# APNIC eLearning:
# OSPF Basics

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APNIC

# Overview

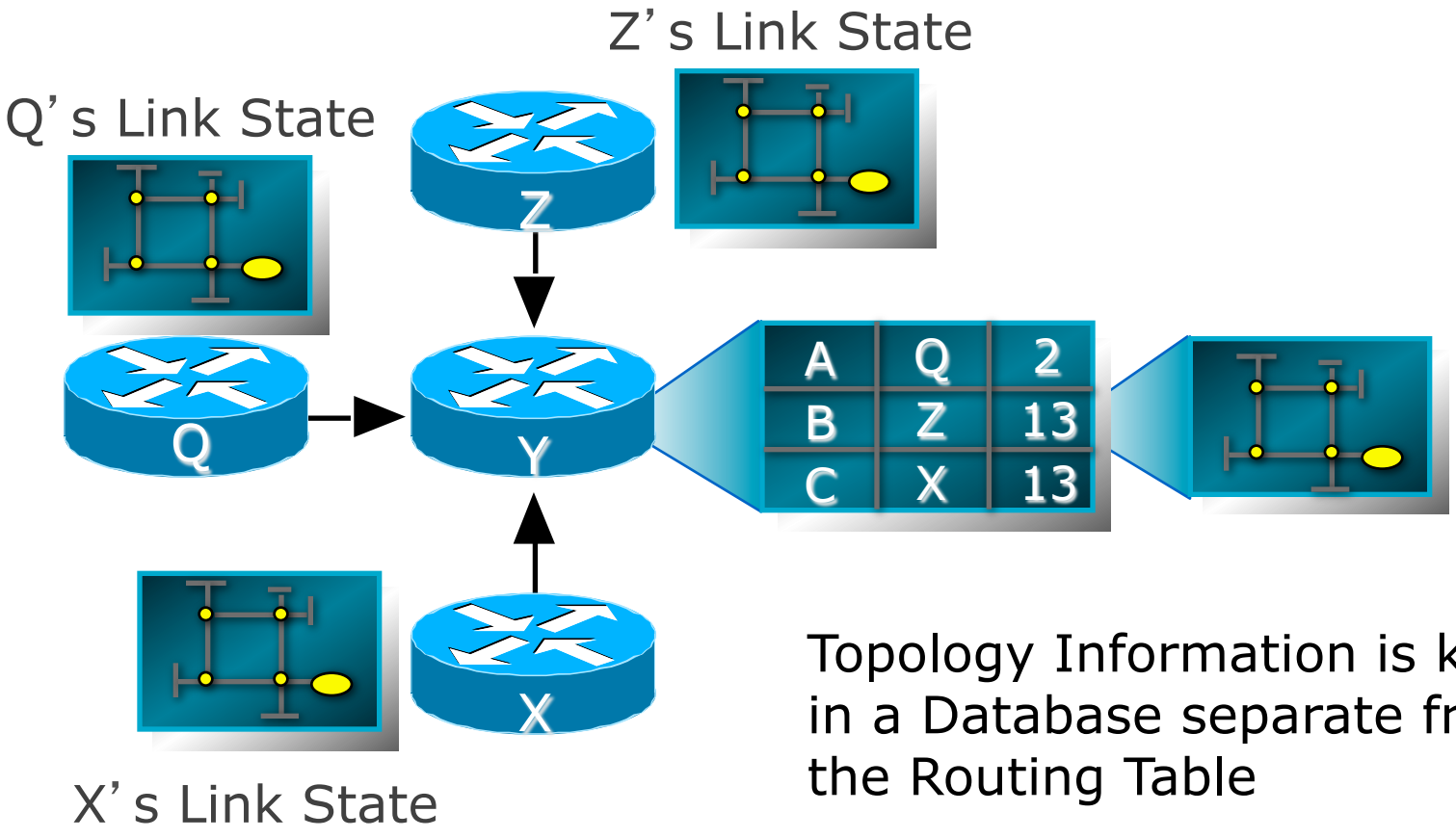
- OSPF Basics and Features
- Link State Routing Protocol
- Fast Convergence
- Basic OSPF Operation
- OSPF Neighbor Discovery Process
- OSPF Packet Types and Format
- OSPF Network Topology

# OSPF

- Open Shortest Path First
- Link state or SPF technology
- Developed by OSPF working group of IETF (RFC 1247)
- OSPFv2 (IPv4) standard described in RFC2328
- OSPFv3 (IPv6) standard described in RFC2740

- Designed for:
  - TCP/IP environment
  - Fast convergence
  - Variable-length subnet masks
  - Discontiguous subnets
  - Incremental updates
  - Route authentication
- Runs on IP, Protocol 89

# Link State Routing Protocol




Topology Information is kept in a Database separate from the Routing Table

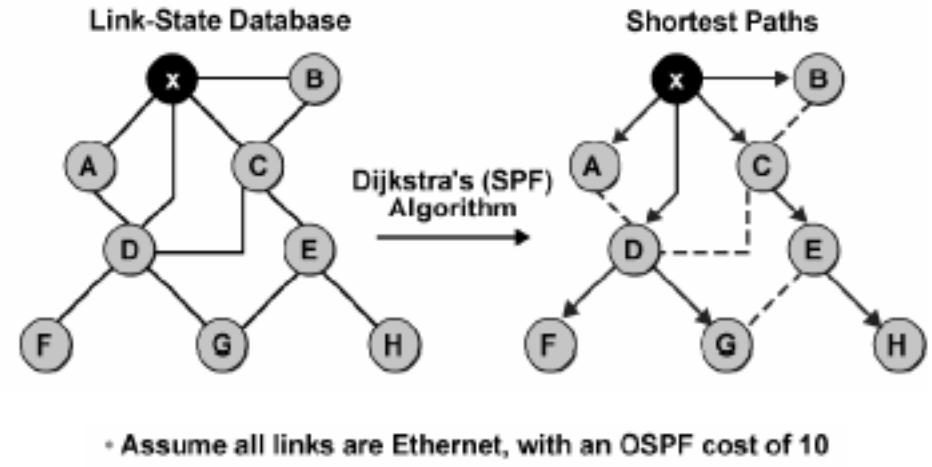
# What is Link State Routing

- Do not send full routing table on periodic interval
- Maintain three tables to collect routing information
  - Neighbor table
  - Topology Table
  - Routing table
- Use Shortest Path First (SPF) algorithm to select best path from topology table
- Send very small periodic (Hello) message to maintain link condition
- Send triggered update instantly when network change occur

# Link State Data Structure

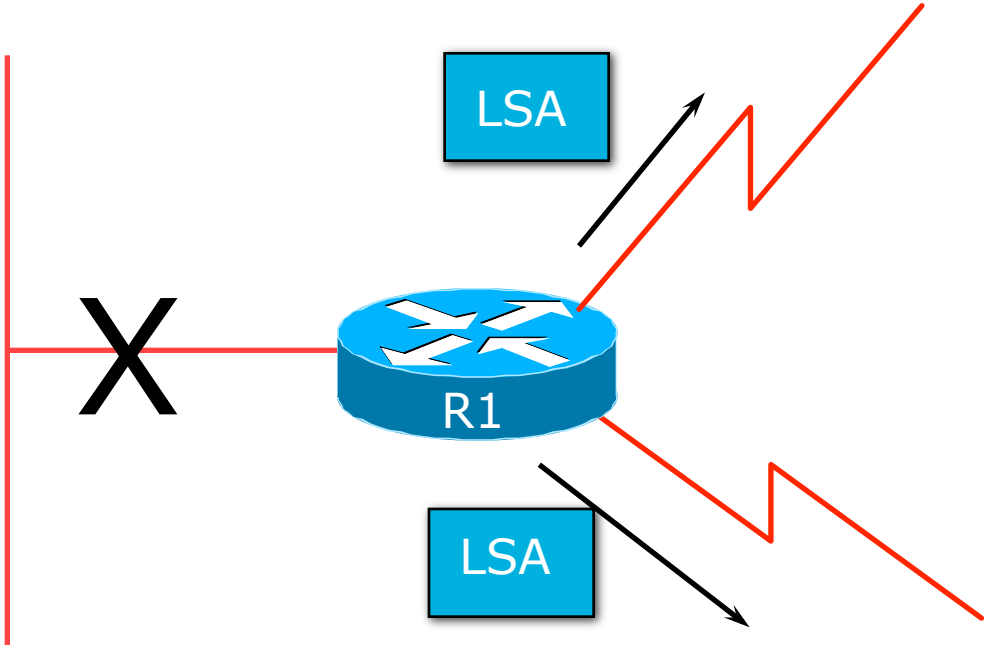
- Neighbor Table
  - List of all recognized neighboring router to whom routing information will be interchanged
- Topology Table
  - Also called LSDB which maintain list of routers and their link information i.e network destination, prefix length, link cost etc
- Routing table
  - Also called forwarding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

# Shortest Path First (SPF) Tree




- Every router in an OSPF network maintain an identical topology database
- Router place itself at the root of SPF tree when calculate the best path

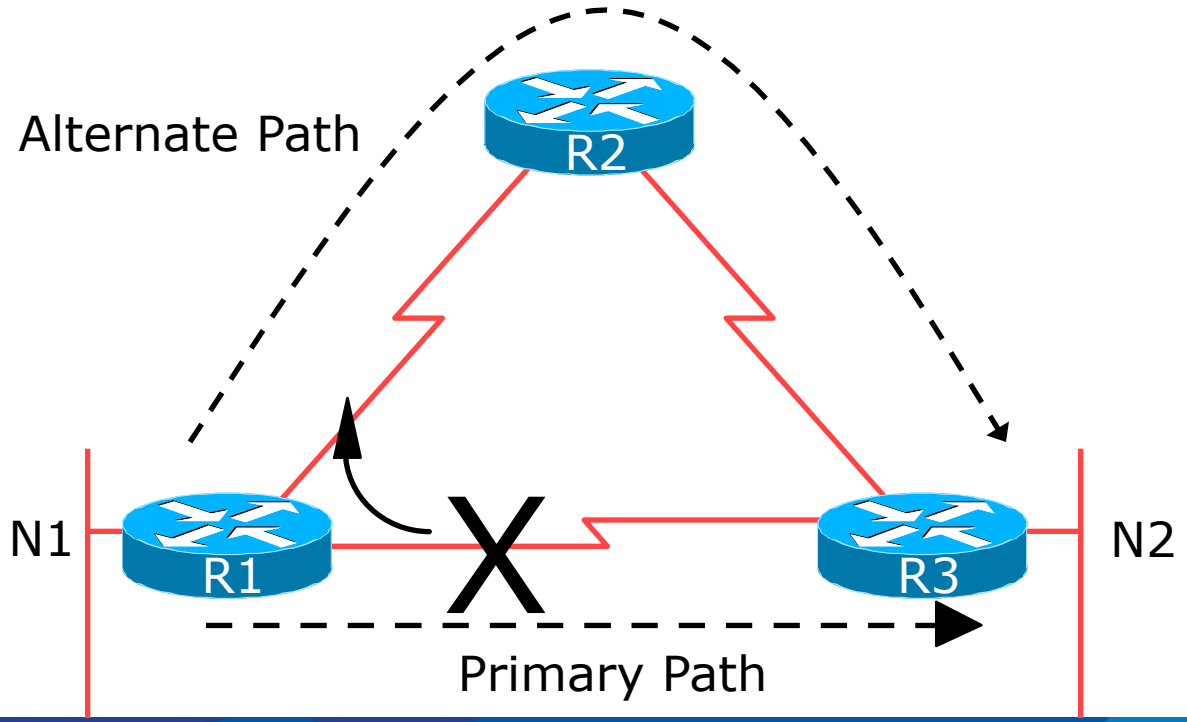
# Low Bandwidth Utilisation




- Only changes propagated
- Uses multicast on multi-access broadcast networks

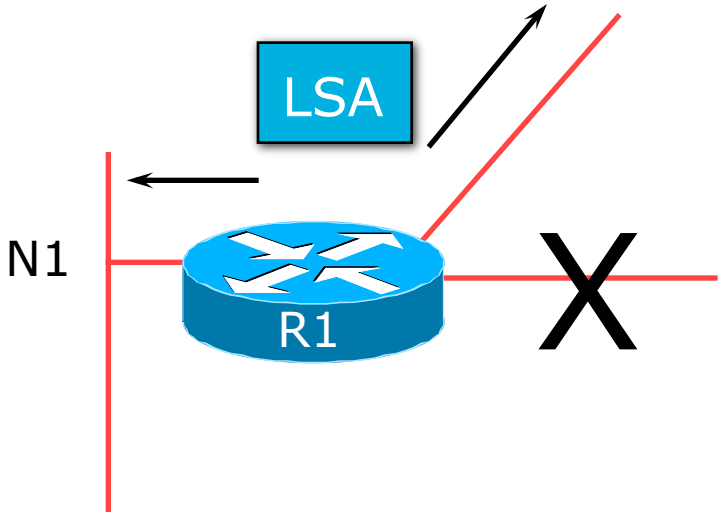
# Fast Convergence

- Detection Plus LSA/SPF
  - Known as the Dijkstra Algorithm



# Fast Convergence

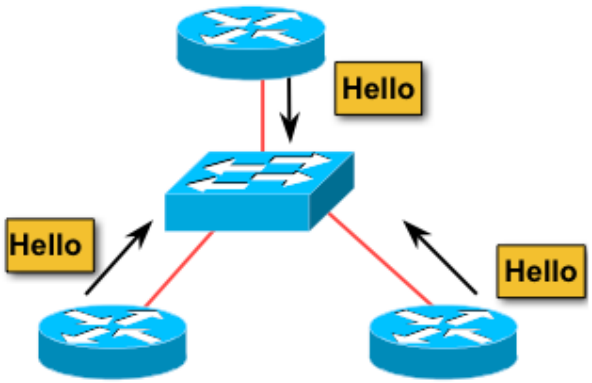
- Finding a new route
  - LSA flooded throughout area
  - Acknowledgement based
  - Topology database synchronised
  - Each router derives routing table to destination network



# Basic OSPF Operation

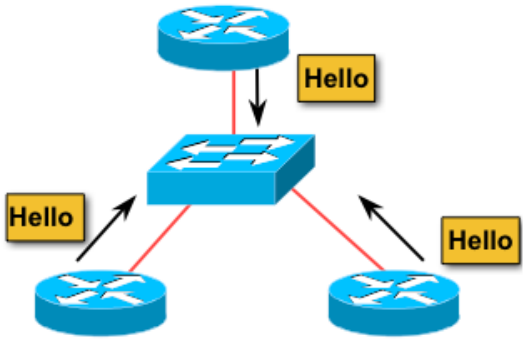
- Neighbor discovery
  - Send L3 multicast message (hello) to discover neighbors
- Exchanging topology table (LSDB)
  - Send L3 multicast message (DBD packets)
- Use SPF algorithm to select best path
  - Each router independently calculates best path from an identical topology database of an OSPF network or area
- Building up routing table
  - All the SPF selected best paths are installed in routing table for the traffic to be forwarded

# 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**

# Contents Of A Hello Packet

- Required information to build up adjacency:
  - Router ID of sending router
  - Hello and dead interval time *
  - List of neighbors
  - Network mask
  - Router priority
  - Area ID *
  - DR & BDR IP
  - Authentication information (If any) *

* Need to match to create neighbor relationship

# 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 Stage**
- Then they will start exchanging link state database. This stage is **Exchange Stage**

# Adding Network Information

- When router receive the LSDB it perform following action:
  - Acknowledge the receipt of DBD by sending Ack packet (LSAck)
  - 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 Stage
- When all LSR have been satisfied and all routers has an identical LSDB this stage is OSPF **Full Stage**

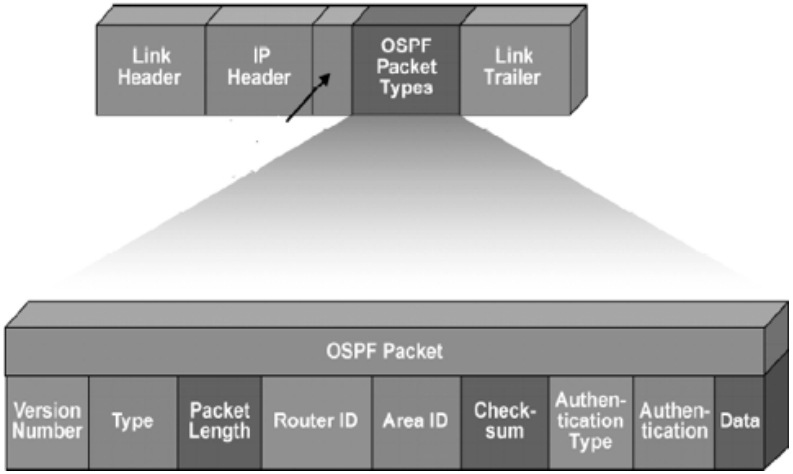
# Maintaining Routing Information

- Send periodic updates (Hello) to all neighbors to make sure link with the neighbor is active. I.e 10 sec for LAN
- Send triggered (Instant) update if any network information changed
- Maintain link state sequence number to make sure all information are up-to-date
- Sequence number is 4-byte number that begins with 0x80000001 to 0x7fffffff

# OSPF Packet Types

- OSPF use following five packet types to flow routing information between routers:
  - 1: hello [every 10 sec]
    - Hello Builds adjacencies between neighbors
  - 2: DBD [Database Descriptor Packet]
    - DBD for database synchronization between routers
  - 3: LSR [Link State Request Packet]
    - Requests specific link-state records from router to router
  - 4: LSU [Link State Update Packet]
    - Sends specifically requested link-state records
  - 5: LSAck [Link State Ack Packet]
    - Acknowledges the above packet types

# 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)

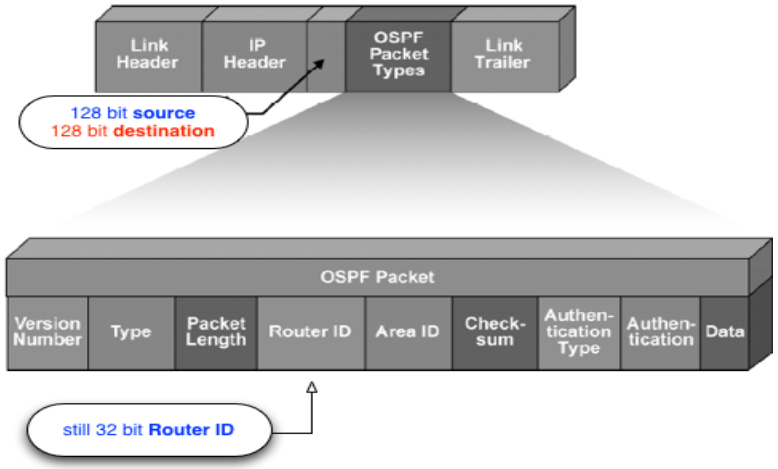
# Format of OSPF Packet Header Field

- Version number
  - 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 packet in bytes
- Router ID
  - Defines which router is the source of the packet [Not always source address of IP header]
- Area ID
  - Defines the area where the packet originated
- 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

# Content of OSPF Packet Data

- Data (for hello packet):
  - Contains a list of known neighbors
- Data (for DBD packet):
  - Contains a summary of the LSDB, which includes all known router IDs and their last sequence number, among a number of other fields
- Data (for LSR packet):
  - Contains the type of LSU needed and the router ID of the needed LSU
- Data (for LSU packet):
  - Contains the full LSA entry. Multiple LSA entries can fit in one OSPF update packet
- Data (for LSAck packet):
  - Is empty

# Difference is OSPFv3 for IPv6



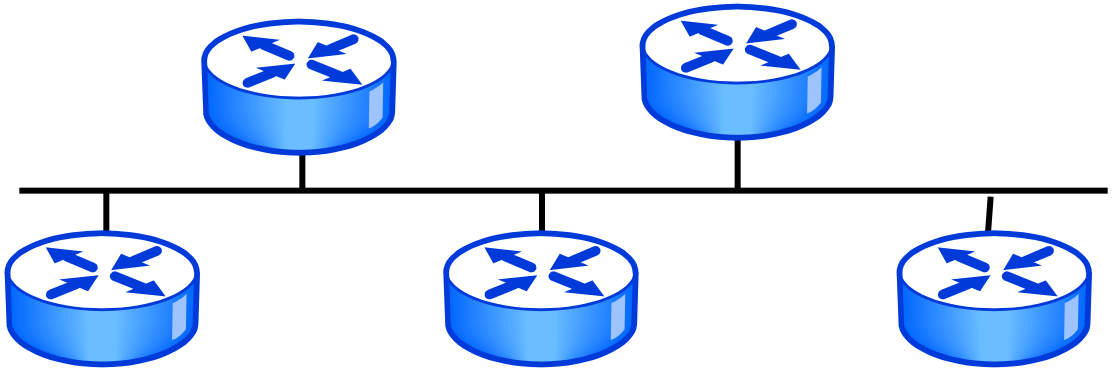

- OSPFv3 still use 32 bit number as router ID
- So OSPFv3 operation and packet types are same as OSPFv2
- Change will be in IP header where source address will be interface address and destination will be  FF02::5 which is 128 bit address.
- Change will be in DBD [t2]  and LSU packet [t4] to carry 128 bit prefix

# OSPF Network Topology

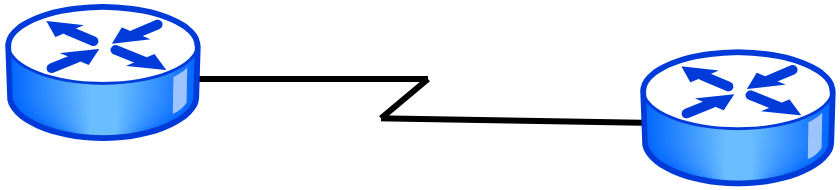
- OSPF network can made up of different types of network links
- Neighbor relationship behavior will also be  different for each network type
- It is important for OSPF to be configured correctly based on its network types to be functioned properly
- Some network type create neighbor relationship automatically some need to create it manually

# OSPF Network Topology

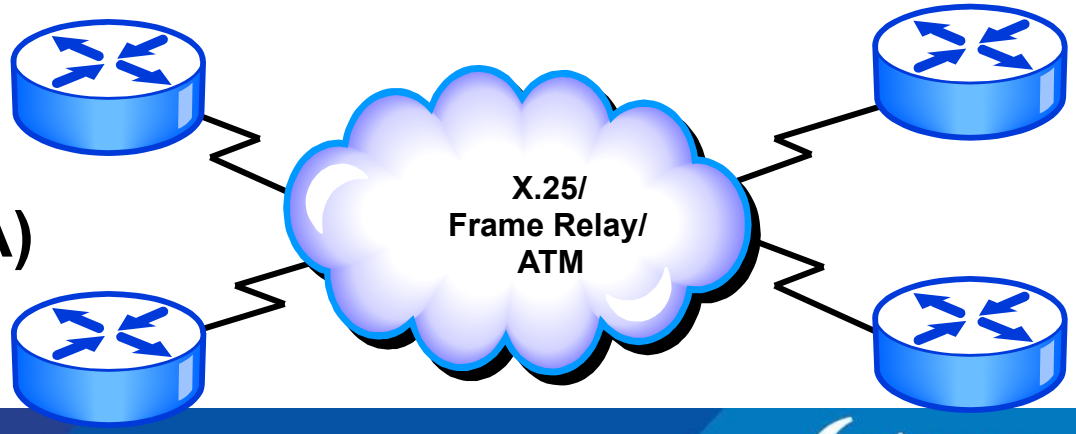
**Broadcast Multi-access**



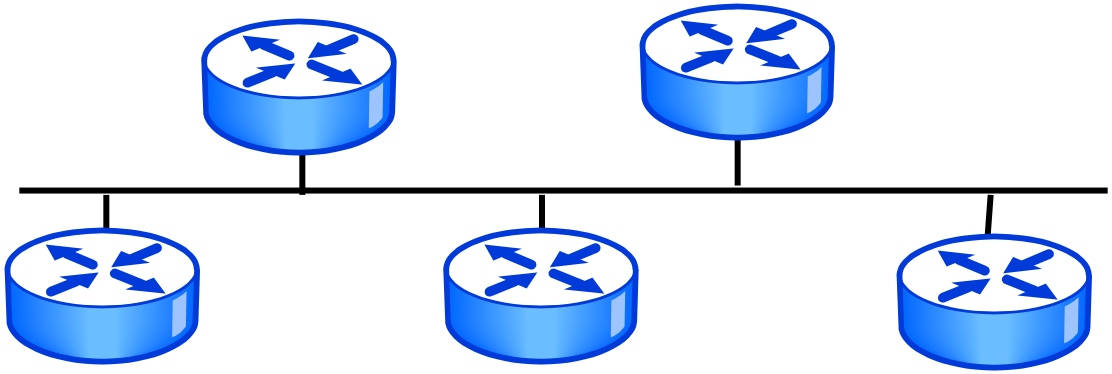
**Point-to-Point**



**Non Broadcast Multi-access (NBMA)**



# Broadcast Multi-access Network



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

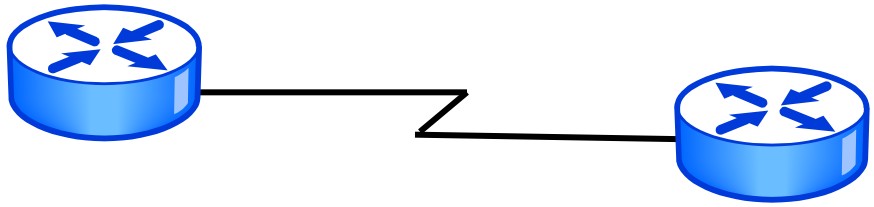
# Broadcast Multi-access Network

- Broadcast network use flooding process to send routing update
- Broadcast network use DR/BDR concept to reduce routing update traffic  in the LAN
- Packet sent to DR/BDR use 224.0.0.6/FF02::6 multicast address
- Packets from DR to all other routers use 224.0.0.5/FF02::5 multicast address
- All neighbor routers form full adjacencies relation with the DR and BDR only

# DB/BDR Election Process

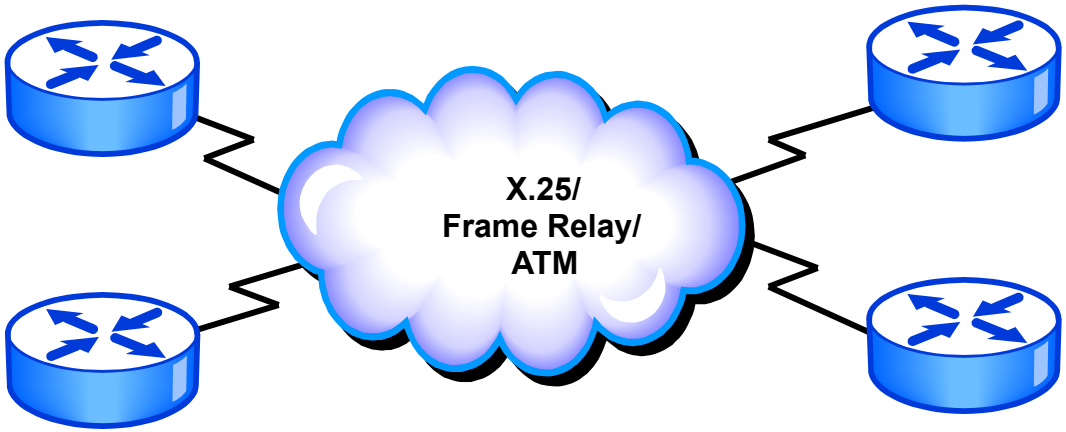
- Router with the highest priority value is the DR, Second highest is BDR
- In the event of tie router with the highest IP address on an interface become DR and second highest is BDR
- DR/BDR election can be manipulated by using router-ID command.
- In practice loopback IP address is used as router ID and the highest IP address will become DR, Second highest is BDR
- The DR/BDR election is non-preemptive
  - Generates network link advertisements
- Assists in database synchronization

# 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

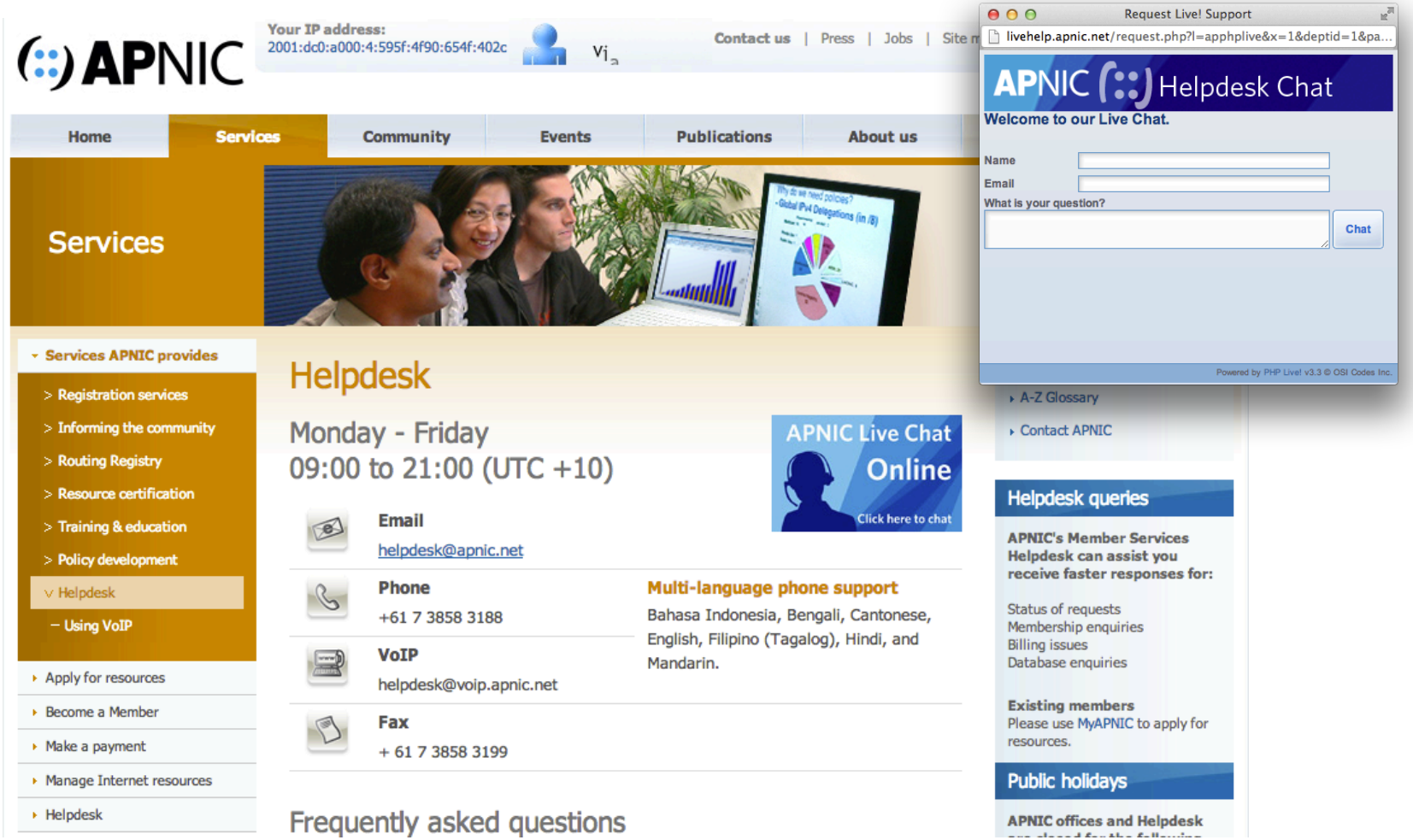



- A single interface interconnects multiple sites like Frame Relay/ATM/X.25
- NBMA topologies support multiple routers, but without broadcasting capabilities
- OSPF neighbor relation need to create manually, DR/BDR will be elected
- Default OSPF hello is 30 sec and dead interval is 120 sec

# Questions

- Please remember to fill out the feedback form
  - <survey-link>
- Slide handouts will be available after completing the survey

# APNIC Helpdesk Chat



# Thank you!

End of Session

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