



## **Network Protocol**

### **Network Layer Part: 2**

# Computer Networks Protocols

## Lecture No.4:Network Layer Part 2

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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,load)

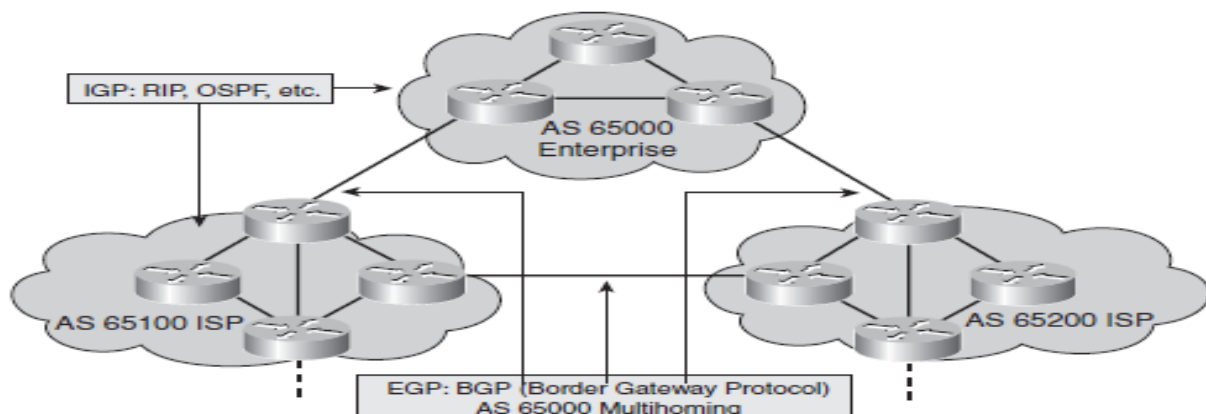
### Interior Versus Exterior Routing Protocols

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.

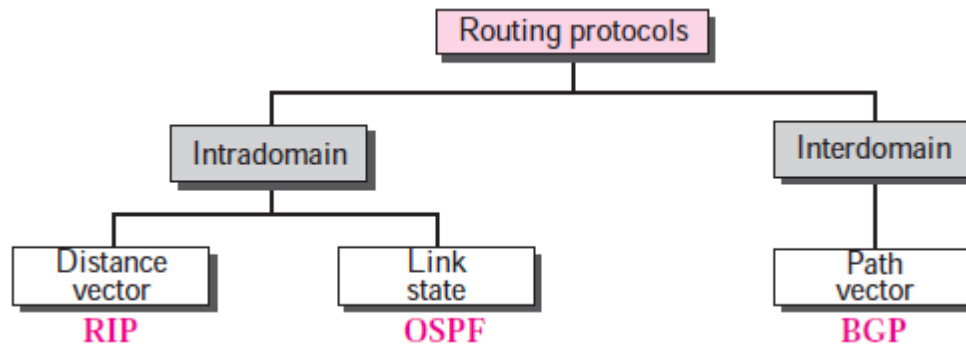
Because the Internet is based on the AS concept, two types of routing protocols are required:

Interior gateway protocols (IGP)	Exterior gateway protocols (EGP)
Intra-AS ( <b>inside an AS</b> ) routing protocols.	Inter-AS (between autonomous systems) routing protocols.
Examples of IGP's 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	<b>Slower</b> to converge and more complex to configure.

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



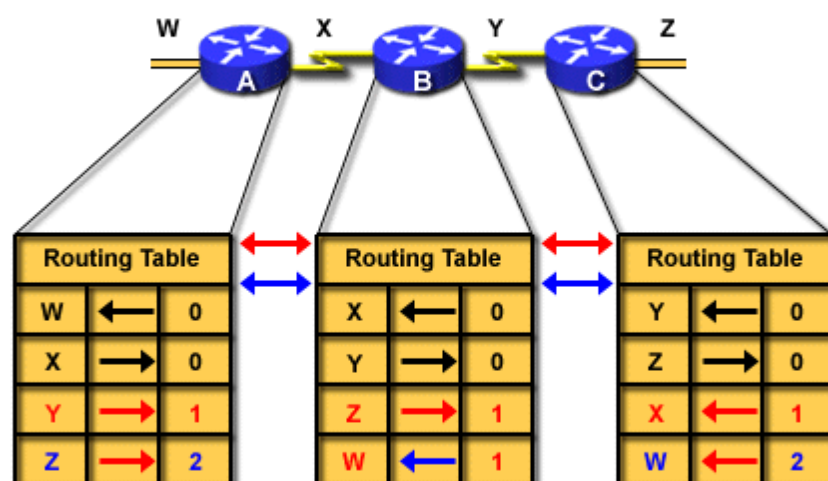
## Popular routing protocols



### 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**.
- 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

## 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*)

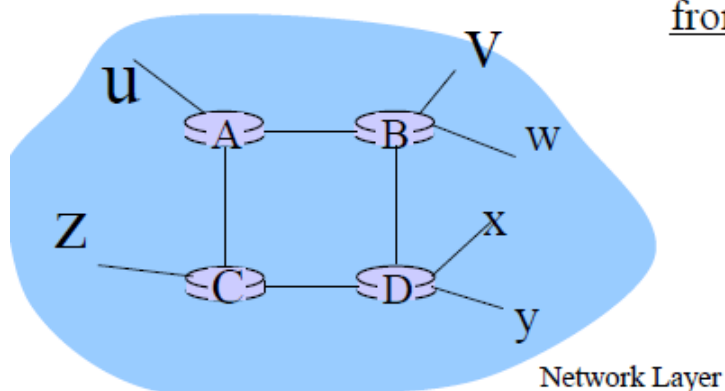
- If there is a **problem** on an internet and **no update** is received within the allotted 180 s, the route is considered expired and the hop count of the route is set to 16, which means the **destination is unreachable**.

### Route-flush timer (*Garbage Collection Timer*)

- After the route **timeout expires**, the route-flush timer eventually expires, **deleting** the route from the table.

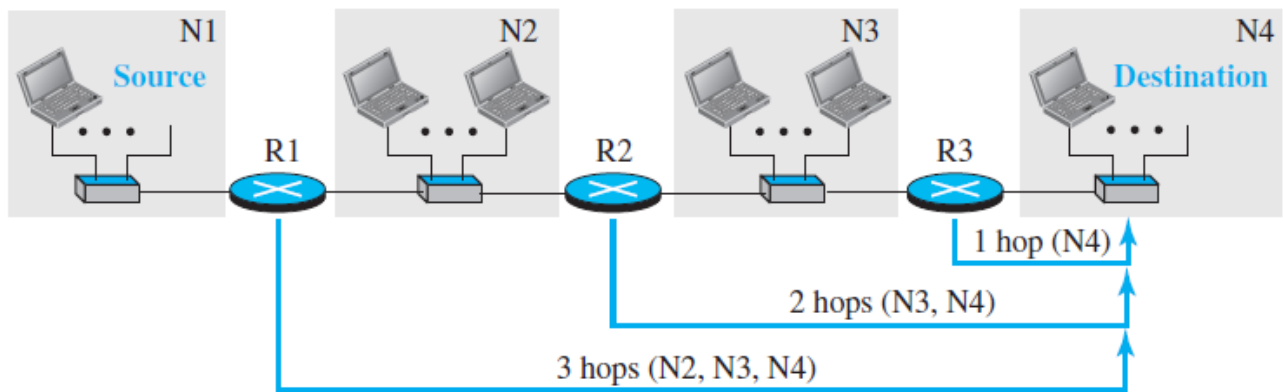
## Drawbacks

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



from router A to destination *subnets*:

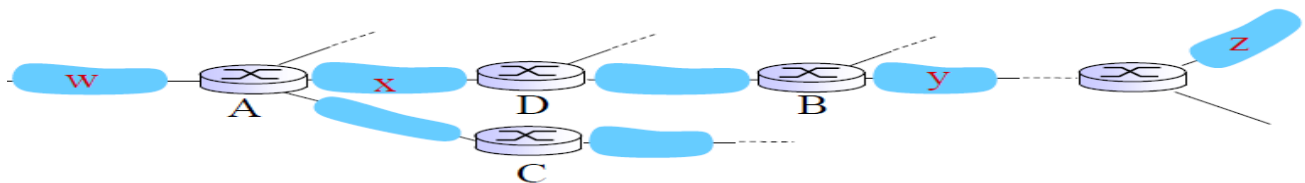
<u>subnet</u>	<u>hops</u>
u	1
v	2
w	2
x	3
y	3
z	2



Forwarding table for R1

Destination network	Next router	Cost in hops
N1	—	1
N2	—	1
N3	R2	2
N4	R2	3

## RIP: example



routing table in router D

destination subnet	next router	# hops to dest
w	A	2
y	B	2
z	B	7
x	--	1
....	....	....

routing table in router D

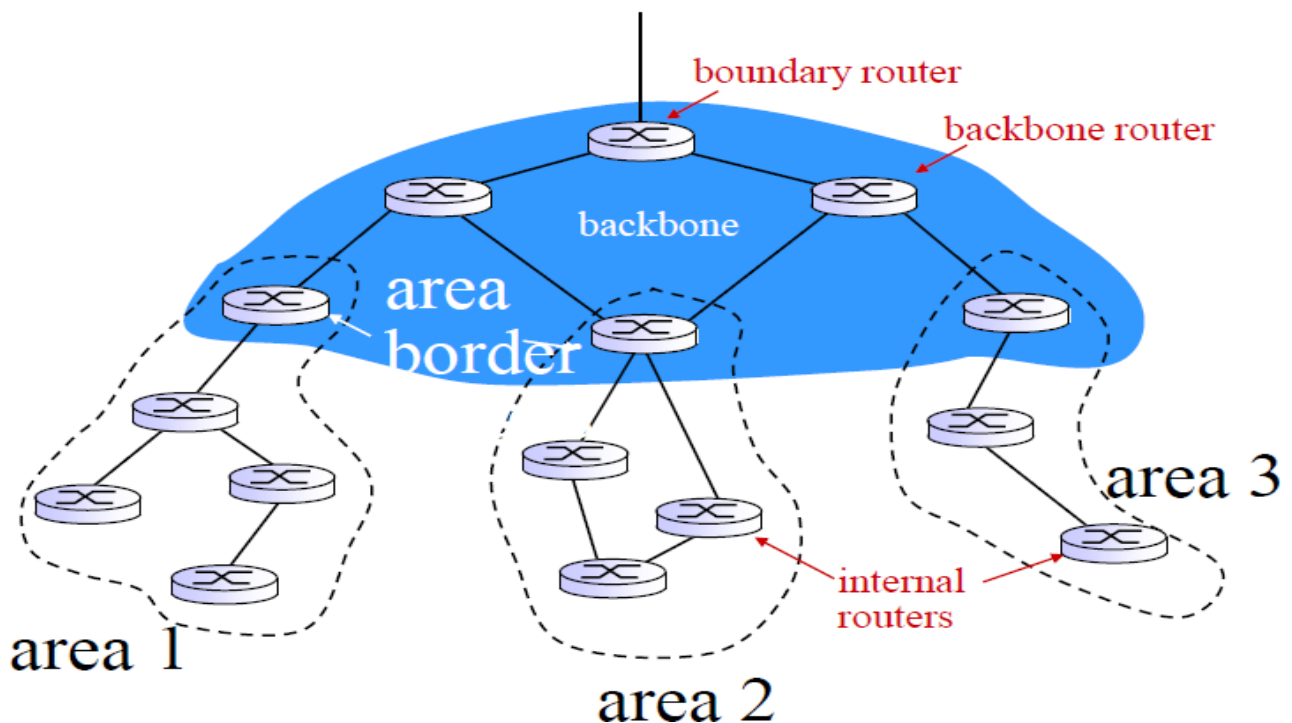
destination subnet	next router	# hops to dest
w	A	2
y	B	2
z	<del>B</del> → A	<del>7</del> → 5
x	--	1
....	....	....

## 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

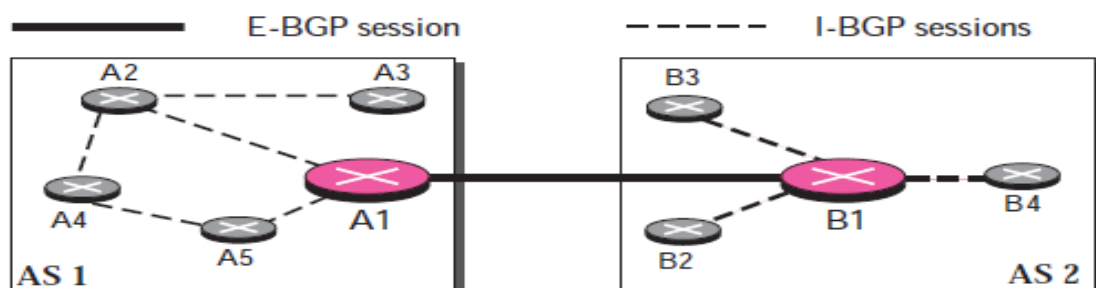
- EIGRP is a protocol for routing IPv4 and IPv6 .
- EIGRP, however, is a hybrid routing protocol—it is a **distance vector protocol with additional link-state protocol features**.
- Uses triggered updates (EIGRP has **no periodic** updates).
- provide **fast convergence to minimize network traffic**.
- 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).

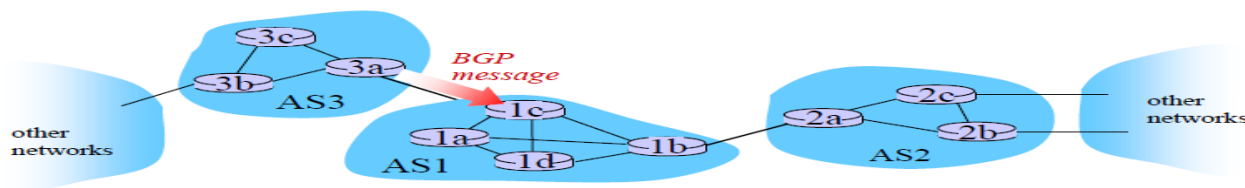
### Internal and external BGP sessions

iBGP	eBGP
<ul style="list-style-type: none"> <li>• used to connect different routers have <b>same</b> AS(same company)</li> <li>• propagate reach ability information <b>to all AS-internal routers</b>.</li> </ul>	<ul style="list-style-type: none"> <li>• used to connect different routers have <b>different</b> AS(different company)</li> <li>• obtain subnet reach ability information <b>from neighboring ASs</b>.</li> </ul>



**Example:** when AS3 advertises a prefix to AS1:

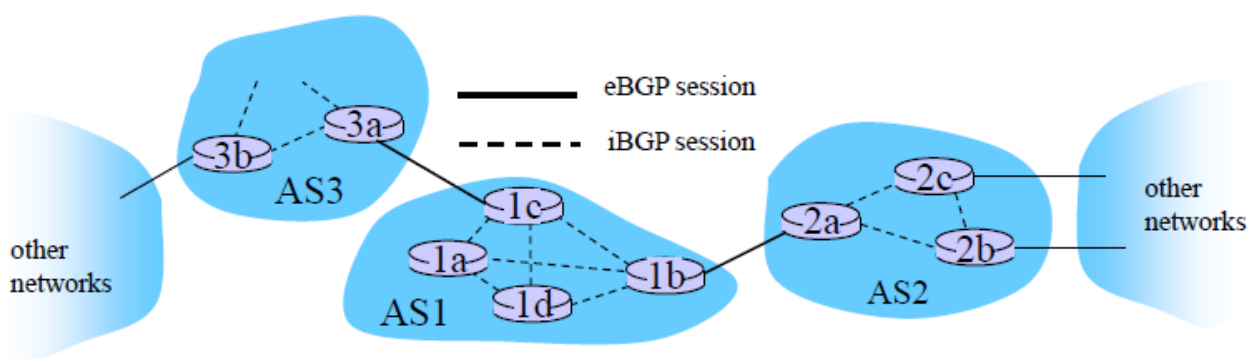
- AS3 *promises* it will forward datagrams towards that prefix
- AS3 can aggregate prefixes in its advertisement



### **BGP basics: distributing path information**

Using eBGP session between 3a and 1c, AS3 sends prefix reachability info to AS1.

- 1c can then use iBGP do **distribute new** prefix info to all routers in AS1
- 1b can then **re-advertise** new reachability info to AS2 over 1b-to-2a eBGP session
- When router learns of new prefix, it creates **entry for prefix** in its forwarding table.



### **BGP route selection**

Router may learn about more than 1 route to destination AS, **selects route based on:**

1. Local preference value attribute: **policy decision**
2. **Shortest AS-PATH**
3. **Closest NEXT-HOP router.**
4. **Additional criteria**

### **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