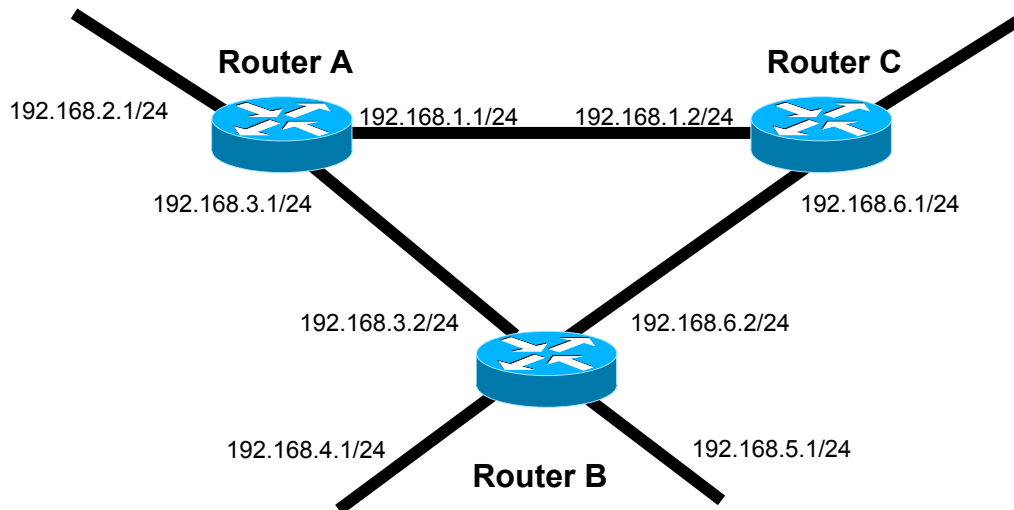


# Open Shortest Path First - OSPF

## Internetworking - Module 12

OSPF is the link state routing protocol developed by the Internet Engineering Task Force for use in TCP/IP internetworks as an Interior Router Protocol

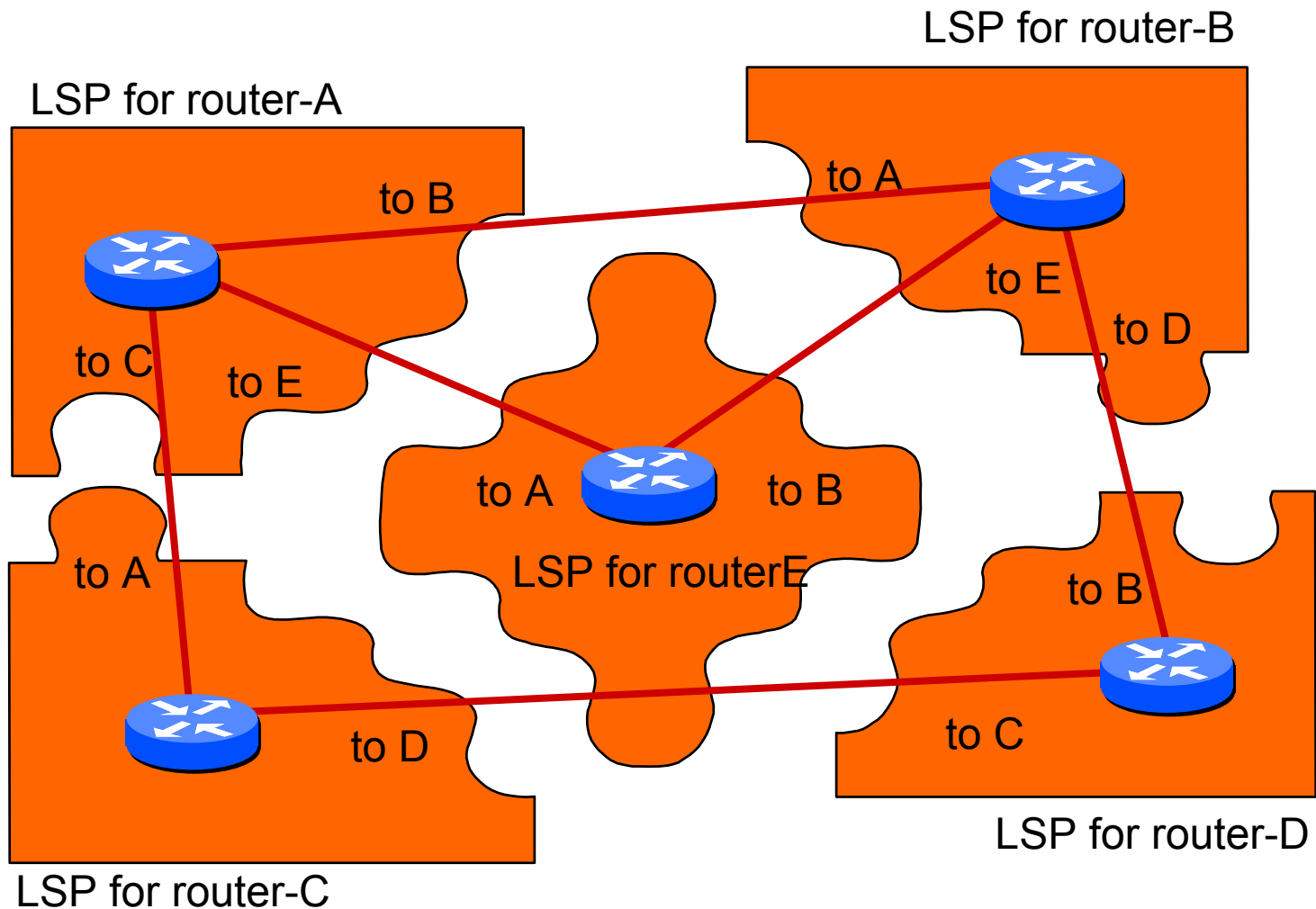


# About link-state protocols

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- In a link-state protocol, the network can be viewed as a jigsaw puzzle
- Each jigsaw piece holds one router
- Each router creates a packet which represents its own jigsaw piece
  - ⊗ This packet is called a Link State PDU (LSP)
- These packets are flooded everywhere
- Therefore each router receives all pieces of the jigsaw puzzle
- Each routers compute SPF algorithm to put the pieces together
  - ⊗ Input: all jigsaw puzzle pieces (LSPs)
  - ⊗ Output: Area or network topology tree  
Shortest Path Tree

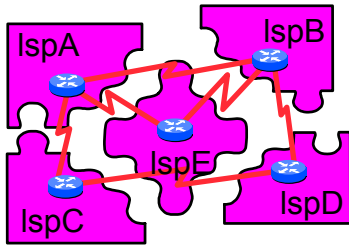
# The jigsaw puzzle



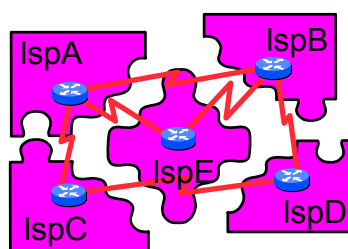
# All routers have same LSPDB

- All routers exchange all LSPs
  - via a reliable flooding mechanism
- All routers store all LSPs in a so-called link-state database (LSPDB)
  - separate from the routing table (RIB)
  - all routers should have exactly the same LSPDB, but different RIBs

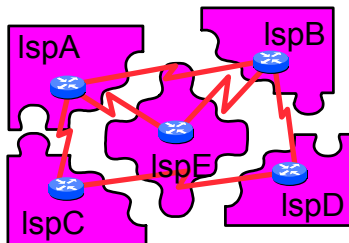
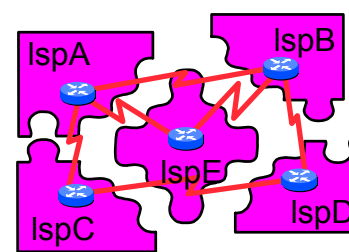
RouterA's LSPDB



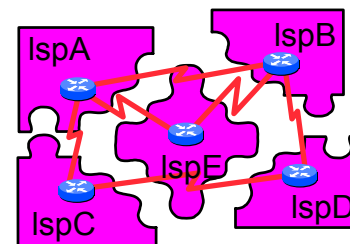
RouterE's LSPDB



RouterB's LSPDB



RouterC's LSPDB



RouterD's LSPDB

# What to do with LSPs ?

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- Each router ‘composes the jigsaw puzzle’ by executing Dijkstra’s Shortest Path First algorithm (SPF)
  - ⊗ the topology is calculated as a Shortest Path Tree (SPT), with itself as root
  - ⊗ each router computes a different SPT
- From the SPT the RIBs are calculated

# OSPF - RFC2328

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- OSPF = Open Shortest Path First
- Open in the sense of an open standard as opposed to a proprietary
- SPF = Dijkstra's Algorithm applied on LSD to generate routing information
- Developed by IETF as a link state interior router protocol
- Uses IP (Protocol ID=89)
- Sends updates only when change occurs
  - ⊗ (unlike RIP's every 30 secs)
- Sends hellos & updates to multicast addresses
  - ⊗ 224.0.0.5 & 224.0.0.6

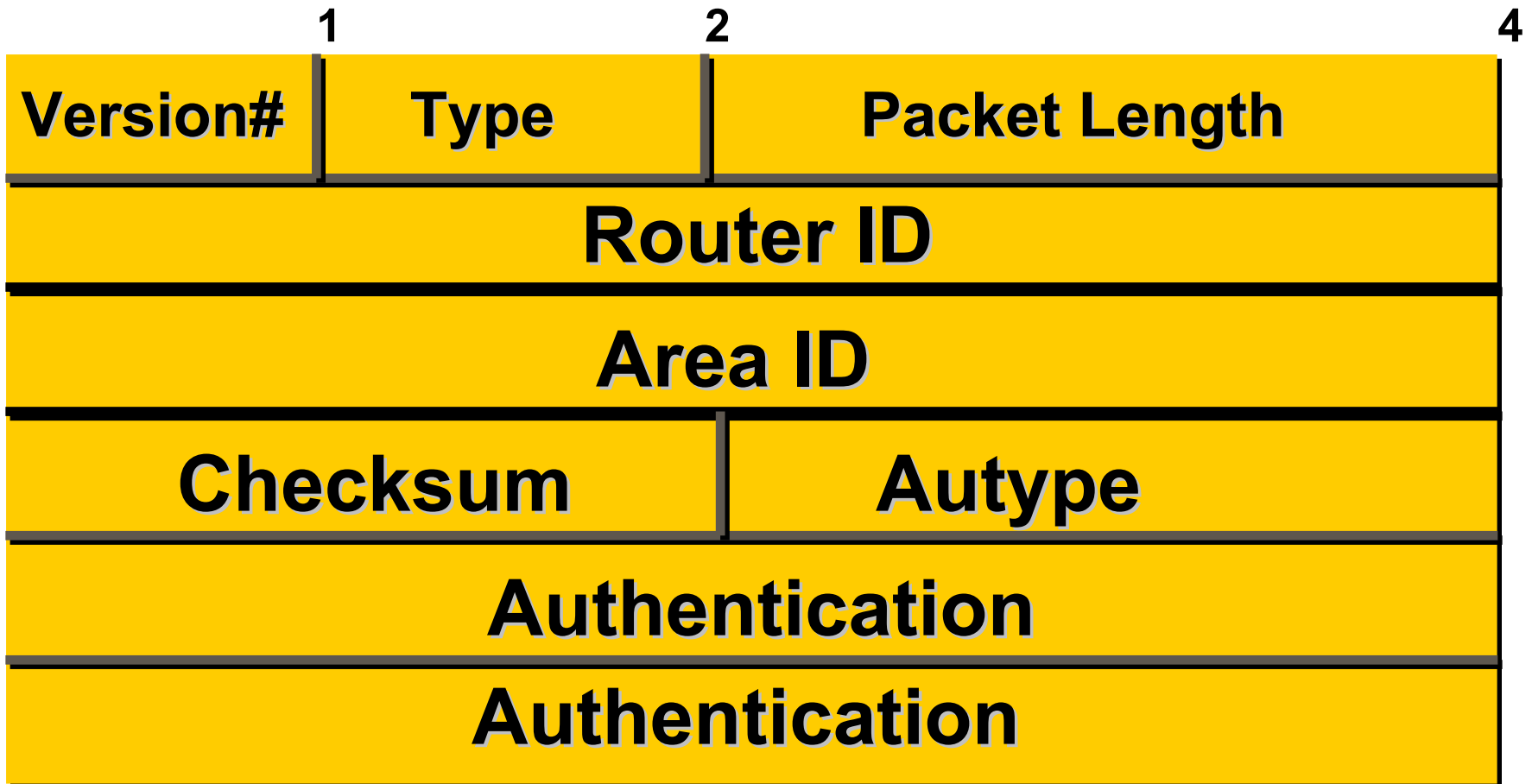
# Five types of OSPF routing protocol packets

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- Hello
- Database Description
- Link State Request
- Link State Update
- Link State Acknowledgment

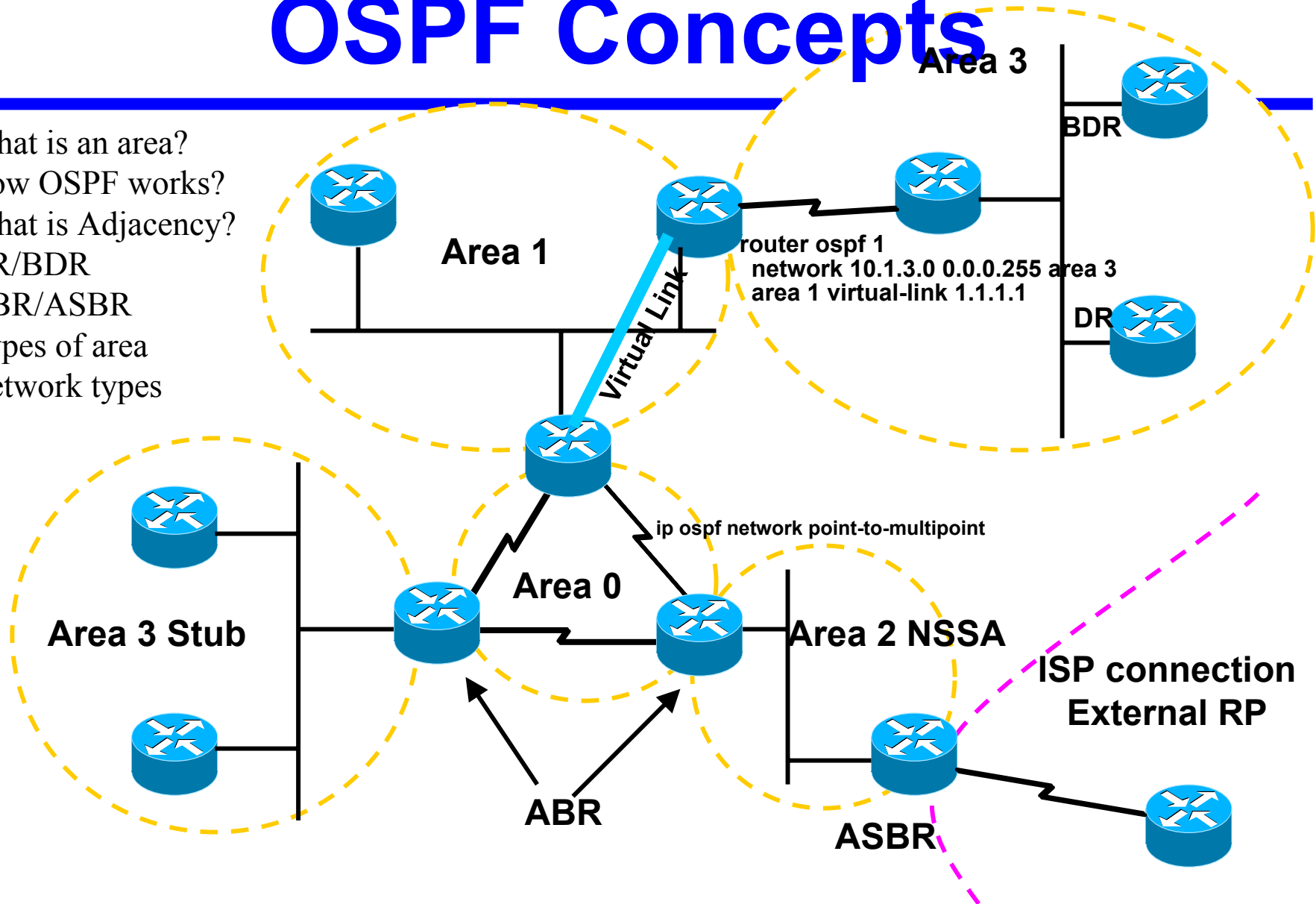
# OSPF Protocol Packets - OSPF Header

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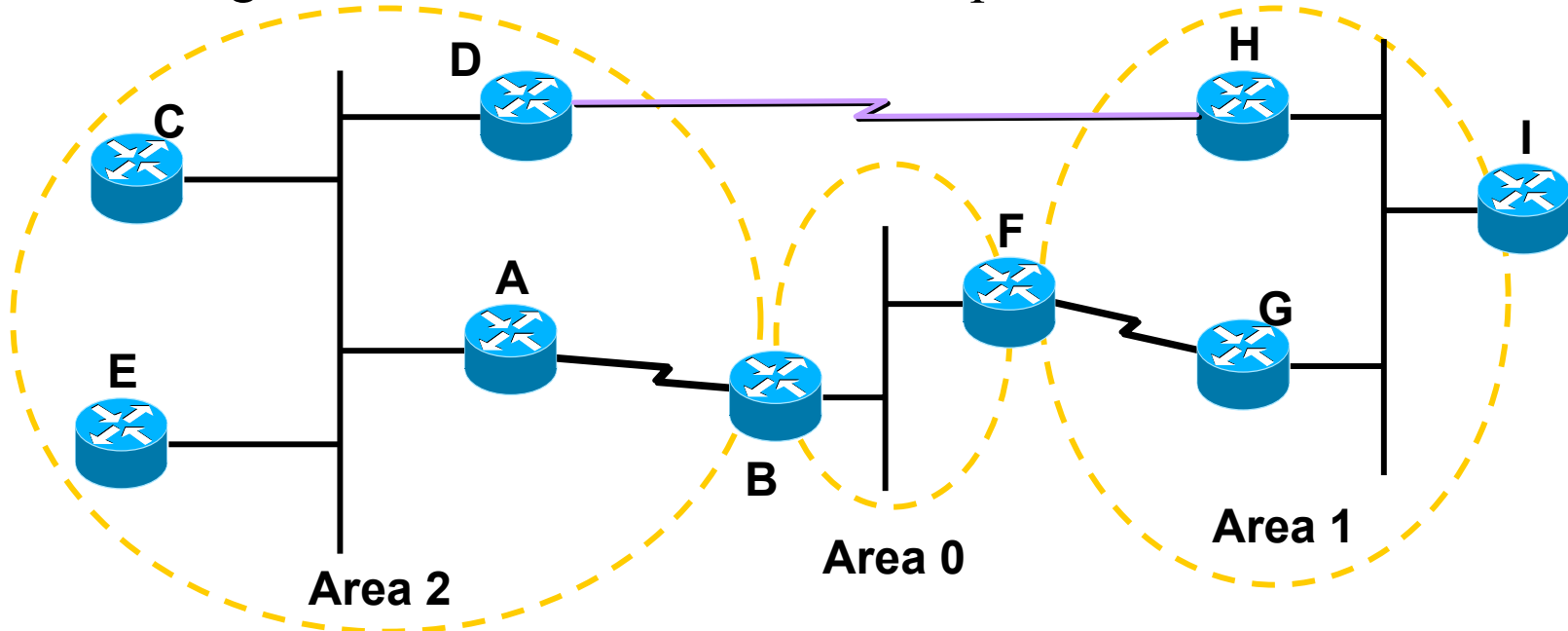
# OSPF Concepts

- What is an area?
- How OSPF works?
- What is Adjacency?
- DR/BDR
- ABR/ASBR
- Types of area
- Network types



# What is an Area?

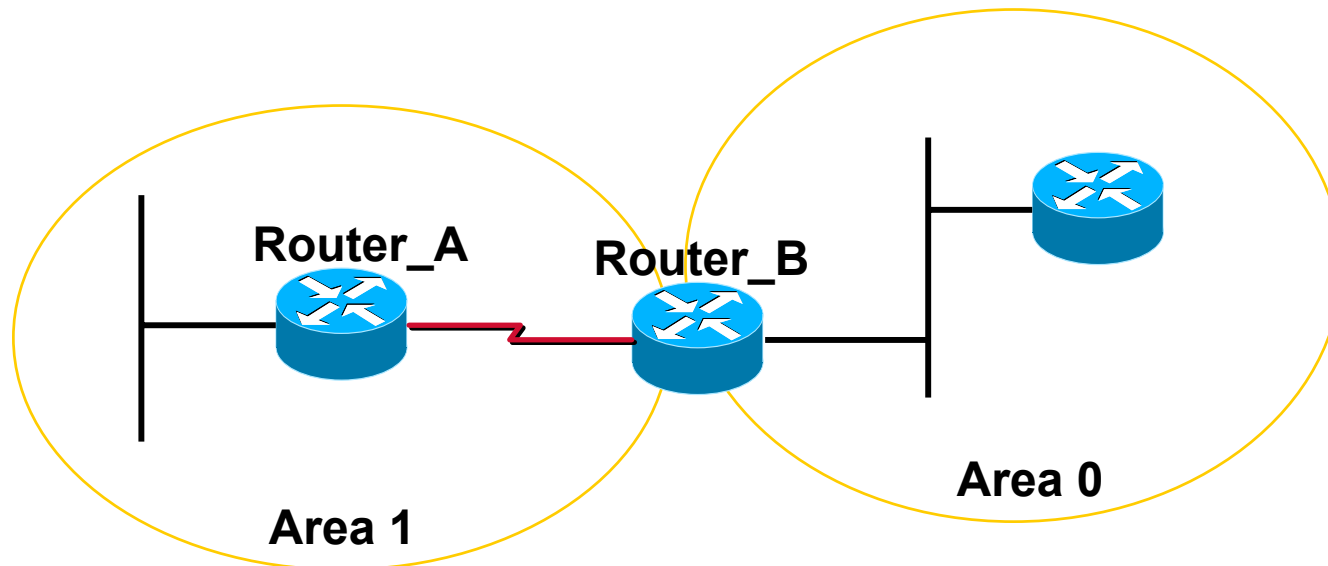
- Area is a collection of routers
  - ⊗ All routers within an area maintain same database
  - ⊗ Routes within an area are **intra area routes**, 'O'
  - ⊗ if more than one area, area 0 must be configured
  - ⊗ to get from one area to another we pass thru area 0



# How OSPF works ?

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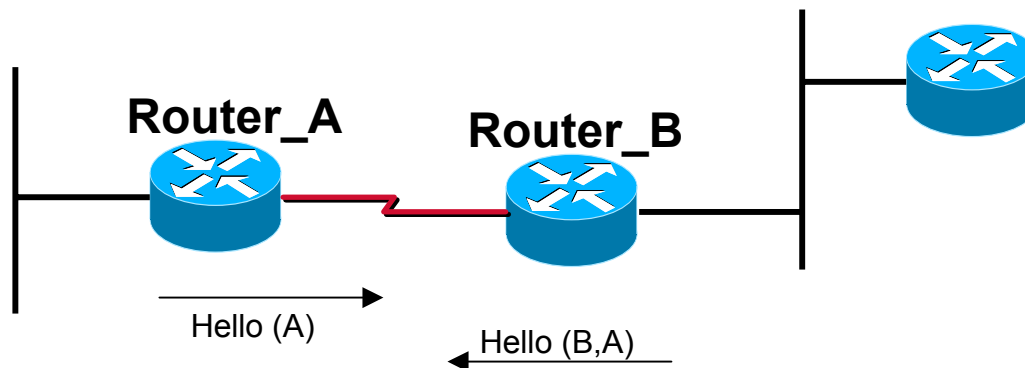
- Advertise its LSA (Link State Advertisement) through flooding within a specific Area
- LSA contains state of router's link, e.g cost, type of link etc
- Every router generates **Router LSA(Type 1)**
- To Exchange these LSAs, routers must be adjacent



# What is Adjacency ?

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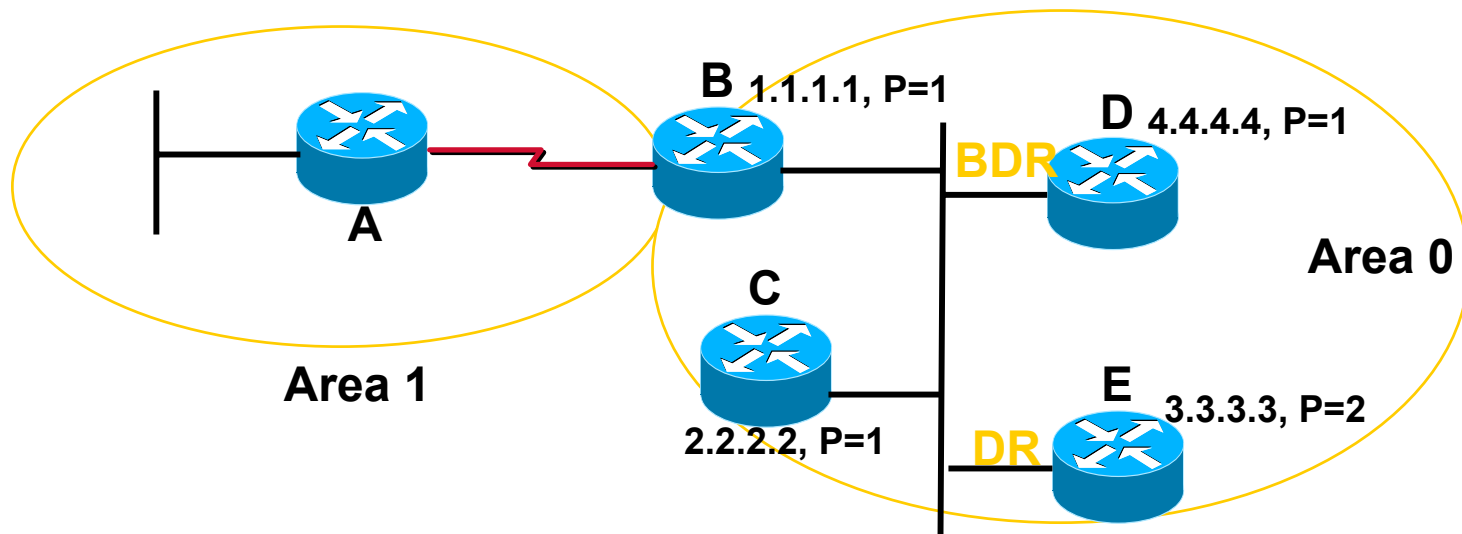
- A sends hello to B
- B sends hello to A
- If B acknowledges A's hellos then it's a **2-WAY** state
- Otherwise its **INIT** state (one-way hello)
- next state is **EXSTART/EXCHANGE**(database syncing)
- When fully synced its **FULL** state
- “*show ip ospf neighbor*” will show **FULL/-** or **FULL/DR**



# Designated Router (DR)

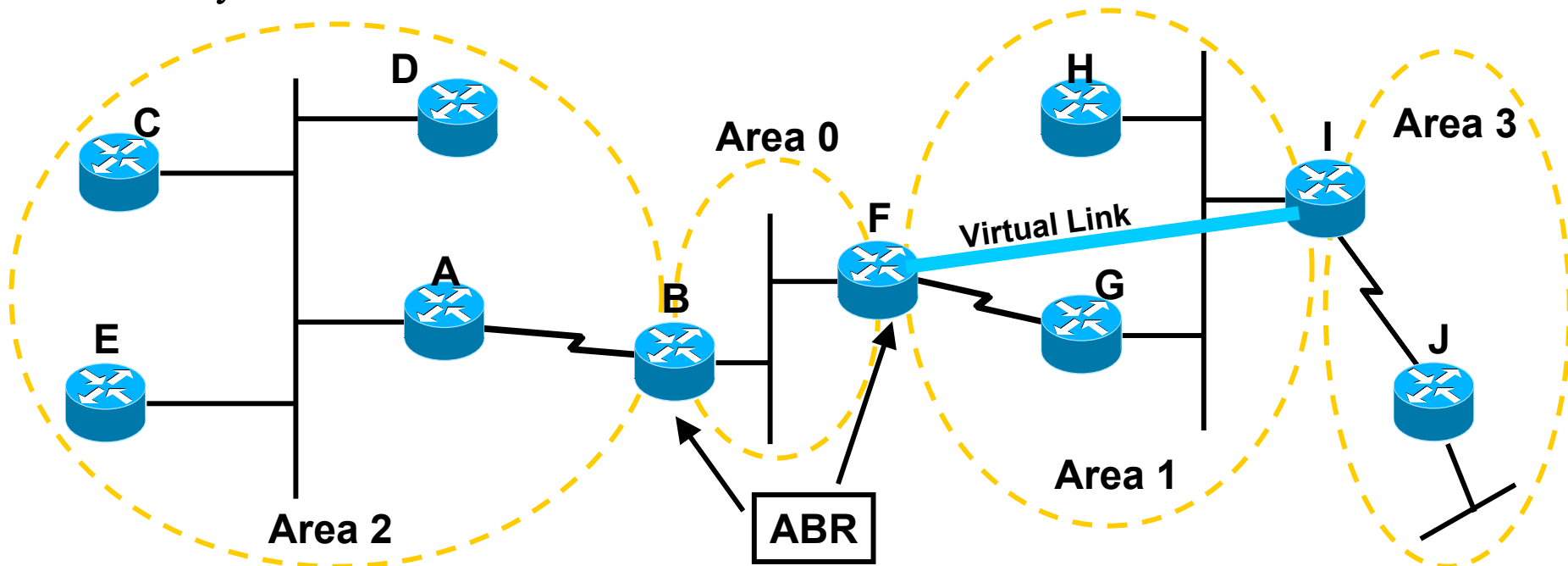
## Backup Designated Router (BDR)

- On a broadcast network, there is a DR & BDR to reduce flooding
- DR does all the flooding of LSA
- BDR is a backup. If DR dies BDR takes over
- DR is elected via hello protocol
- Highest priority becomes DR, next highest becomes BDR
- if priorities are equal then highest router ID
- Every DR generate **network LSA(Type 2)**



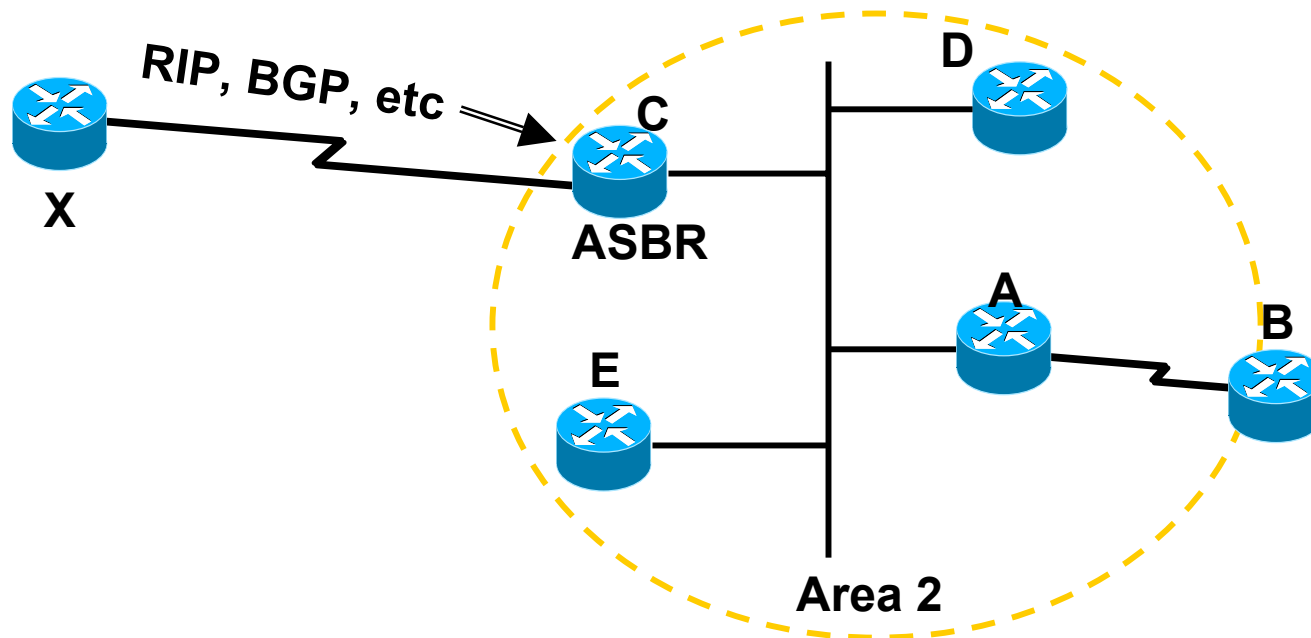
# Area Border Router (ABR)

- It's the router that sits at the border of area <x> & area 0
  - ⊗ ABR is responsible to generate **summary LSA** (Type 3 & 4)
  - ⊗ One area knows about routes to the other area via summary LSA
  - ⊗ Routes from another area are inter area routes, '**O IA**'
  - ⊗ Every area must connect to area 0 otherwise virtual link is needed



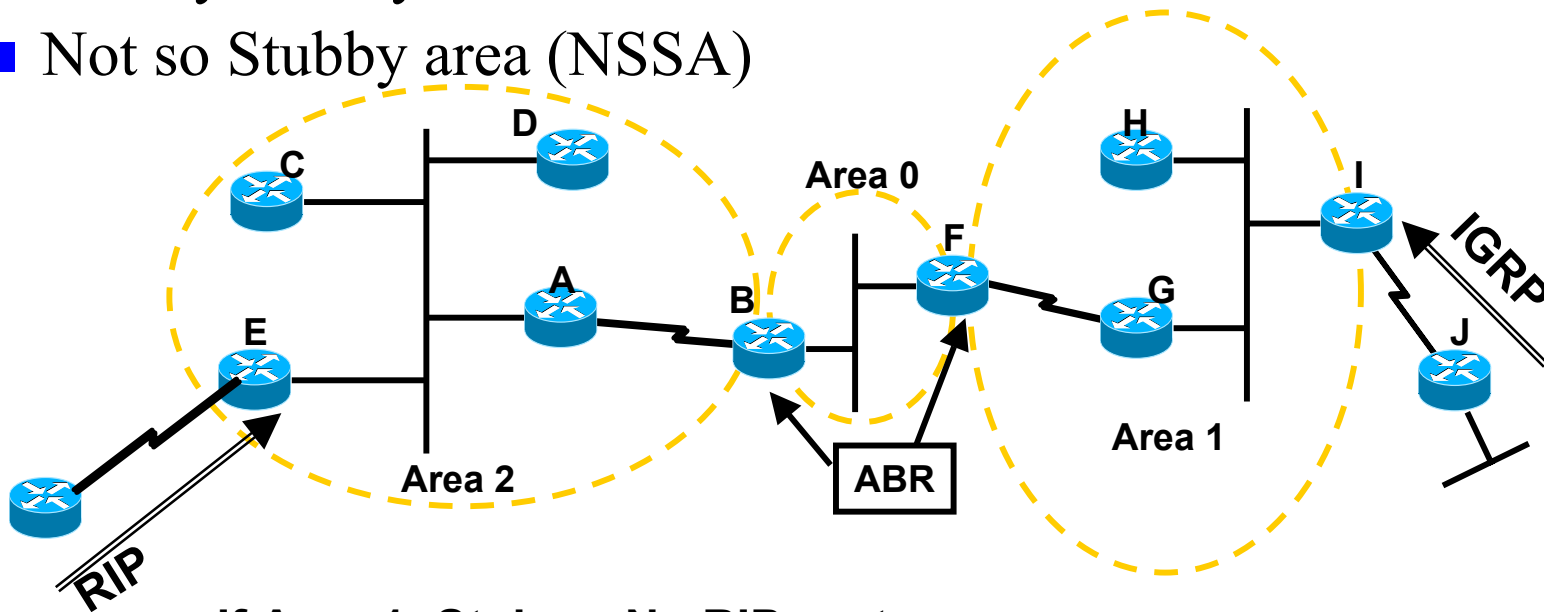
# Autonomous System Boundary Router (ASBR)

- Routes redistributed into OSPF are considered external
  - It could be directly connected, static or IGP routes
  - Router that redistributes these into OSPF area called ASBR
  - ASBR generates **external LSA (Type 5)** for each network
  - These routes are external routes, '**O E2**' or '**O E1**'
  - In E1 we add internal cost, in E2 we don't



# OSPF Types of Areas

- **Normal Area:** Contains intra-area routes, summary routes for other areas, and external routes
- **Stub Area:** Contains only intra-area & summary routes, but no external routes
- **Totally Stubby area:** Contains only intra-area routes. no summary, no external routes.
- **Not so Stubby area (NSSA)**



If Area 1: Stub => No RIP routes

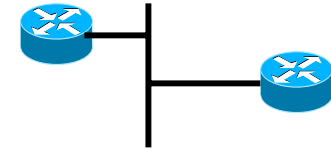
If Area 1: Totally Stubby Area => No RIP or Area 2 Routes

If Area 1: NSSA => IGRP information will be passed via Area 1

# OSPF Network Types

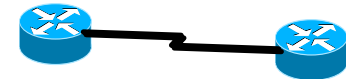
## ■ Broadcast

- ⊗ on by default on broadcast media (ethernet, token ring etc)



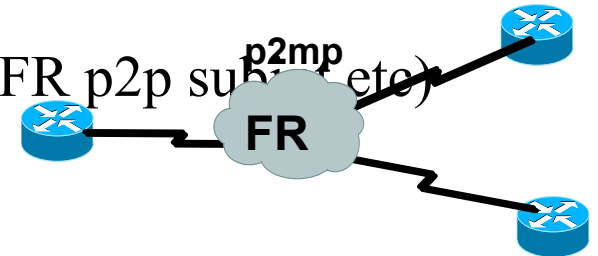
## ■ Point-to-point

- ⊗ on by default on p2p link (HDLC, FR p2p sub, etc)



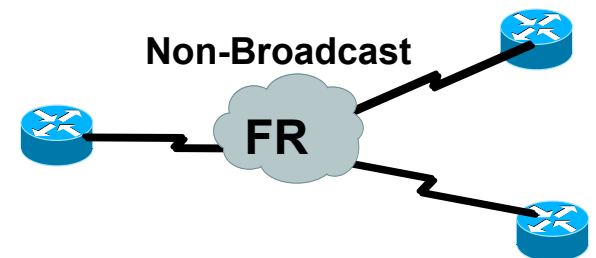
## ■ Point-to-multipoint

- ⊗ recommended on non-fully meshed frame-relay



## ■ Non-Broadcast

- ⊗ requires neighbor configuration



# Advantages of OSPF

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- Classless
- Fast convergence
- Supports VLSM
- IETF standard, non proprietary
- Ideal for large networks

# Where and How to learn more

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- Interconnections Second Edition by Radia Perlman
- Cisco Connection Online <http://www.cisco.com>
- Do the routing labs – use ZEBRA if you do not have a Cisco router