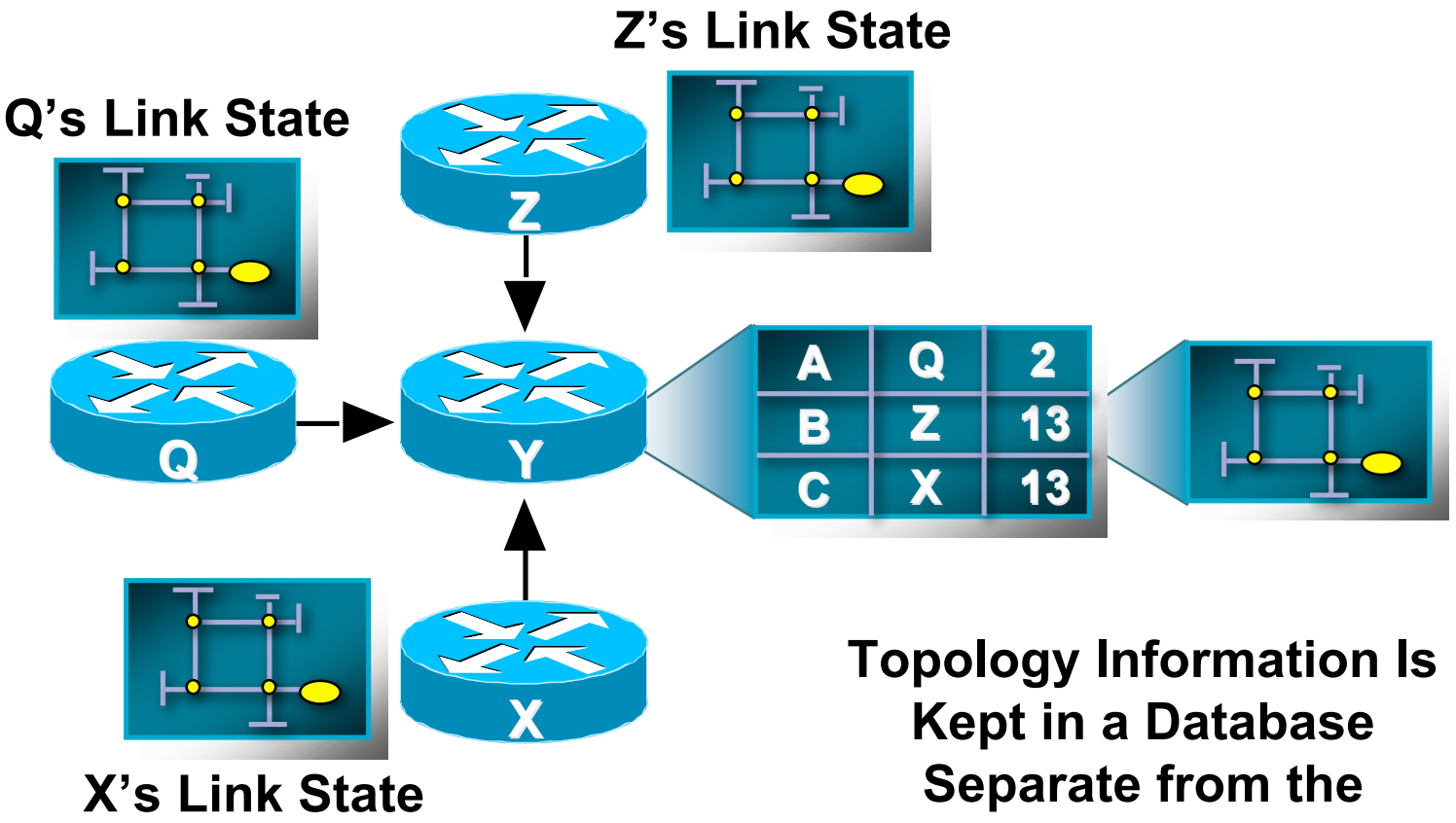
Introduction to OSPF

ISP/IXP Workshops

OSPF

- Open Shortest Path First
- Link state or SPF technology
- Developed by OSPF working group of IETF (RFC 1247)
- Designed for TCP/IP Internet environment
- Fast convergence
- Variable-length subnet masks
- Discontiguous subnets
- No periodic updates
- Route authentication
- OSPF standard described in RFC2328

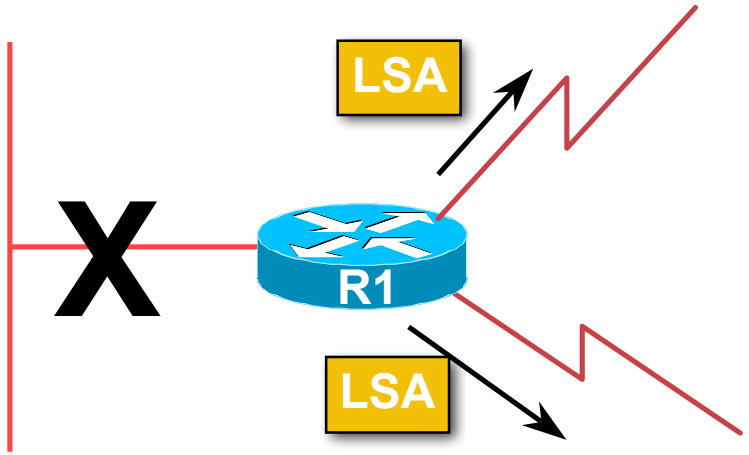
Link State



Link State Routing

- Neighbour discovery
- Constructing a Link State Packet (LSP)
- Distribute the LSP
  - (Link State Announcement – LSA)
- Compute routes
- On network failure
  - New LSPs flooded
  - All routers recompute routing tables

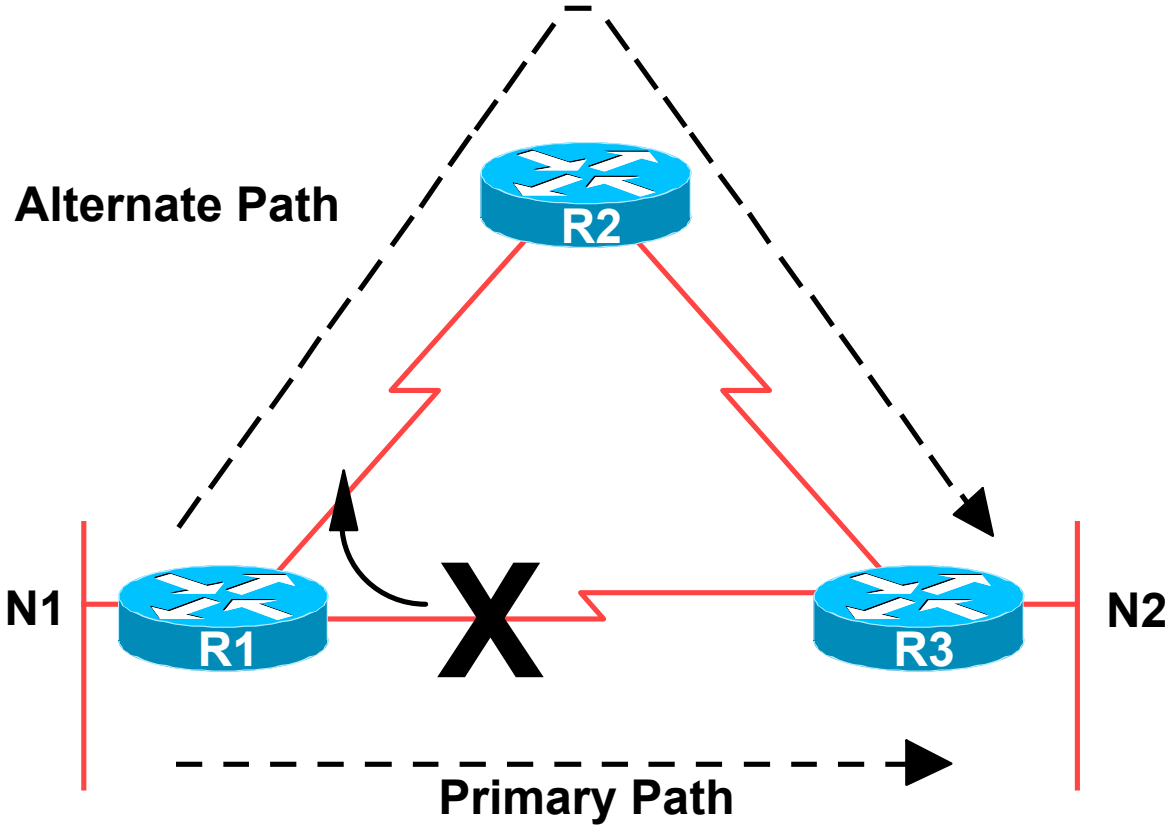
Low Bandwidth Utilisation



- **Only changes propagated**
- **Multicast on multi-access broadcast networks**

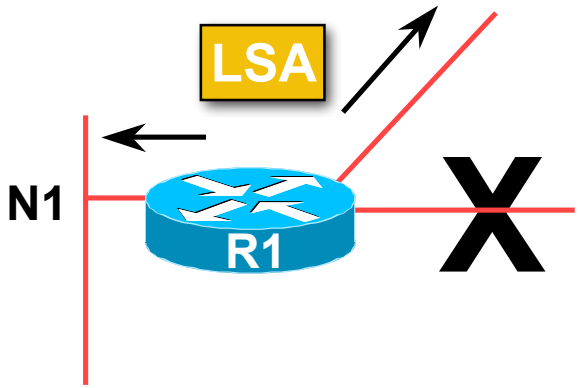
Fast Convergence

- **Detection Plus LSA/SPF**



Fast Convergence

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



IP Multicast for Sending/Receiving Updates

- **Broadcast networks**

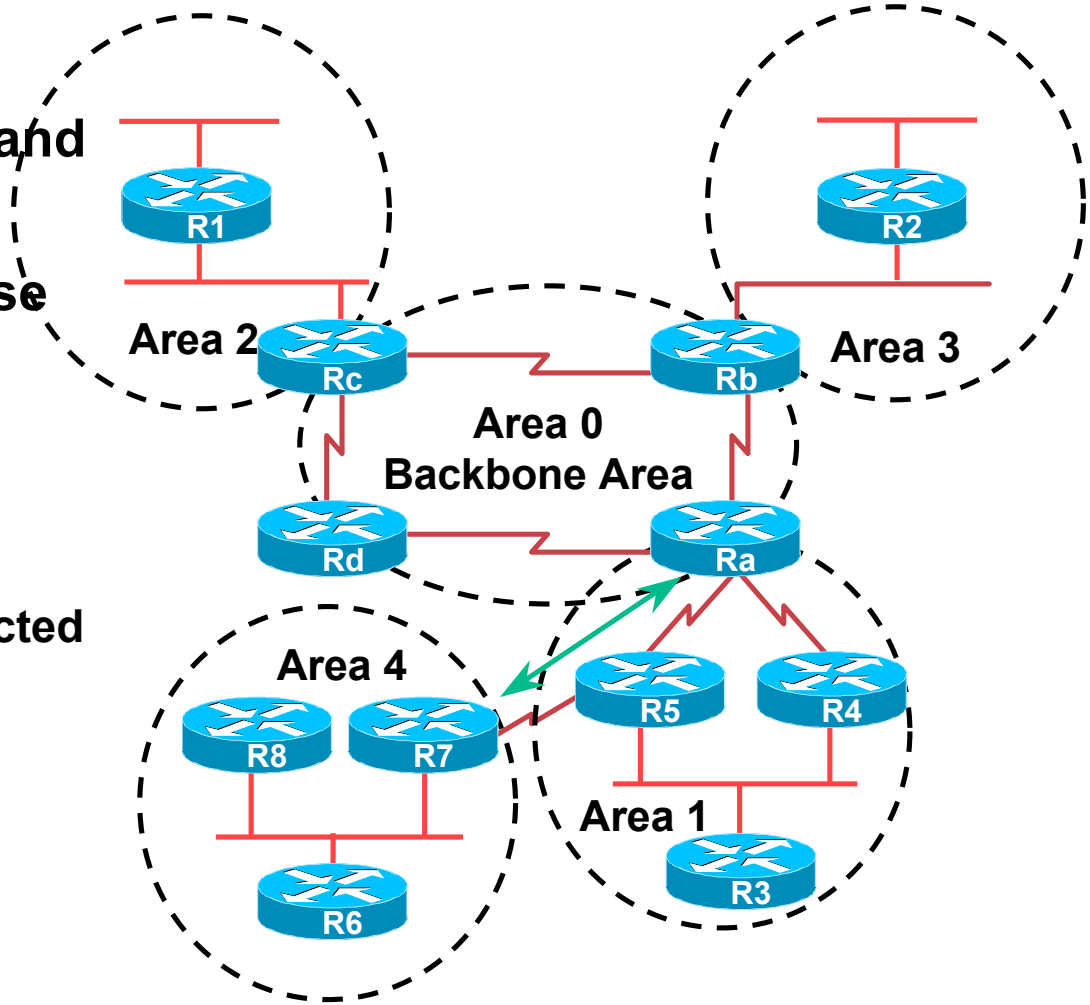
  All routers must accept packets sent to AllSPFRouters (224.0.0.5)

  All DR and BDR routers must accept packets sent to AllDRouters (224.0.0.6)

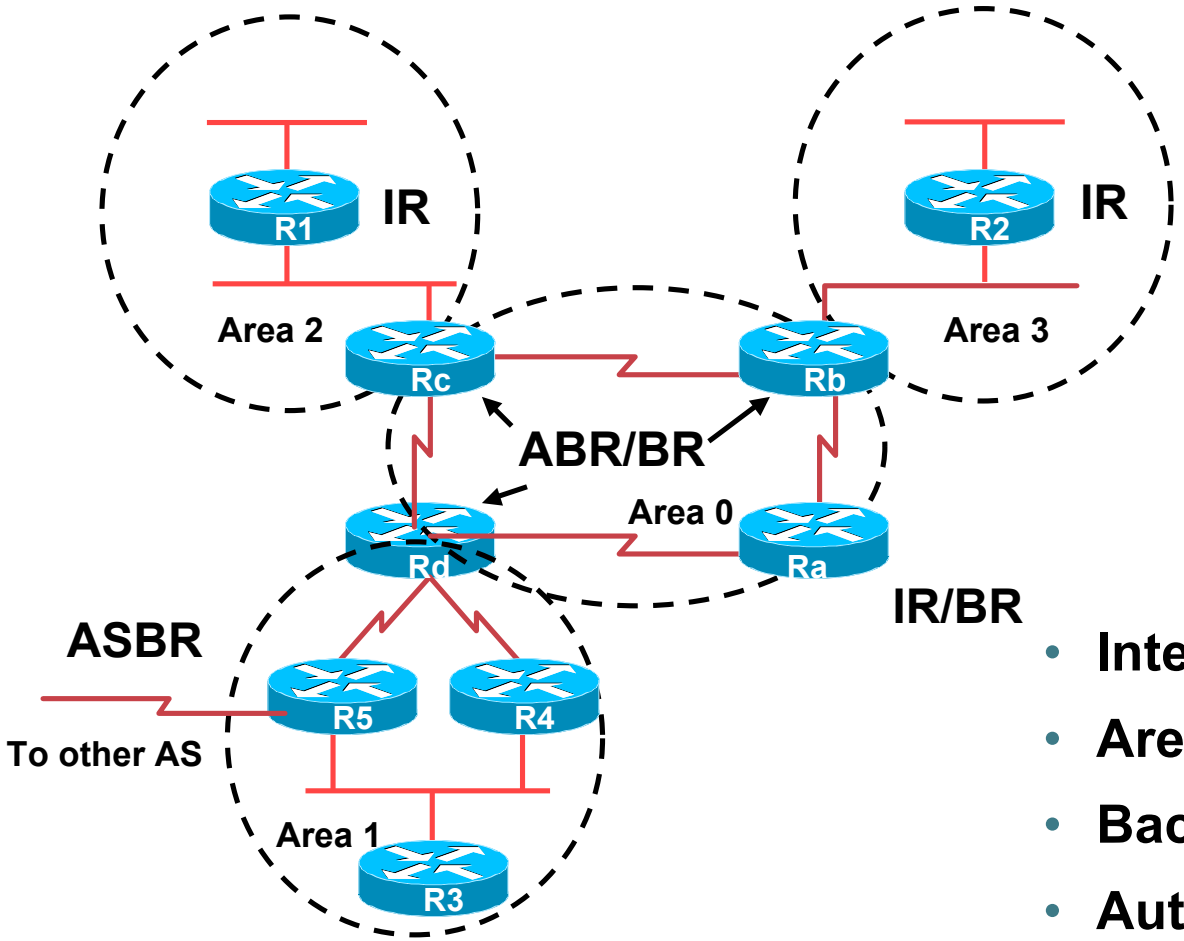
- **Hello packets sent to AllSPFRouters (Unicast on point-to-point and virtual links)**

OSPF Areas

- Group of contiguous hosts and networks
- Per area topological database
  - Invisible outside the area
  - Reduction in routing traffic
- Backbone area contiguous
  - All other areas must be connected to the backbone
- Virtual Links

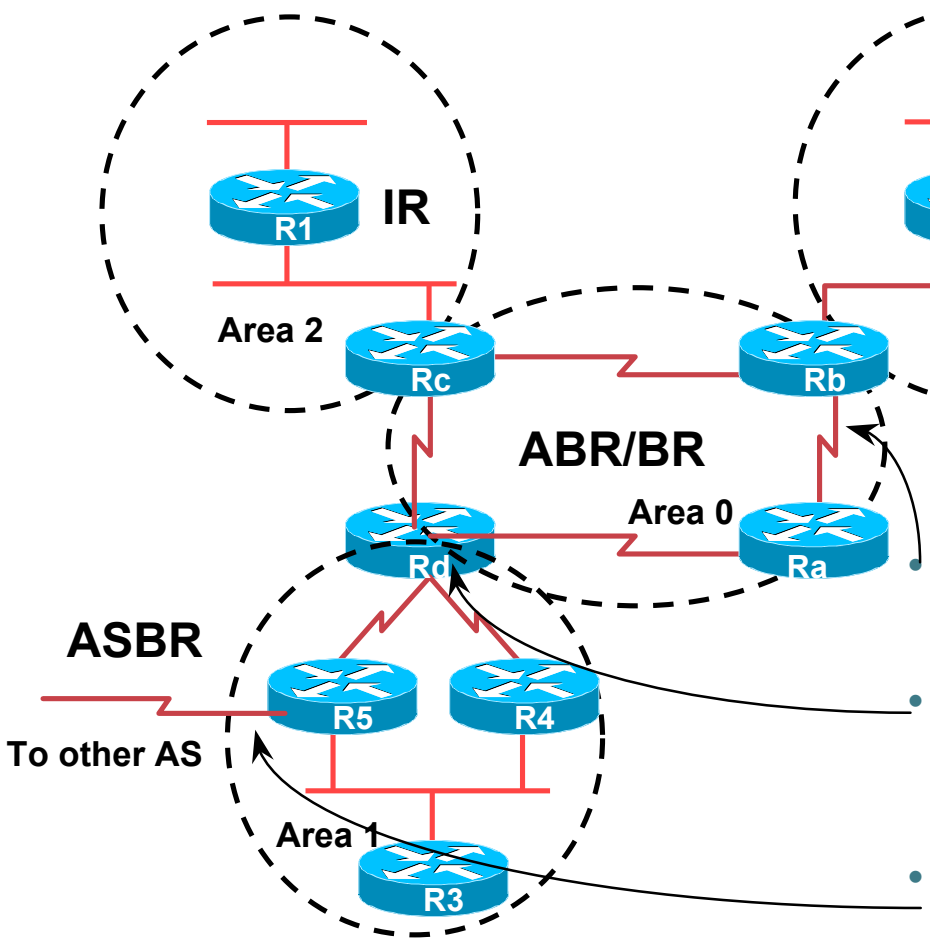


Classification of Routers



- Internal Router (IR)
- Area Border Router (ABR)
- Backbone Router (BR)
- Autonomous System Border Router (ASBR)

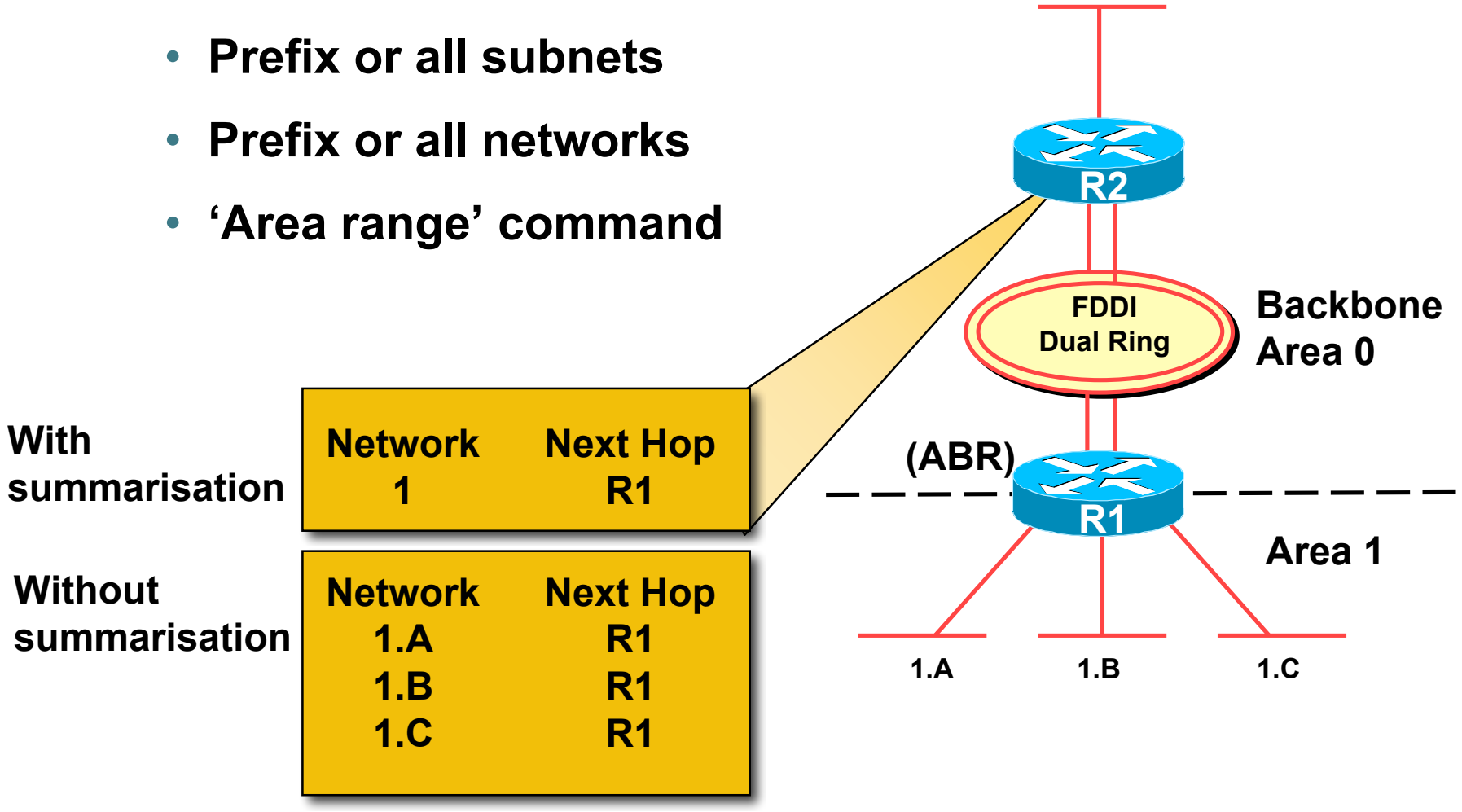
OSPF Route Types



- **Intra-area Route**
  - all routes inside an area
- **Inter-area Route**
  - routes advertised from one area to another by an Area Border Router
- **External Route**
  - routes imported into OSPF from other protocol or static routes

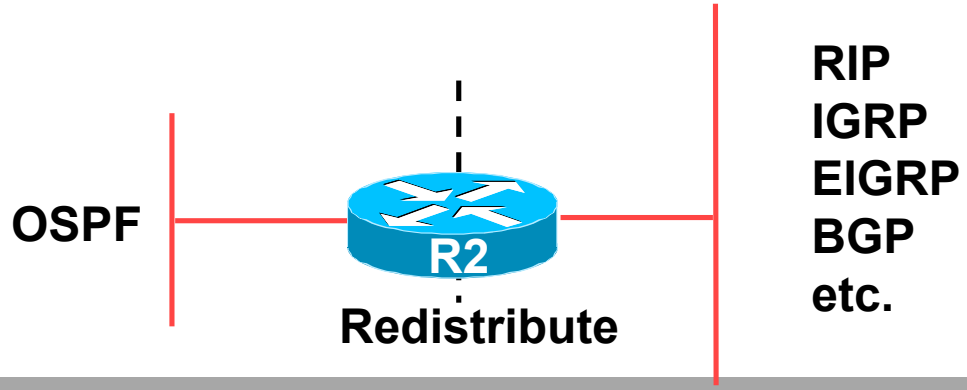
Inter-Area Route Summarisation

- Prefix or all subnets
- Prefix or all networks
- ‘Area range’ command



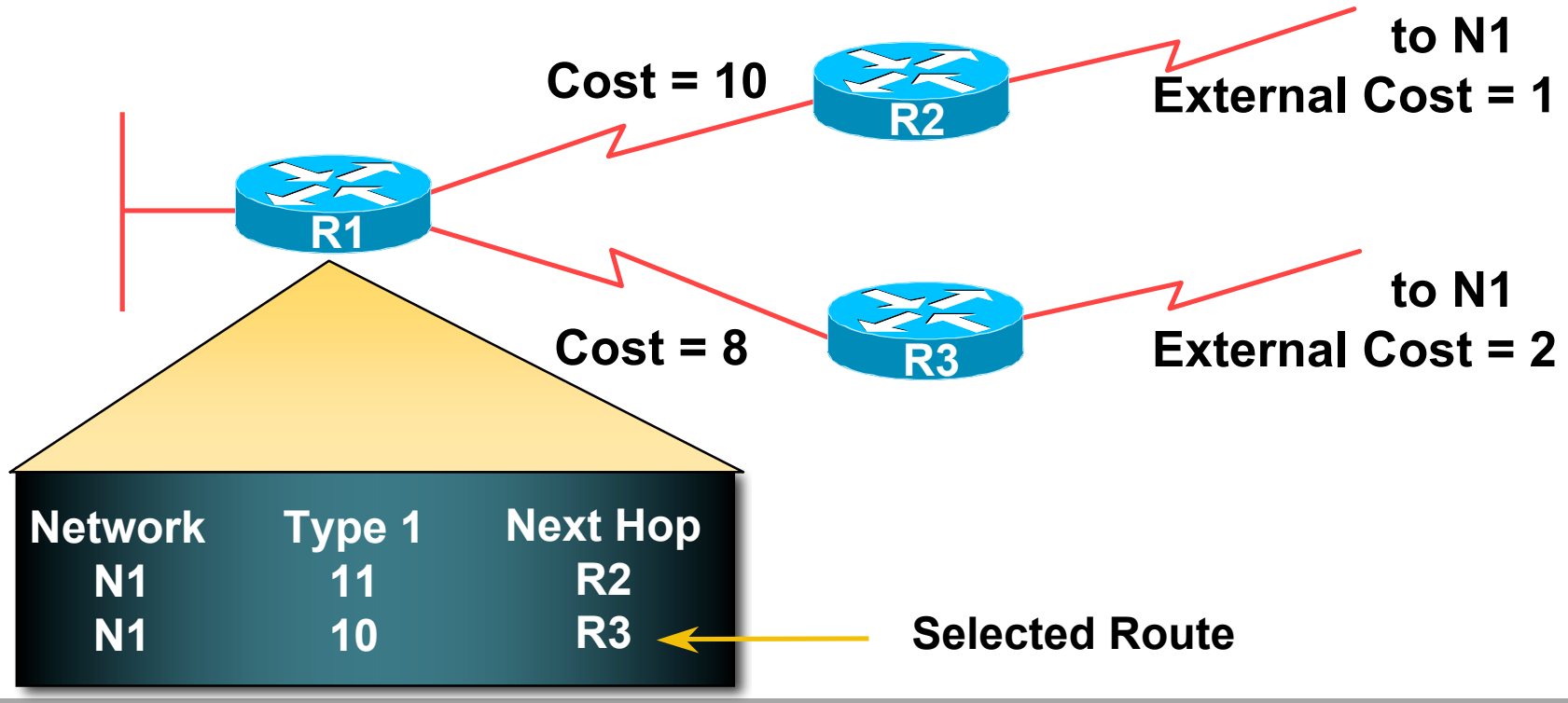
External Routes

- **Prefixes which are redistributed into OSPF from other protocols**
- **Flooded unaltered throughout the AS**
- **OSPF supports two types of external metrics**
  - **Type 1 external metrics**
  - **Type 2 external metrics (Default)**



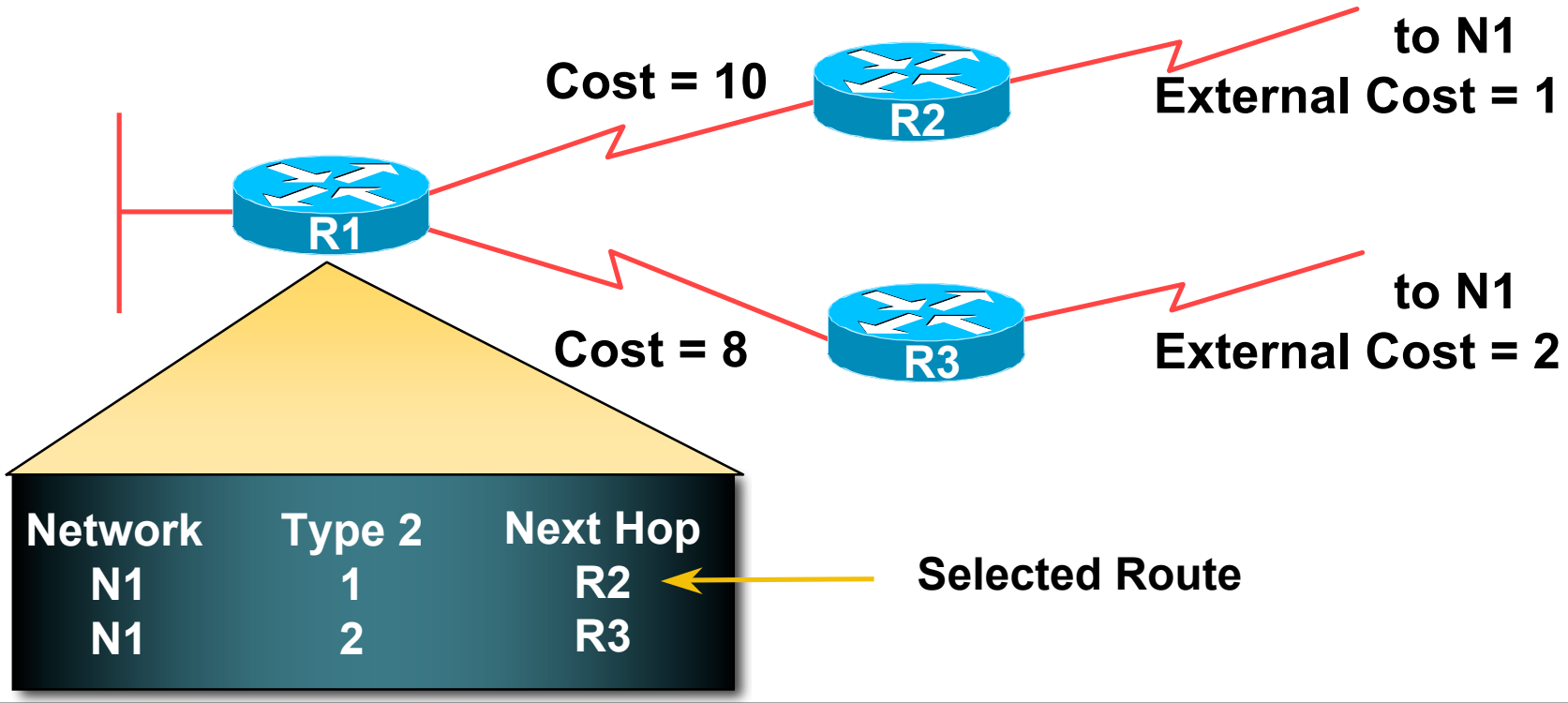
External Routes

- **Type 1 external metric: metrics are added to the summarised internal link cost**



External Routes

- **Type 2 external metric: metrics are compared without adding to the internal link cost**



Topology/Link State Database

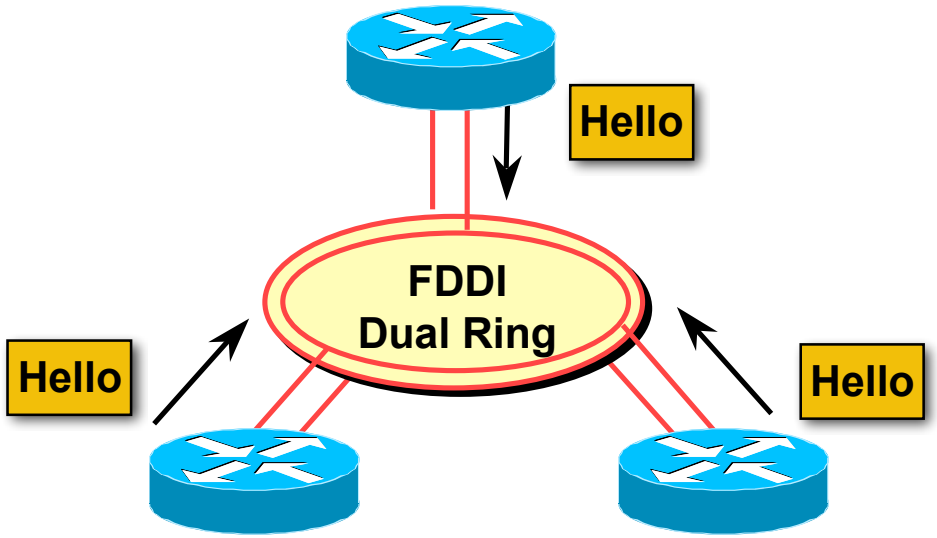
- A router has a separate LS database for each area to which it belongs
- All routers belonging to the same area have identical database
- SPF calculation is performed separately for each area
- LSA flooding is bounded by area

Protocol Functionality

- **Bringing up adjacencies**
- **LSA types**
- **Area classification**

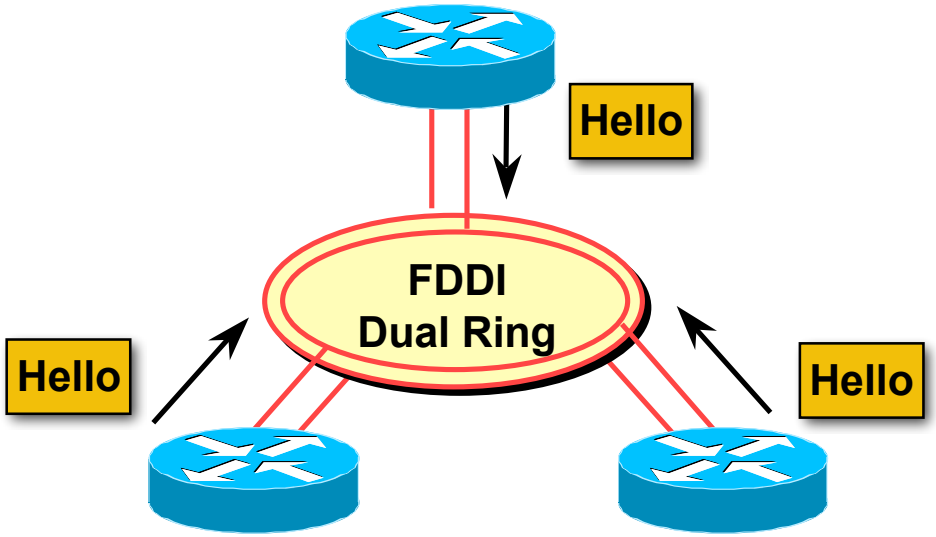
The Hello Protocol

- **Responsible for establishing and maintaining neighbour relationships**
- **Elects designated router on multi-access networks**



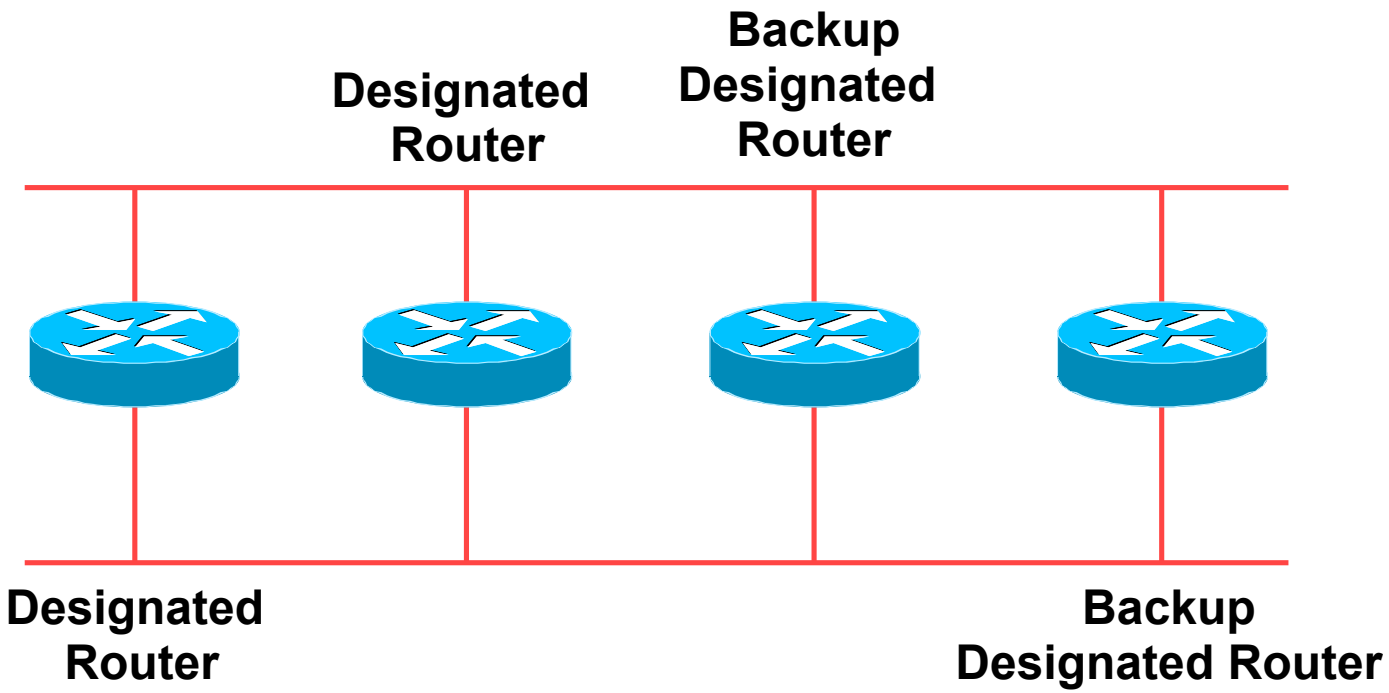
The Hello Packet

- Router priority
- Hello interval
- Router dead interval
- Network mask
- Options: T-bit, E-bit
- List of neighbours



Designated Router

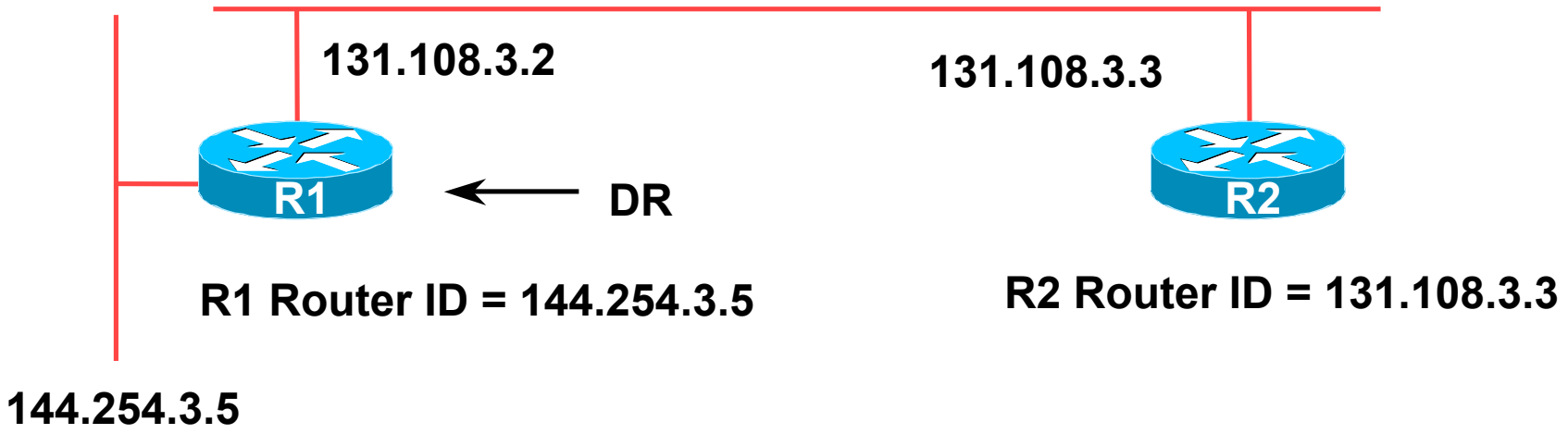
- There is ONE designated router per multi-access network
  - Generates network link advertisements
  - Assists in database synchronization



Designated Router by Priority

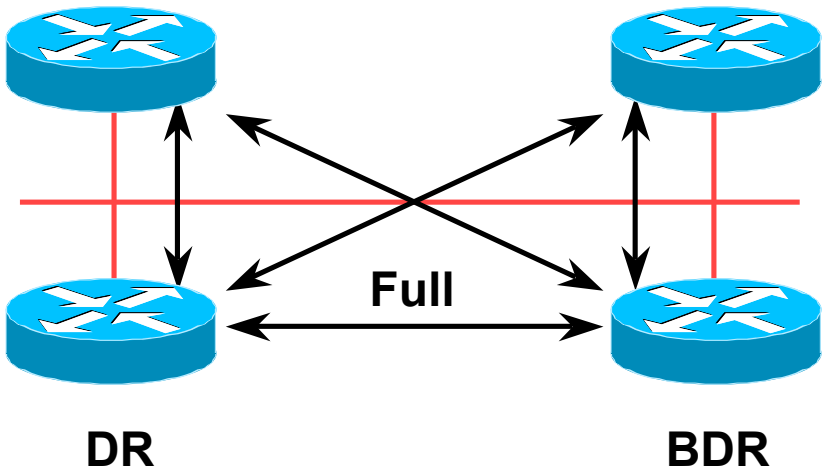
- **Configured priority (per interface)**
- **Else determined by highest router ID**

  Router ID is the loopback interface address, if configured, otherwise the highest IP address



Neighbouring States

- **Full**
  - **Routers are fully adjacent**
  - **Databases synchronised**
  - **Relationship to DR and BDR**

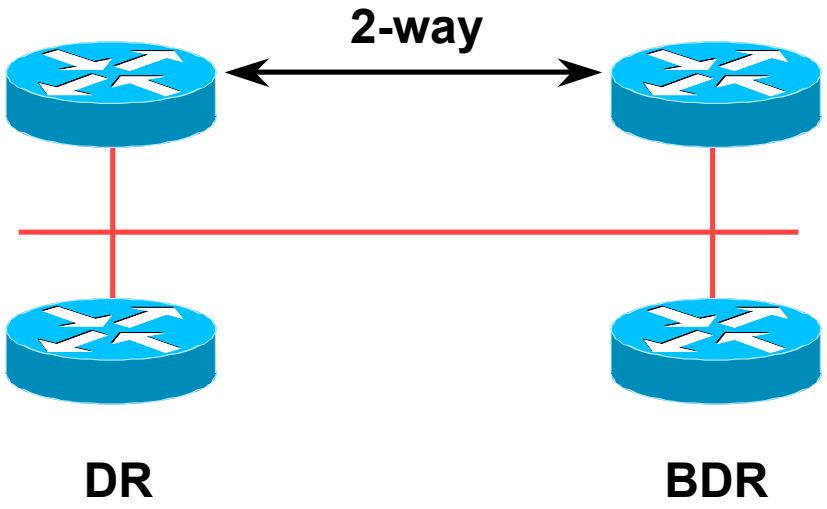


Neighbouring States

- **2-way**

  Router sees itself in other Hello packets

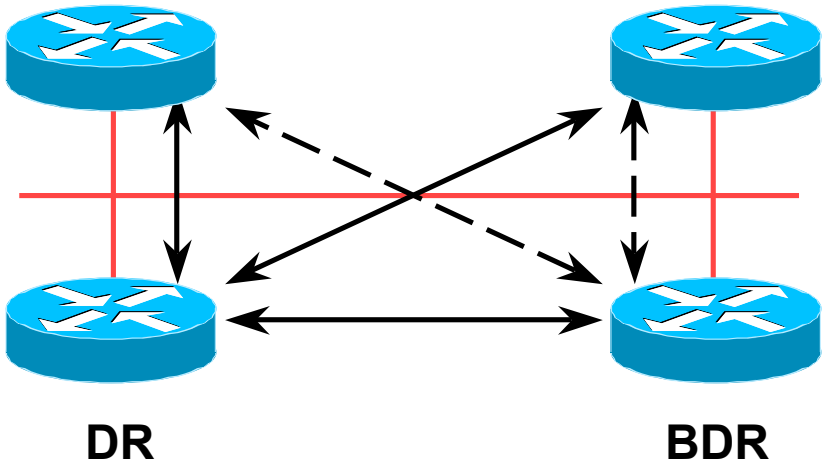
  DR selected from neighbours in state 2-way or greater



When to Become Adjacent

- Underlying network is point to point
- Underlying network type is virtual link
- The router itself is the designated router
- The router itself is the backup designated router
- The neighbouring router is the designated router
- The neighbouring router is the backup designated router

LSAs Propagate Along Adjacencies



- **LSAs acknowledged along adjacencies**

Routing Protocol Packets

- Share a common protocol header
- Routing protocol packets are sent with type of service (TOS) of 0
- Five types of OSPF routing protocol packets
  - Hello – packet type 1
  - Database description – packet type 2
  - Link-state request – packet type 3
  - Link-state update – packet type 4
  - Link-state acknowledgement – packet type 5

Different Types of LSAs

- **Four distinct type of LSAs**
  - **Type 1 : Router LSA**
  - **Type 2 : Network LSA**
  - **Type 3 and 4: Summary LSA**
  - **Type 5 and 7: External LSA**

Router LSA (Type 1)

- Describes the state and cost of the router's links to the area
- All of the router's links in an area must be described in a single LSA
- Flooded throughout the particular area and no more
- Router indicates whether it is an ASBR, ABR, or end point of virtual link

Network LSA (Type 2)

- Generated for every transit broadcast and NBMA network
- Describes all the routers attached to the network
- Only the designated router originates this LSA
- Flooded throughout the area and no more

Summary LSA (Type 3 and 4)

- Describes the destination outside the area but still in the AS
- Flooded throughout a single area
- Originated by an ABR
- Only inter-area routes are advertised into the backbone
- Type 4 is the information about the ASBR

External LSA (Type 5 and 7)

- Defines routes to destination external to the AS
- Default route is also sent as external
- Two types of external LSA:

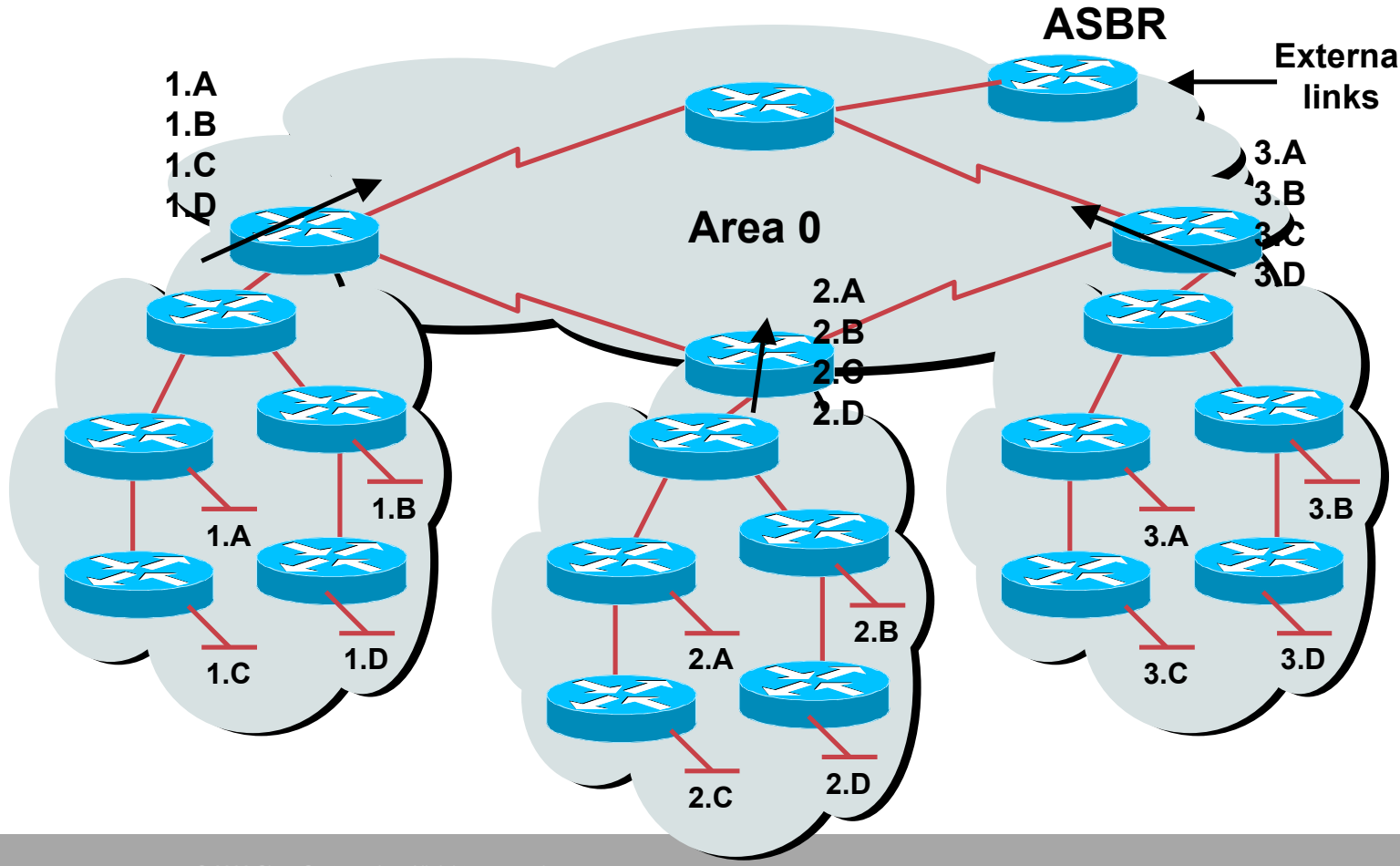
  E1: Consider the total cost up to the external destination

  E2: Considers only the cost of the outgoing interface to the external destination

- (Type 7 LSAs used to describe external LSA for one specific OSPF area type)

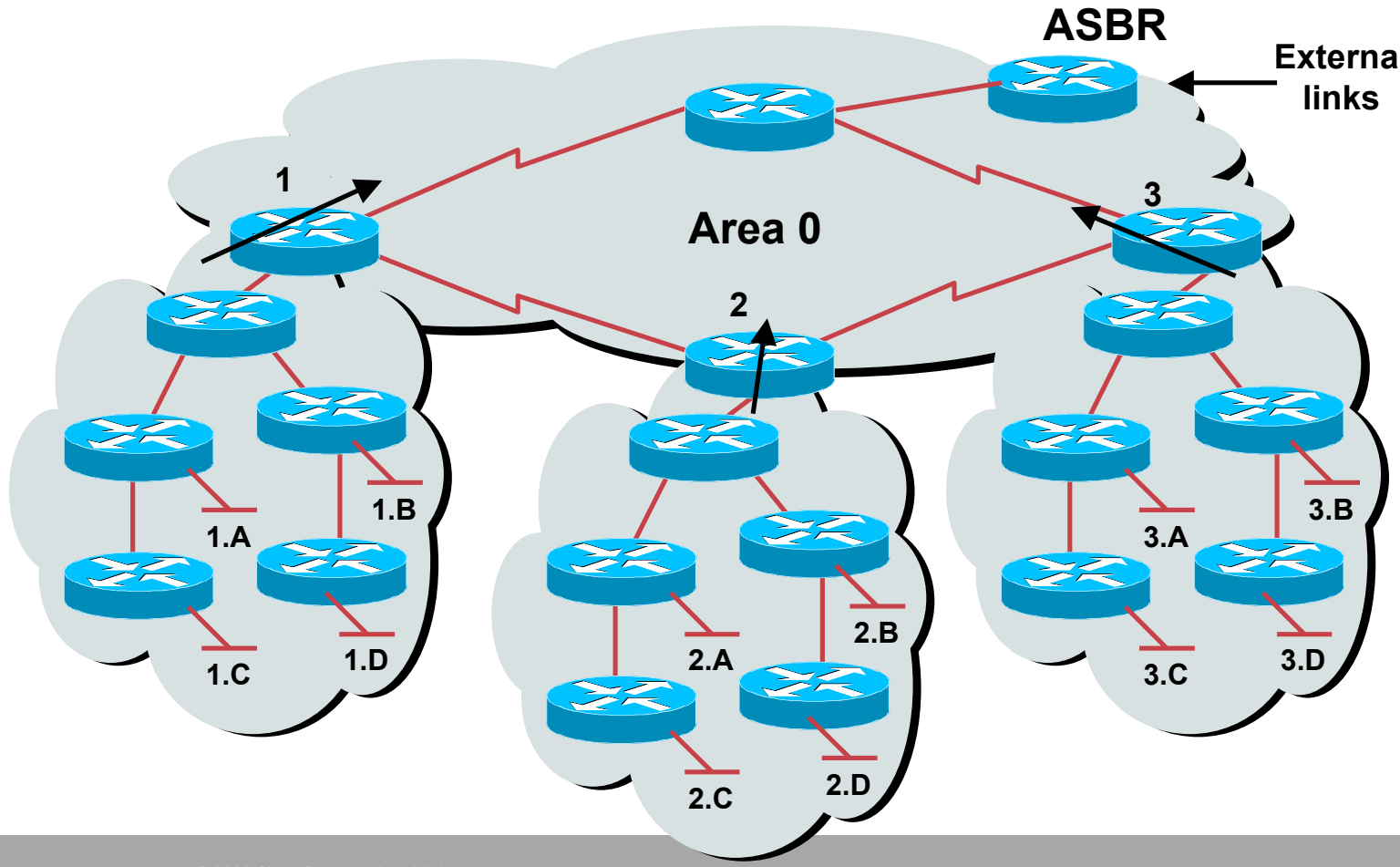
No Summarisation

- Specific Link LSA advertised out of each area
- Link state changes propagated out of each area



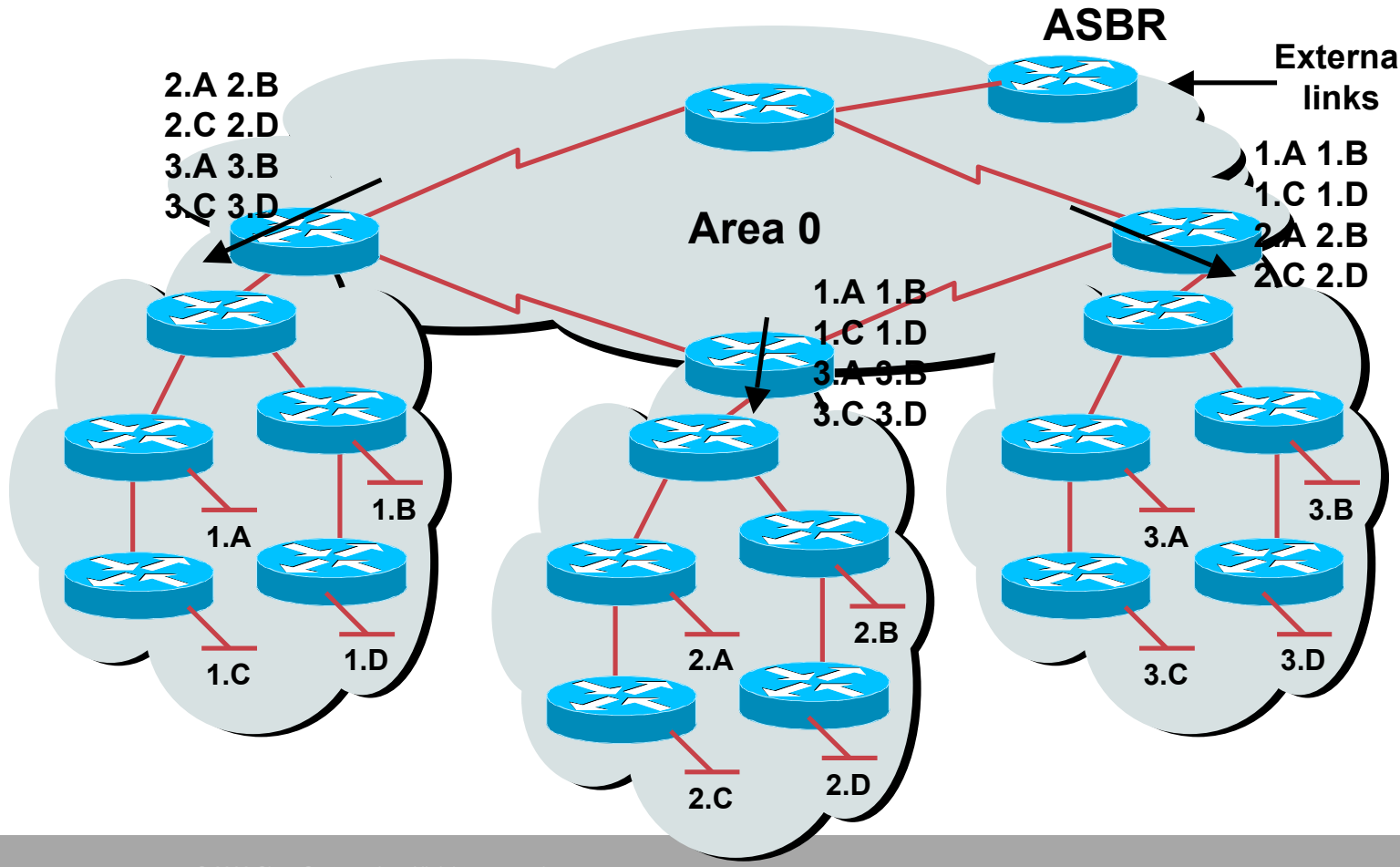
With Summarisation

- Only summary LSA advertised out of each area
- Link state changes do not propagate out of the area



No Summarisation

- Specific Link LSA advertised in to each area
- Link state changes propagated in to each area



With Summarisation

- Only summary link LSA advertised in to each area
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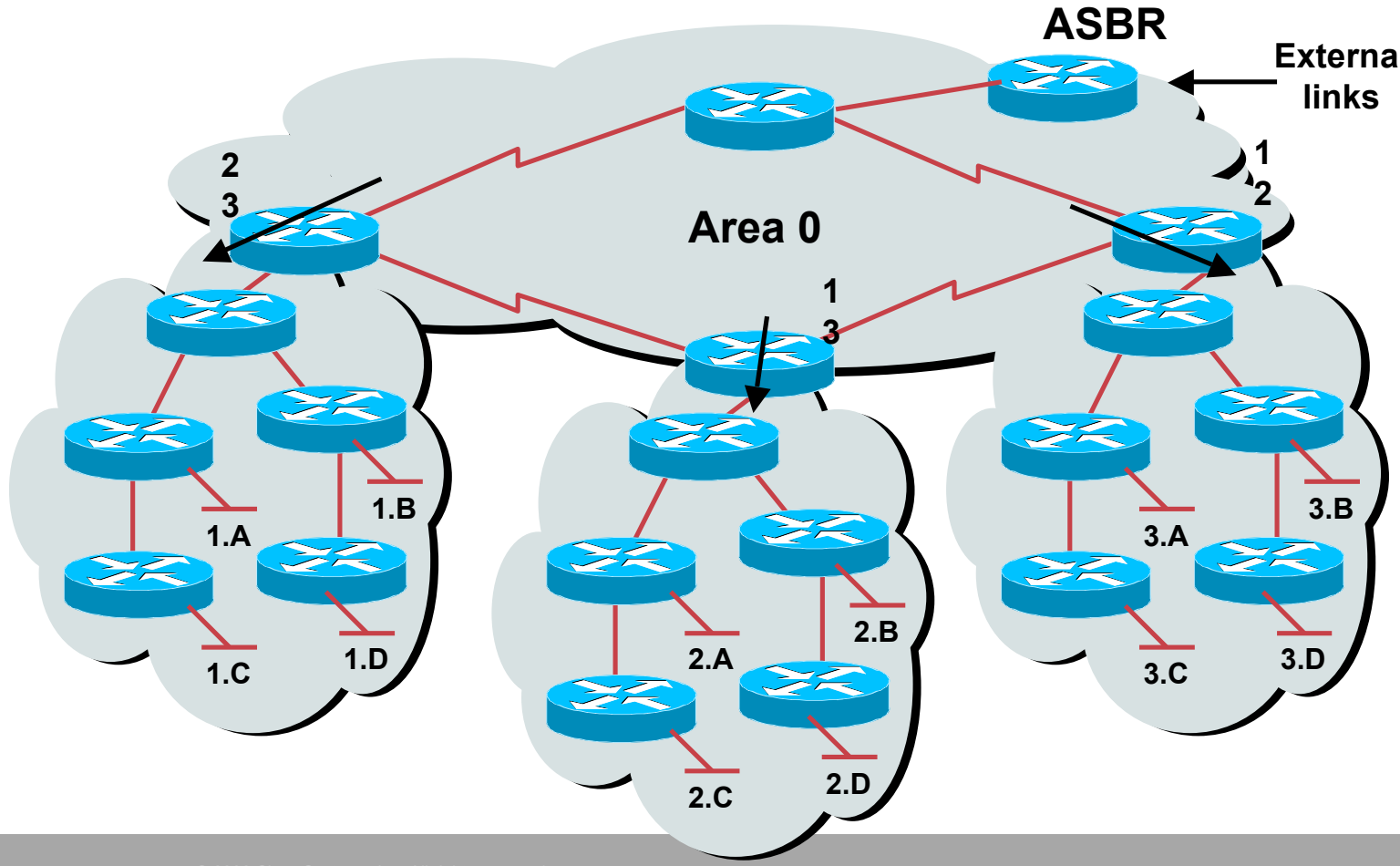
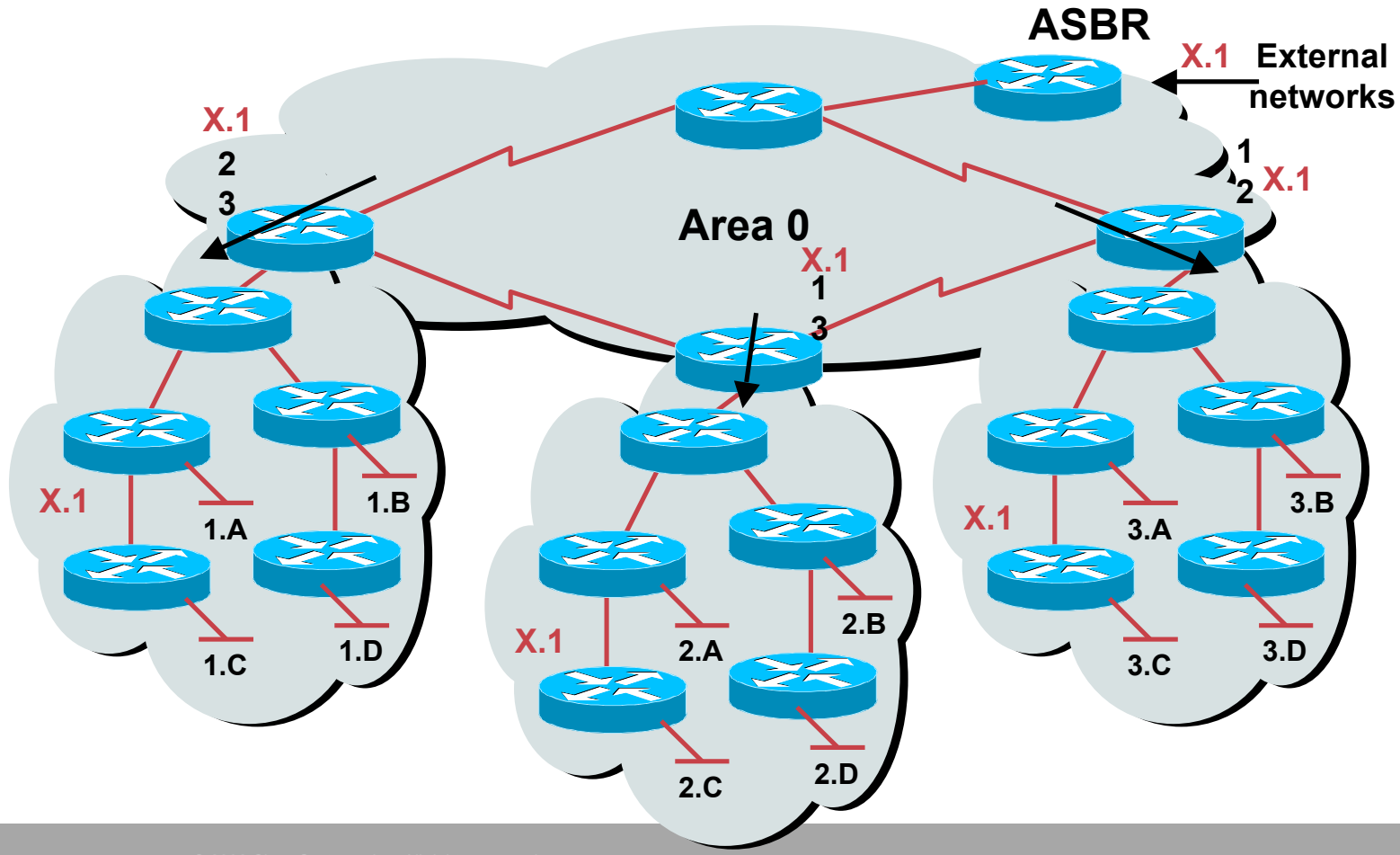


Types of Areas

- **Regular**
- **Stub**
- **Totally Stubby**
- **Not-So-Stubby**

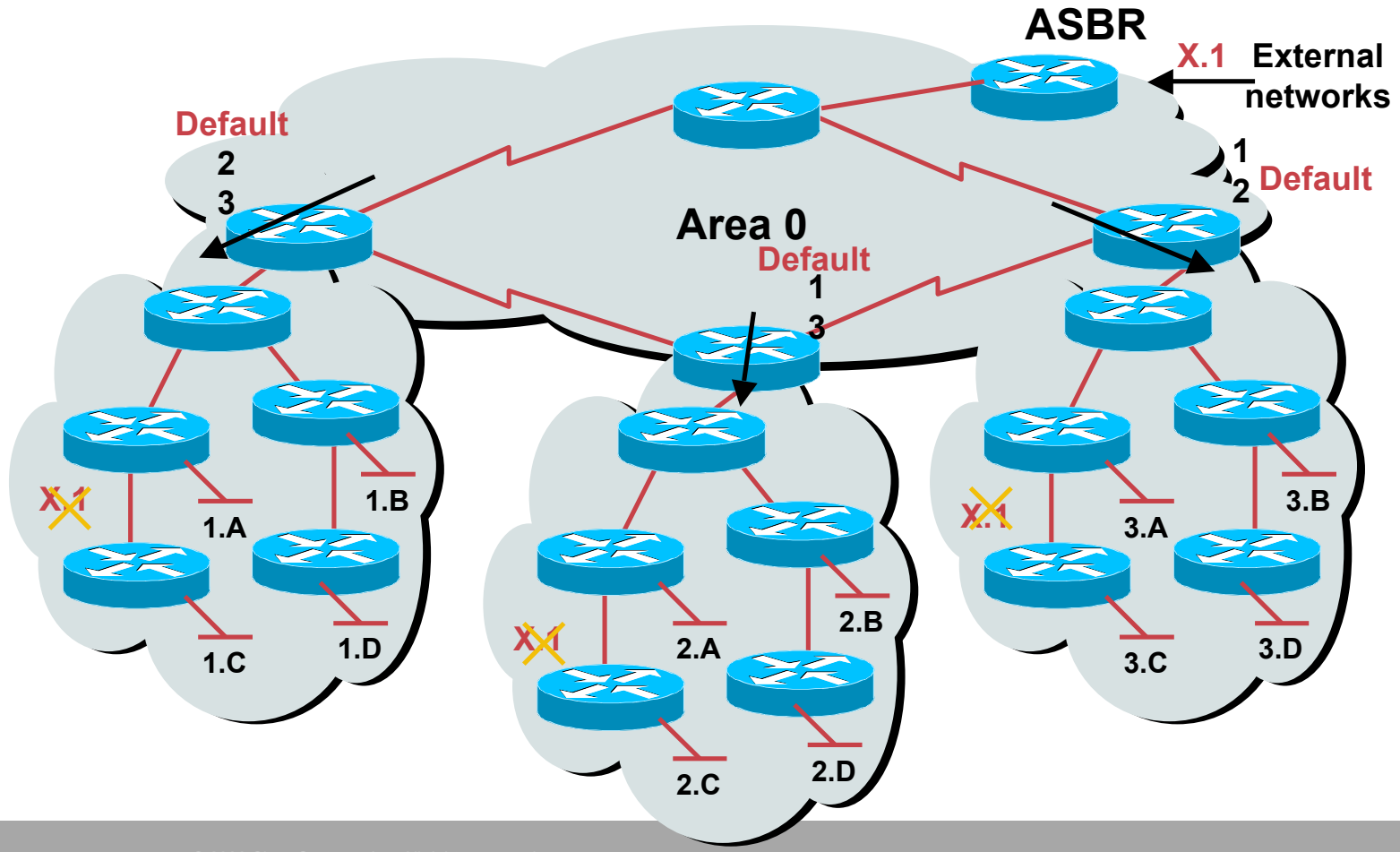
Regular Area (Not a Stub)

- **From Area 1's point of view, summary networks from other areas are injected as are external networks such as X.1**



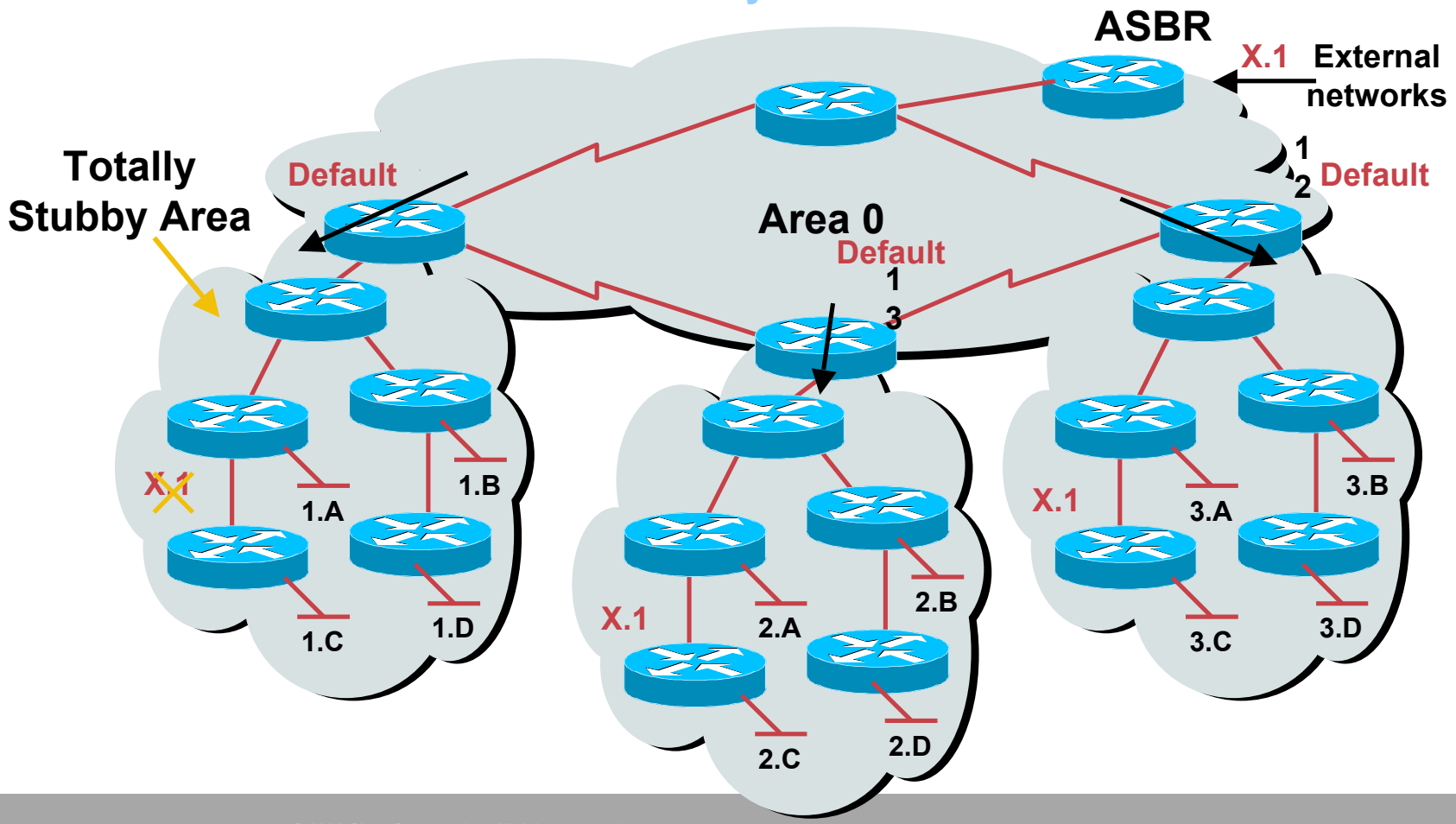
Normal Stub Area

- Summary networks, default route injected
- Command is area x stub



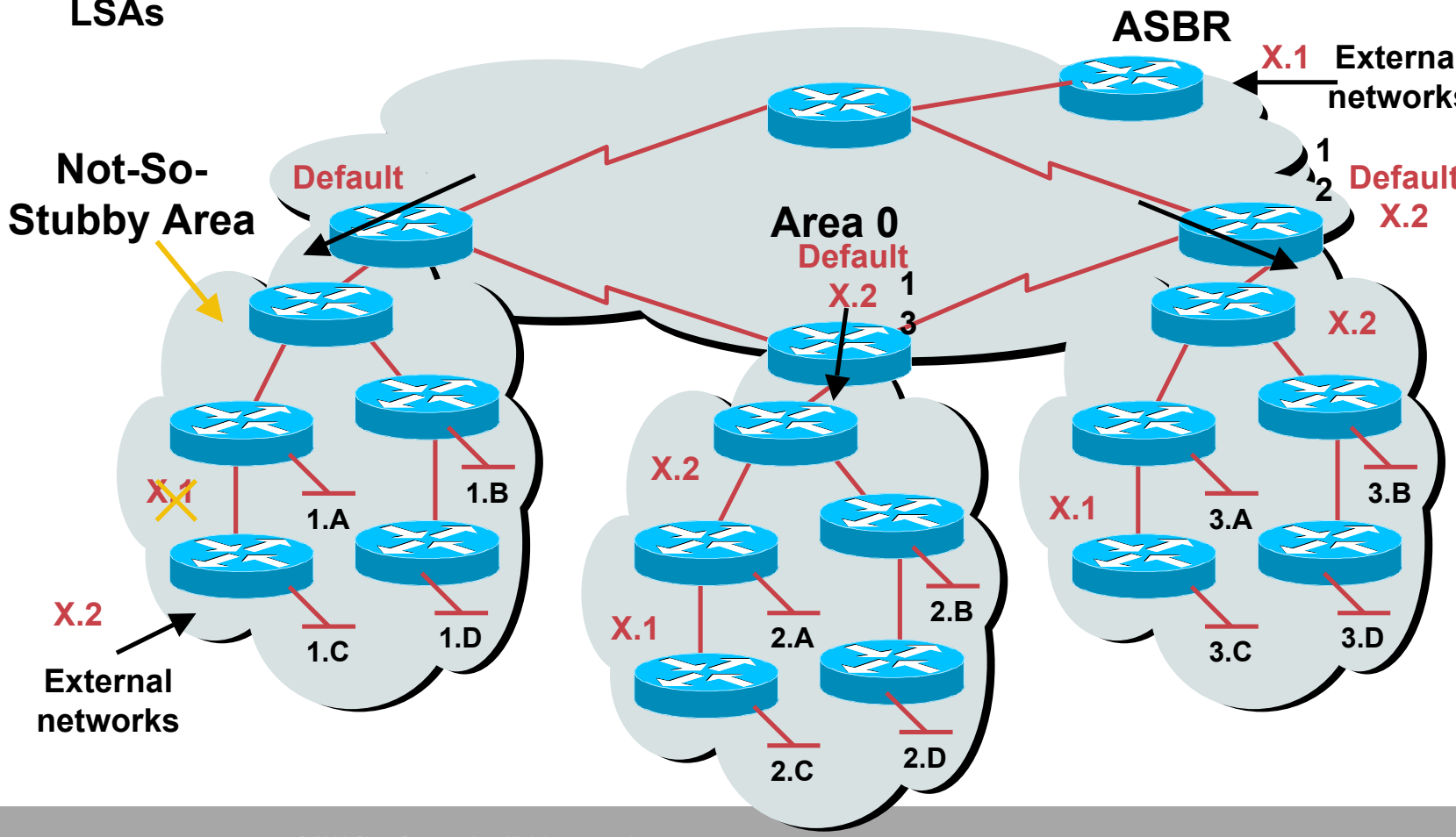
Totally Stubby Area

- Only a default route injected
  - Default path to closest area border router
- Command is area x stub no-summary

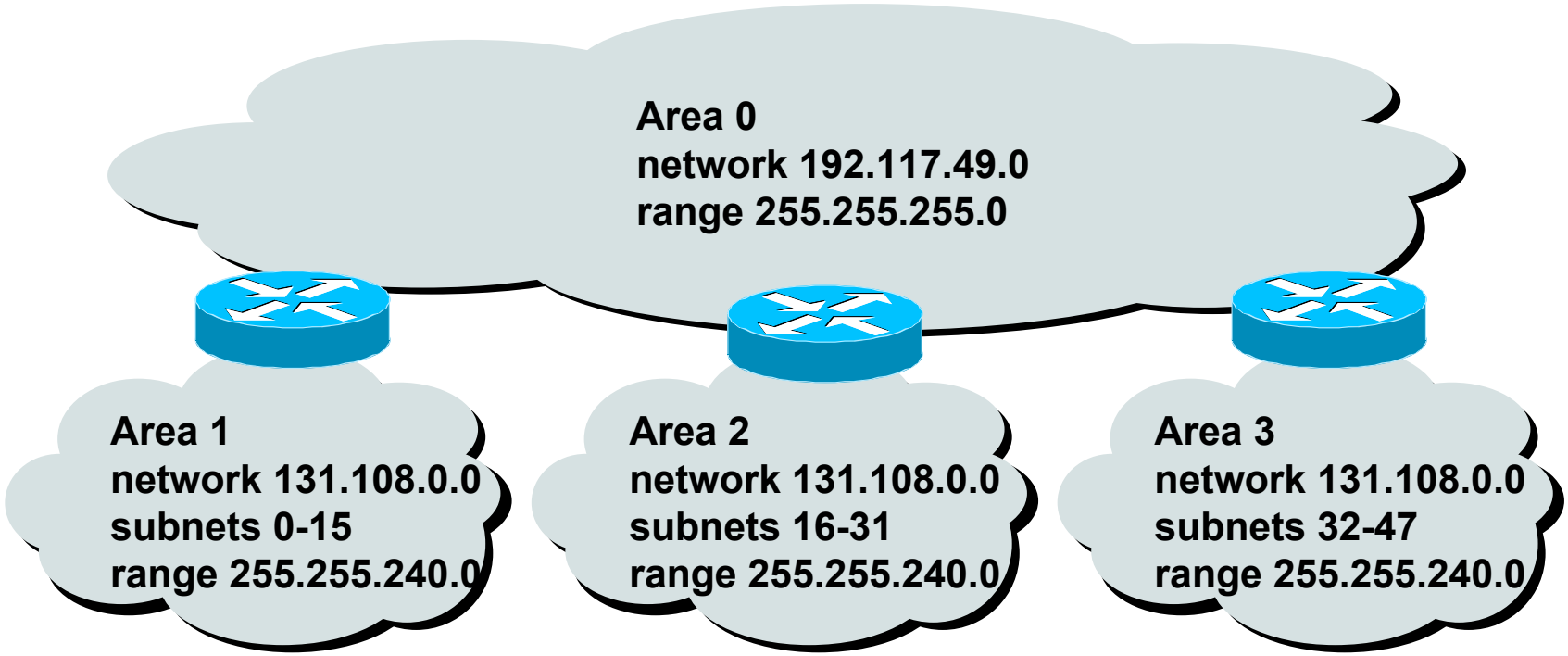


Not-So-Stubby Area

- Capable of importing routes in a limited fashion
- Type-7 LSA's carry external information within an NSSA
- NSSA Border routers translate selected type-7 LSAs into type-5 external network LSAs



Addressing for Areas



Assign contiguous ranges of subnets per area to facilitate summarisation

Summary

- **Scalable OSPF Network Design**
  - **Area hierarchy**
  - **Stub areas**
  - **Contiguous addressing**
  - **Route summarisation**

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