COMPUTER COMMUNICATION NETWORKS

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Intra-AS routing protocol: Concept of Autonomous Systems, RIP & OSPF

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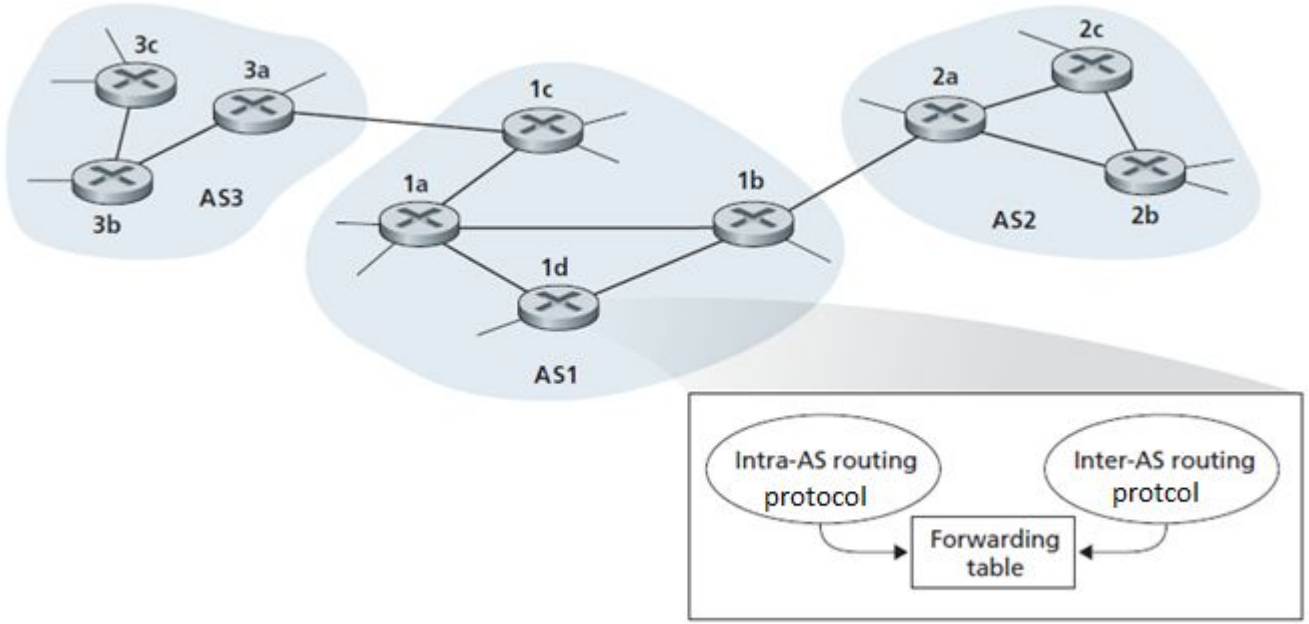
Autonomous systems (AS) :

- An AS is a **set of routers** and **networks** managed by a single organization.
- Routers in AS can be classified as **gateway routers and non-gateway routers.**
- An AS which generates packets is referred to as a **stub AS.**
- Every AS has **unique 16-bit ID** called **AS number** (ASN).
  - ASN is assigned by Regional Internet Registries (RIR) under ICANN
- The forwarding table of a router in an AS is updated by a set of routing protocols (inter and intra)
- Information regarding various subnets received by these protocols also varies

Autonomous systems (AS) (Contd.):

- An **intra AS** routing protocol passes routing information **between routers within an AS** (e.g., RIP, OSPF, IS-IS, EIGRP)
- Different ASs may use different IRPs independently
- An **inter AS** routing protocol passes routing information **between routers across different ASs** (e.g., BGP)



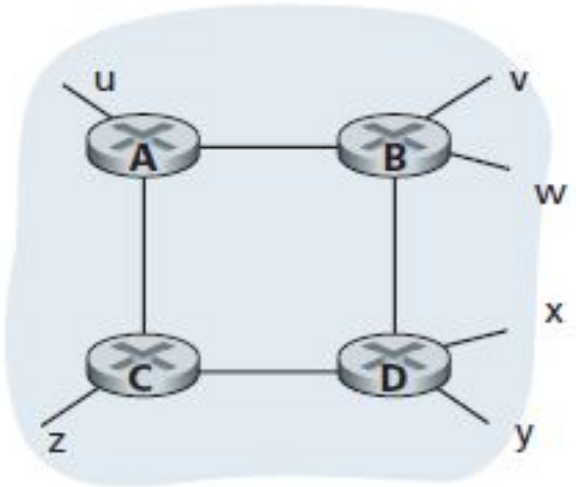
Routing Information Protocol (RIP):

Key features:

- Follows the **DV algorithm**
- **Hop count** is set as **metric** in RFC 1058
- RIP restricts the **maximum hop count to 15 hops**
- Routers find shortest paths to each subnet in the AS
- **RIP response** messages exchanged every 30 seconds
- RIP (ver. 2) **does not use subnet mask** information
- RIP response timeout of more than 180 seconds treated as **"subnet not reachable"**
- RIP messages are exchanged using **UDP over port 520!**

Routing Information Protocol (RIP) (Contd.):

Hops to subnets



Destination	Hops
u	1
v	2
w	2
x	3
y	3
z	2

Figure 4.34 ♦ Number of hops from source router A to various subnets

Routing Information Protocol (RIP) (Contd.):

How router D adapts to route changes.....

Routing table of D (initial)

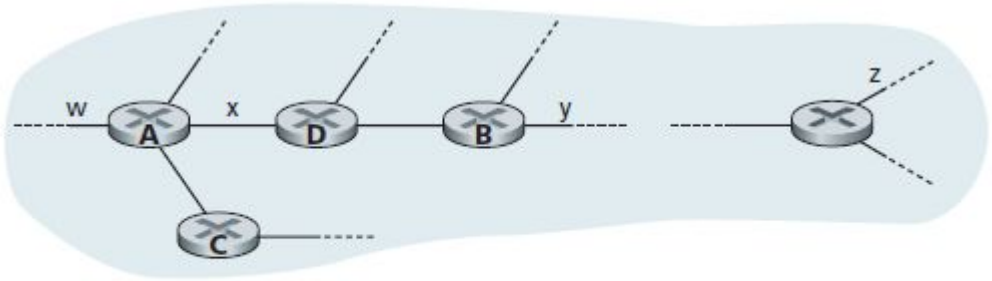


Figure 4.35 ♦ A portion of an autonomous system

Destination Subnet	Next Router	Number of Hops to Destination
w	A	2
y	B	2
z	B	7
x	—	1
....	....	....

Figure 4.36 ♦ Routing table in router *D* before receiving advertisement from router *A*

Routing Information Protocol (RIP) (Contd.):

Routing table of A (changes)

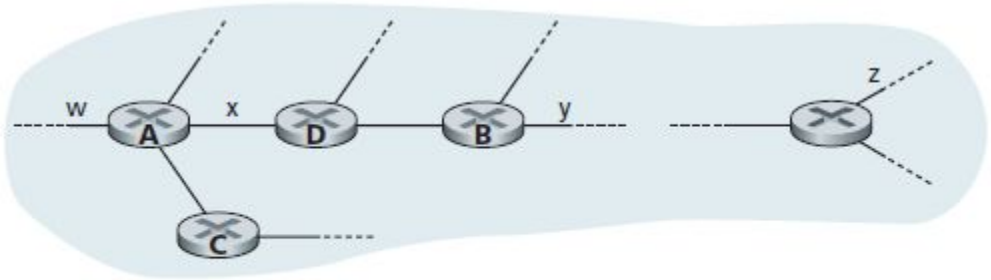


Figure 4.35 ♦ A portion of an autonomous system

Destination Subnet	Next Router	Number of Hops to Destination
z	C	4
w	—	1
x	—	1
....	....	....

Figure 4.37 ♦ Advertisement from router A

Routing Information Protocol (RIP) (Contd.):

Routing table of D (updated after receiving new table from A)

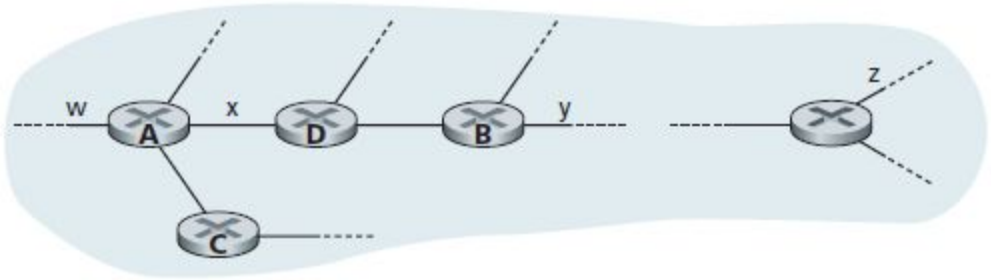


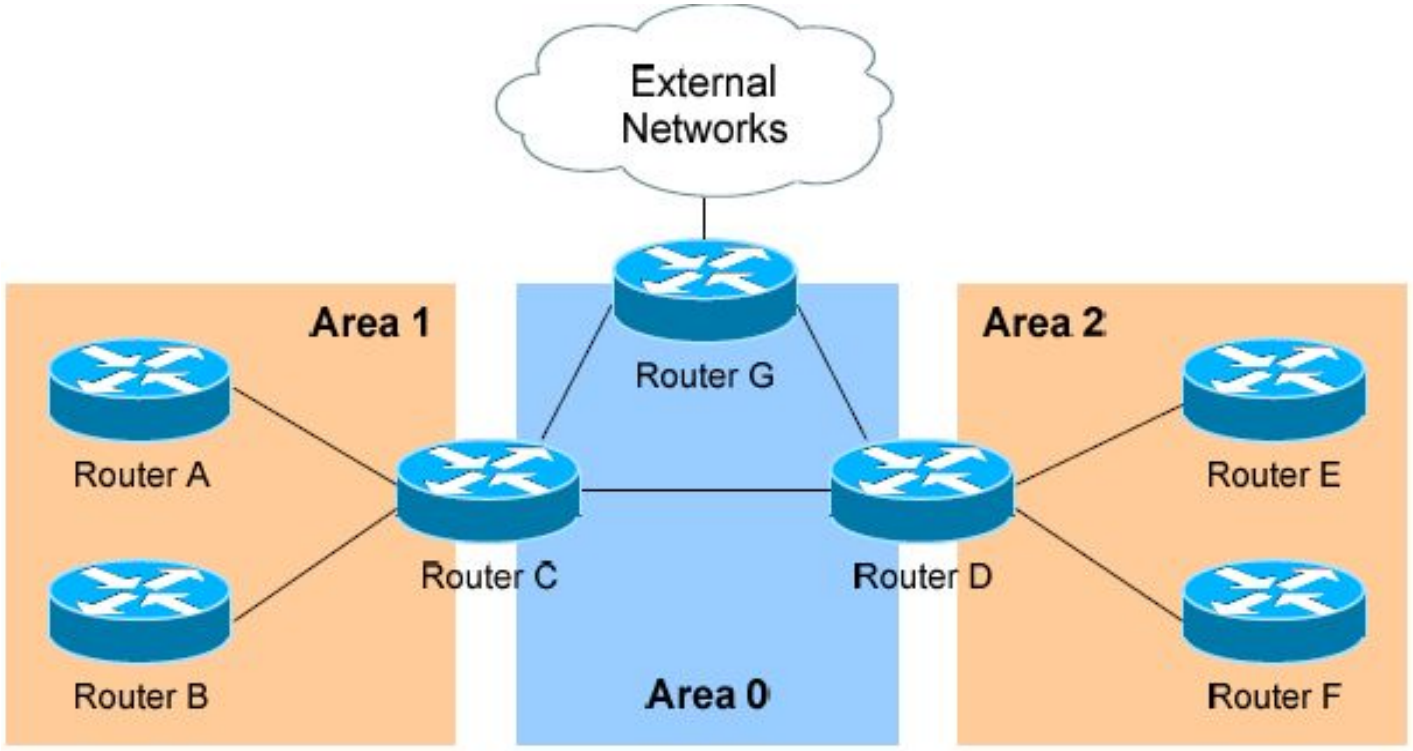
Figure 4.35 ♦ A portion of an autonomous system

Destination Subnet	Next Router	Number of Hops to Destination
w	A	2
y	B	2
z	A	5
....	....	....

Figure 4.38 ♦ Routing table in router *D* after receiving advertisement from router *A*

OSPF: Open Shortest Path First (OSPF)

Concept of Areas and roles of routers

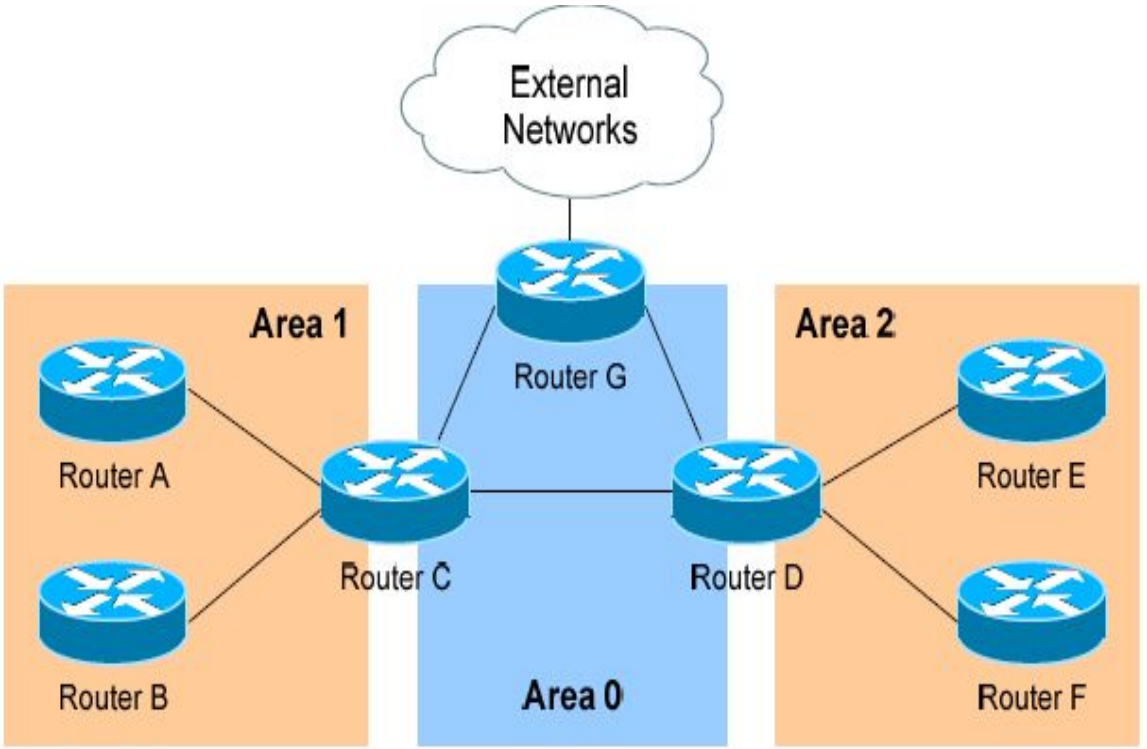


OSPF: Concept of Areas and roles of routers

- The LSA traffic is reduced by designating the routers within an Area as **Designated Router** (DR) and **Backup Designated Router (BDR).**
- If a change occurs to a link, the update is forwarded only to the DR, which then forwards it to all other routers.
- Router with **highest OSPF priority** (i.e., no. of links and more bandwidth) in an area is elected as **DR** (BDR is second best).
- The idea of defining Areas within an AS is to minimize the amount of LSA traffic within the AS.
- **Hierarchy and multicasting** (broadcasting to a subset of routers) **reduces time complexity and LSA traffic.**

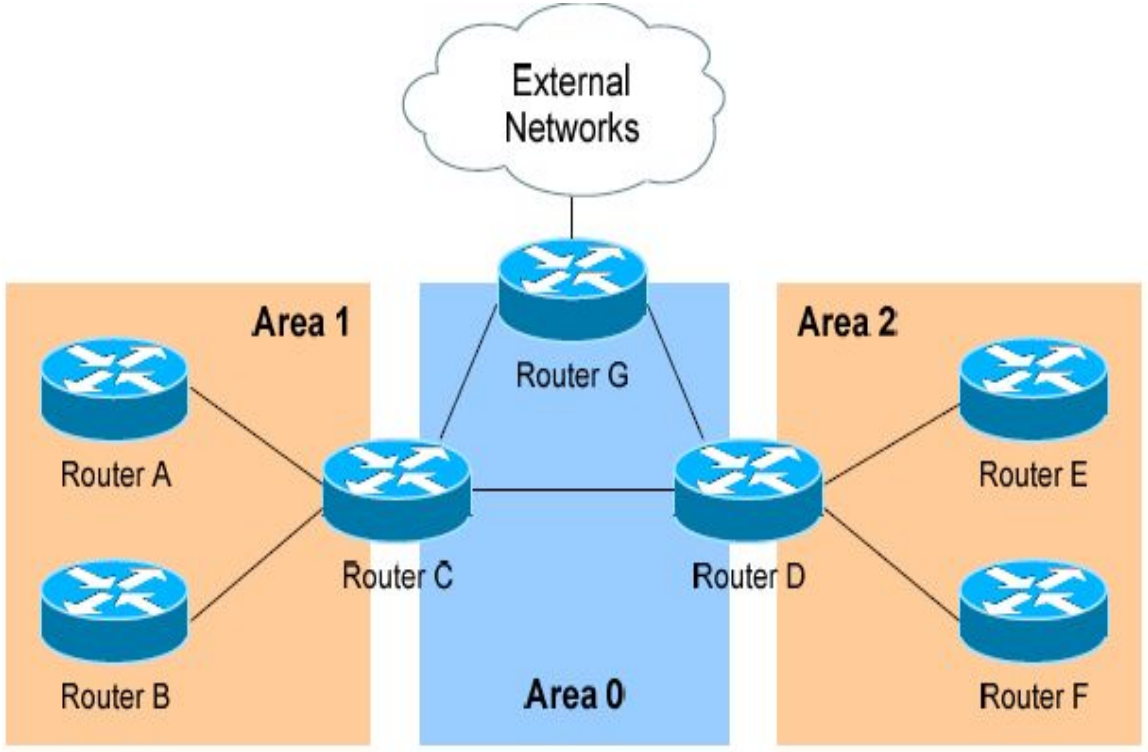
OSPF: Concept of Areas and roles of routers

- Area 0: It is required for OSPF to function, and is considered the **Backbone area or transit area.** As a rule, all other areas must have a connection into Area 0.
- Backbone routers: Routers C, D and G in this example are backbone routers because they have one interface in Area 0
- Area Border Routers (ABRs): These are **OSPF routers belonging to multiple areas**. They contain separate topology databases for each area. Routers C and D in this example



OSPF: Concept of Areas and roles of routers

- Internal Routers: These belong to one of the Areas (other than Area 0). They maintain the **link state information of their active interfaces.** Routers A and B in Area 1, and routers E and F in Area 2 are internal routers
- Autonomous System Border Routers (ASBRs)**: Routers connecting multiple ASs**. Router G in this example



Open Shortest Path First (OSPF) (Described in RFC 2328): Basics

- The OSPF process builds and **maintains three separate tables**:
  - **A neighbor table** – contains a list of all neighboring routers.
  - **A topology table** – contains a list of all possible routes to all known networks within an area.
  - **A routing table** – contains the best route for each known network

Open Shortest Path First (OSPF) (Described in RFC 2328): Basics

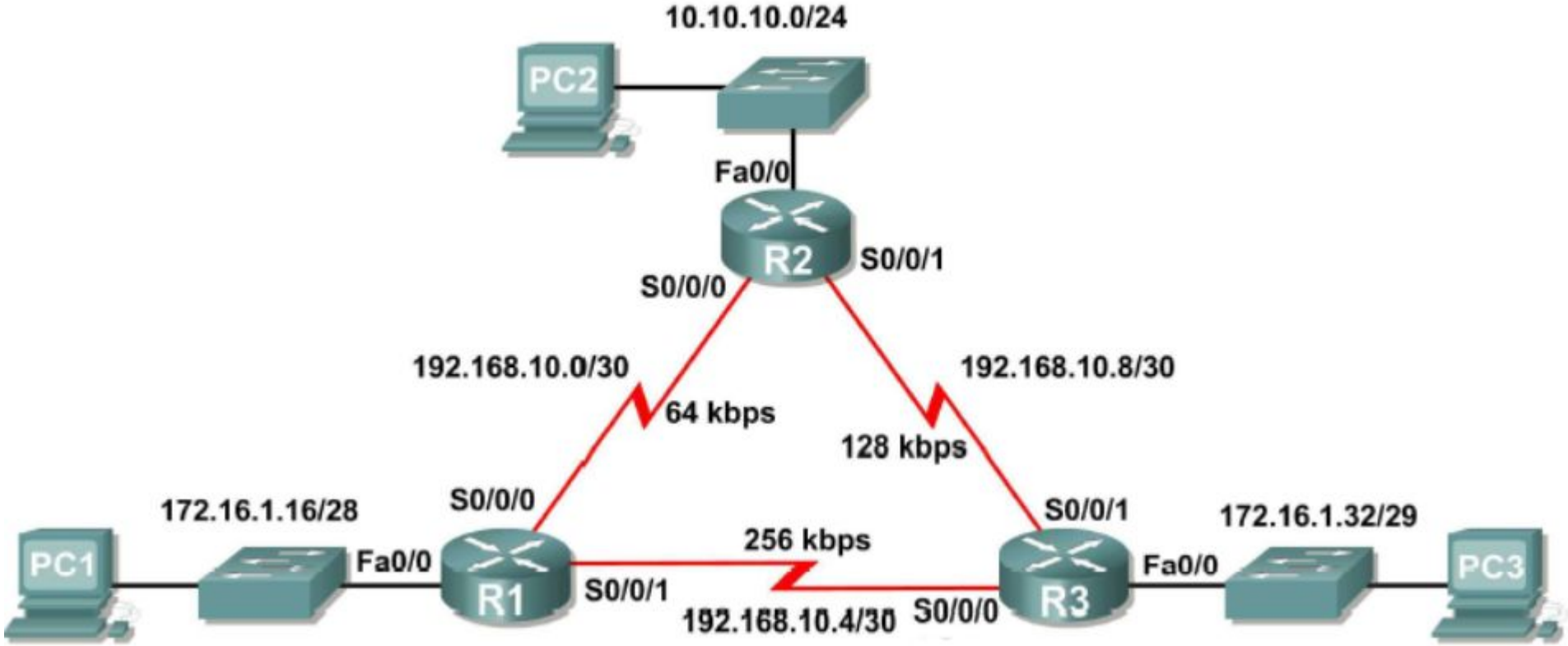
- The OSPF process supports **5 types of packets or messages**:

Message type	Description
Hello	Used to discover who the neighbors are
Link state update	Provides the sender's costs to its neighbors
Link state ack	Acknowledges link state update
Database description	Announces which updates the sender has
Link state request	Requests information from the partner

  - OSPF forms neighbor relationships, called **adjacencies**, with other routers in the same Area by exchanging Hello packets to multicast address 224.0.0.5.

Open Shortest Path First (OSPF) :

Example :



Open Shortest Path First (OSPF) (Described in RFC 2328): Basics

- OSPF uses the **Dijkstra Shortest Path First algorithm**
- OSPF can have **administrative distance** of **110**
- Digital authentication can be provided to ensure security
- **Upper layer protocol value is 89** in the IP datagram field
- Allows **multiple same cost** paths
- OSPF employs a **hierarchical network design** using Areas
- OSPF will form neighbor relationships with adjacent routers in the same Area
- Instead of advertising the distance to connected networks, OSPF advertises the status of directly connected links using Link-State Advertisements (LSAs)

Open Shortest Path First (OSPF) (Described in RFC 2328): Basics

- OSPF sends updates (LSAs) when there is a change to one of its links, and will **only send** the **change in the update.**
- **LSAs** are additionally refreshed **every 30 minutes.**
  - **Hello packets** are exchanged **every 10 seconds.**
- OSPF uses **cost as its metric**, which is computed based on the bandwidth of the link.
  - OSPF has **no hop-count limit.**

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RIP Vs OSPF

RIP	OSPF
RIP used UDP (port 520)	OSPF uses TCP (pot 89)
Distance vector algorithm	Link state algorithm
Administrative distance 120	Administrative distance 110
Applicable for max of 15 hops	Applicable for larger networks (sub-divided into areas)
Does not recognize network prefix	Recognizes network prefix
No authentication	Authentication provided
Only one shortest path established per destination	Allows multiple same cost paths to a destination
RFC1058	RFC2328
Update messages every 30 seconds	Longer duration (about 30 mins)

THANK YOU

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