OSPF Operations

WEBINAR COURSE

Overview

- OSPF Introduction
- Link State Routing Protocol
- OSPF Neighbor Discovery Process
- OSPF Topology
- OSPF Packets

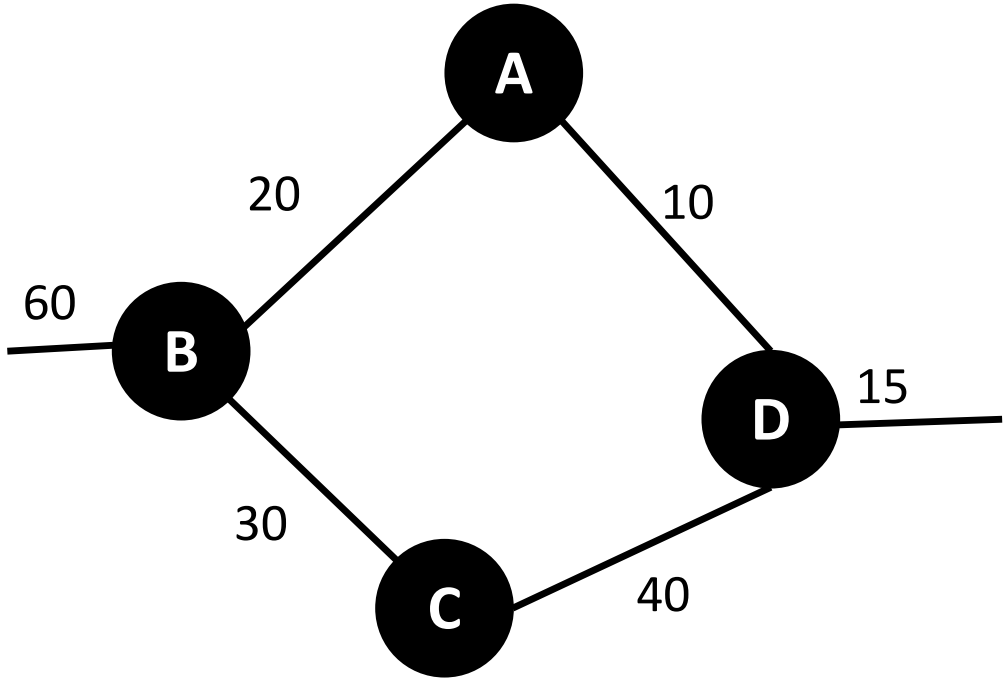
OSPF

- **O**pen **S**hortest **P**ath **F**irst
- Link State Protocol or SPF technology
- Developed by OSPF working group of IETF
- Comes with two version
  - OSPFv2 (IPv4) standard described in (RFC 2328)
  - OSPFv3 (IPv6) standard described in (RFC 5340)
  - Support of address families in OSPFv3 (RFC 5838)

OSPF

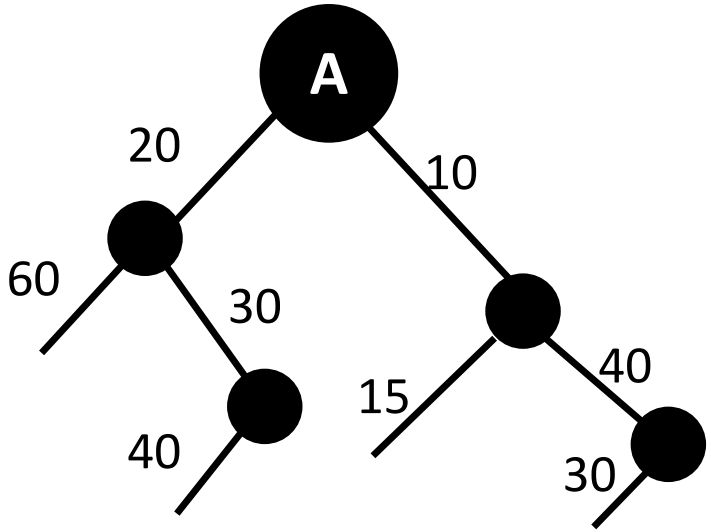
- Designed for
  - TCP/IP environment
  - Fast convergence
  - Route redistribution
  - Variable length subnet masks (VLSM)
  - Dis-contiguous subnets
  - Incremental updates
  - Route authentication
- **OSPF runs on IP, Protocol 89**

Link State Routing Protocol



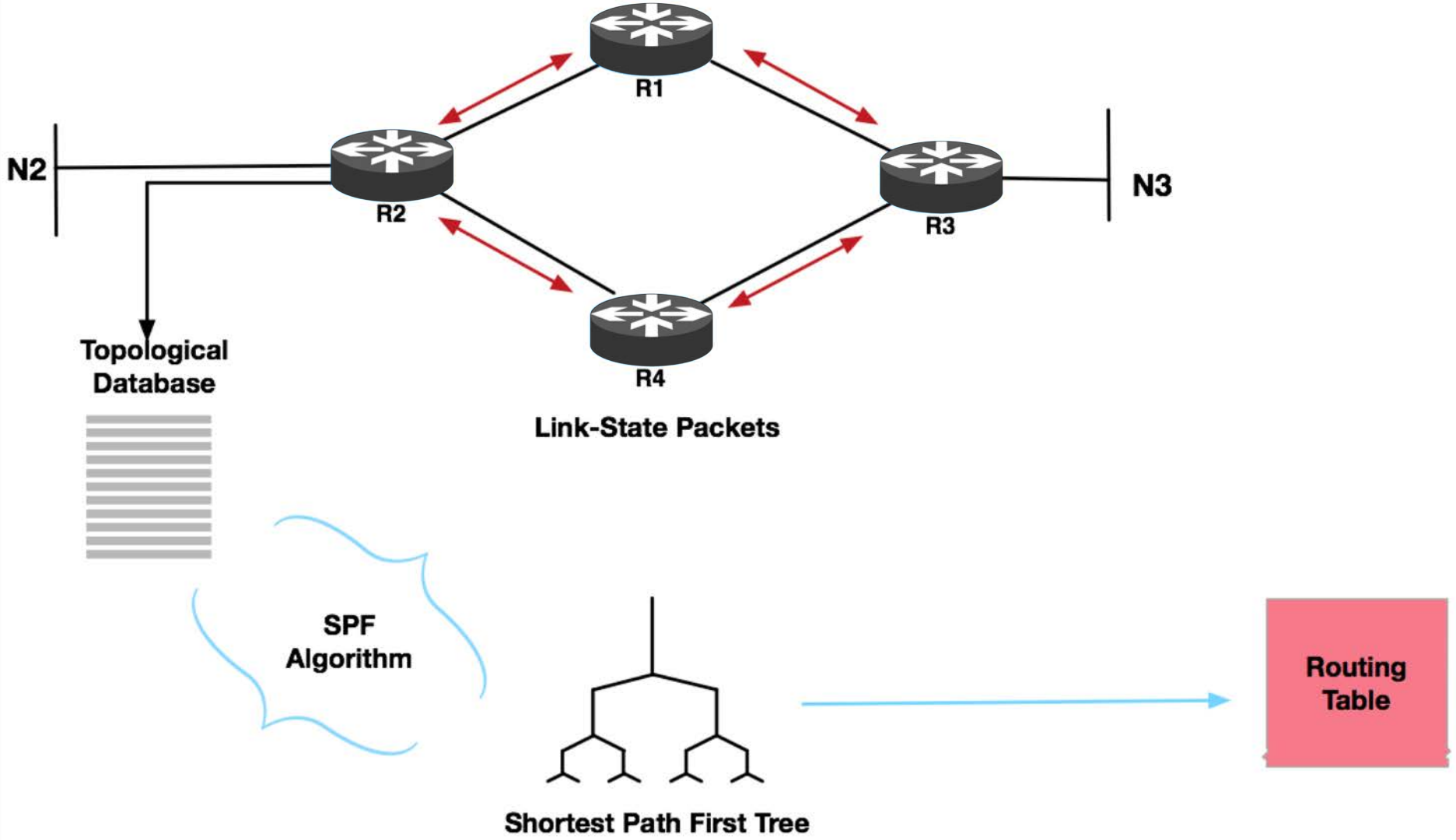
Every router in an OSPF network maintain an identical topology database

A	10	20	
B	20	30	60
C	30	40	
D	10	15	40



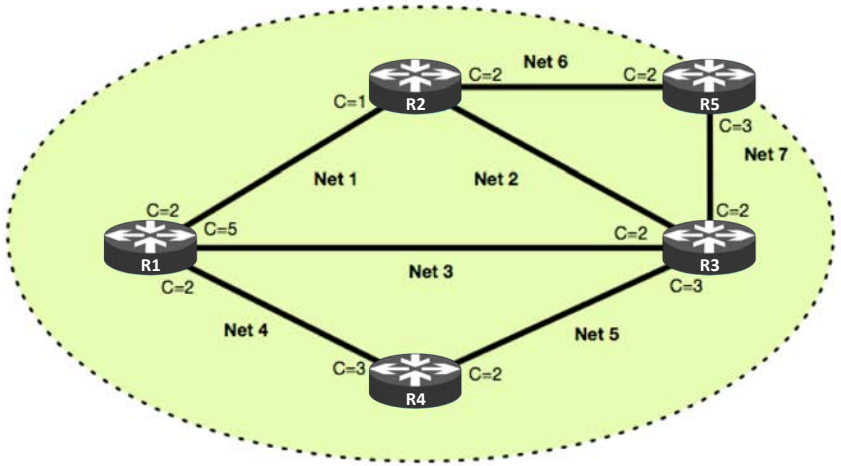
Router place itself at the root of SPF tree when calculate the best path

Link State Routing Protocol

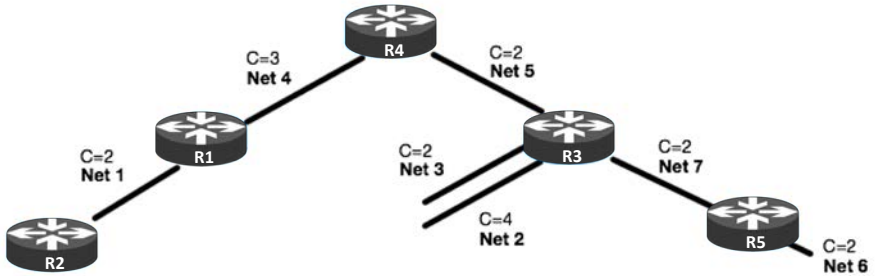


Basic OSPF Operation

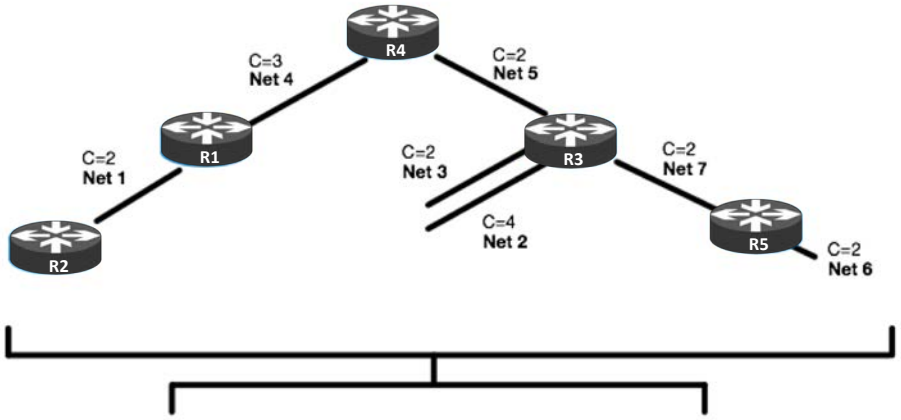
1. Neighbor Discovery & Exchanging topology table (LSDB)



2. Use SPF algorithm to select best path



3. Building up Routing Table



Network	Forwarding IP	Port	Metric
4	--	1	3
5	--	2	2
1	R1	1	5
3	R3	2	4
2	R3	2	6
7	R3	2	4
6	R3	2	6

Link State Data Structure

- Neighbor Table
  - List of all recognized neighboring router to whom routing information will be interchanged
- Topology Table
  - Also called LSDB which maintain list of routers and their link information i.e network destination, prefix length, link cost etc
- Routing Table
  - Also called forwarding table contains only the best path to forward data traffic

OSPF Metric

- Uses link/path cost as metric, can be configured manually
- Generally, inversely proportional to the link BW
  - Higher the BW lower the cost
    - configurable

$$Cost = \frac{reference\ bw}{interface\ bw}\ (bps)$$

- The reference BW is generally 100Mbps (FE)
  - interfaces bigger than a FE would have a cost of 1
- For more granularity/accuracy of cost calculation
  - change reference BW for bigger links (all OSPF routers)

IOS:

```
router ospf/v3 <process-id>
 auto-cost reference-bandwidth <Mbps>
```

Junos:

```
set protocols ospf/3 reference-bandwidth <Gbps>
```

Router ID

- Uniquely identifies a link-state router
  - 4-byte Router ID
- Either:
  - Explicitly configured =>

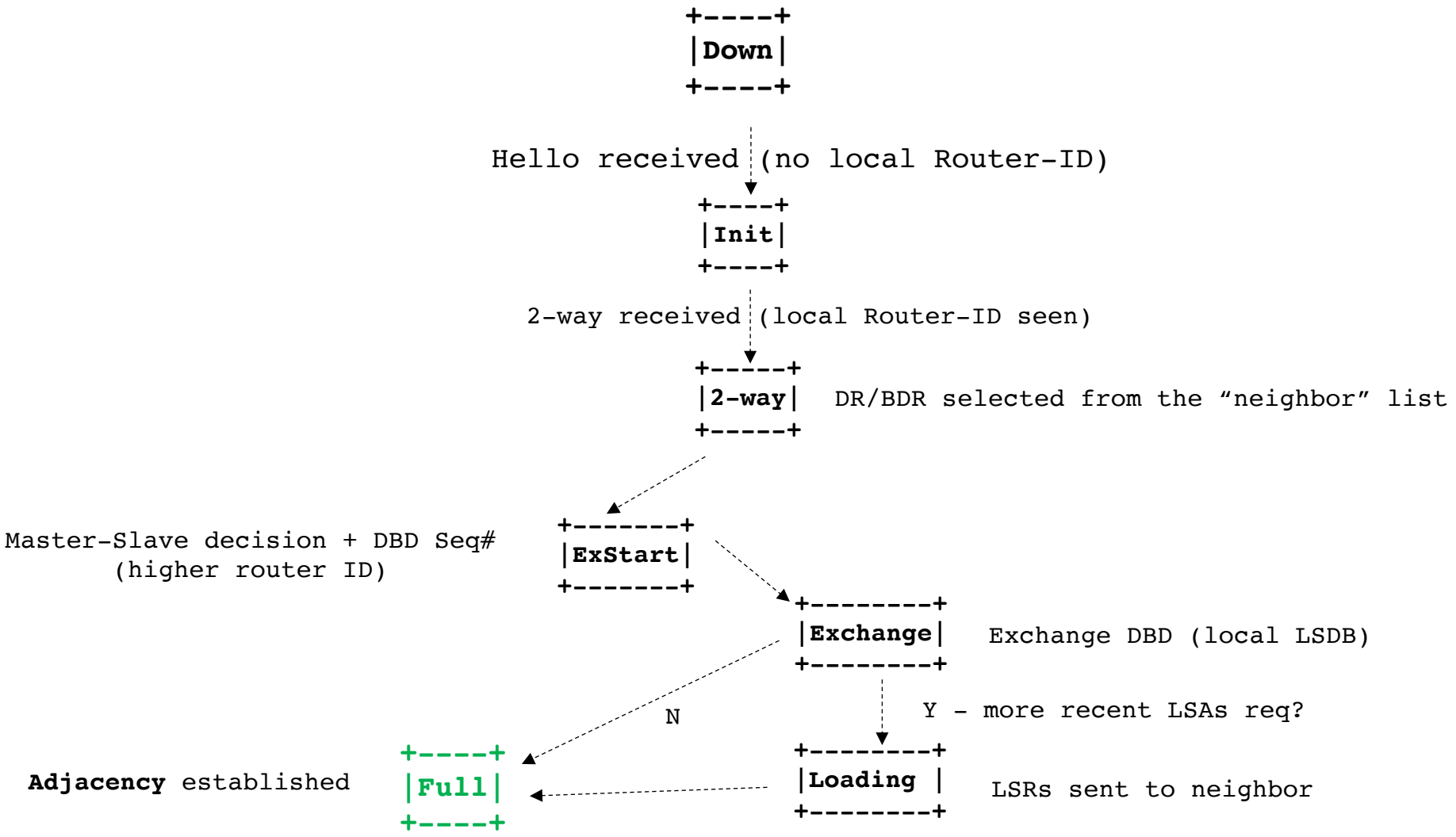
IOS:
```
router-id <4-byte>
```

Junos:
```
set routing-options router-id <4-byte>
```

  - Else, the highest/lowest IPv4 address of any active loopback interface
  - If no loopbacks, the highest/lowest IPv4 address of any active physical interface
  - ** Loopbacks preferred!

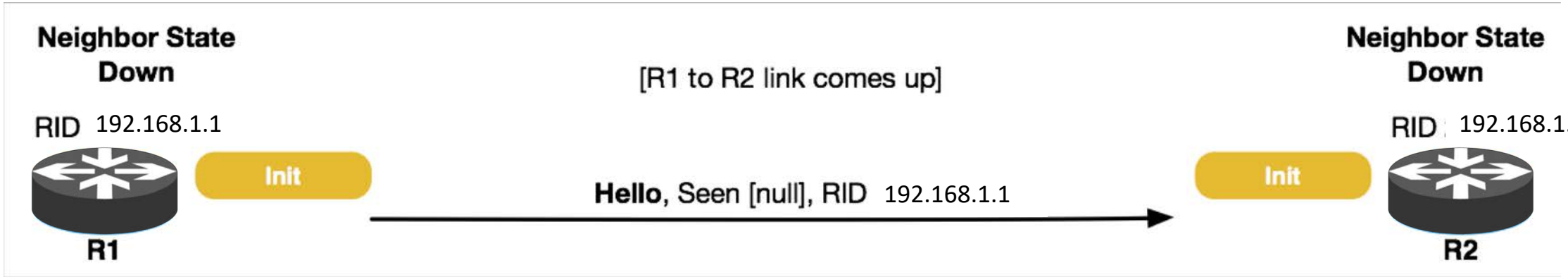
OSPF Neighbor Discovery Process

Neighbor States



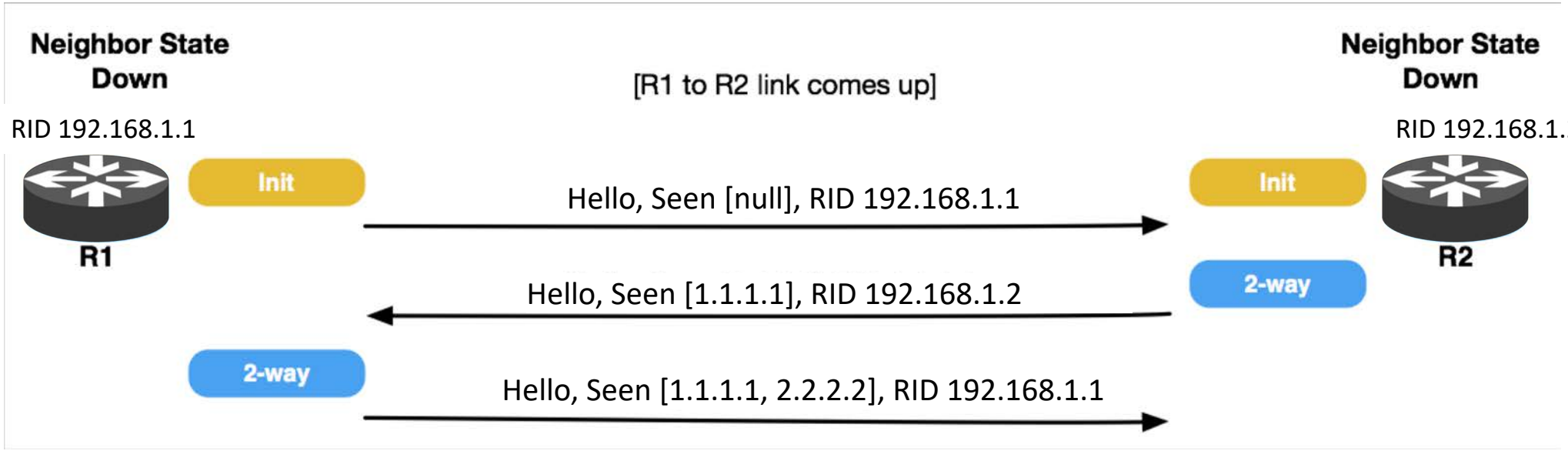
OSPF Neighbor Discovery Process

- Use IP packet to send hello message. At start routers are at **OSPF Down State**
- Use multicast address **224.0.0.5/FF02::5** to make sure single IP packet will be forwarded to every router within OSPF network.
- Router now at OSPF **Init State**



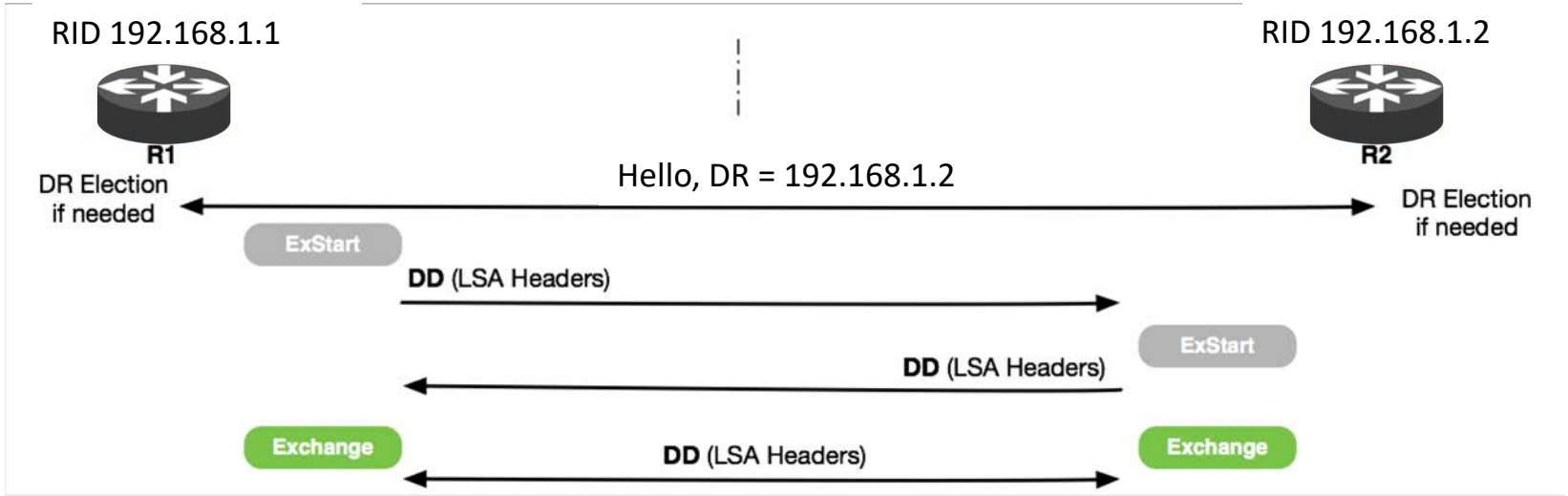
OSPF Neighbor Discovery Process

- All neighboring router with OSPF enabled receive the hello packet
- Checks contents of the hello message and if certain information match it reply (Unicast) to that hello with sending its router ID in the neighbor list.
- This is OSPF **Two-way State**



Discovering Network Information

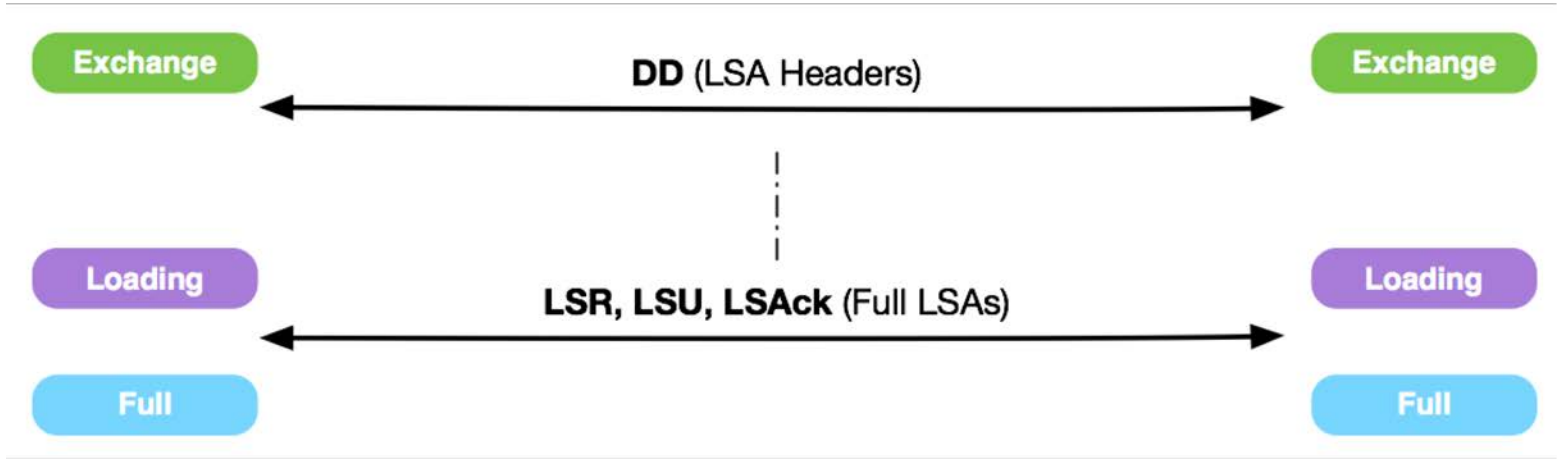
- After creating **2-way** neighbor relationship neighboring routers will start exchanging network related information. At this stage they will decide who will send network information first. Router with the highest router ID will start sending first. This stage is called OSPF **Exstart State**
- Then they will start exchanging link state database. This stage is **Exchange State**



Adding Network Information

- When router receive the LSDB it perform following action:
  - Compare the information it received with the existing DB (if any)
  - If the new DB is more up to date the router send link state request (LSR) for detail information of that link. This is **Loading State**

- When all LSR have been satisfied and all routers has an identical LSDB this stage is OSPF **Full State.** Neighbors in this state are fully adjacent.



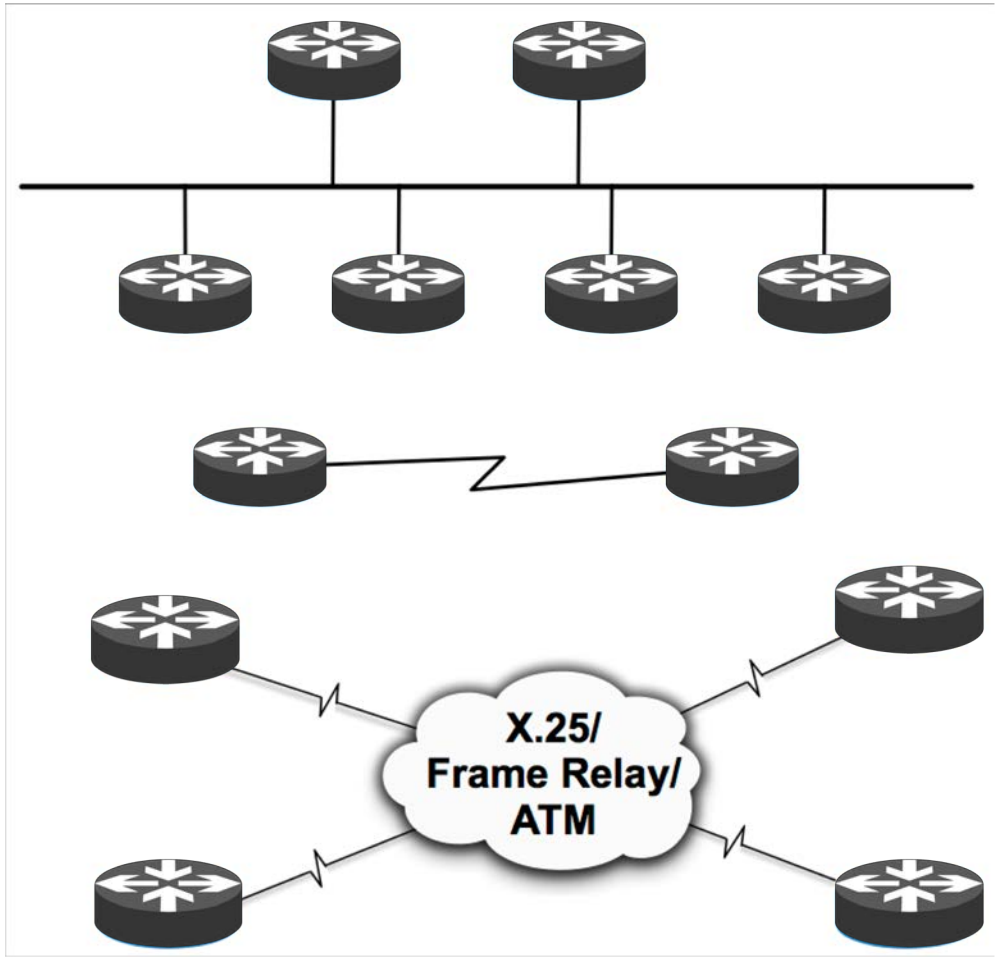
OSPF Topology

OSPF Network Topology

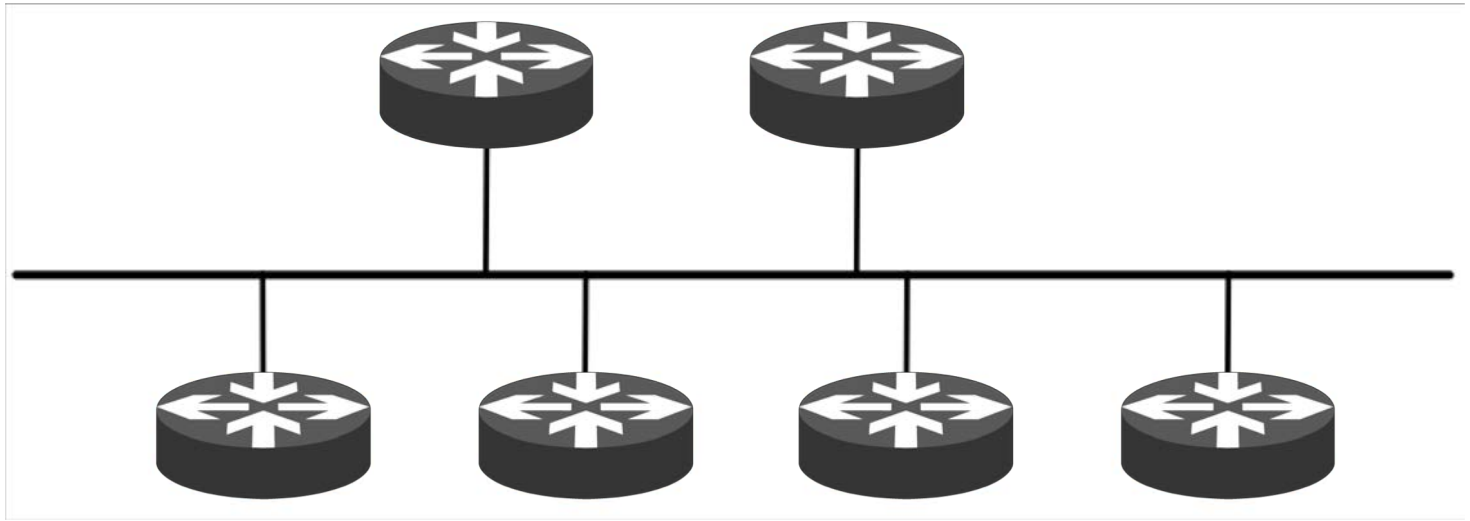
Broadcast Multi-access

Point-to-Point

Non Broadcast Multi-access (NBMA)



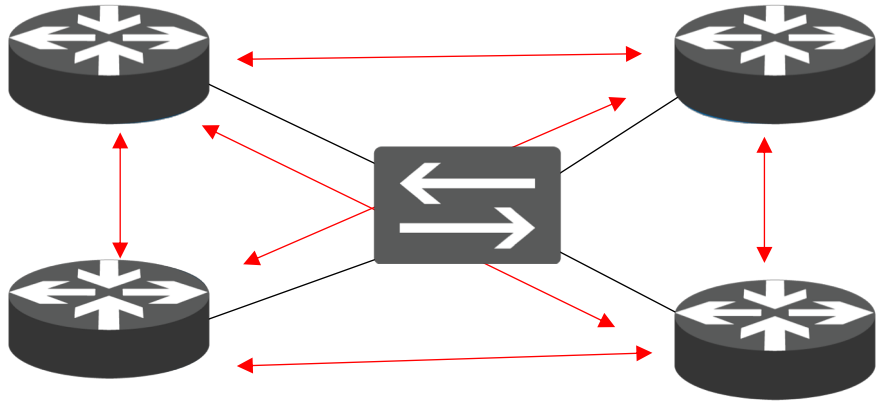
Broadcast Multi-access Network

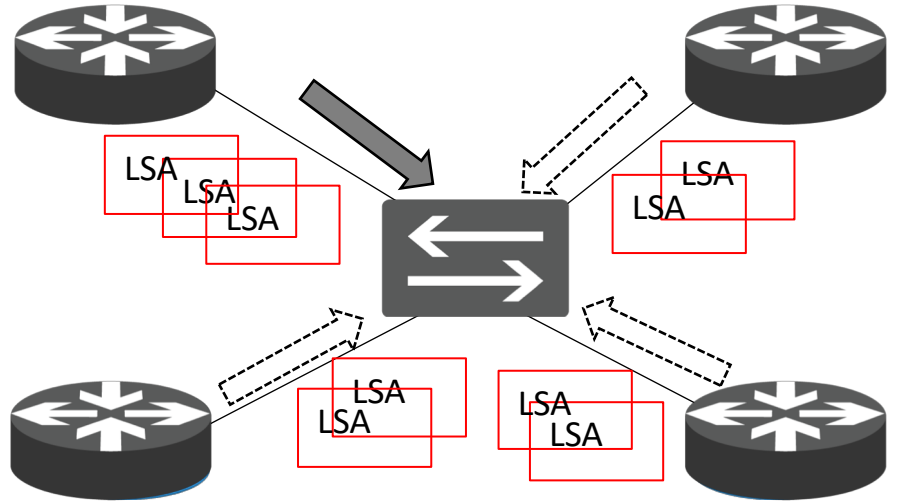


- Generally LAN type of technologies like Ethernet
- Neighbor relationship are created automatically
- DR/BDR election is required
- Default OSPF hello is 10 sec dead interval is 40 sec

Broadcast NW issues

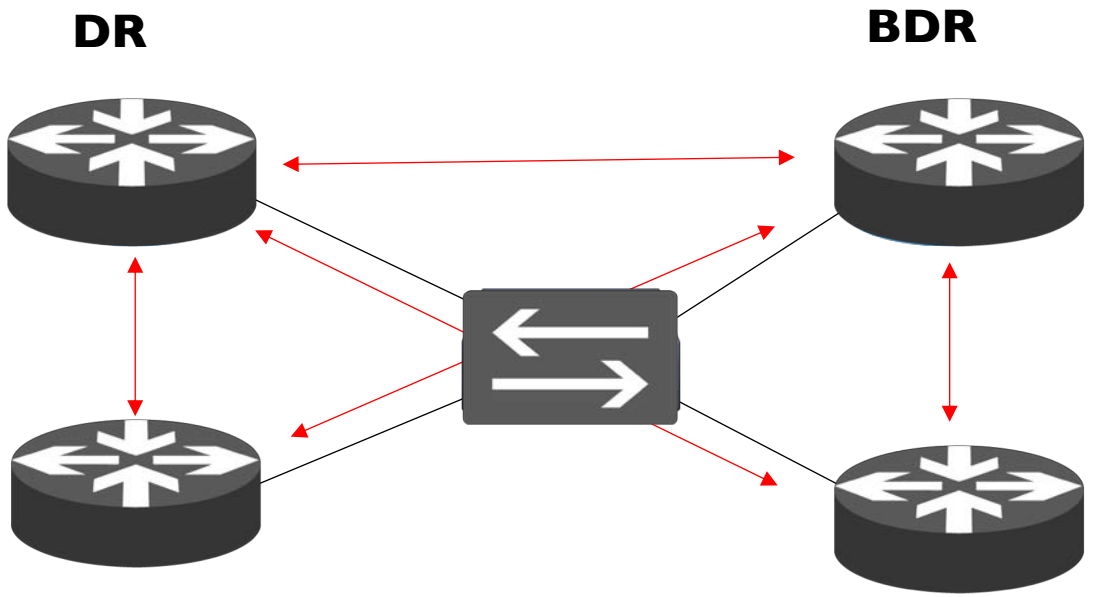
- Number of adjacencies
  - `Number of Adj = n(n-1)/2;`
- Extensive LSA flooding
  - Initially, the whole LSDB
    - LSAck too
  - Periodic hellos for adjacencies
  - Triggered updates
    - During topology changes, each router will send LSUs to neighbors - contains the same info
    - LSAck too





DR/BDR

- Hence, OSPF elects a Designated and Backup Designated router for broadcast networks
  - Adjacencies only formed with DR and BDR
- LSAs sent only to DR (BDR listens)
  - 224.0.0.6/FF02::6
- DR floods to others
  - 224.0.0.5/FF02::5



DR/BDR Election

- Uses the Hello protocol (Router Priority)
  - Highest OSPF interface priority – DR
    - Next highest priority – BDR
  - Configurable:

IOS:
```
(config-if)#ip/ipv6 ospf priority <0-255>
```

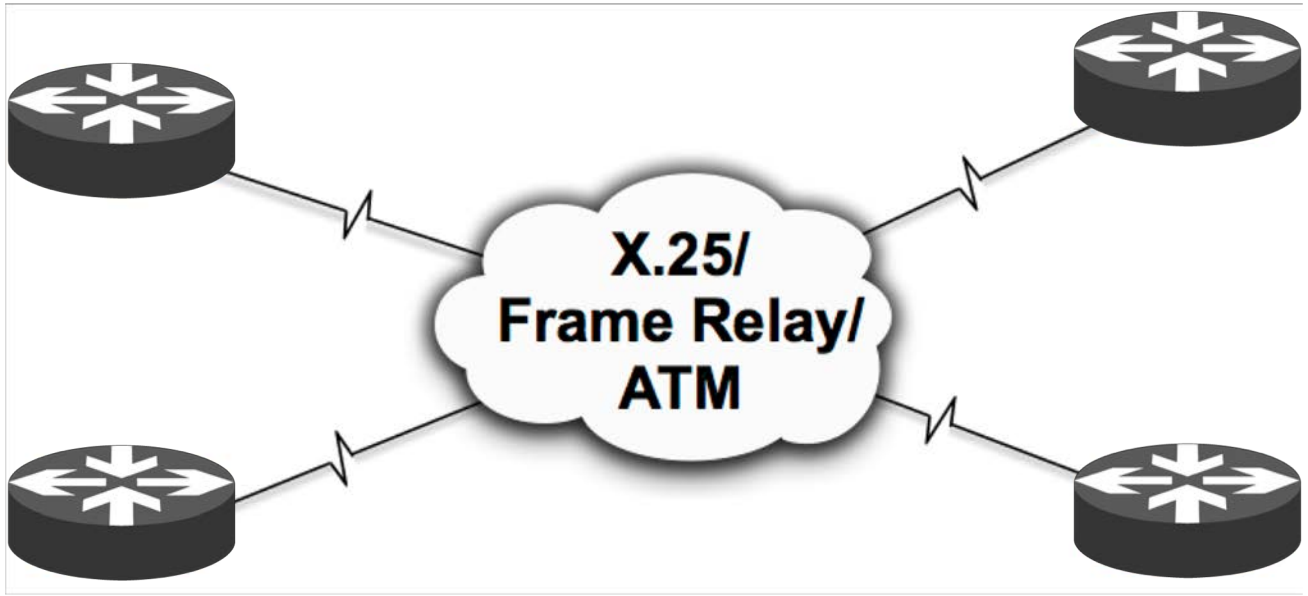
Junos:
```
set protocols ospf/3 area <area-id> interface <id> priority <0-255>
```

  - Else, highest router ID – DR
    - Next highest – BDR
  - Recommended:
    - configure higher priority for routers meant to be DR and BDR!

Point-to-Point Network

- Usually a serial interface running either PPP or HDLC
- Neighbor relationship are created automatically
- No DR or BDR election required
- Default OSPF hello is 10 sec and dead interval is 40 sec

Non Broadcast Multi-access Network



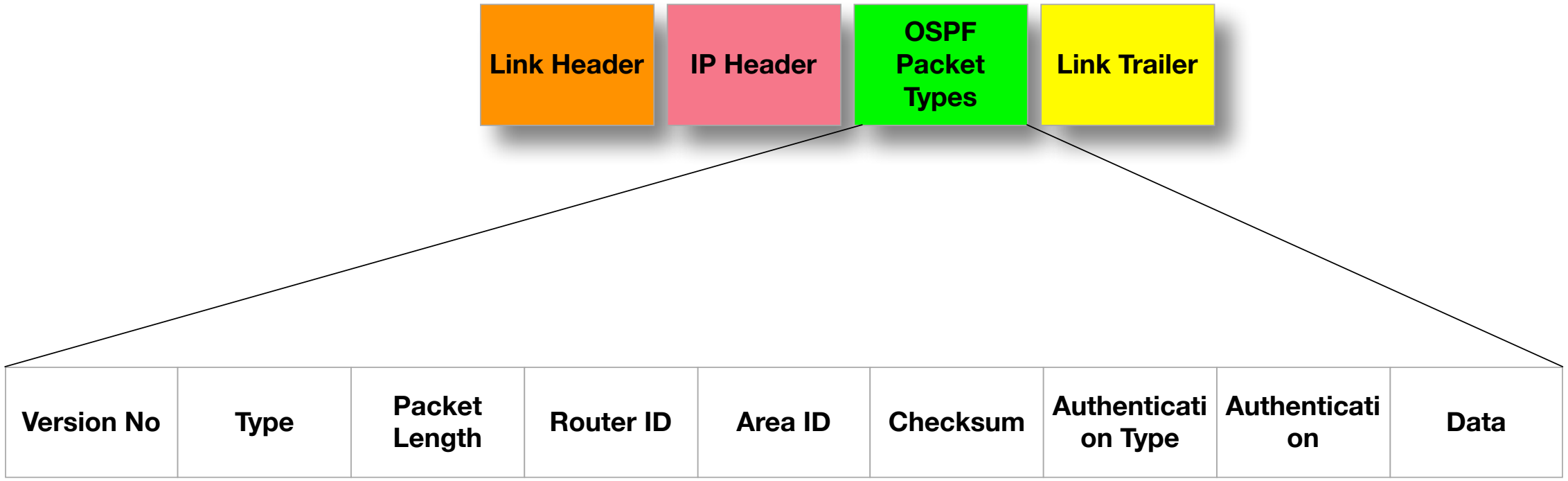
- A single interface interconnects multiple sites like Frame Relay/ATM/X.25
- NBMA topologies support multiple routers, but without broadcasting capabilities
- OSPF neighbor relationships need to be created manually, DR/BDR will be elected

OSPF Packets

OSPF Packet Types

- OSPF use following five packet types to flow routing information between routers:
  - 1: Hello
    - Discover/maintain neighbors
  - 2: Database Description
    - Summarize database contents
  - 3: Link State Request
    - Database download
  - 4: Link State Update
    - Database update
  - 5: Link State Ack
    - Flooding acknowledgment

Format of OSPF Packet



- All five OSPF packets encapsulated in IP payload (Not TCP)
- To ensure reliable deliver using IP packet OSPF use its own Ack packet (Type 5)

Format of OSPF Packet Header Field

Version No	Type	Packet Length	Router ID	Area ID	Checksum	Authentication Type	Authentication	Data

Version No	Either OSPF version 2 (IPv4) or version 3 (IPv6)
Packet Type	Differentiates the five OSPF packet types [Type 1 to Type 5]
Packet Length	Length of OSPF protocol packet in bytes
Router ID	The Router ID of the packet's source.
Area ID	A 32 bit number identifying the area that this packet belongs to.
Checksum	Used for packet-header error-detection to ensure that the OSPF packet was not corrupted during transmission
Authentication Type	An option in OSPF that describes either clear-text passwords or encrypted Message Digest 5 (MD5) formats for router authentication

APNIC Helpdesk Chat

Helpdesk

APNIC Helpdesk provides assistance to all on matters related to APNIC Services, such as membership and IP address enquiries.

APNIC Helpdesk offers (through prior arrangement) multi-language phone support for the following: Bahasa Indonesia, Bahasa Malaysia, Burmese, Cantonese, English, Filipino (Tagalog), Hindi, Japanese, Mandarin, Sinhalese, Tamil and Telugu.

You may also find our FAQs helpful with your enquiries.

Contact details

Helpdesk hours	09:00 to 21:00 (UTC +10) Monday – Friday (closed for some public holidays)
Chat	APNIC Live Chat Online Click here to chat
Skype	Call ID: apnic-helpdesk
Email	helpdesk@apnic.net
Phone	+61 7 3858 3188
VoIP	helpdesk@voip.apnic.net Using VoIP
Fax	+ 61 7 3858 3199

Service Updates

Upgrade edge router firmware

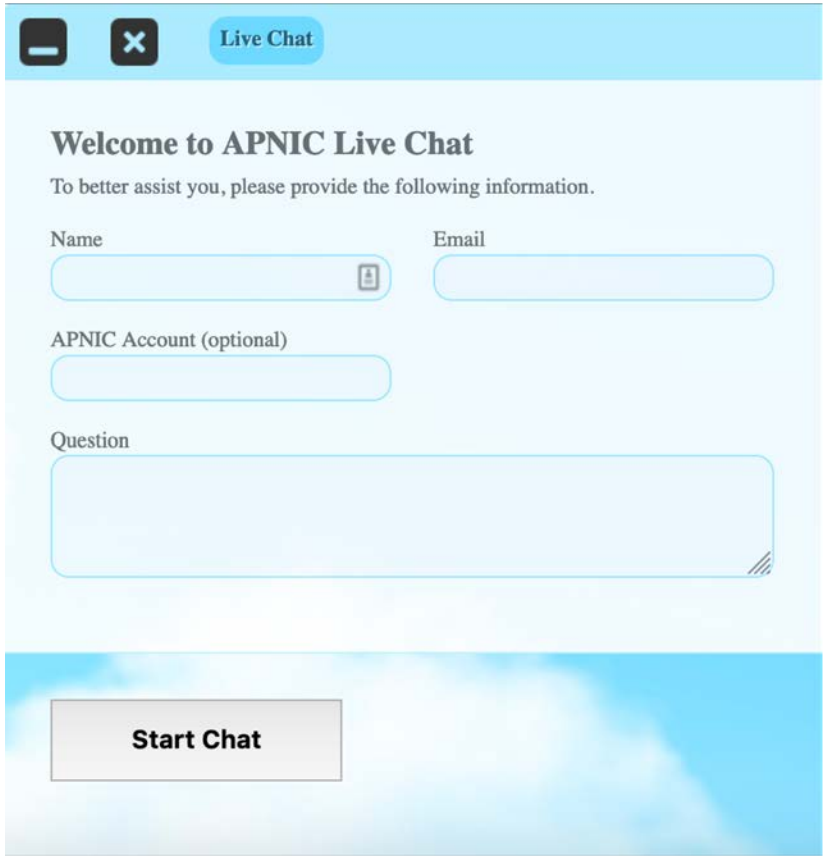
Start: Thursday, 31 January 2019 07:00 AM (UTC +10)
End: Thursday, 31 Jan 2019 08:00 AM (UTC +10)

This maintenance is required to upgrade our edge router firmware in DC2. There may be one or two interruptions to the services listed above for a maximum of 30 minutes within the change window.

More Updates

Subscribe to APNIC Service Announcements

Learn more about system maintenance



Acknowledgements

All images and icons used on these slides, that include an APNIC logo, are licensed or owned by APNIC.