

Cisco Enterprise Networks: Implementing OSPF

INTRODUCTION TO OSPF



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Course Overview



Introduction to OSPF

Configuring OSPF for IPv4

Configuring OSPFv3 for IPv6

Route redistribution

Relevant CCNP ENCOR (350-401) Objectives



3.0 Infrastructure

- 3.2 Layer 3
 - 3.2a Compare routing concepts of EIGRP and OSPF
 - 3.2b Configure and verify simple OSPF environments, including multiple normal areas, summarization, and filtering

Relevant CCNP ENARSI (300-410) Objectives



1.0 Layer 3 Technologies

- 1.1 Troubleshoot administrative distance
- 1.2 Troubleshoot route map for any routing protocol
- 1.3 Troubleshoot loop prevention mechanisms
- 1.4 Troubleshoot redistribution between any routing protocols or routing sources
- 1.5 Troubleshoot manual and auto-summarization with any routing protocol
- 1.10 Troubleshoot OSPF (v2/v3)

Lab Options

Use existing topology from *Cisco Enterprise Networks: Basic Networking and IP Fundamentals*

Lab Options

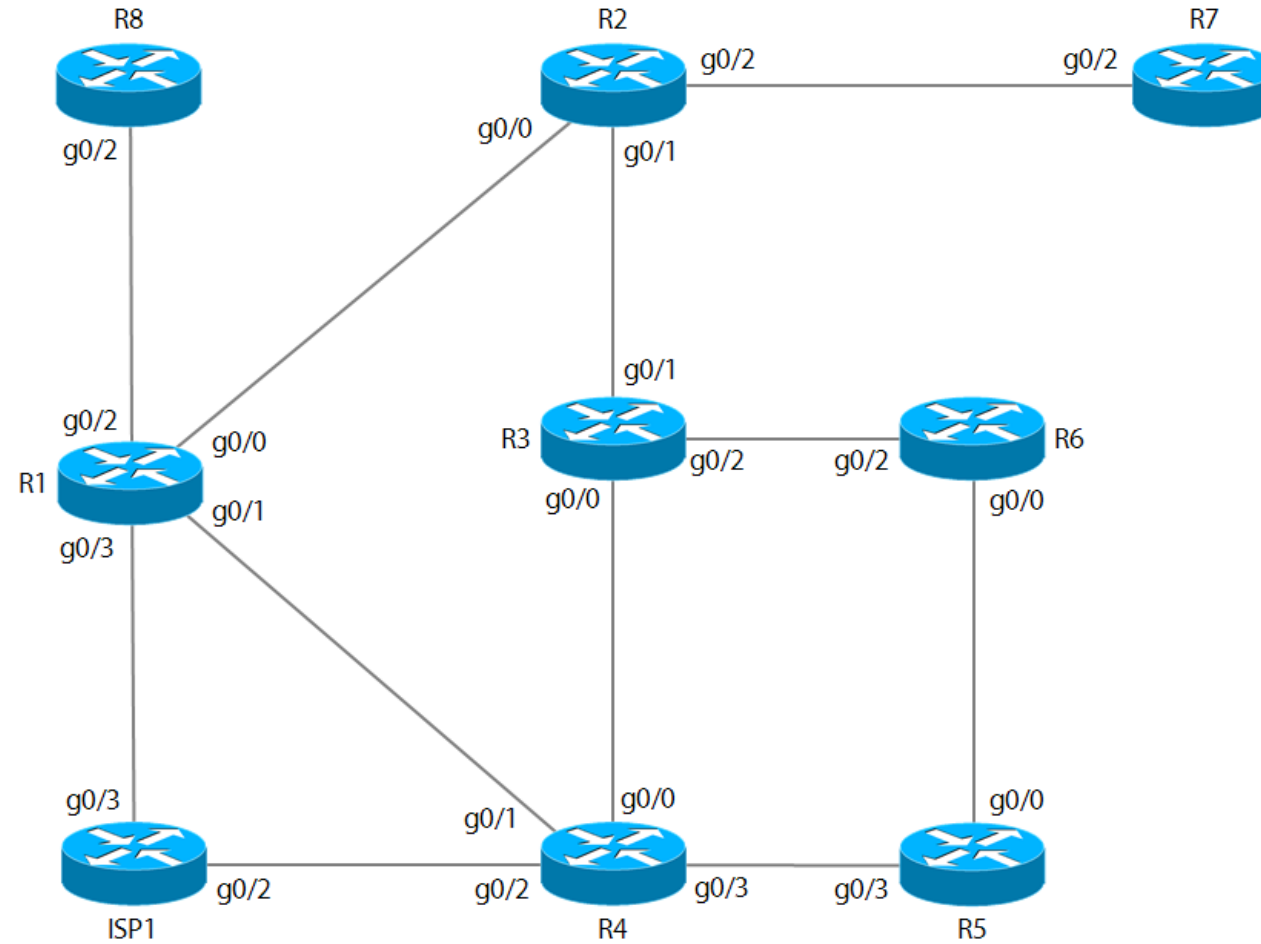


Router configurations and topology diagrams are available at <https://github.com/benpiper/ccnp-enterprise>

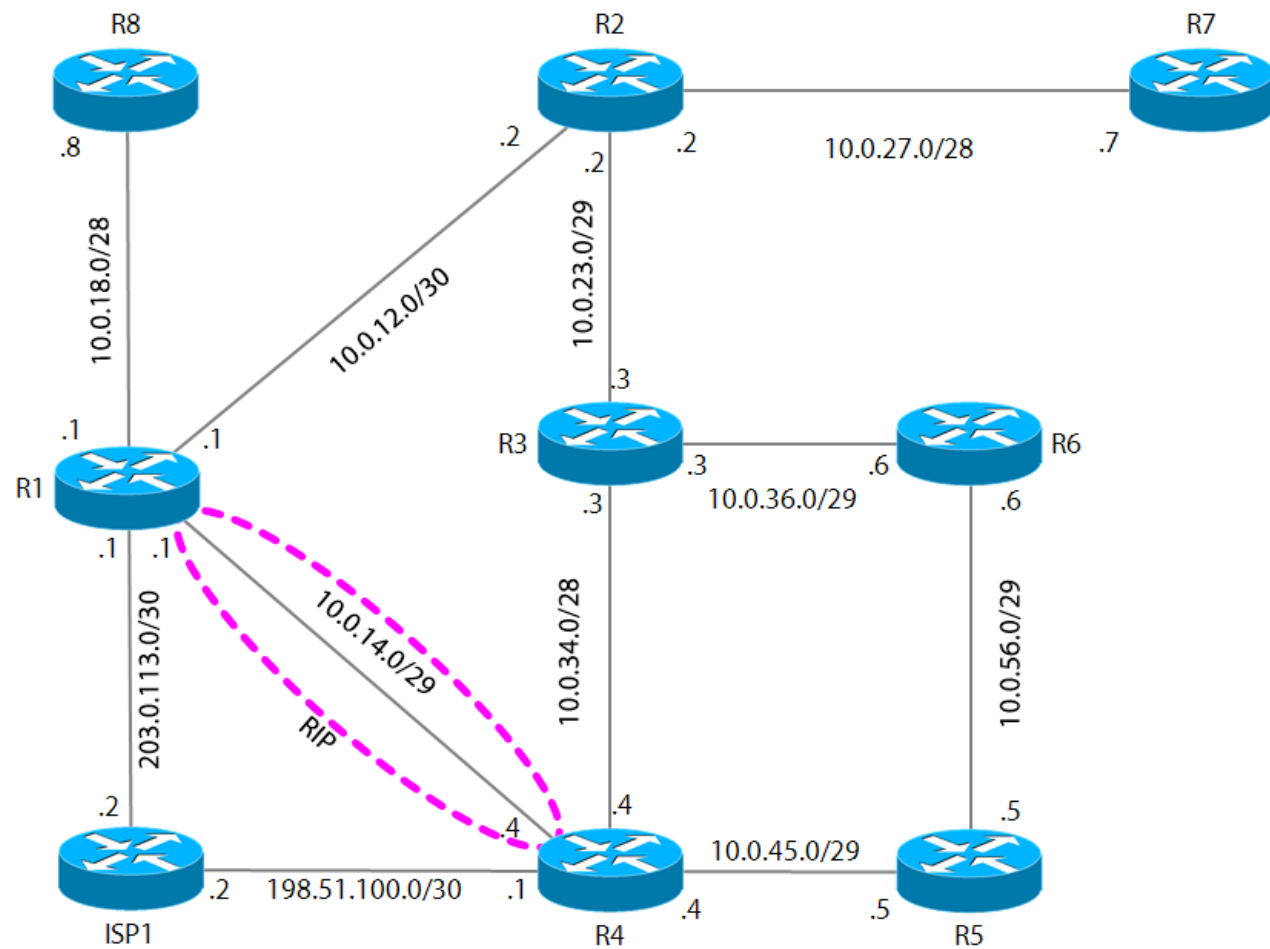
Cisco VIRL: <http://virl.cisco.com>

GNS3: <https://gns3.com>

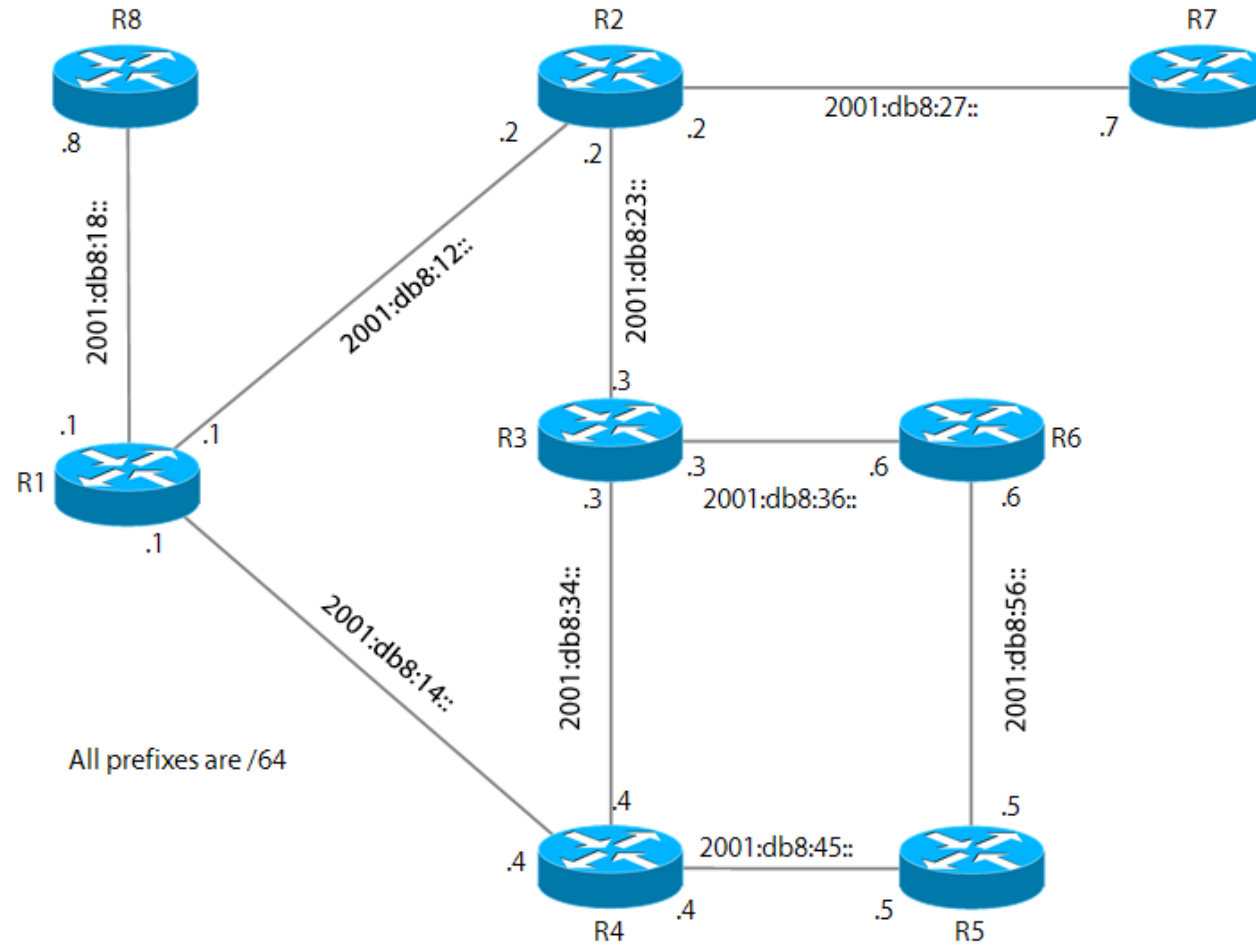
Layer 2 Topology



Layer 3 IPv4 Topology



Layer 3 IPv6 Topology



Introduction to OSPF

Why Was OSPF Invented?

**Faster
convergence time**

**Larger network
diameter**

**Consideration of
bandwidth and
delay**

**Equal-cost multi-
pathing**

Better scaling

Link-state routing protocol

Every router builds an identical map of the network by sharing link-state advertisements (LSAs).

Each OSPF Router Creates a Router LSA

Operational
interfaces

Associated cost

Connected IP
network

LSA Flooding



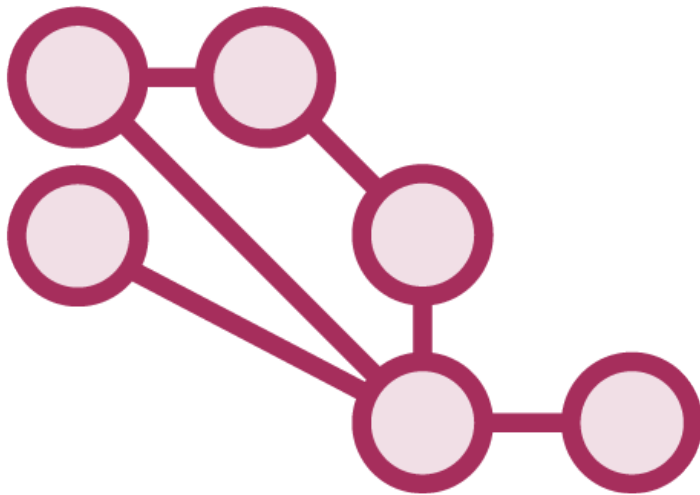
Each router *floods* its LSAs to connected routers.

LSA Flooding



All OSPF routers end up with an identical copy of the link-state database (LSDB).

Shortest Path First



OSPF routers use the Dijkstra shortest path first (SPF) algorithm to arrive at the same routing decisions.

What Makes OSPF Scalable?

Minimizes the amount of information carried by LSAs to reduce bandwidth and memory consumption

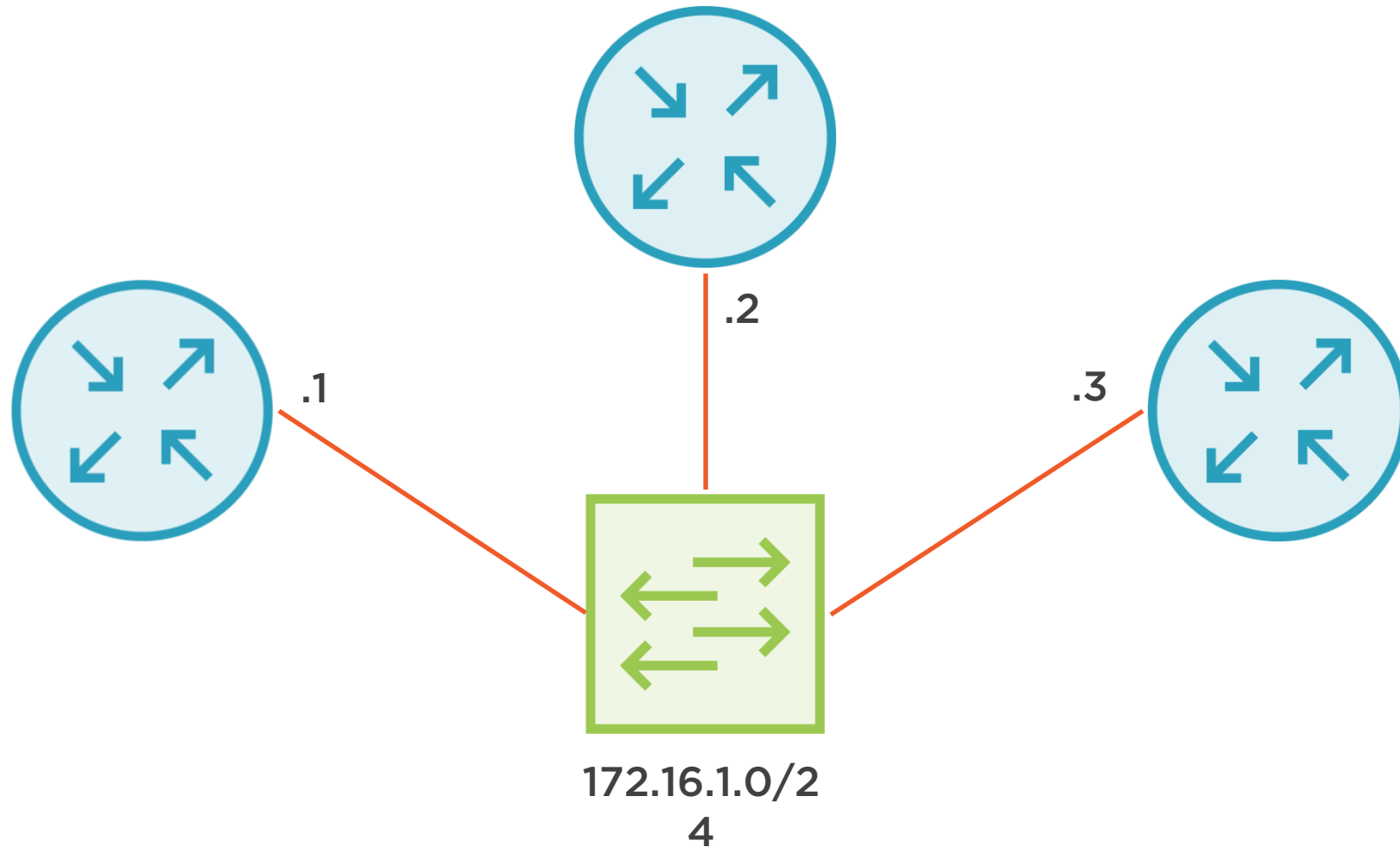
There are 7 LSA types for OSPFv2 with varying amounts of information

Why 7 LSA Types?

If all routers shared detailed link-state information with all other routers, OSPF wouldn't scale well

If there were 100 routers in a full-mesh topology, *each* router would have to store 9,900 LSAs!

Full Link-state Information May Be Redundant



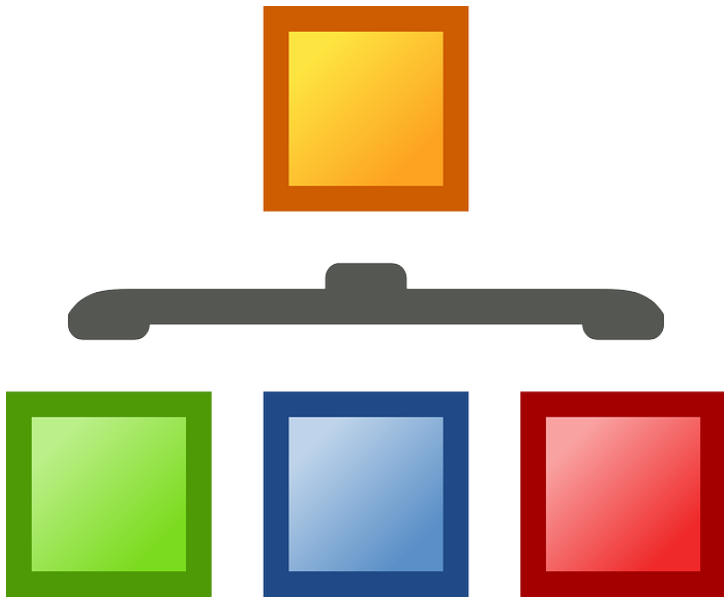
Why 7 LSA Types?



OSPF areas limit the propagation of LSAs

OSPF Areas

OSPF Areas Are Implemented in a Two-level Hierarchy



The area 0 *backbone* connects to all other areas

OSPF Areas Are Implemented in a Two-level Hierarchy

Reduces the
number of
redundant paths

Some LSAs stay
within an area
whereas others are
flooded to all areas

All other areas
must be logically
connected to
area 0

OSPF Areas



All routers know about the other routers and networks within the same area

Intra-area LSA Types

Type 1 —
Router LSA

Link type

IP prefix of each connected interface

OSPF Link Types

Type 1

Point-to-point

Type 2

Transit network

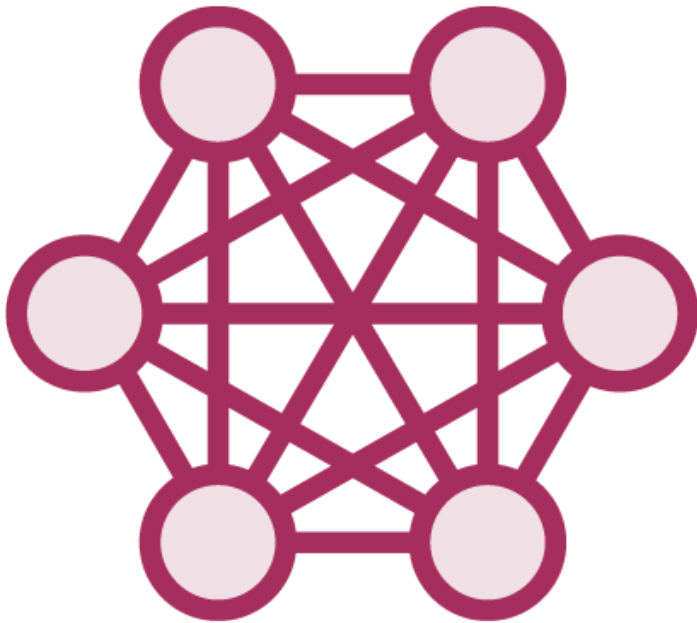
Type 4

Virtual link

Type 3

Stub network

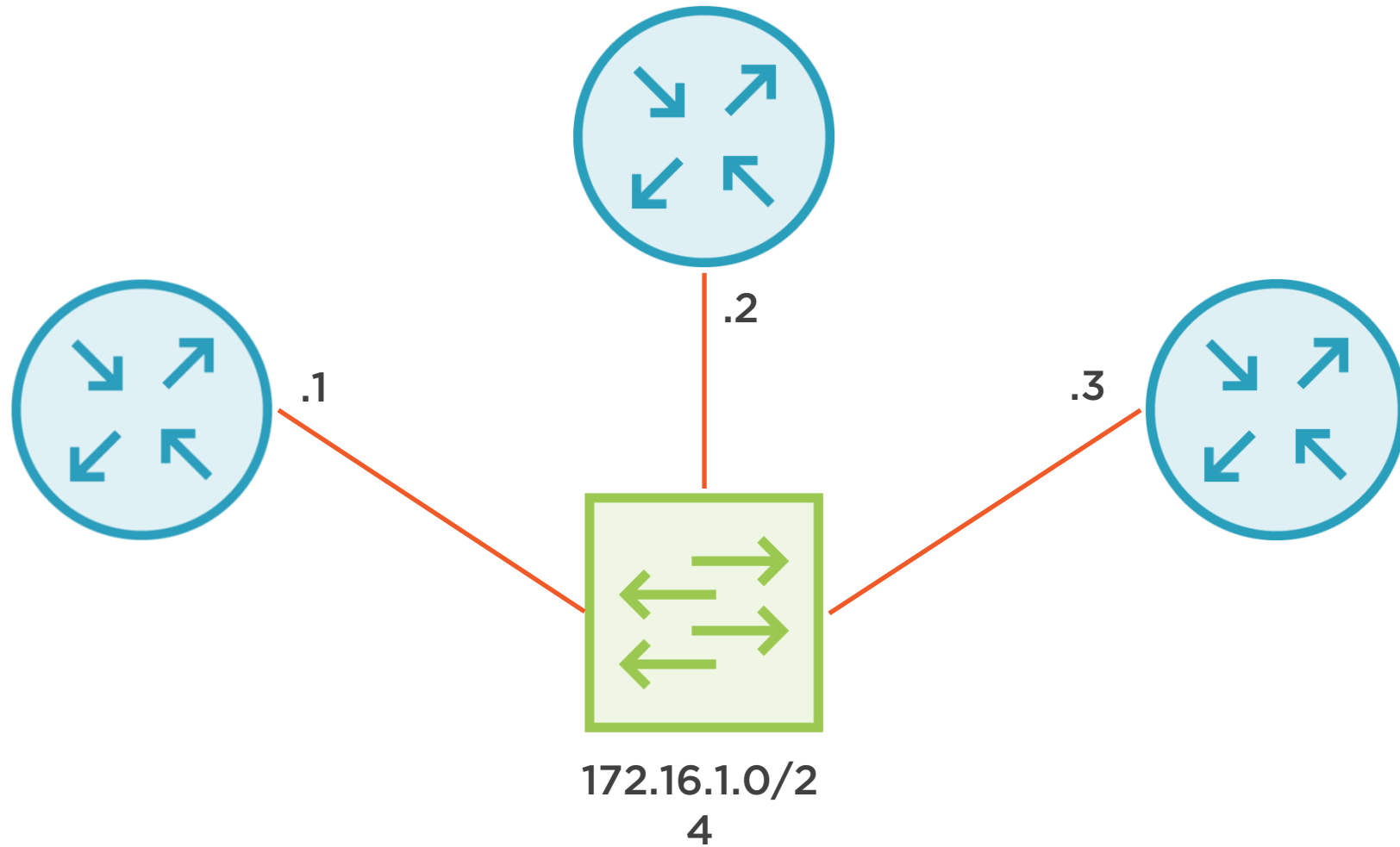
Intra-area LSA Types



Type 2 — Network LSA

- Describes all routers connected to an Ethernet subnet
- Generated by the designated router (DR)

Type 2 – Network LSA



LSA Types 1 and 2

**Always stay within the area
they originated from**

**Information they contain can
be sent to other areas as a
different LSA type, depending
on the area type**

Area Types

OSPF's complexity is due to its scalability.

OSPF Area Types

Stub

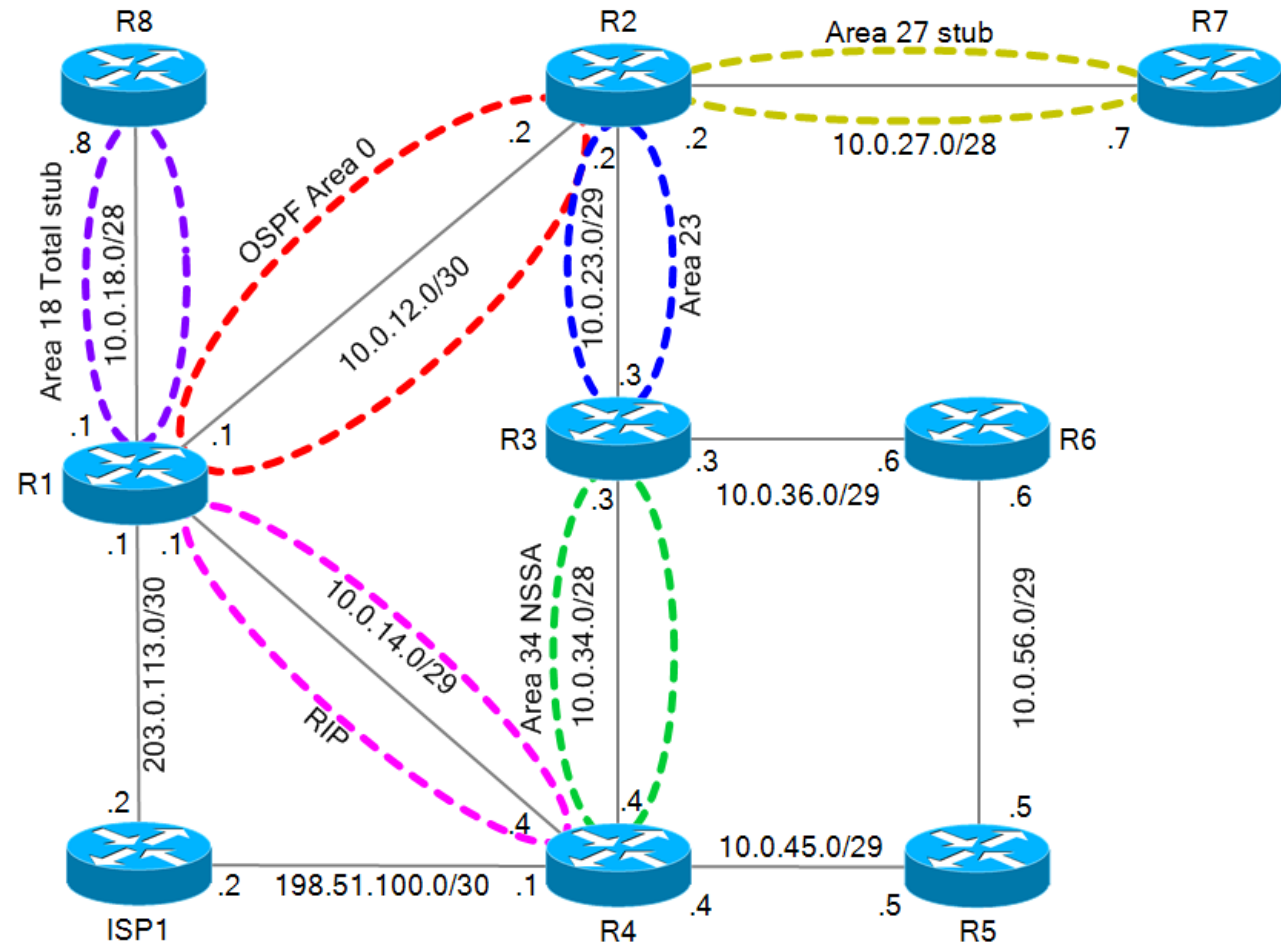
Totally stubby

Totally not-so-stubby

Not-so-stubby

Normal

OSPF IPv4 Topology



Normal Areas



Contain LSA types 1, 2, 3, 4, and 5

Type 3 — Network Summary LSA

Includes prefixes from other areas (inter-area)

Generated by area border routers (ABR)

Area Border Router (ABR)

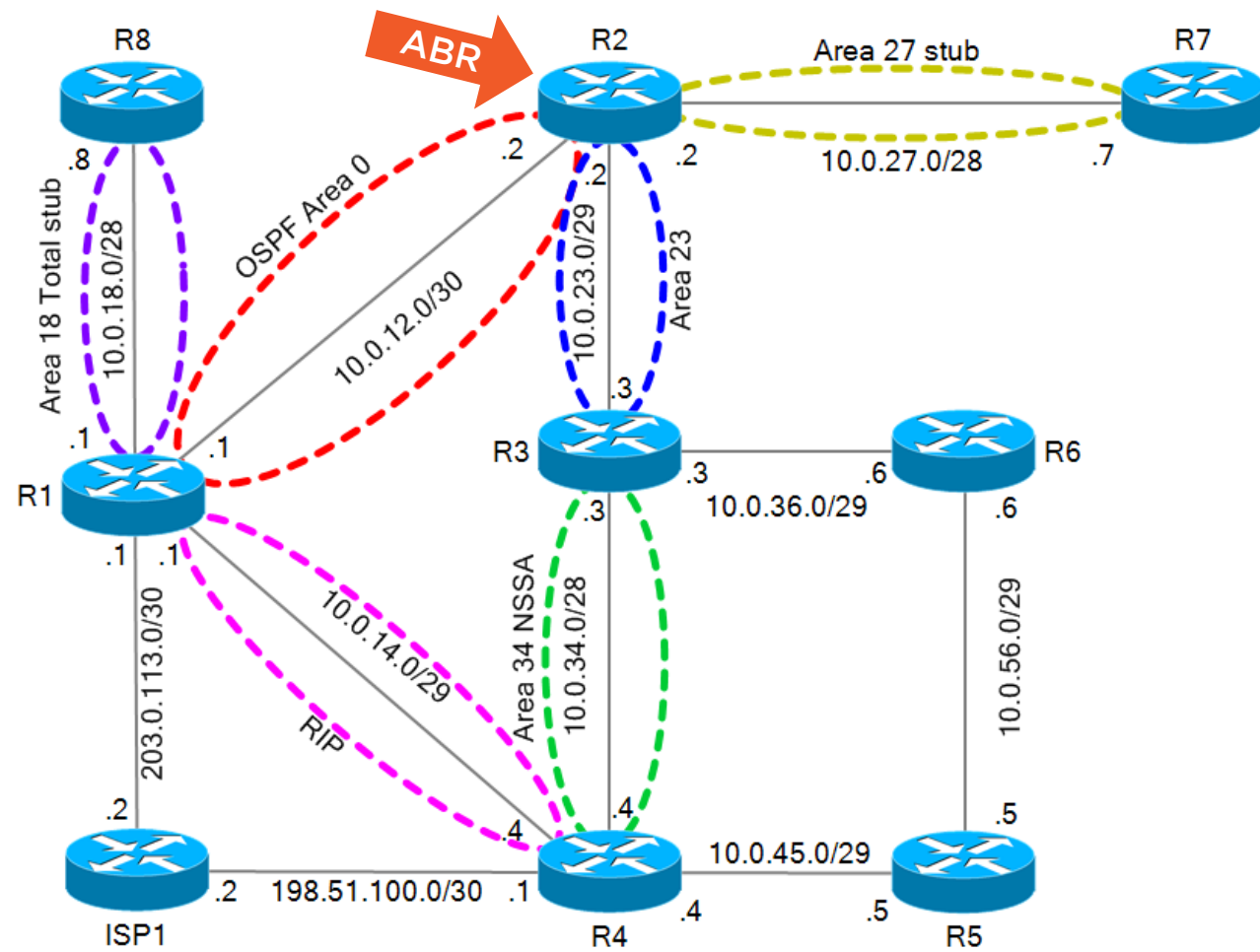
Attached to two or
more areas

Data traffic between areas
(inter-area) passes through
an ABR

Type 3 — Network Summary LSA



ABR takes information from LSA types 1 and 2 and converts it to a type 3 LSA that it sends to adjoining area

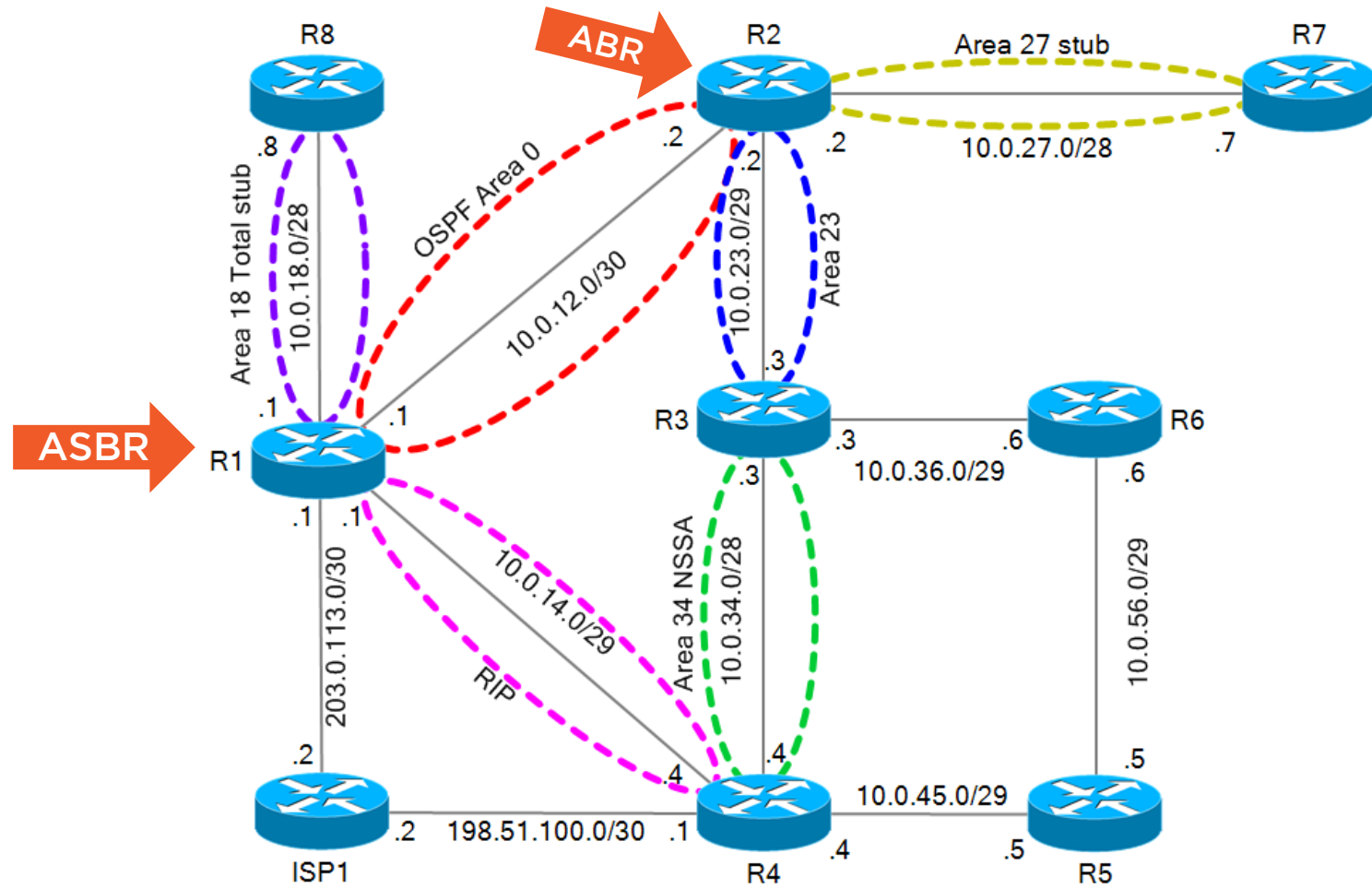


Autonomous System Boundary Router (ASBR)



Redistributes the following into OSPF:

- Interior gateway protocol (IGP) routes
- Static routes
- Connected routes



Type 5 — AS External LSA

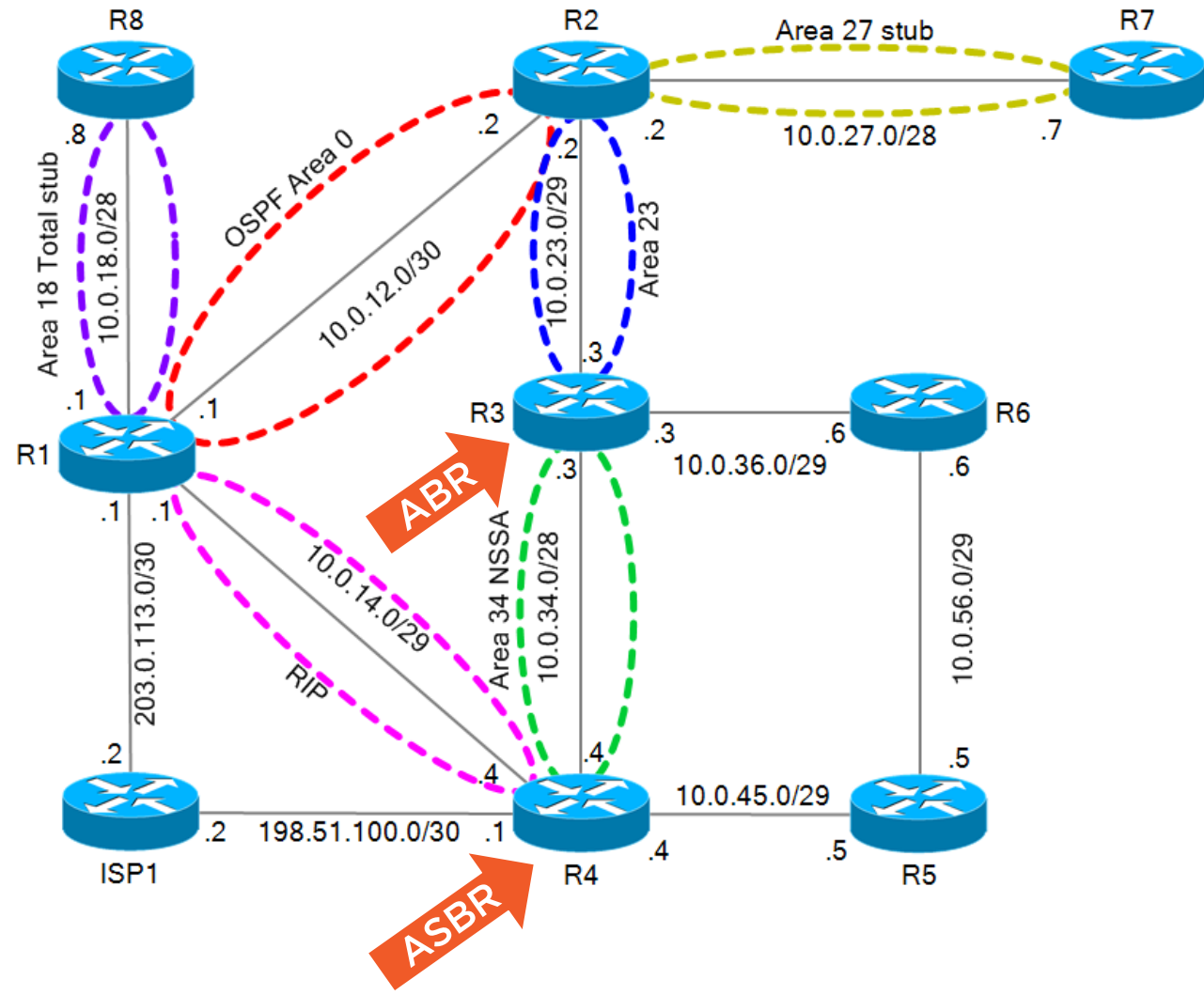
**Generated by
an ASBR**

**Describes the
external prefix
and the gateway
to reach it**

**Flooded to all
normal areas**

Type 4 — ASBR Summary

Generated by an ABR that borders an area containing an ASBR



Type 4 — ASBR Summary



The ABR (R3) converts the ASBR's (R4) type 1 router LSA into a type 4 ASBR summary LSA

Type 4 — ASBR Summary

Generated by an ABR

Describes an ASBR

Flooded to all normal areas

The backbone (area 0) is a normal area.

Stub Areas

**Receives type 3
summary LSAs
from other areas**



**Has a default
route for external
prefixes**

Totally Stubby Areas

**Has only a
default route**



**Does not receive
type 3 summary
LSAs**

Not-so-stubby Areas (NSSA)

Generally used to
inject external
prefixes into OSPF
routing domain

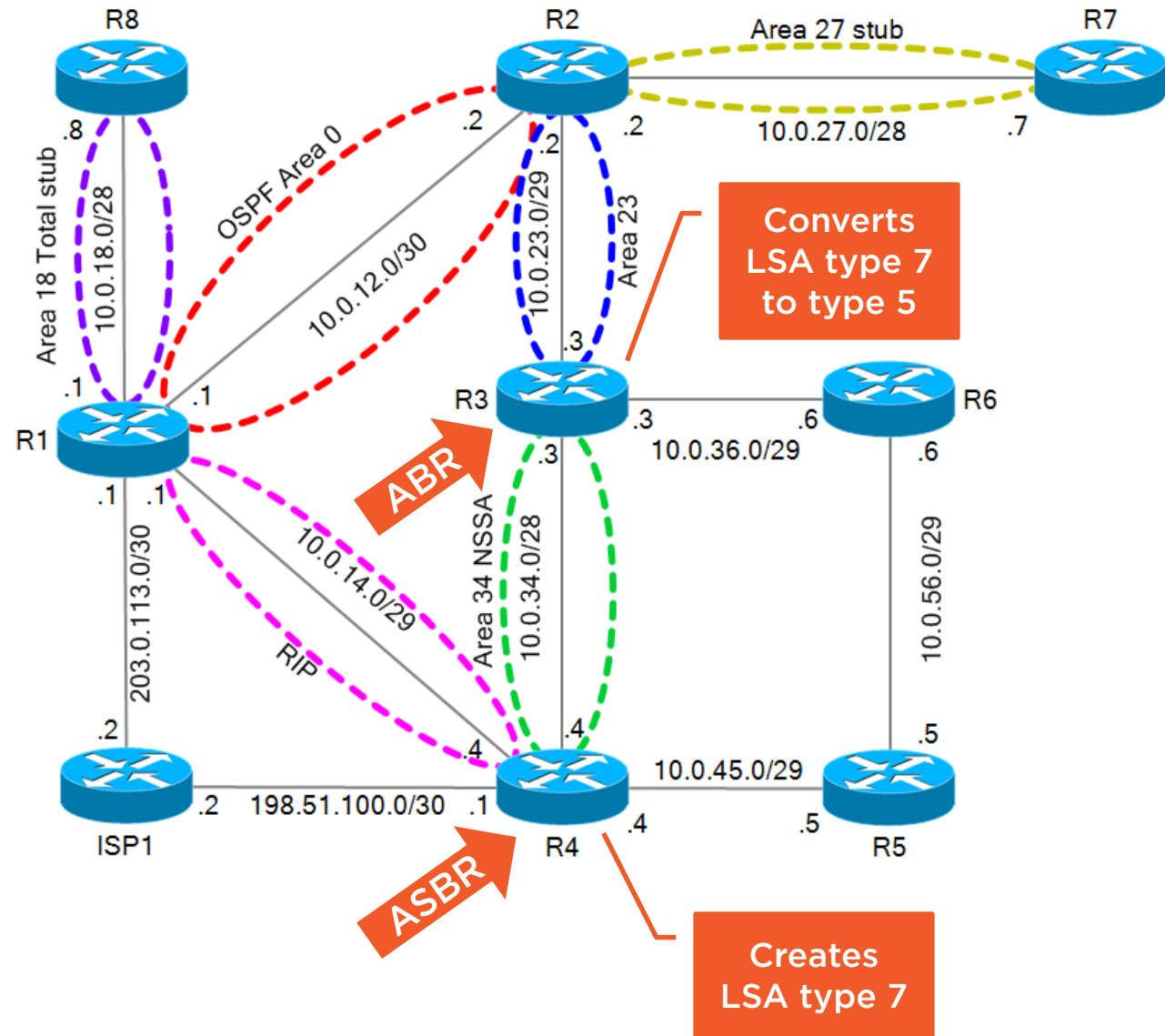


Does not have a
default route

Not-so-stubby Areas (NSSA)

**ASBR creates a type 7
external stub LSA**

**ABR converts type 7 LSA to
type 5 AS external LSA**



Totally Not-
so-stubby
Areas

Same as NSSA but *does* have a
default route

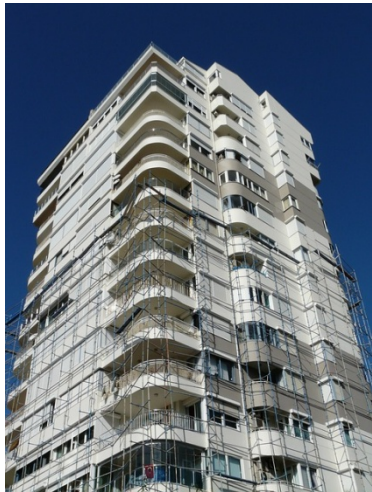
OSPF Area Types

Intra-area routes take
precedence over
inter-area routes

Inter-area routes take
precedence over
external routes

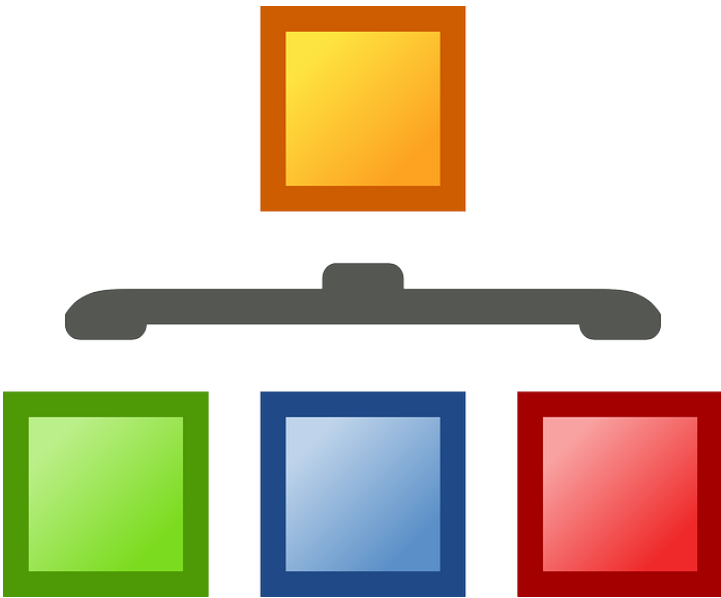
Summary

Summary



OSPF was designed to be scalable

Summary



OSPF uses areas to implement a two-level hierarchy

Summary



There are 5 area types: normal, stub, totally stubby, NSSA, and totally NSSA

Summary



Instead of one LSA type, OSPFv2 uses 7

Summary



The area type determines which LSAs are allowed in or out

Summary



**Knowing how an area's type influences
prefix information in that area is crucial**

Summary



Don't memorize specific LSA details!

**You can derive these from IOS
show commands**

In the Next Module



We're going to configure OSPF for IPv4 and different area types!