

# Introducing Multi-area OSPF

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# Module Overview



# Module Overview



**What is multi-area OSPF?**



# Module Overview



**What is multi-area OSPF?**

**Reviewing the different OSPF device types**



# Module Overview



**What is multi-area OSPF?**

**Reviewing the different OSPF device types**

**Differentiating the different OSPF area types**



# Module Overview



**What is multi-area OSPF?**

**Reviewing the different OSPF device types**

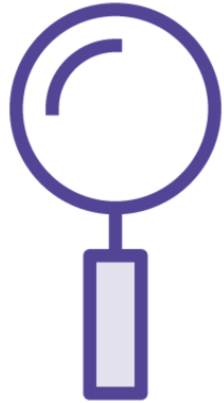
**Differentiating the different OSPF area types**

**Decoding multi-area OSPF building blocks**





# Single Area OSPF

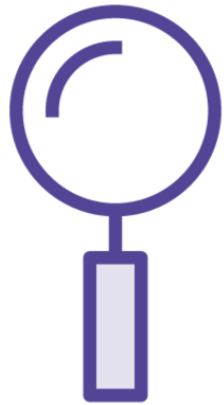


Initial course focus





# Single Area OSPF



Initial course focus



Works well in small implementations



# Review

**Router(1) and network(2)  
LSAs send to all area devices**



# Review

**External(5)LSAs send  
everywhere by default**



# Single Area OSPF



# Single Area OSPF



**All device LSDB are identical**



# Single Area OSPF



**All device LSDB are identical**  
**Do all devices need a full view?**





Works well in small networks





Works well in small networks  
Requires lots of resources



Just imagine this with 50  
devices



# Large Example

50 devices

**Minimum of 50 LSA entries**



# Large Example

50 devices

Minimum of 50 LSA entries



Assumes no DR's



# LANs

**Don't forget the LANs!**



# LANs

Will add additional link entries



Failure?



Failure?

LSAs are updated





Failure?

LSAs are updated  
All devices LSDB need to match



# Failure?



# Failure?



Just imagine multiple failures



# Failure?



Just imagine multiple failures

Places a large burden on the network



# OSPF Structure

**Very important for efficiency**



# OSPF Structure

OSPF supports multiple areas



# OSPF Structure

**Allows hierarchy**



# OSPF Structure

Utilizes a primary  
backbone area (0)





# Multiple Areas



Router(1) and  
network(2) LSAs  
limited to area  
boundary



# Multiple Areas



Router(1) and  
network(2) LSAs  
limited to area  
boundary



By itself, loses some  
reachability  
information



# Multiple Areas



Router(1) and  
network(2) LSAs  
limited to area  
boundary



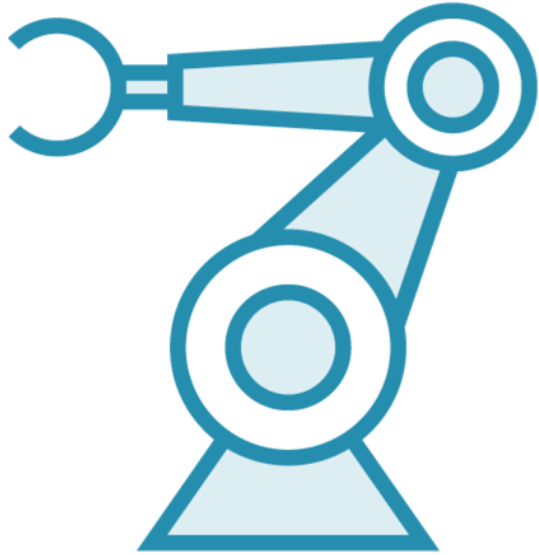
By itself, loses some  
reachability  
information



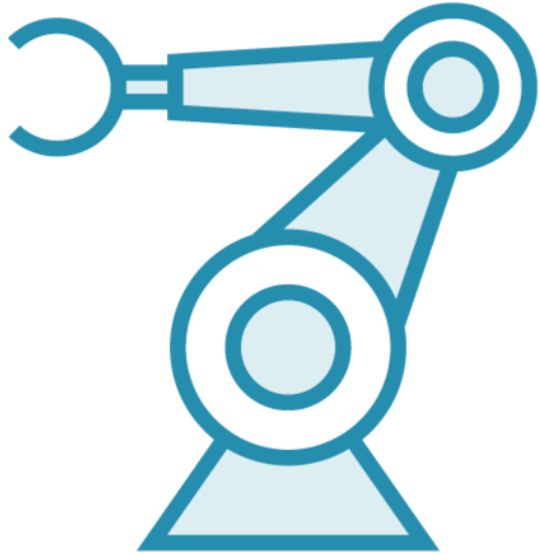
Additional LSAs  
replace this missing  
information



# Type 3 - Summary



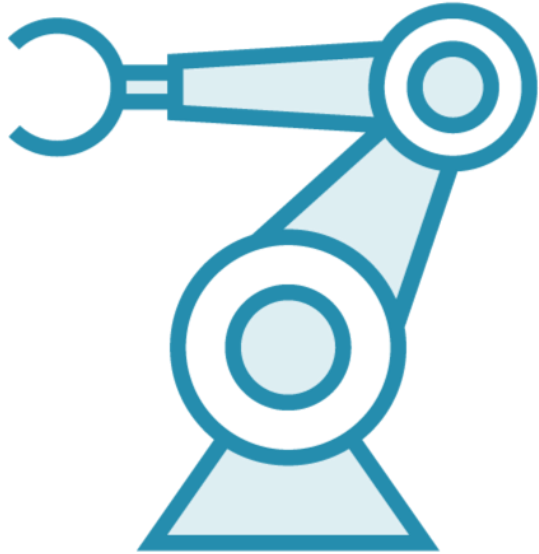
# Type 3 - Summary



**Carries reachability information  
into other areas**



# Type 3 - Summary



**Carries reachability information  
into other areas**

**Takes information from  
router and network LSAs**



# Type 4 - Summary

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# Type 4 - Summary

Used with type 5 external LSA





# Type 4 - Summary

Used with type 5 external LSA

Ensures ASBR is reachable



Deeper LSA coverage will  
come in a later section

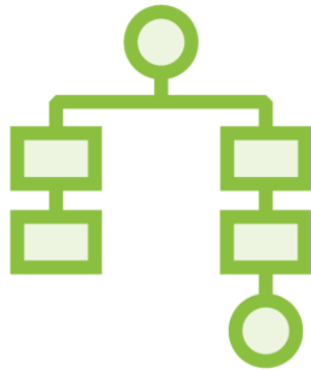


# OSPF device roles

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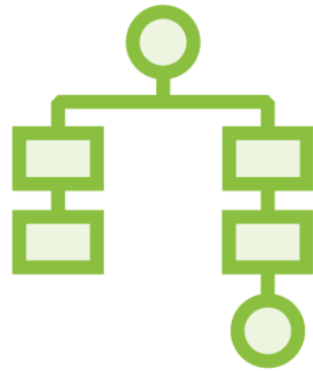
# OSPF Device Types



Multiple OSPF device categories



# OSPF Device Types



Multiple OSPF device categories



Previously reviewed an autonomous system boundary router (ASBR)



# OSPF Device Types

**Internal**



# OSPF Device Types

**Backbone**



# OSPF Device Types

Area border



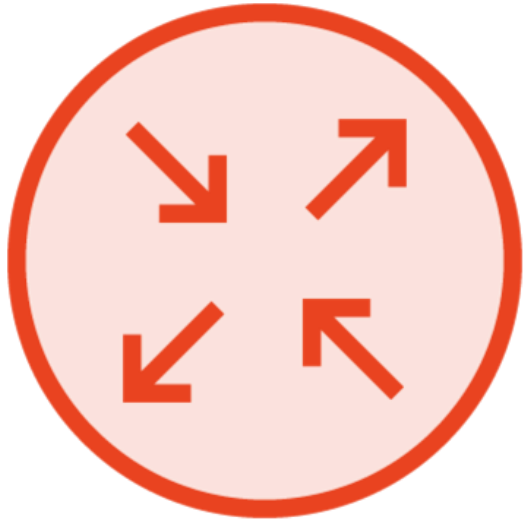


# OSPF Device Types

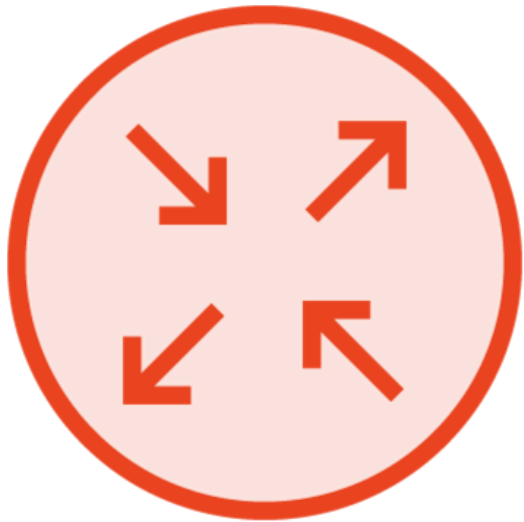
**AS boundary**



# Internal Devices



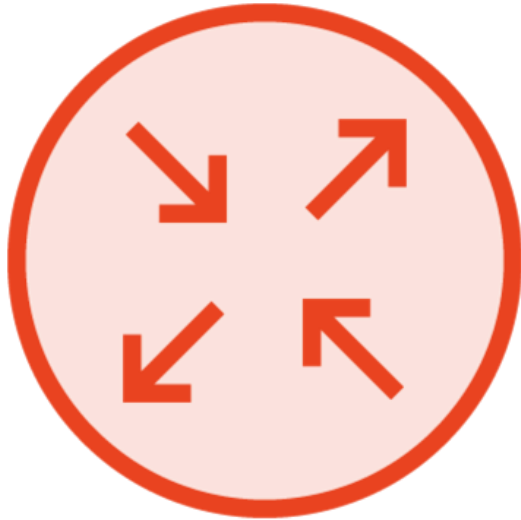
# Internal Devices



**Internal router**



# Internal Devices

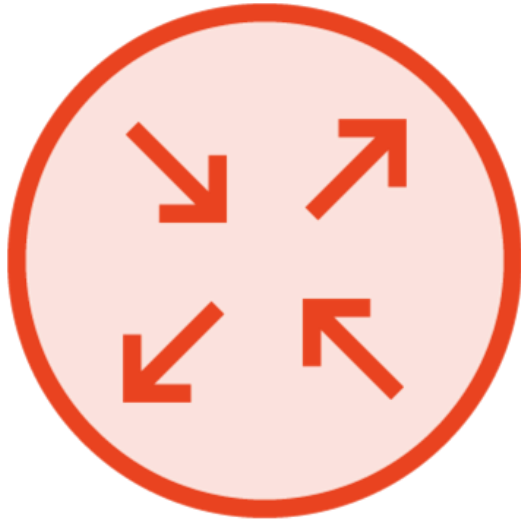


**Internal router**

**Device configured in single area**



# Internal Devices



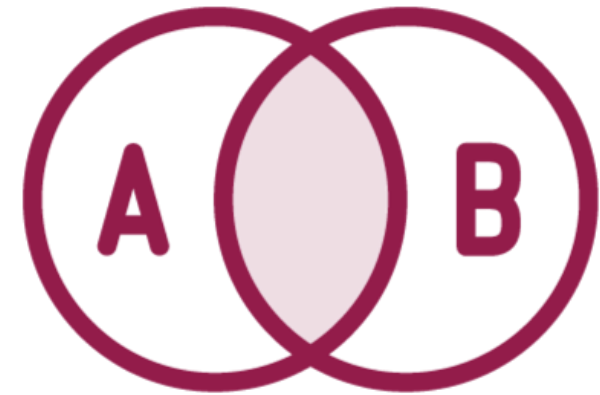
**Internal router**

**Device configured in single area**

**Maintains single copy of LSDB**

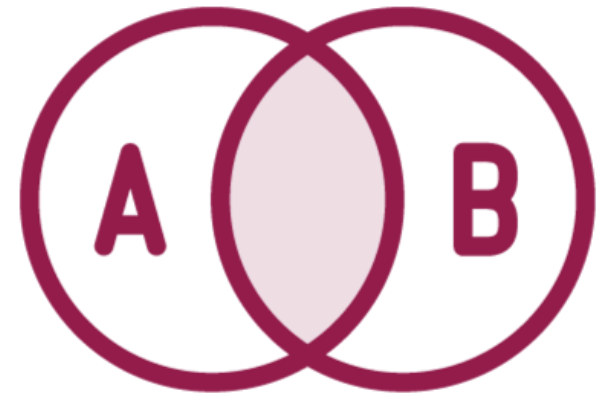


# Area Border Router (ABR)



# Area Border Router (ABR)

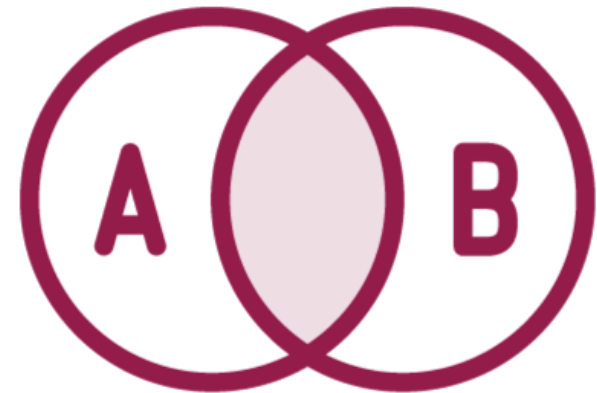
Connects different areas



# Area Border Router (ABR)

Connects different areas

Relays reachability information  
between areas





# Router LSA - Type 1

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Link State Age															Options										1						
Link State ID																															
Advertising Router																															
Link State Sequence Number																															
Link State Checksum															Length																
0		V	E	B	0										# of Links																



# Backbone

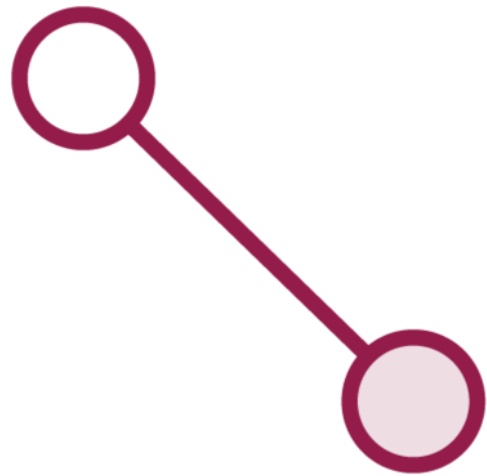
Device configured into area 0



# Backbone

Can also be  
internal router or ABR

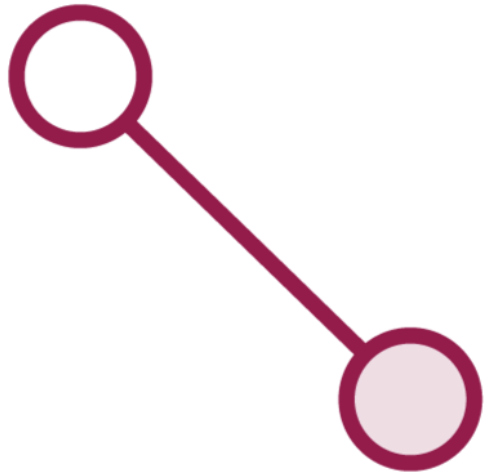




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## AS Boundary



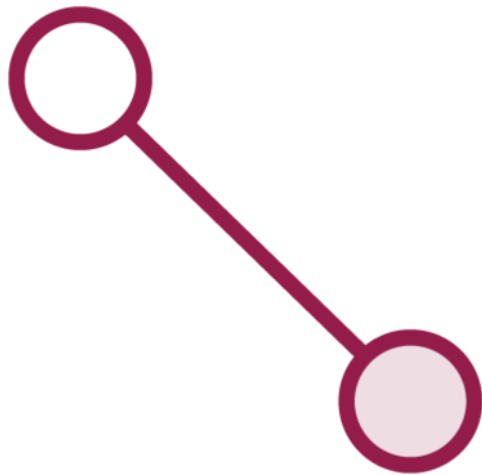


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## AS Boundary

Commonly, autonomous system boundary router (ASBR)





## AS Boundary

Commonly, autonomous system boundary router (ASBR)

At least one interface configured with OSPF





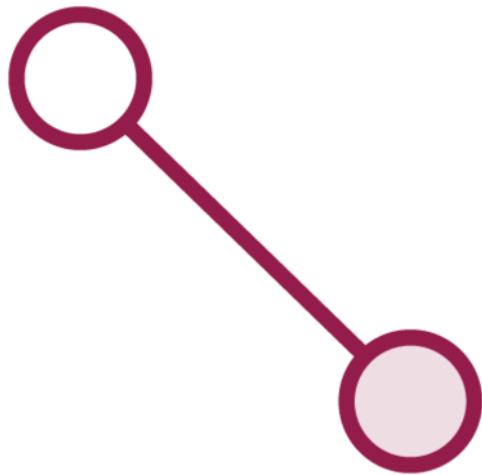
## AS Boundary

Commonly, autonomous system boundary router (ASBR)

At least one interface configured with OSPF

At least one interface not





## AS Boundary

Commonly, autonomous system boundary router (ASBR)

At least one interface configured with OSPF

At least one interface not

Other interface inserted into OSPF as external





# Router LSA - Type 1

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Link State Age															Options										1						
Link State ID																															
Advertising Router																															
Link State Sequence Number																															
Link State Checksum															Length																
0					V E B					0					# of Links																



Let's move back into the lab



# Area types





OSPF splits into areas



**OSPF splits into areas**  
**There are different types of area**



# Area Types

Backbone



# Area Types

Normal





# Area Types

Stub



# Area Types

Totally stubby



# Area Types

Not so stubby



# Backbone Area (0)



Center of the network



# Backbone Area (0)



Center of the network



Inter-area  
communications go  
through backbone



# Backbone Area (0)



Center of the network



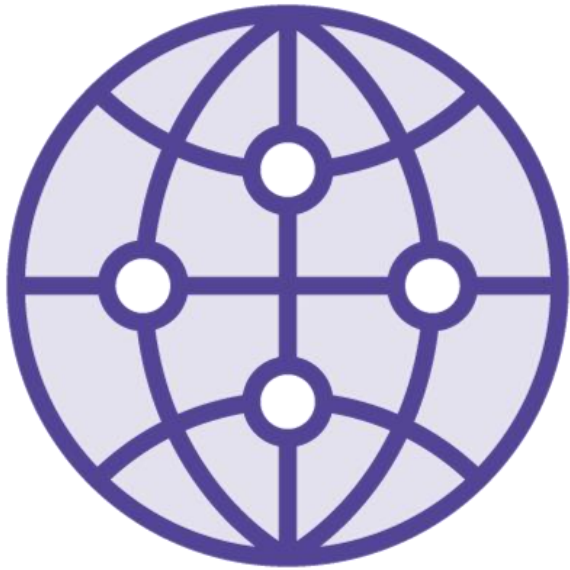
Inter-area  
communications go  
through backbone



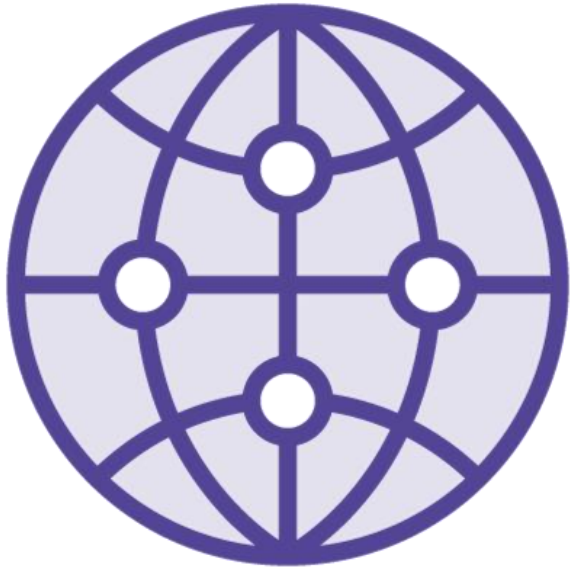
ABRs are always part  
of the backbone



# Backbone Area (0)



# Backbone Area (0)

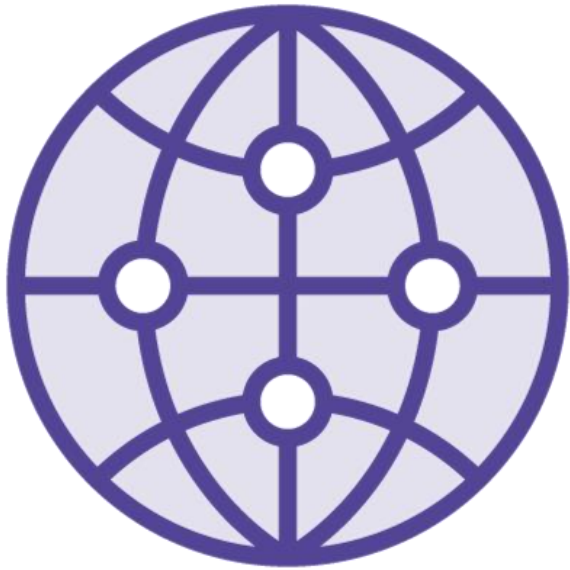


**Must be contiguous**





# Backbone Area (0)

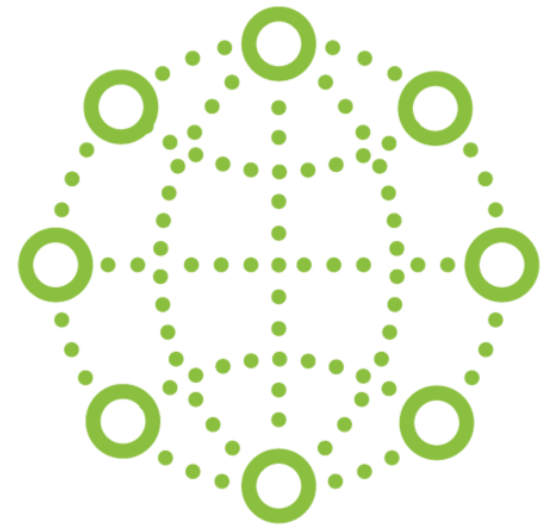


**Must be contiguous**

**Must attach to other backbone devices**

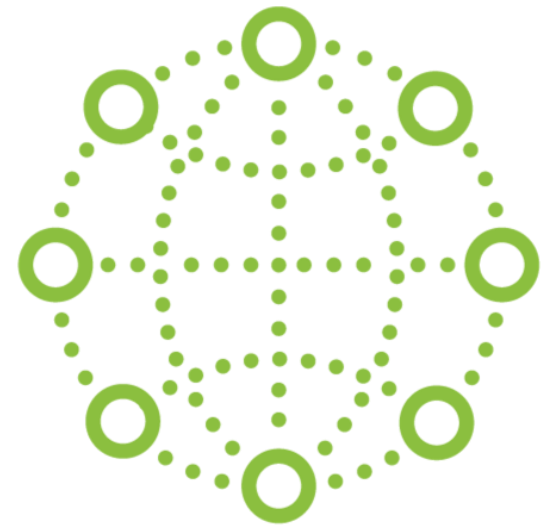


Backbone (0)



Backbone (0)

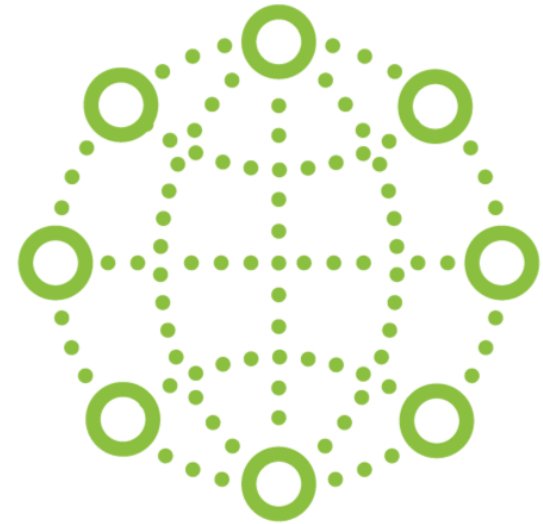
Some special cases exist



Backbone (0)

Some special cases exist

Sometimes a device can't physically connect



# Virtual Link

Allows a  
connection  
through a non-  
backbone area



# Virtual Link

**Normal  
neighborships are  
maintained**



# Virtual Link

**Adds additional  
virtual  
neighborship to  
ABR**



# Router LSA - Type 1

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
Link State Age															Options										1								
Link State ID																																	
Advertising Router																																	
Link State Sequence Number																																	
Link State Checksum															Length																		
0				V			E		B		0						# of Links																





# Normal Areas



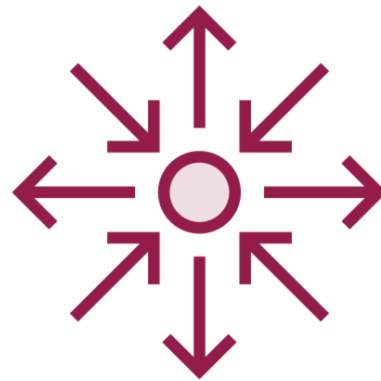
**Not backbone or  
special area**



# Normal Areas



Not backbone or  
special area



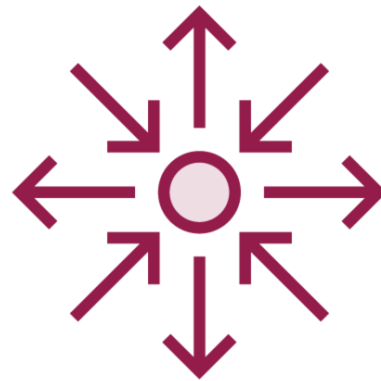
Exchange router and  
network LSAs (intra)



# Normal Areas



Not backbone or  
special area



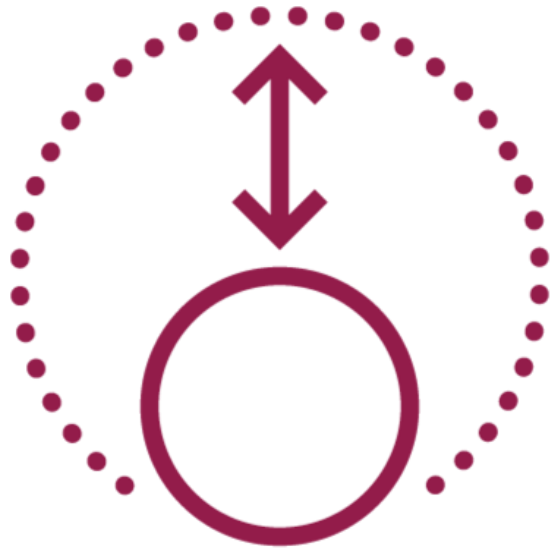
Exchange router and  
network LSAs (intra)



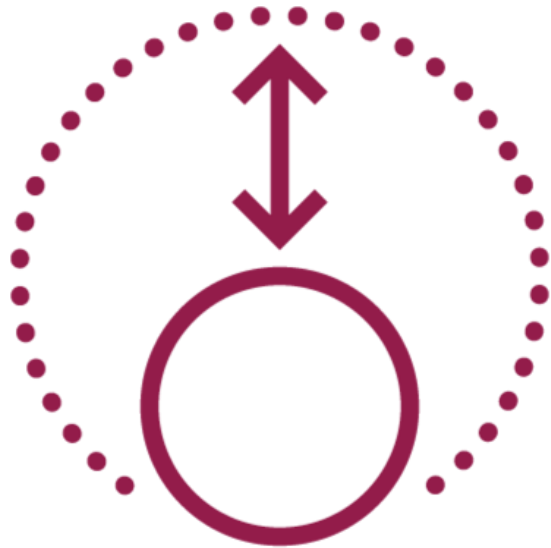
No restricted LSAs



# Stub Area



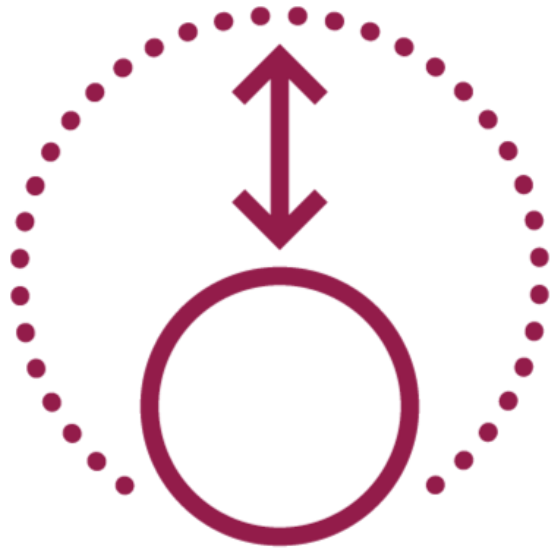
# Stub Area



Limits inserted LSAs



# Stub Area

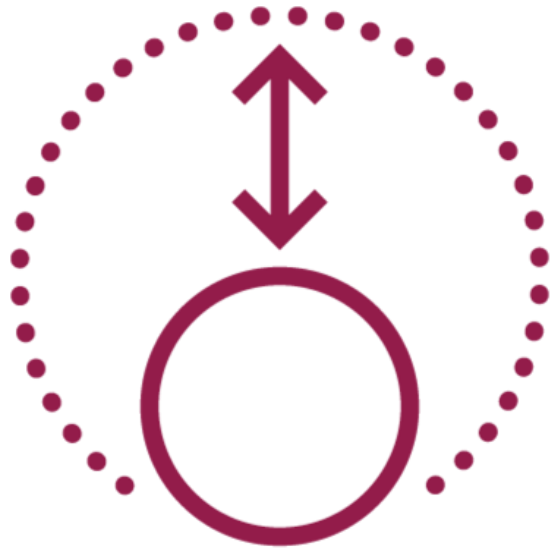


Limits inserted LSAs

Type 4 (summary) & type 5 (external) LSAs  
not allowed



# Stub Area



Limits inserted LSAs

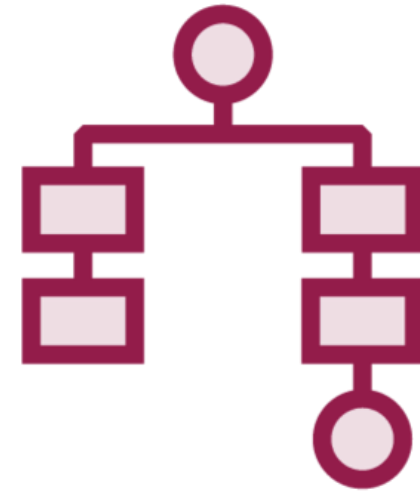
Type 4 (summary) & type 5 (external) LSAs  
not allowed

Replaced with type 3 (summary) LSA



# Stub Area

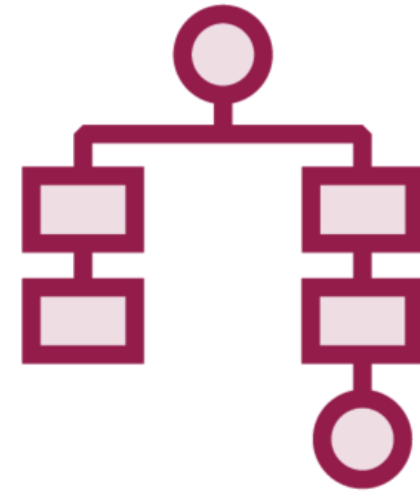
---





# Stub Area

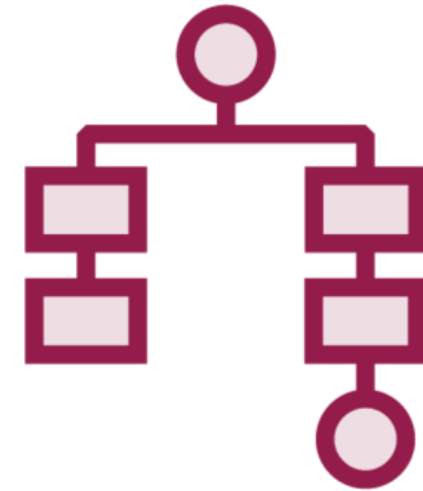
ASBRs not allowed



## Stub Area

ASBRs not allowed

Type 5 (external) LSAs not allowed

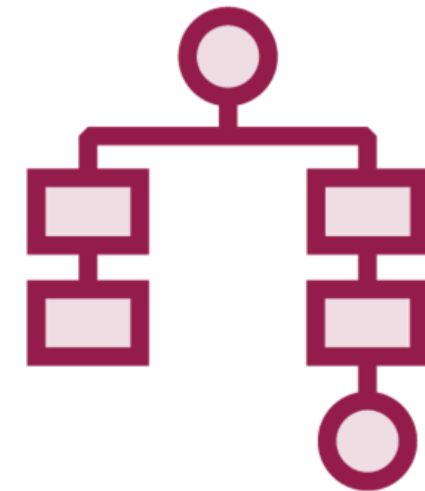


## Stub Area

ASBRs not allowed

Type 5 (external) LSAs not allowed

Restricted from being transit area  
(virtual link)



Single ABR recommended  
for stub area



# Totally Stubby Area

**Not part of original RFC**



# Totally Stubby Area

Restricted LSAs:

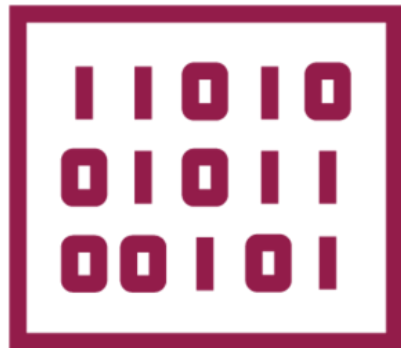
Type 3 & 4 summaries

Type 5 external

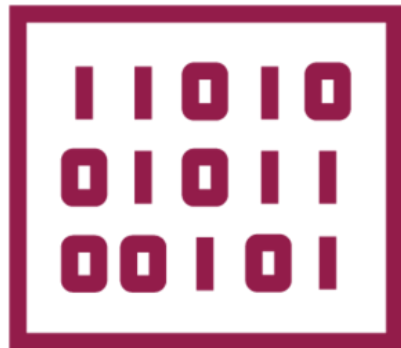
Replaced with type 3  
(summary) LSA



# Stub Areas



# Stub Areas

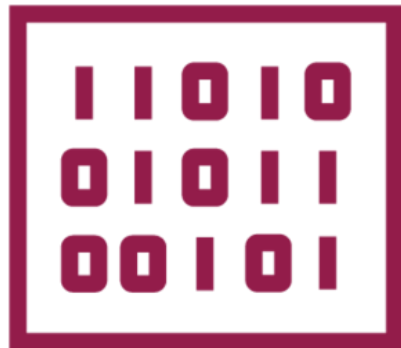


Stub and totally stubby areas use options E-bit





# Stub Areas

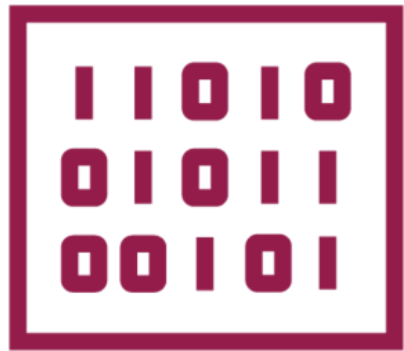


Stub and totally stubby areas use options  
E-bit

set to 1 = not stub



# Stub Areas



Stub and totally stubby areas use options  
E-bit

set to 1 = not stub

set to 0 = stub



NSSA used for stubs  
attached to external  
network





ASBRs not typically part of stub areas



ASBRs not typically part of stub areas  
NSSA created as a workaround



# NSSA

7

Transports external routes via  
LSA type 7



# NSSA

7

Transports external routes via  
LSA type 7

5

Converted to LSA type 5 at ABR





# Stub Areas

**Stubs provide ability to limit  
LSA entries**



# Stub Areas

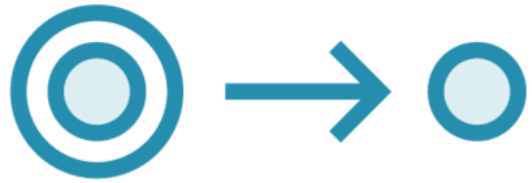
**Allows less powerful  
equipment to be used**



Back to the lab!









**Areas limit required device communications**





Areas limit required device communications

Without using stub areas, router (1) and network (2) LSAs converted to summary (3) LSAs at ABR



# Summary LSA - Type 3

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Link State Age										Options										3											
Link State ID																															
Advertising Router																															
Link State Sequence Number																															
Link State Checksum																Length															
Network Mask																															
0								Metric																							





# Summary LSA - Type 3

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Link State Age										Options										3											
Link State ID																															
Advertising Router																															
Link State Sequence Number																															
Link State Checksum																Length															
Network Mask																															
0								Metric																							



# Summary LSA - Type 3

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Link State Age										Options										3											
Link State ID																															
Advertised network number										Advertising Router																					
Link State Sequence Number																															
Link State Checksum																Length															
Network Mask																															
0										Metric																					



# Summary LSA - Type 3

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Link State Age										Options										3											
Link State ID																															
Advertising device RID (ABR)										Advertising Router																					
Link State Sequence Number																															
Link State Checksum																Length															
Network Mask																															
0								Metric																							



# Summary LSA - Type 3

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Link State Age										Options										3											
Link State ID																															
Advertising Router																															
Link State Sequence Number																															
Link State Checksum																Length															
Network Mask																															
0								Metric																							



# Summary LSA - Type 3

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Link State Age										Options					3										
Link State ID																									
Advertising Router																									
Link State Sequence Number																									
Link State Checksum										Length															
Network Mask																									
0								Metric																	



Type 4 Summary LSA



## Type 4 Summary LSA

Used to advertise ASBR reachability



## Type 4 Summary LSA

Used to advertise ASBR reachability

Originated at the ABR





# Type 4 Summary LSA

**External (5) send through  
whole OSPF domain**



# Type 4 Summary LSA

**Advertises ASBR router-ID**



# Type 4 Summary LSA

**Not known by devices outside  
of ASBR area**



# Type 4 Summary LSA

**Reachability part of Summary  
(4) LSA**



# Summary LSA - Type 4

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Link State Age															Options										4						
Link State ID																															
Advertising Router																															
Link State Sequence Number																															
Link State Checksum															Length																
0.0.0.0																															
0										Metric																					



# Summary LSA - Type 4

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Link State Age															Options										4						
Link State ID																															
ASBR RID											Advertising Router																				
Link State Sequence Number																															
Link State Checksum															Length																
0.0.0.0																															
0										Metric																					



# Summary LSA - Type 4

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Link State Age										Options										4											
Link State ID																															
Advertising device RID (ABR)										Advertising Router																					
Link State Sequence Number																															
Link State Checksum																Length															
0.0.0.0																															
0								Metric																							



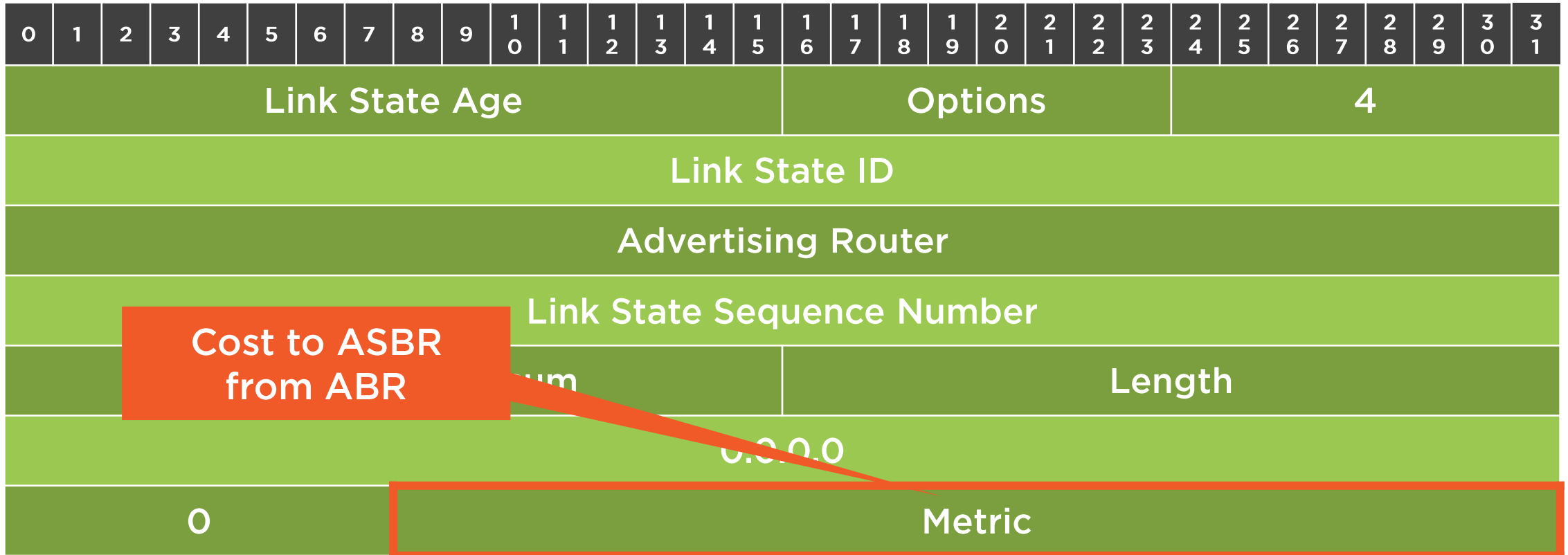
# Summary LSA - Type 4

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Link State Age															Options										4						
Link State ID																															
Advertising Router																															
Link State Sequence Number																															
Link State Checksum															Length																
0															0.0.0.0																
0															Metric																





# Summary LSA - Type 4



Not so stubby area LSA (7)



# NSSA LSA



Used to get around  
external route restrictions



# NSSA LSA



Used to get around  
external route restrictions



Summary (4) and external (5) not  
allowed in stub areas



# NSSA Area



# NSSA Area



**Allows external routes to be advertised**



# NSSA Area



**Allows external routes to be advertised**

**Uses NSSA (7) LSA**



# NSSA Area



**Allows external routes to be advertised**

**Uses NSSA (7) LSA**

**Almost identical to external (5) LSA**





# NSSA LSA - Type 7

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Link State Age										Options										7											
Link State ID																															
Advertising Router																															
Link State Sequence Number																															
Link State Checksum																Length															
Network Mask																															
E	O					Metric																									
Forwarding Address																															
External Route Tag																															

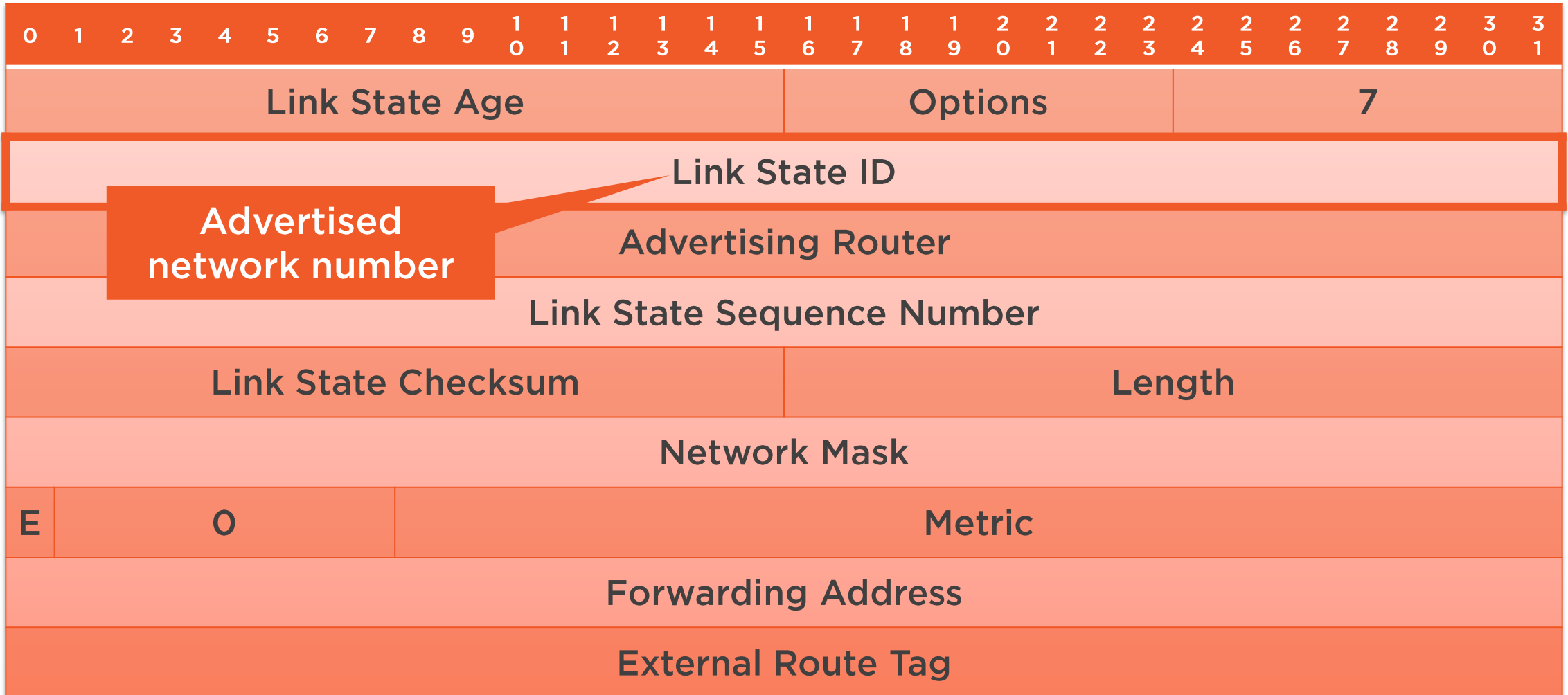


# NSSA LSA - Type 7

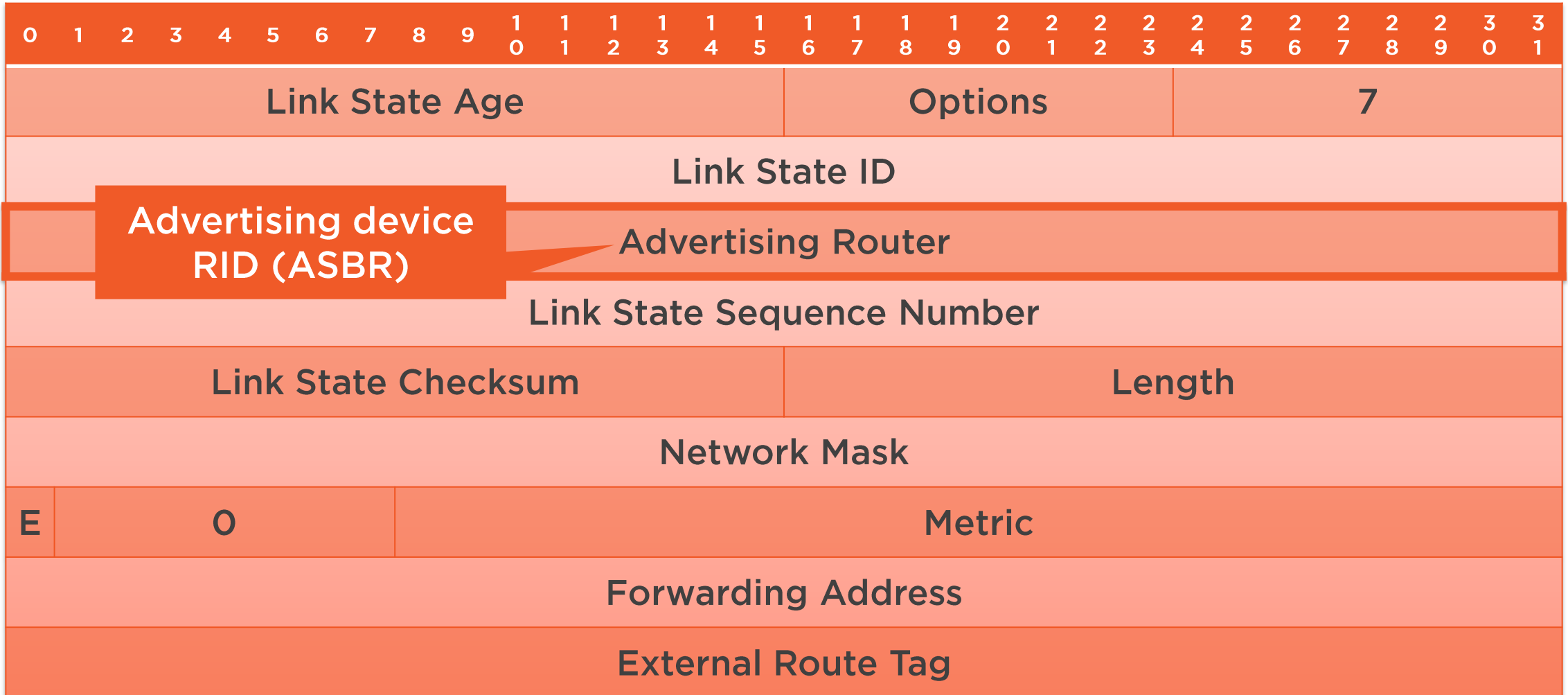
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Link State Age										Options										7												
Link State ID																																
Advertising Router																																
Link State Sequence Number																																
Link State Checksum																Length																
Network Mask																																
E	O								Metric																							
Forwarding Address																																
External Route Tag																																



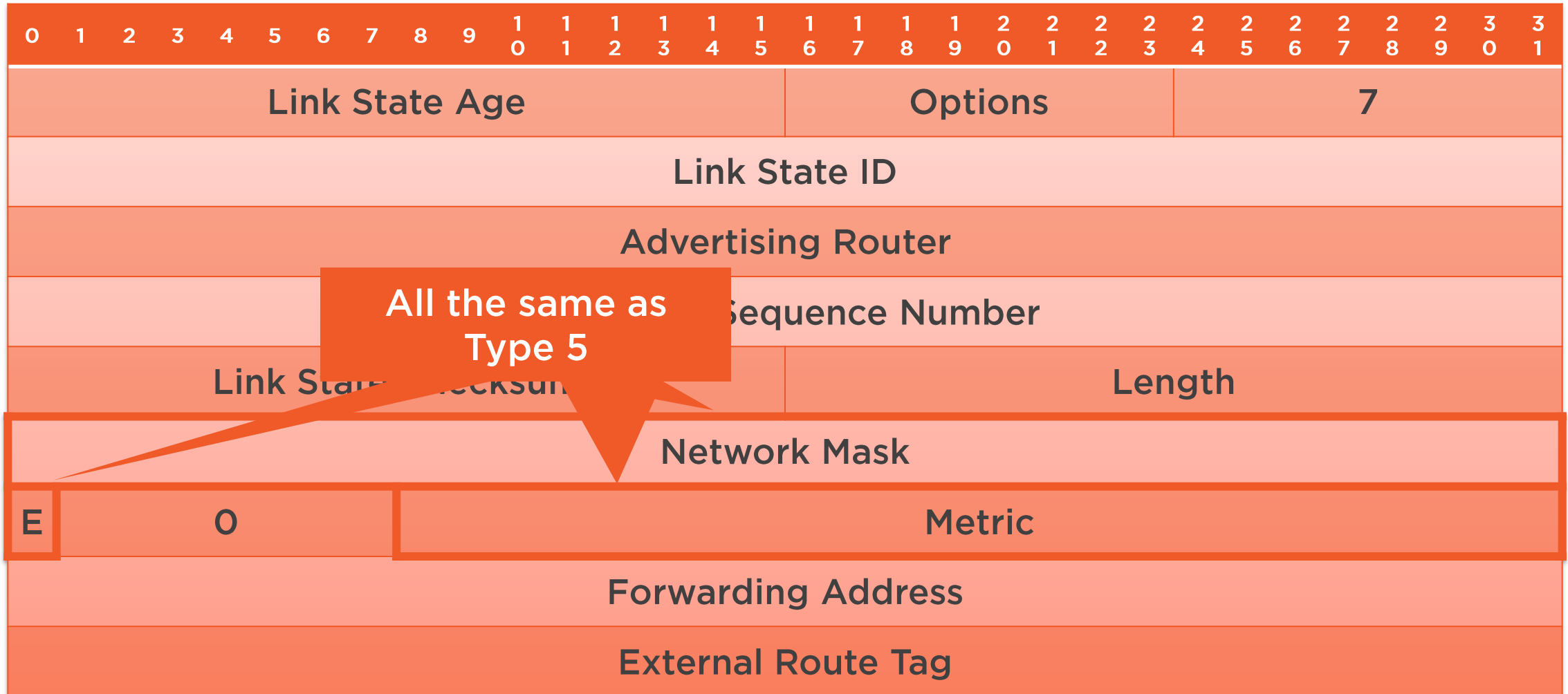
# NSSA LSA - Type 7



# NSSA LSA - Type 7



# NSSA LSA - Type 7



# NSSA LSA - Type 7

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Link State Age										0	0	D	E	N	M	E	0	7							
Link State ID																									
Advertising Router																									
Link State Sequence Number																									
Link State Checksum												Length													
Network Mask																									
E	0				Metric																				
Forwarding Address																									
External Route Tag																									



# NSSA LSA - Type 7

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Link State Age										0	0	D	E	N	M	E	0	7													
Link State ID																															
Advertising Router																															
<p><b>Hello/DBD: 1 = Configured NSSA</b>  <b>Link State: 1 = Propagate information</b></p>																															
Link State Checksum																Length															
Network Mask																															
E	0										Metric																				
Forwarding Address																															
External Route Tag																															



# NSSA LSA - Type 7

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Link State Age										0	0	D	E	N	M	E	0	7							
Link State ID																									
Advertising Router																									
Used in place of E-bit																									
Link State Checksum												Length													
Network Mask																									
E	0				Metric																				
Forwarding Address																									
External Route Tag																									





# NSSA LSA - Type 7

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Link State Age										0	0	D	E	N	M	E	0	7													
Link State ID																															
Advertising Router																															
Link State Sequence Number																															
Link S																Length															
ASBR interface IP address																work Mask															
E	0										Metric																				
Forwarding Address																															
External Route Tag																															





# Stub Area

Doesn't allow:

Summary (4) LSA

External (5) LSA



# Stub Area

Does allow:

Router (1) LSA

Summary (3)  
LSA

Network (2)  
LSA

Default  
summary (3)  
LSA



# Totally Stubby Area

Doesn't allow:

Summary (3) LSA

Summary (4) LSA

External (5) LSA



# Totally Stubby Area

Does allow:

Router (1) LSA

Network (2)  
LSA

Default  
summary (3)  
LSA



# NSSA Stub Area

Doesn't allow:

Summary (4) LSA

External (5) LSA



# NSSA Stub Area

Does allow:

Router (1) LSA

All summary (3)  
LSAs

Network (2) LSA

NSSA (7) LSA





# NSSA Totally Stub Area

Doesn't allow:

Summary (3) LSA

Summary (4) LSA

External (5) LSA



# NSSA Totally Stub Area

Does allow:

Router (1) LSA

Network (2)  
LSA

Default  
summary (3)  
LSA

NSSA (7) LSA



# Summary



# Summary



**What is multi-area OSPF?**



# Summary



**What is multi-area OSPF?**

**Reviewing the different OSPF device types**



# Summary



**What is multi-area OSPF?**

**Reviewing the different OSPF device types**

**Differentiating the different OSPF area types**



# Summary



**What is multi-area OSPF?**

**Reviewing the different OSPF device types**

**Differentiating the different OSPF area types**

**Decoding multi-area OSPF building blocks**



# Example Topology

