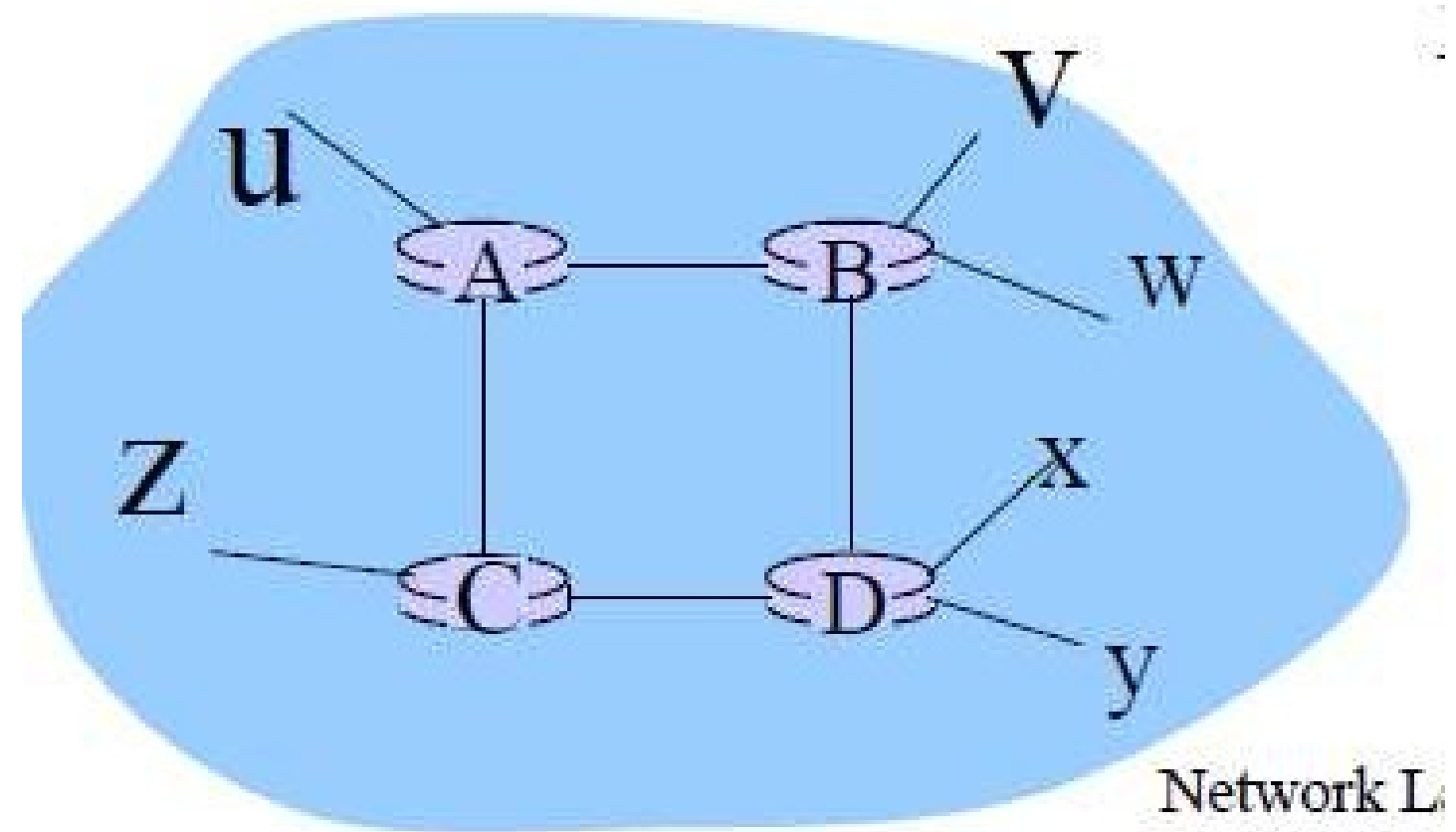
Route-flush timer (*Garbage Collection Timer*)

- After the route **timeout expires** (240 s), the route-flush timer eventually expires, **deleting** the route from the table.

RIP Protocol Drawbacks

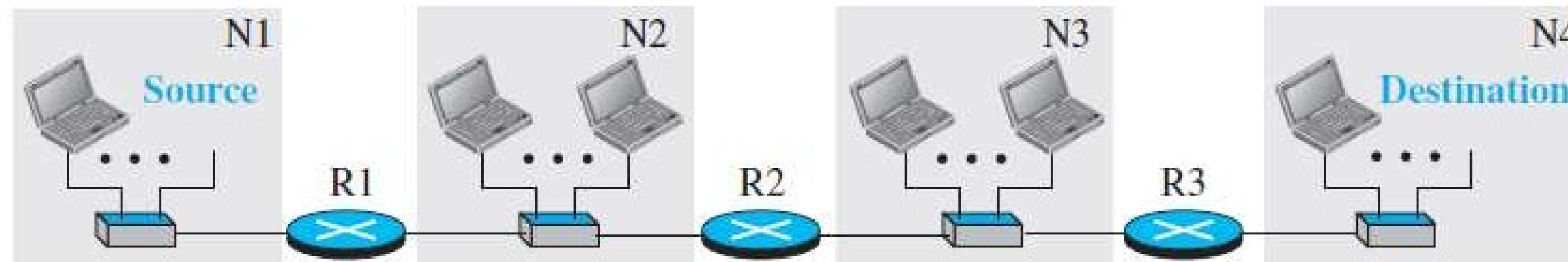
- RIP has **slow convergence** and count to infinity problems
- The **hop count cannot exceed 15**, or routes will be dropped.

Example: Find router A routing table for the network topology shown below:



Dest. Net.	Next hop	Metric (Hop Count)
U	-	0
V	B	1
W	B	1
X	B	2
Y	B	2
Z	C	1

Example: Find the routing table for router R1 for the network topology shown below:



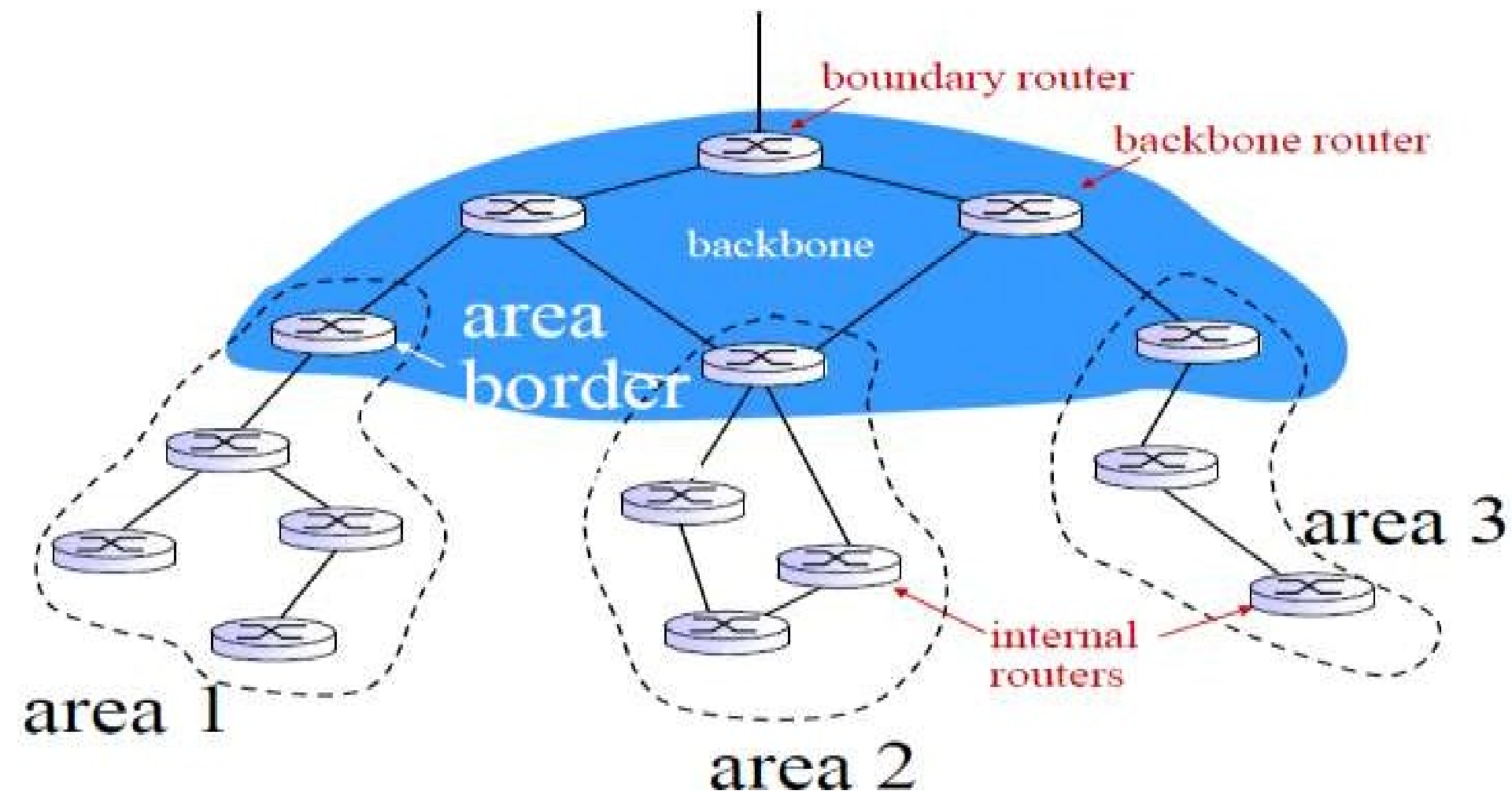
Dest. Net.	Next hop	Metric (Hop Count)
N1	-	0
N2	-	0
N3	R2	1
N4	R2	2

OSPF (Open Shortest Path First)

- It uses a **link state routing algorithm** and falls into the group of interior routing protocols, operating within a single autonomous system (AS).
- **Topology map** at each node
- route computation using **Dijkstra's algorithm**
- OSPF is perhaps the most widely **used interior gateway protocol (IGP)** in large enterprise networks.
- The metric of OSPF is the **cost** of sending packets across a certain interface.
- “**open**”: publicly **available**
- “**Security**”: all OSPF messages authenticated (to **prevent malicious intrusion**)
- Hierarchical OSPF in large domains.

Hierarchical OSPF

- *Two-level hierarchy*: **local area, backbone**.
- Link-state advertisements only in **area**
- Each node has **detailed area topology**; only know direction (shortest path) to nets in other areas.
- *Area border routers*: “**summarize**” distances to nets in own area, advertise to other Area Border routers.
- *Backbone routers*: run OSPF routing limited to backbone.
- *Boundary routers*: connect to other AS's.



OSPF is superior to RIP in all aspects, including the following:

- It converges much faster.
- It supports hierarchical structures.
- It has improved metric calculation for best path selection.
- It does not have hop-count limitations
- At its inception, OSPF supported the largest networks.
- Compare to RIP, OSPF has no limitation due to hops (RIP has a limit of 15 hops so any network with more than 15 hops cannot be achieved by RIP).

EIGRP (Enhanced Interior Gateway Routing Protocol)

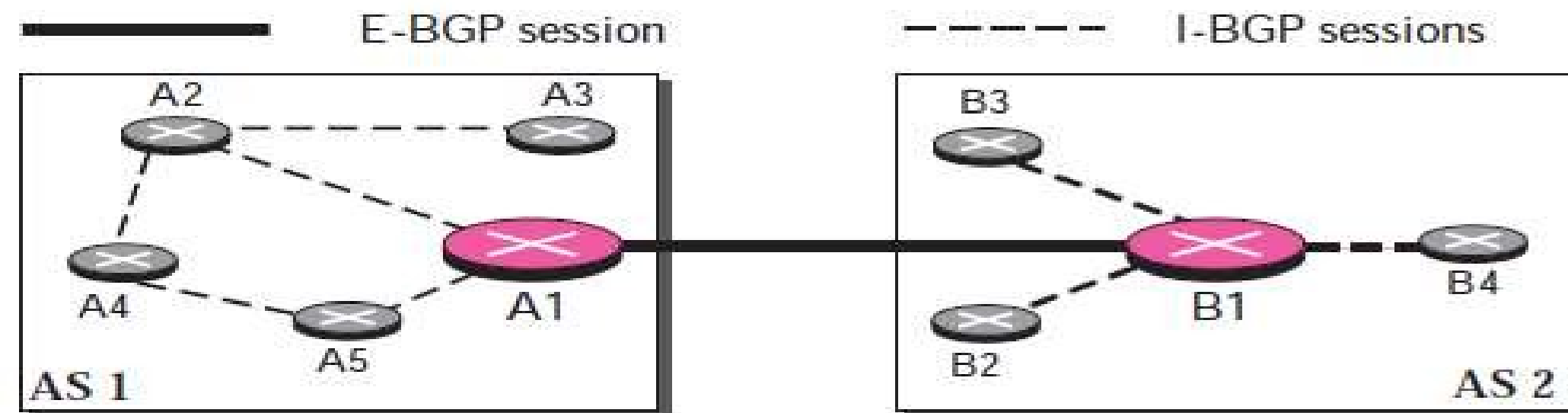
- EIGRP is a protocol for routing IPv4 and IPv6.
- EIGRP, however, is a hybrid routing protocol—it is a **distance vector protocol with additional link-state protocol features**.
- Uses triggered updates (EIGRP has **no periodic** updates).
- provide **fast convergence to minimize network traffic**.
- uses the **minimum bandwidth** on the path of the destination network, and calculate a route from the total delay metrics.

Border Gateway Protocol (BGP)

- **Inter-domain routing protocol** for routing between autonomous systems (holds the Internet together)
- BGP is **neither a link state, nor a distance vector protocol**. Routing messages in BGP contain complete routes.
- Network administrators can specify routing policies (**BGP supports flexibility** -- paths could be chosen by a provider based on a policy).
- Network administrators can specify routing policies.
- BGP's goal is to find **any path** (not an optimal one).

Internal and external BGP sessions

iBGP	eBGP
<ul style="list-style-type: none">• Used to connect different routers have same AS (same company)• Propagate reachability information to all AS-internal routers.	<ul style="list-style-type: none">• Used to connect different routers have different AS (different company)• Obtain subnet reachability information from neighboring ASs.



BGP Messages

BGP messages exchanged between peers over TCP connection, **BGP has four types of messages**

- **OPEN:** Establish a connection with a BGP peer
- **UPDATE:** advertise or withdraw routes to a destination
- **KEEPALIVE:** Inform a peer that the sender is still alive but has no information to send.
- **NOTIFICATION:** Notify that errors are detected, also used to close connection