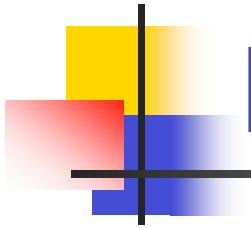
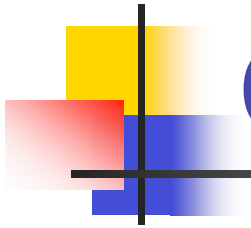
Introduction to OSPF

Nishal Goburdhan



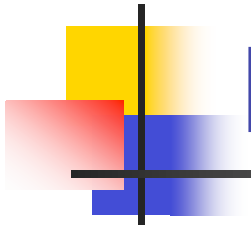
Routing and Forwarding

- Routing is not the same as Forwarding
- Routing is the building of maps
  - Each routing protocol usually has its own routing database
  - Routing protocols populate the forwarding table
- Forwarding is passing the packet to the next hop device
  - Forwarding table contains the best path to the next hop for each prefix
  - There is only ONE forwarding table



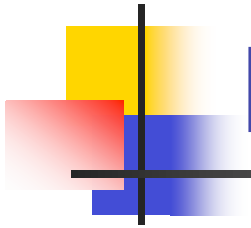
OSPF Background

- Developed by IETF – RFC1247
  - Designed for Internet TCP/IP environment
- OSPF v2 described in RFC2328/STD54
- OSPF v3 described in RFC2740 - IPv6
- Link state/Shortest Path First Technology
- Dynamic Routing
- Fast Convergence
- Route authentication



Link State Algorithm

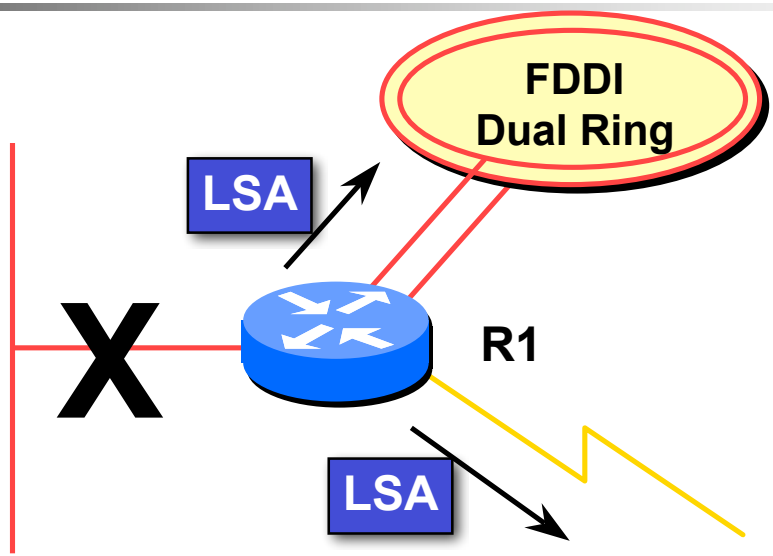
- Each router contains a database containing a map of the whole topology
  - Links
  - Their state (including cost)
- All routers have the same information
- All routers calculate the best path to every destination
- Any link state changes are flooded across the network
  - “Global spread of local knowledge”



Link State Routing

- Automatic neighbour discovery
  - Neighbours are physically connected routers
- Each router constructs a Link State Packet (LSP)
  - Distributes the LSP to neighbours…
  - …using an LSA (Link State Announcement)
- Each router computes its best path to every destination
- On network failure
  - New LSPs are flooded
  - All routers recompute routing table

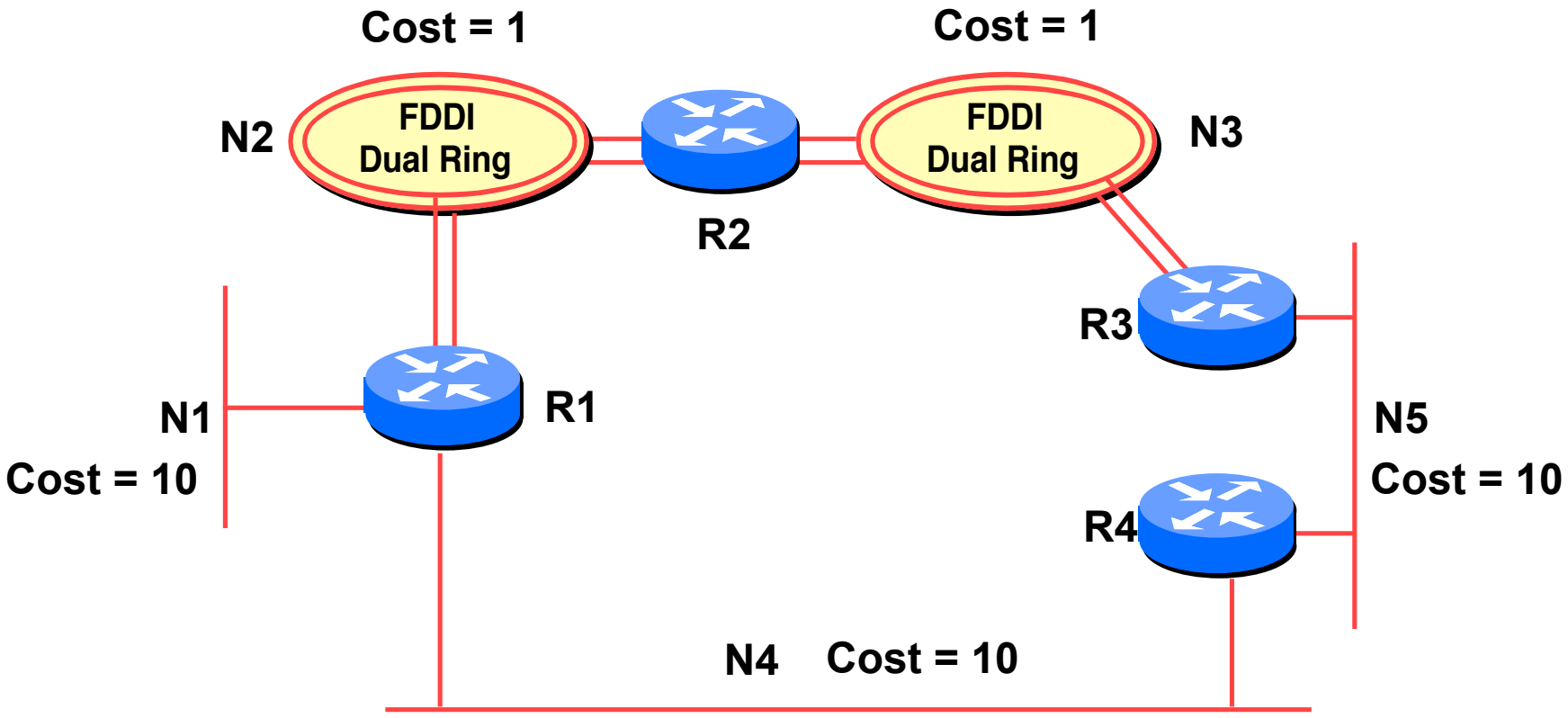
Low Bandwidth Requirements



- Only changes are propagated
- Multicast used on multi-access broadcast networks
  - 224.0.0.5 used for all OSPF speakers
  - 224.0.0.6 used for DR and BDR routers

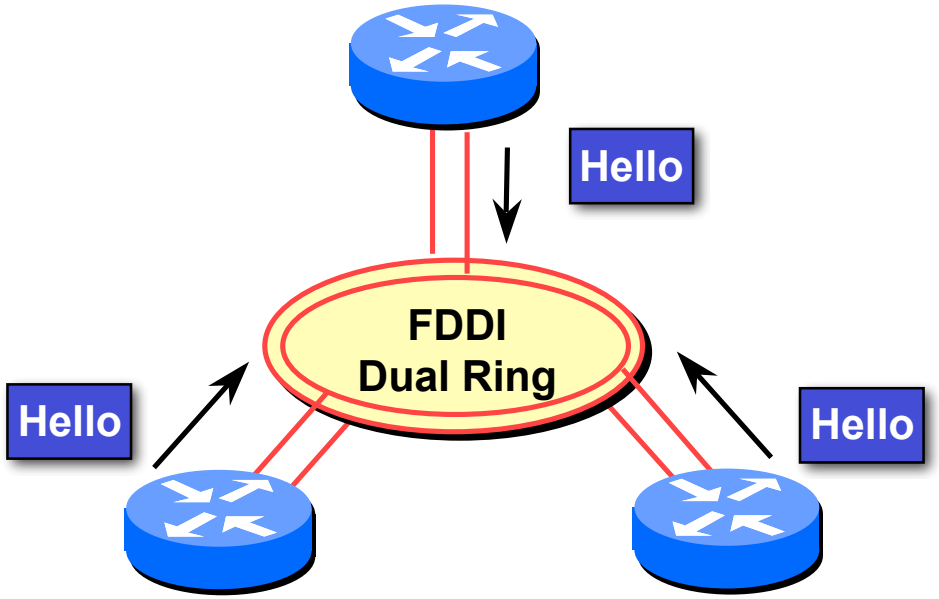
"Shortest Path First"

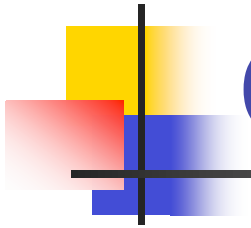
- The optimal path is determined by the sum of the interface costs



OSPF: How it works

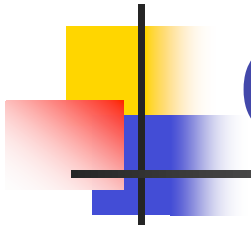
- Hello Protocol
  - Responsible for establishing and maintaining neighbour relationships
  - Elects Designated Router on broadcast networks





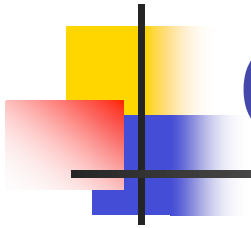
OSPF: How it works

- Hello Protocol
  - Hello Packets sent periodically on all OSPF enabled interfaces
  - Adjacencies formed between ***some*** neighbours
- Hello Packet
  - Contains information like Router Priority, Hello Interval, a list of known neighbours, Router Dead Interval, and the network mask



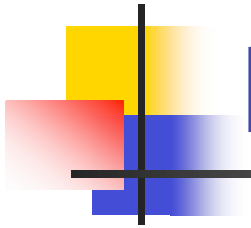
OSPF: How it works

- Trade Information using LSAs
  - LSAs are added to the OSPF database
  - LSAs are passed on to OSPF neighbours
- Each router builds an identical link state database
- SPF algorithm run on the database
- Forwarding table built from the SPF tree



OSPF: How it works

- When change occurs:
  - Announce the change to all OSPF neighbours
  - All routers run the SPF algorithm on the revised database
  - Install any change in the forwarding table

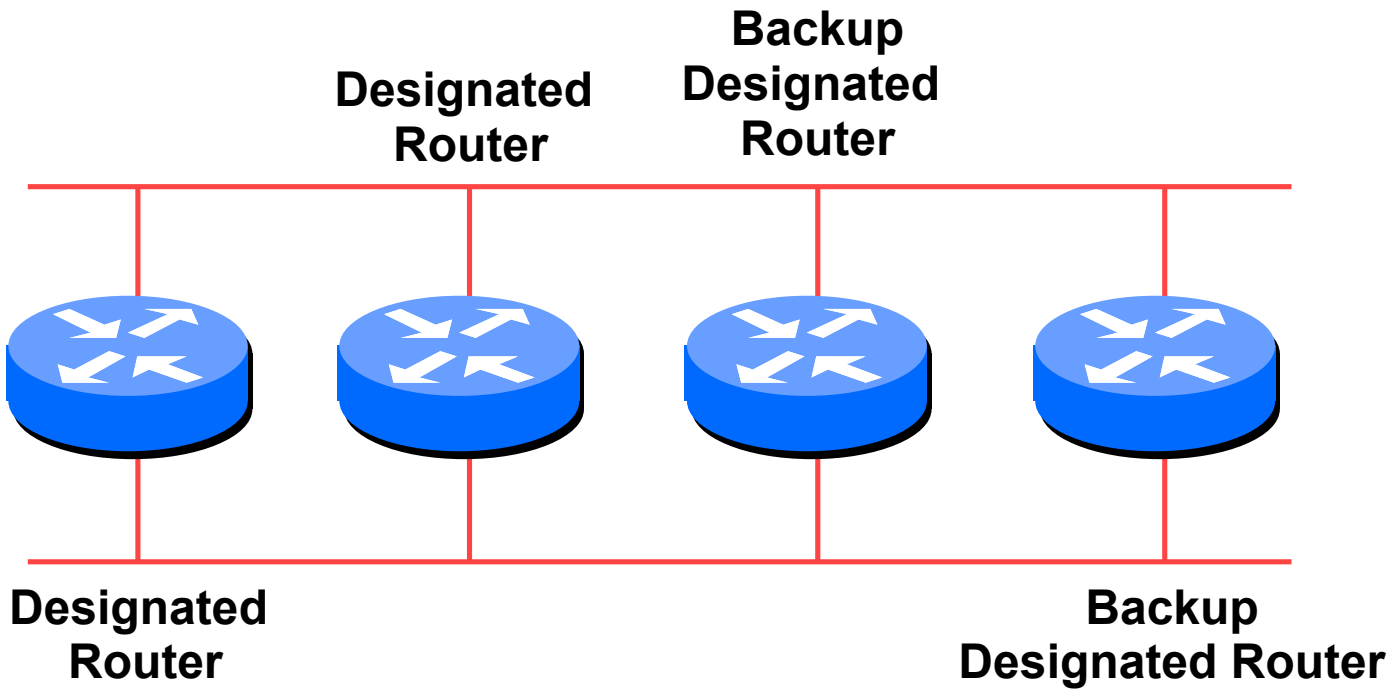


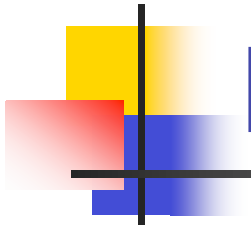
Broadcast Networks

- These are network technologies such as Ethernet and FDDI
- Introduces Designated and Backup Designated routers (DR and BDR)
  - Only DR and BDR form full adjacencies with other routers
  - The remaining routers remain in a “2-way” state with each other
    - If they were adjacent, we’d have n-squared scaling problem
  - If DR or BDR “disappear”, re-election of missing router takes place

Designated Router

- One per multi-access network
  - Generates network link advertisements for the multi-access network
  - Speeds database synchronisation

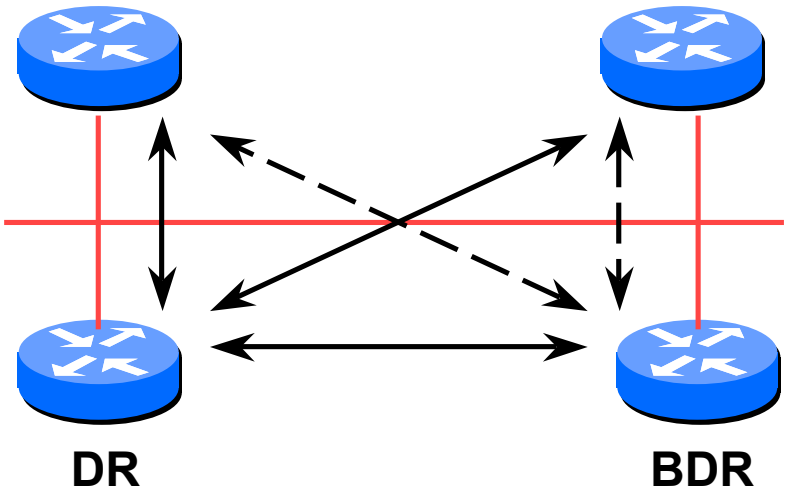




Designated Router

- All routers are adjacent to the DR
  - All routers are adjacent to the BDR also
- All routers exchange routing information with DR (..)
  - All routers exchange routing information with the BDR
- DR updates the database of all its neighbours
  - BDR updates the database of all its neighbours
- This scales! *2n* problem rather than having an *n-squared* problem.

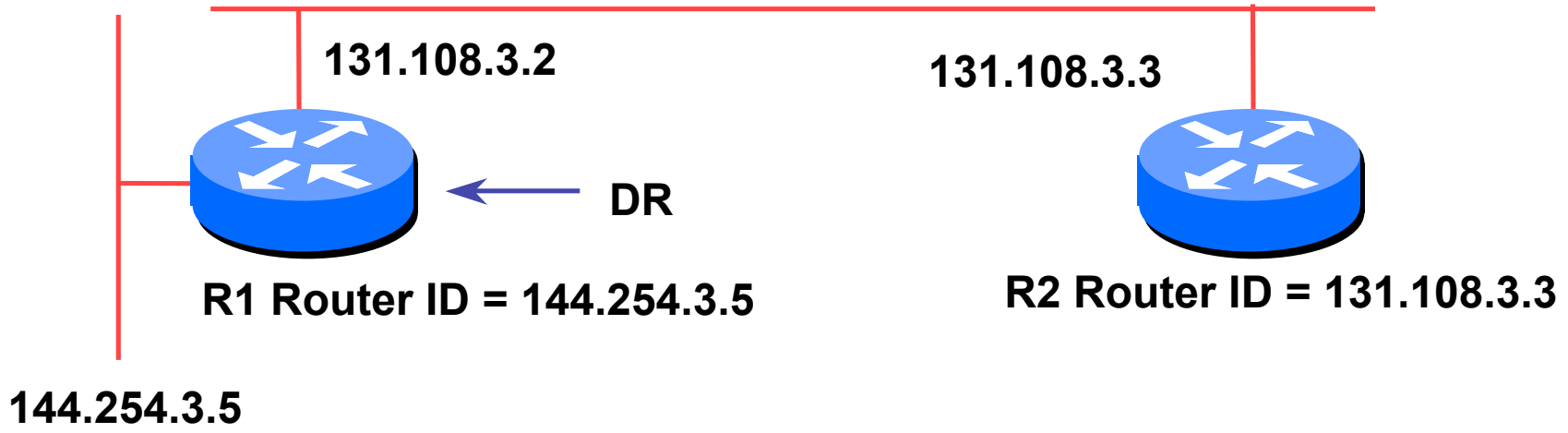
Designated Router

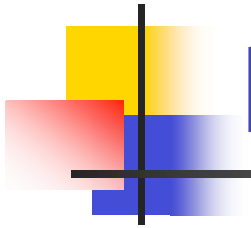


- Adjacencies only formed with DR and BDR
- LSAs propagate along the adjacencies

Designated Router Priority

- Determined by interface priority
- Otherwise by highest router ID
  - (For Cisco IOS, this is address of loopback interface, otherwise highest IP address on router)



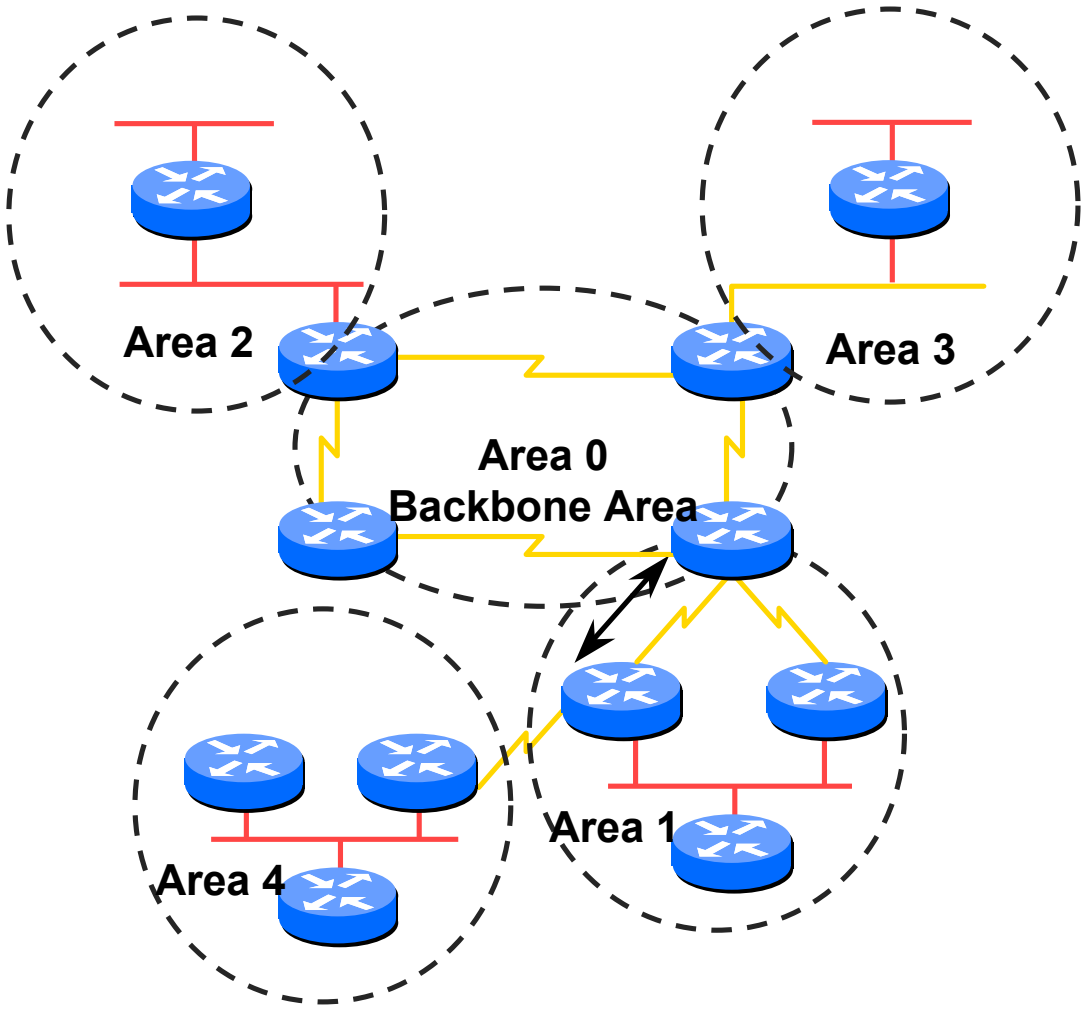


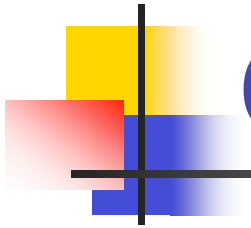
More Advanced OSPF

- OSPF Areas
- Virtual Links
- Router Classification
- OSPF route types
- External Routes
- Route authentication
- Equal cost multipath

OSPF Areas

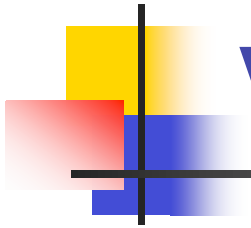
- Group of contiguous hosts and networks
- Per area topological database
  - Invisible outside the area
  - Reduction in routing traffic
- Backbone area contiguous
  - All other areas must be connected to the backbone
- Virtual Links





OSPF Areas

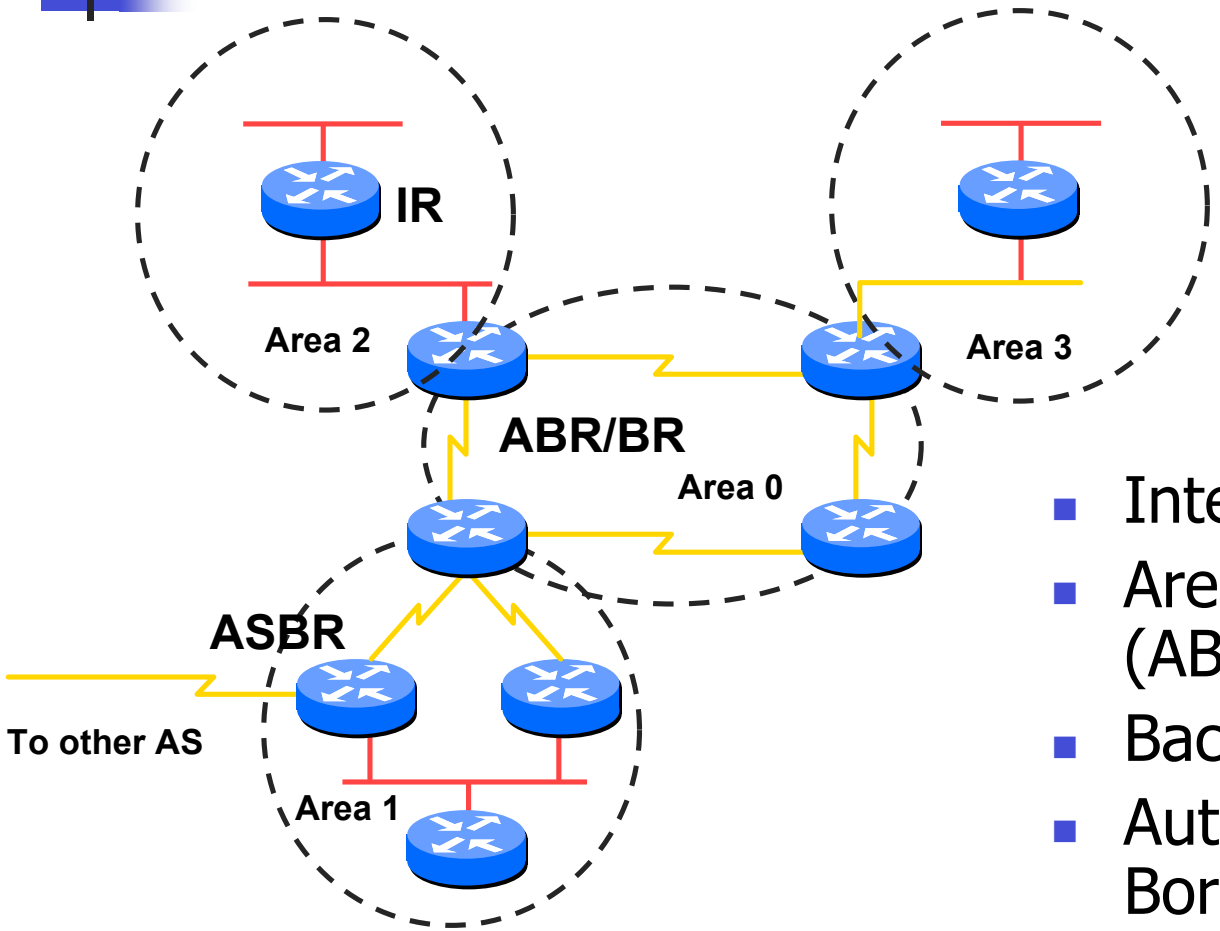
- Reduces routing traffic in area 0
- Consider subdividing network into areas
  - Once area 0 is more than 10 to 15 routers
  - Once area 0 topology starts getting complex
- Area design often mimics typical ISP core network design
- Virtual links are used for “awkward” connectivity topologies (…)



Virtual Links

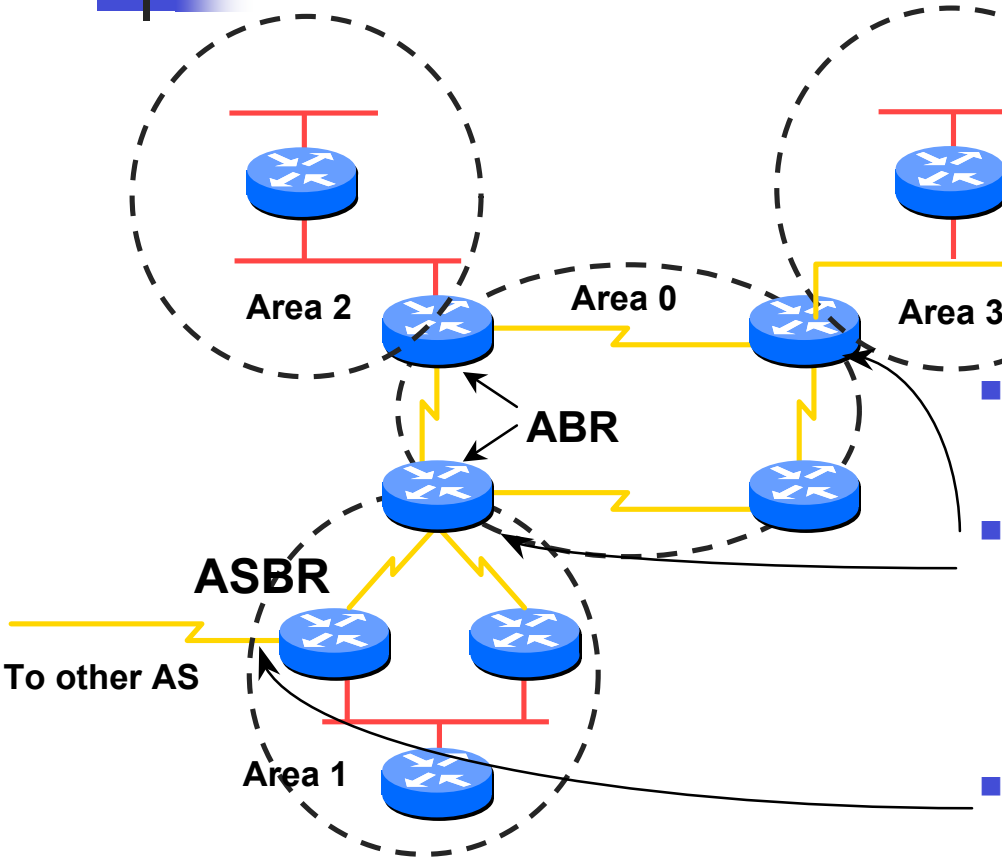
- OSPF requires that all areas MUST be connected to area 0
- If topology is such that an area cannot have a physical connection to a device in area 0, then a virtual link must be configured
- Otherwise the disconnected area will only be able to have connectivity to its immediately neighbouring area, and not the rest of the network

Classification of Routers



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

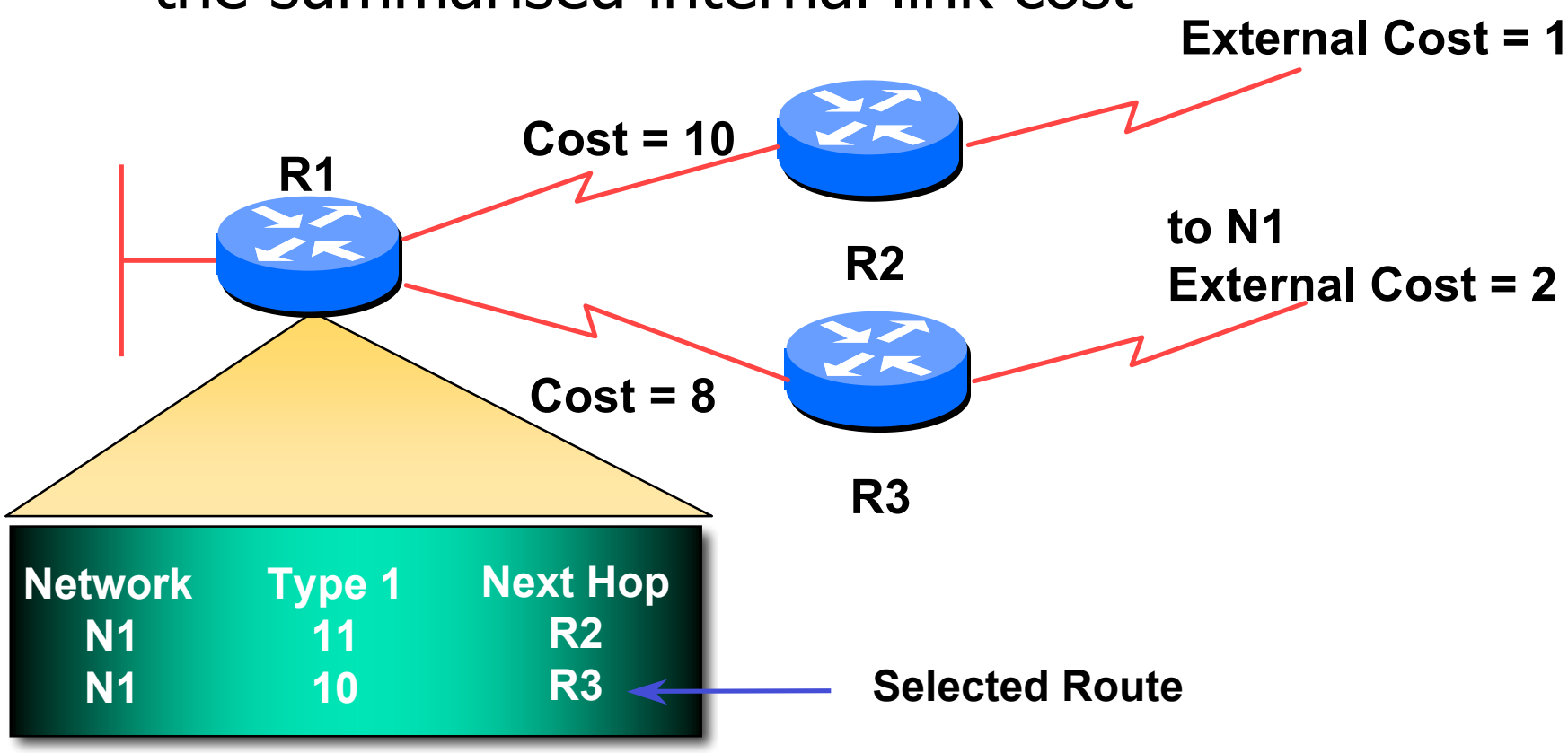
OSPF Route Types



- Intra-Area route
  - All routes inside an area
- Inter-Area route
  - Routes advertised from one area to another area by an ABR
- External route
  - Routes imported into OSPF from another routing protocol by an ASBR

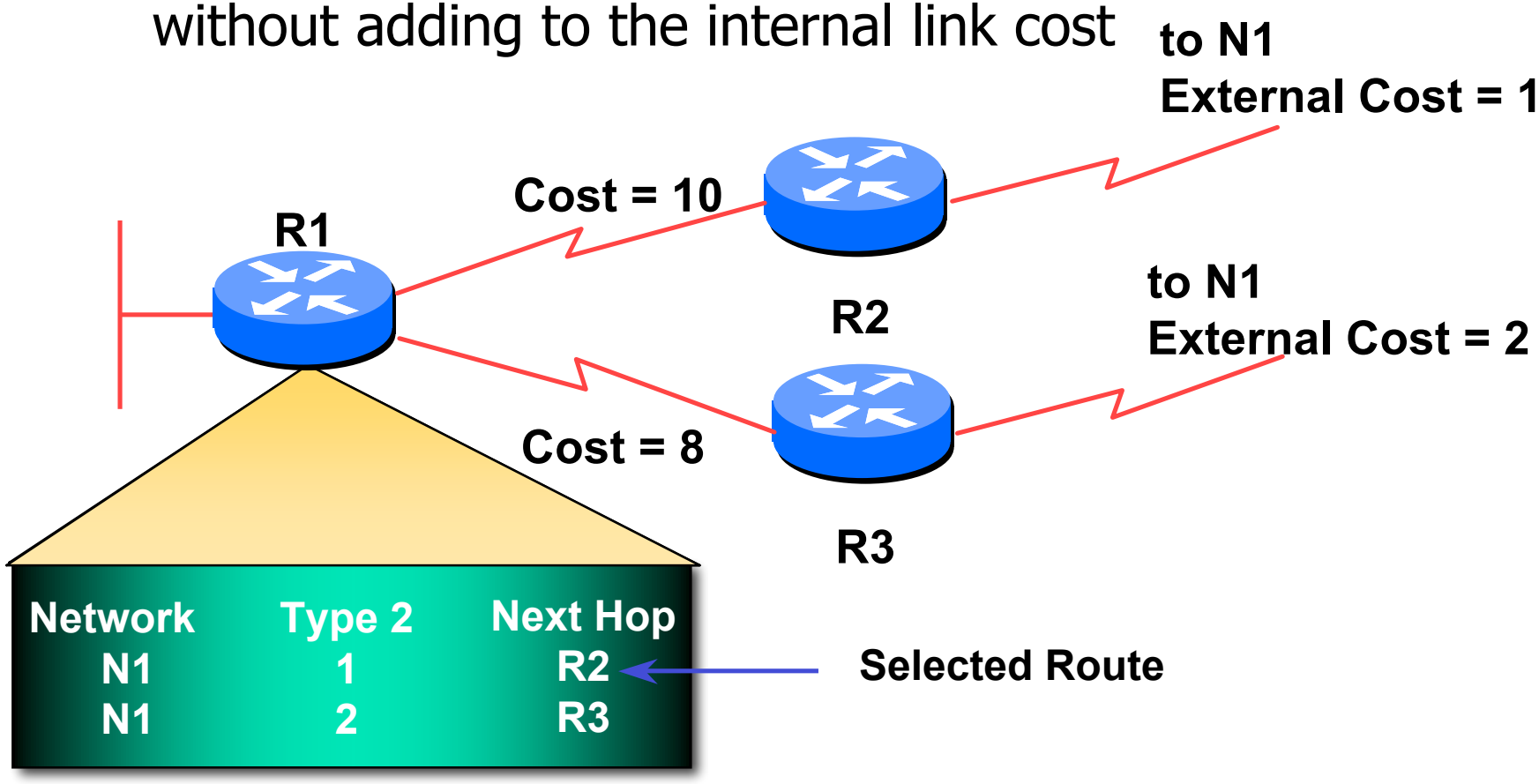
External Routes

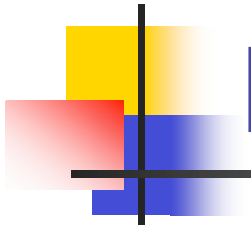
- Type 1 external metric: metrics are added to the summarised internal link cost



External Routes

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

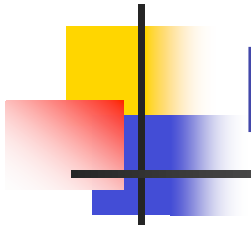




Route Authentication

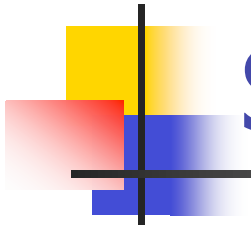
- Now recommended to use route authentication for OSPF
  - ...and all other routing protocols
- Susceptible to denial of service attacks
  - OSPF runs on TCP/IP
  - Automatic neighbour discovery
- Route authentication – Cisco example:

```
router ospf <pid>
 network 192.0.2.0 0.0.0.255 area 0
 area 0 authentication
interface ethernet 0/0
 ip ospf authentication-key <password>
```



Equal Cost Multipath

- If *n* paths to same destination have equal cost, OSPF will install *n* entries in the forwarding table
  - Loadsharing over the *n* paths
  - Useful for expanding links across an ISP backbone
    - Don’t need to use hardware multiplexors
    - Don’t need to use static routing



Summary

- Link State Protocol
- Shortest Path First
- OSPF operation
- Broadcast networks
  - Designated and Backup Designated Router
- Advanced Topics
  - Areas, router classification, external networks, authentication, multipath

Introduction to OSPF

Questions?