

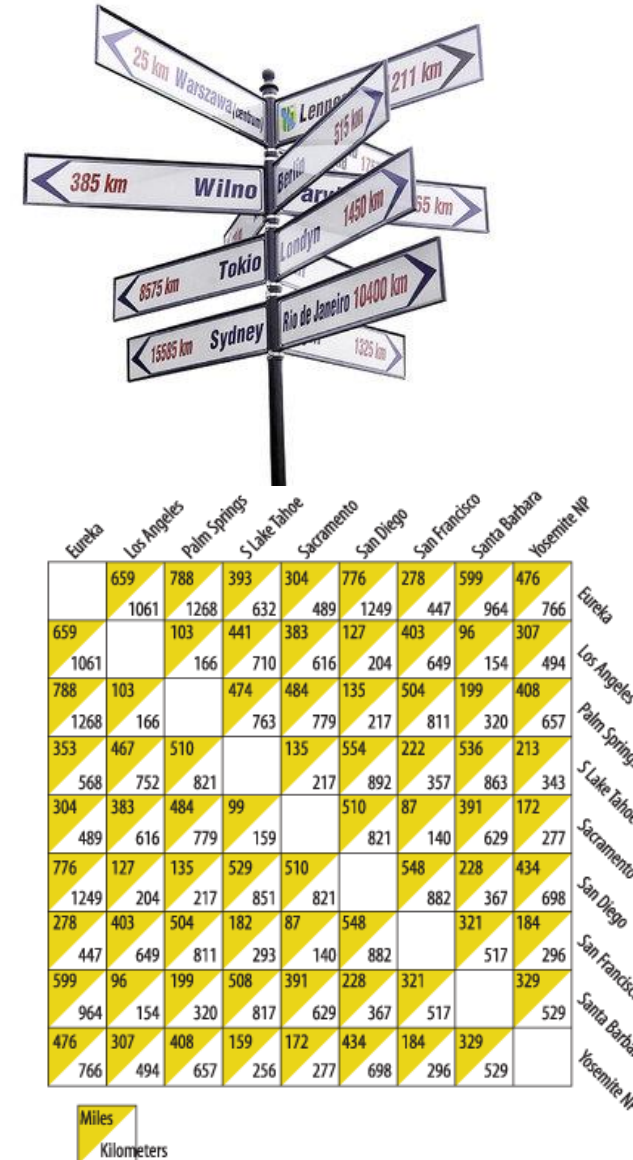
Usmjeravanje i preklapanje u računalskim mrežama

- OSPF (Open Shortest Path First)



Routing protokoli

- **Distance Vector vs Link State**
 - Usmjernici koji koriste „Distance Vector” protokole šalju informacije o pojedinim udaljenim mrežama na temelju kojih usmjernici sastavljaju usmjerničke tablice u usmjeravaju promet
 - Usmjernici koji koriste „Link State” protokole šalju informacije o topologiji (stanju svih linkova) na temelju koje svaki usmjernik za sebe računa najkraći put do svakog odredišta



OSPF-Open Shortest Path First

- OSPF svojstva uključuju:
 - Brzu konvergenciju
 - Podršku za VLSM
 - Podržavaju velike mreže
 - Usmjeravanje je temeljeno na samostalnom izračunu najbolje putanje na svakom usmjerniku
 - Grupiranje usmjernika u područja (Areas)

USMJERNIČKI PROTOKOL	METRIC
RIPv1 i v2	HOP COUNT
EIGRP	Složeni metric temeljen na bandwidth i delay
OSPF	cost temeljen na bandwidth linka 100Mbps=1
BGP	Složeni metric temeljen na "atributima"

OSPF-Open Shortest Path First

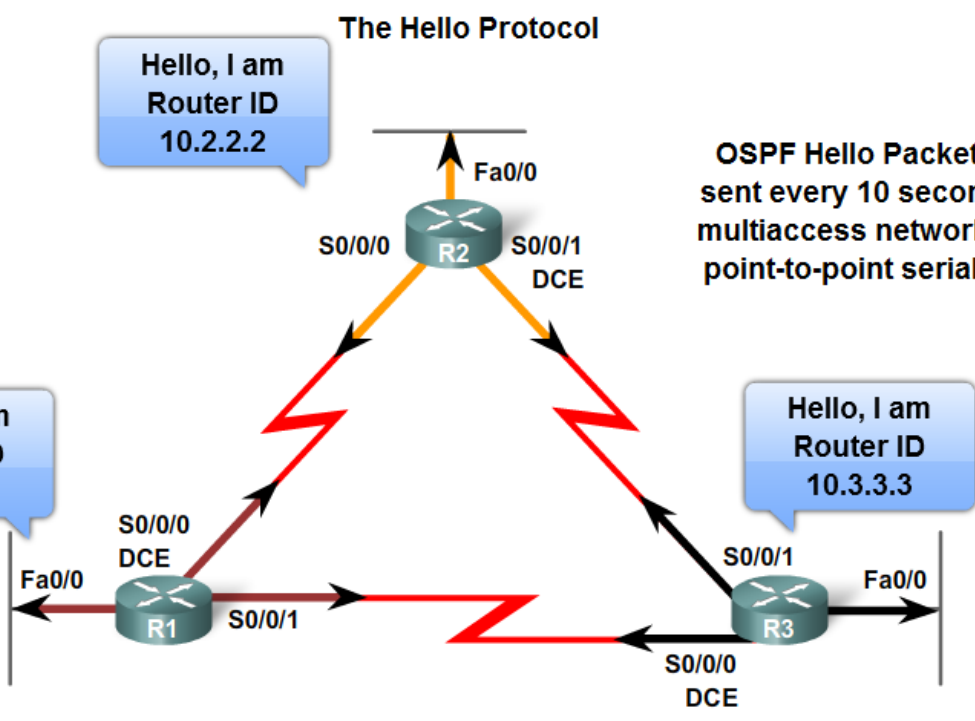
The Hello Protocol

Hello, I am Router ID 10.2.2.2

Hello, I am Router ID 10.1.1.1

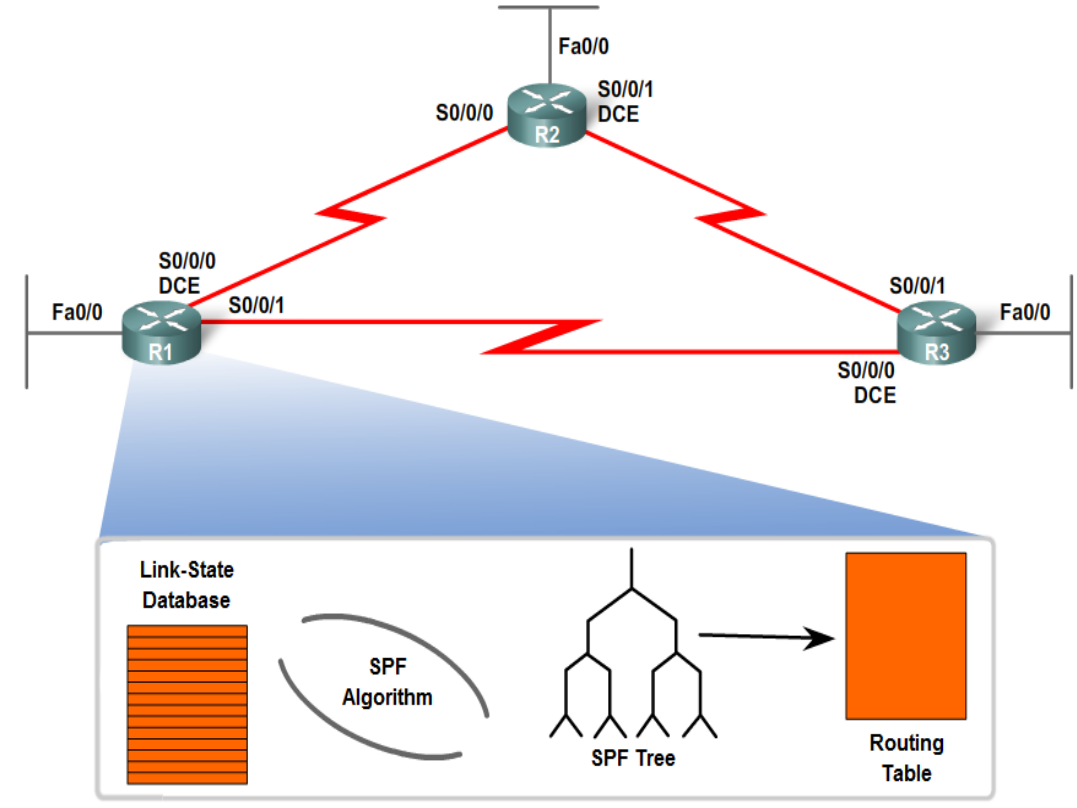
OSPF Hello Packets are sent every 10 seconds on multiaccess networks and point-to-point serial links.

Hello, I am Router ID 10.3.3.3

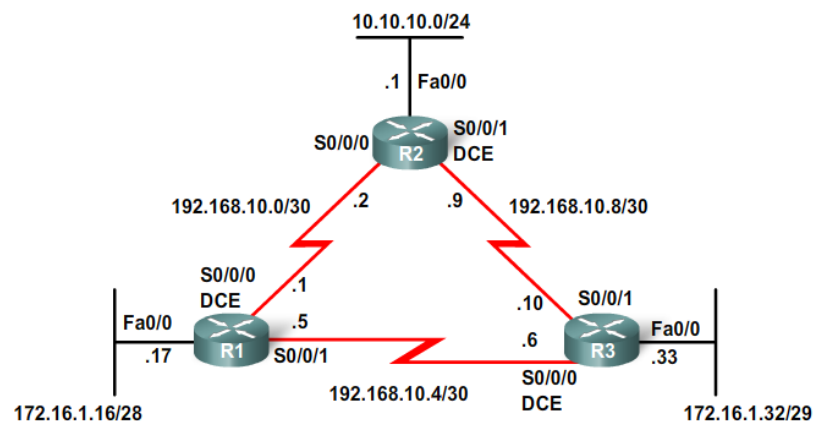


Matching interface values for two routers to form an adjacency

Hello Interval	}	=	{	Hello Interval
Dead Interval				Dead Interval
Network Type				Network Type



OSPF-Open Shortest Path First



- Ako koristimo subnet masku Cisco ruter će u konfiguraciji to prikazati kao wildcard masku

```
R1 (config) #router ospf 1
R1 (config-router) #network 172.16.1.16 0.0.0.15 area 0
R1 (config-router) #network 192.168.10.0 0.0.0.3 area 0
R1 (config-router) #network 192.168.10.4 0.0.0.3 area 0
```

```
R2 (config) #router ospf 1
R2 (config-router) #network 10.10.10.0 0.0.0.255 area 0
R2 (config-router) #network 192.168.10.0 0.0.0.3 area 0
R2 (config-router) #network 192.168.10.8 0.0.0.3 area 0
```

```
R3 (config) #router ospf 1
R3 (config-router) #network 172.16.1.32 0.0.0.7 area 0
R3 (config-router) #network 192.168.10.4 0.0.0.3 area 0
R3 (config-router) #network 192.168.10.8 0.0.0.3 area 0
```

Wildcard maska je suprotno od subnet maske
255.255.255.255 minus 255.255.255.240

OSPF-Open Shortest Path First

- Svaki ruter odabire svoj Router-ID na temelju:
IP adrese koja je konfigurirana kao Router-ID u OSPF procesu
R2(config-router)#router-id 10.0.0.2
- Ako Router-ID nije konfiguriran ručno tada usmjernik odabire najveću IP adresu aktivnog Loopback sučelja
- Ako ne postoje Loopback sučelja, tada usmjernik odabire najvišu IP adresu aktivnog fizičkog sučelja

```
R1#show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 10.1.1.1
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa

R2#show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 10.2.2.2
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa

R3#show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 10.3.3.3
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
```

Nakon dodavanja loopback treba resetirati OSPF proces da bi se promijenio Router-ID
R2#clear ip ospf process

OSPF susjedski odnosi

Prioritet sučelja-sluzi za odabir DR i BDR

R1(config-if)#**ip ospf priority 2**

Max je 255 što veći to bolji

Stanje između
susjeda

```
R1#show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
10.3.3.3	1	FULL/ -	00:00:30	192.168.10.6	Serial0/0/1
10.2.2.2	1	FULL/ -	00:00:33	192.168.10.2	Serial0/0/0

```
R2#show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
10.3.3.3	1	FULL/ -	00:00:36	192.168.10.10	Serial0/0/1
10.1.1.1	1	FULL/ -	00:00:37	192.168.10.1	Serial0/0/0

```
R3#show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
10.2.2.2	1	FULL/ -	00:00:34	192.168.10.9	Serial0/0/1
10.1.1.1	1	FULL/ -	00:00:38	192.168.10.5	Serial0/0/0

Router-ID
susjeda

Adresa sučelja susjeda s kojim
smo direktno spojeni

Adresa sučelja na koju smo
ostvarili susjedске odnose

OSPF susjedski odnosi

Dva rutera neće ostvariti susjedске odnose ako:

- Mrežna maska na sučeljima nije ista
- Ako *hello* i *dead* vremena za OSPF nisu ista na oba usmjernika na vezi koja ih povezuje
- Ako tip mreže na vezi koja povezuje dva usmjernika nije isti (Network type)
- Ako pri oglašavanju podmreže veze koja povezuje dva usmjernika nije korišten isti broj područja
- Ako nismo točno upisali NETWORK naredbu
- Ako ne koristimo istu vrstu autentifikacije i lozinke
- Ako Stub area flag

OSPF show naredbe

```
R1#show ip protocols
```

```
Routing Protocol is "ospf 1"
```

```
Outgoing update filter list for all interfaces is not set
```

```
Incoming update filter list for all interfaces is not set
```

```
Router ID 10.1.1.1
```

```
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
```

```
Maximum path: 4
```

```
Routing for Networks:
```

```
172.16.1.16 0.0.0.15 area 0
```

```
192.168.10.0 0.0.0.3 area 0
```

```
192.168.10.4 0.0.0.3 area 0
```

```
Reference bandwidth unit is 100 mbps
```

```
Routing Information Sources:
```

Gateway	Distance	Last Update
---------	----------	-------------

10.2.2.2	110	11:29:29
----------	-----	----------

10.3.3.3	110	11:29:29
----------	-----	----------

```
Distance: (default is 110)
```

```
R1#show ip ospf
```

```
<some output omitted>
```

```
Routing Process "ospf 1" with ID 10.1.1.1
```

```
Start time: 00:00:19.540, Time elapsed: 11:31:15.776
```

```
Supports only single TOS(TOS0) routes
```

```
Supports opaque LSA
```

```
Supports Link-local Signaling (LLS)
```

```
Supports area transit capability
```

```
Router is not originating router-LSAs with maximum metric
```

```
Initial SPF schedule delay 5000 msecs
```

```
Minimum hold time between two consecutive SPF's 10000 msecs
```

```
Maximum wait time between two consecutive SPF's 10000 msecs
```

```
Incremental-SPF disabled
```

```
Minimum LSA interval 5 secs
```

```
Minimum LSA arrival 1000 msecs
```

```
Area BACKBONE (0)
```

```
Number of interfaces in this area is 3
```

```
Area has no authentication
```

```
SPF algorithm last executed 11:30:31.628 ago
```

```
SPF algorithm executed 5 times
```

```
Area ranges are
```

```
<output omitted>
```

Vezano za odgodu pokretanja SPF algoritma u slučajevima kada je mreža nestabilna i ima puno promjena

OSPF show naredbe

R1(config-if)#**ip ospf hello-interval 5**
R1(config-if)#**ip ospf dead-interval 20**
Default je 10 i 40

```
R1#show ip ospf interface serial 0/0/0
Serial0/0/0 is up, line protocol is up
Internet Address 192.168.10.1/30, Area 0
Process ID 1, Router ID 10.1.1.1, Network Type POINT_TO_POINT, Cost: 64
Transmit Delay is 1 sec, State POINT_TO_POINT,
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
  oob-resync timeout 40
  Hello due in 00:00:07
Supports Link-local Signaling (LLS)
Index 2/2, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 1
Last flood scan time is 0 msec, maximum is 4 msec
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 10.2.2.2
Suppress hello for 0 neighbor(s)
```

Možemo ručno mijenjati pod sučeljem naredbom:
R2(config-if)#**ip ospf cost 10**

OSPF show naredbe

```
R1#show ip route
```

```
Codes: <some code output omitted>
```

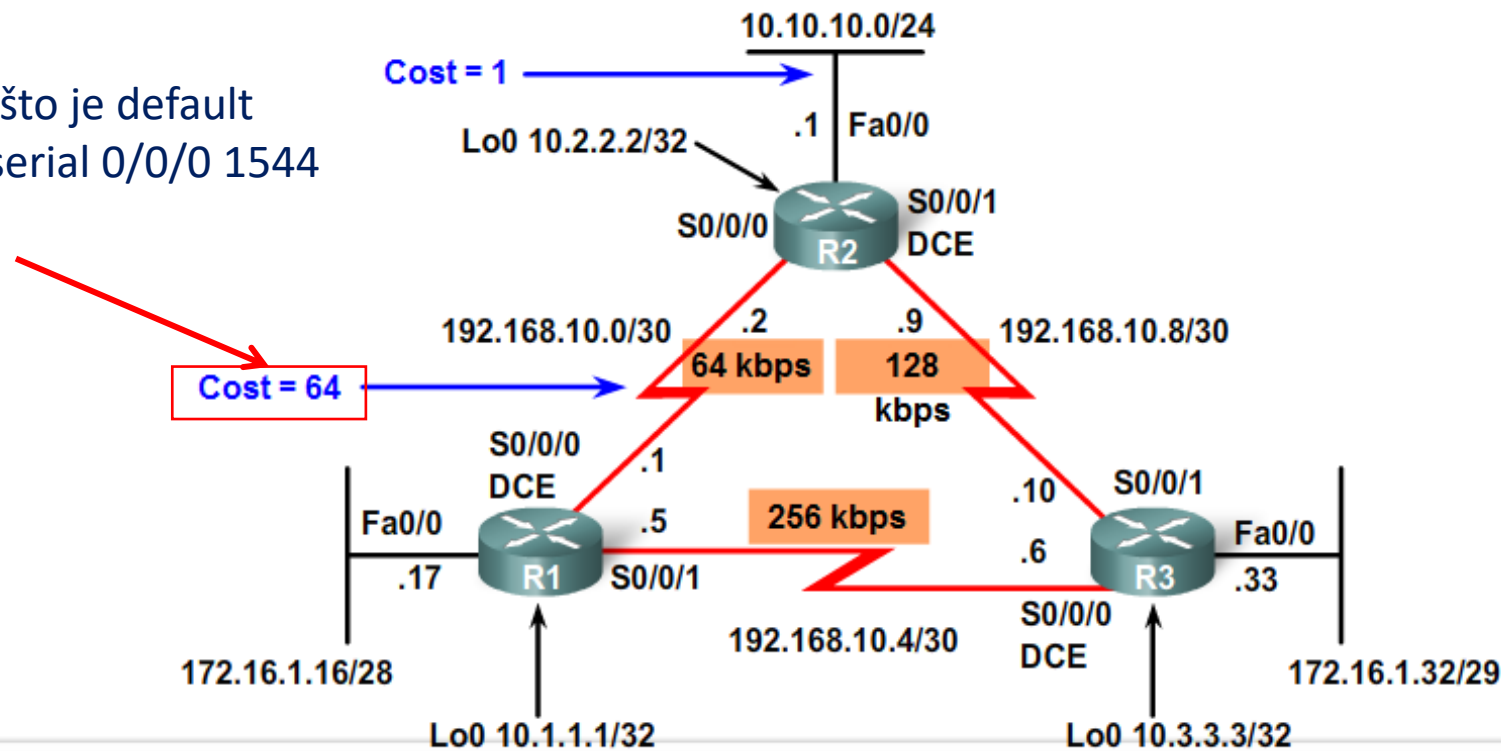
```
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
```

```
Gateway of last resort is not set
```

```
       192.168.10.0/30 is subnetted, 3 subnets
C       192.168.10.0 is directly connected, Serial0/0/0
C       192.168.10.4 is directly connected, Serial0/0/1
O       192.168.10.8 [110/128] via 192.168.10.2, 14:27:57, Serial0/0/0
       172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
O       172.16.1.32/29 [110/65] via 192.168.10.6, 14:27:57, Serial0/0/1
C       172.16.1.16/28 is directly connected, FastEthernet0/0
       10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O       10.10.10.0/24 [110/65] via 192.168.10.2, 14:27:57, Serial0/0/0
C       10.1.1.1/32 is directly connected, Loopback0
```

Cost neke putanje-kumulativan

Cost je 64 zato što je default bandwidth na serial 0/0/0 1544 kbps



```
R1#show ip route
Codes: <some code output omitted>
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area

<route output omitted>
O      10.10.10.0/24 [110/65] via 192.168.10.2, 14:27:57, Serial10/0/0
```

Accumulated Cost = 65

Cost neke putanje-kumulativan

```
R1(config)#inter serial 0/0/0
```

```
R1(config-if)#bandwidth 64
```

```
R1(config-if)#inter serial 0/0/1
```

```
R1(config-if)#bandwidth 256
```

```
R1(config-if)#end
```

```
R1#show ip ospf interface serial 0/0/0
```

```
Serial0/0 is up, line protocol is up
```

```
Internet Address 192.168.10.1/30, Area 0
```

```
Process ID 1, Router ID 10.1.1.1, Network Type POINT_TO_POINT, Cost: 1562
```

```
Transmit Delay is 1 sec, State POINT_TO_POINT,
```

```
<output omitted>
```

$$10^8 / 64,000 \text{ bps} = 1562$$

- Ako je stvarni bandwidth drugačiji od default bandwidtha za određeno sučelje tada trebamo to ueti u obzir (promijeniti bandwidth) ako koristimo OSPF

```
R1(config)#inter serial 0/0/0
```

```
R1(config-if)#ip ospf cost 1562
```

```
R1(config-if)#end
```

```
R1#show ip ospf interface serial 0/0/0
```

```
Serial0/0 is up, line protocol is up
```

```
Internet Address 192.168.10.1/30, Area 0
```

```
Process ID 1, Router ID 10.1.1.1, Network Type POINT_TO_POINT, Cost: 1562
```

```
Transmit Delay is 1 sec, State POINT_TO_POINT,
```

```
<output omitted>
```

No Calculation Needed

OSPF tipovi mreža

OSPF definira 5 tipova mreža:

- Point-to-point
- Broadcast Multiaccess
- Nonbroadcast Multiaccess (NBMA)-FR,ATM
- Nonbroadcast Multiaccess Point-to-multipoint-FR,ATM
- Virtual links

Cisco definira dodatna 3 moda

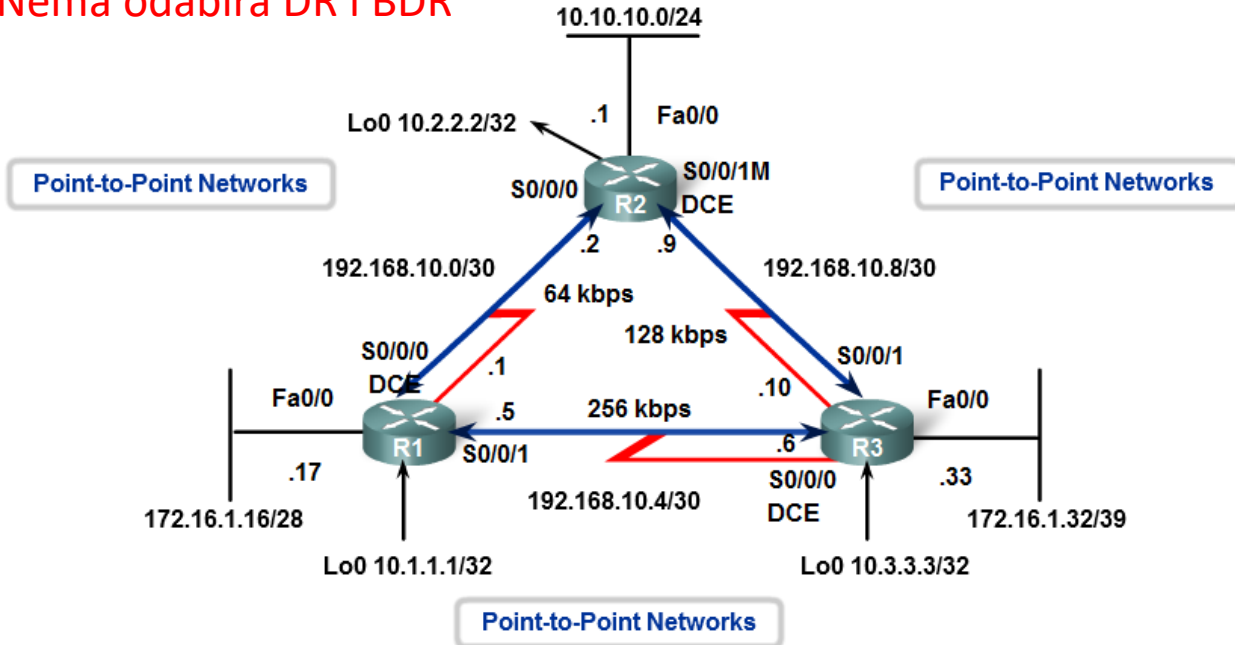
Point-to-multipoint nonbroadcast

Broadcast

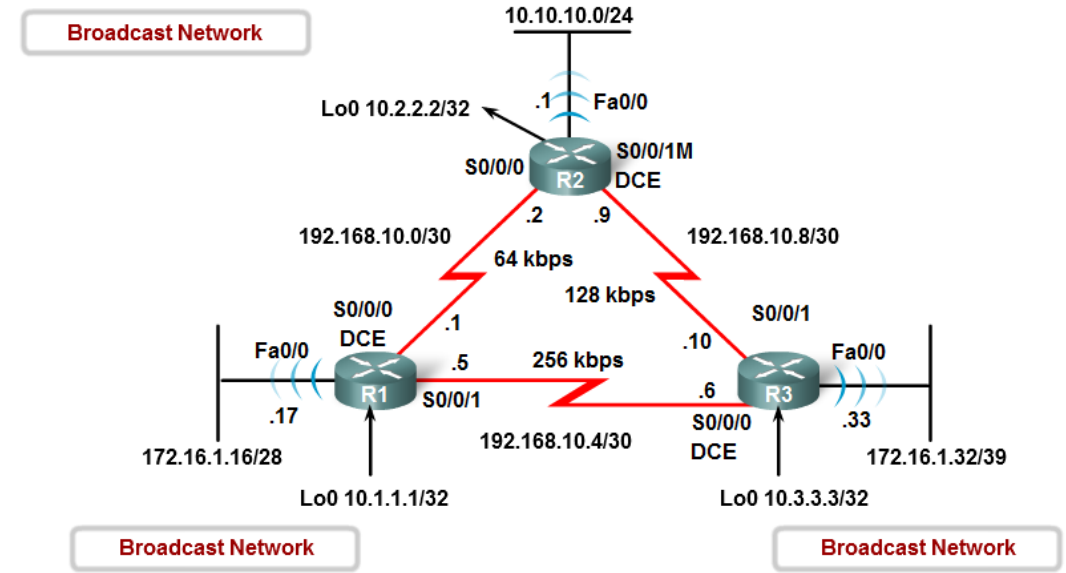
Point-to-point

OSPF tipovi mreža

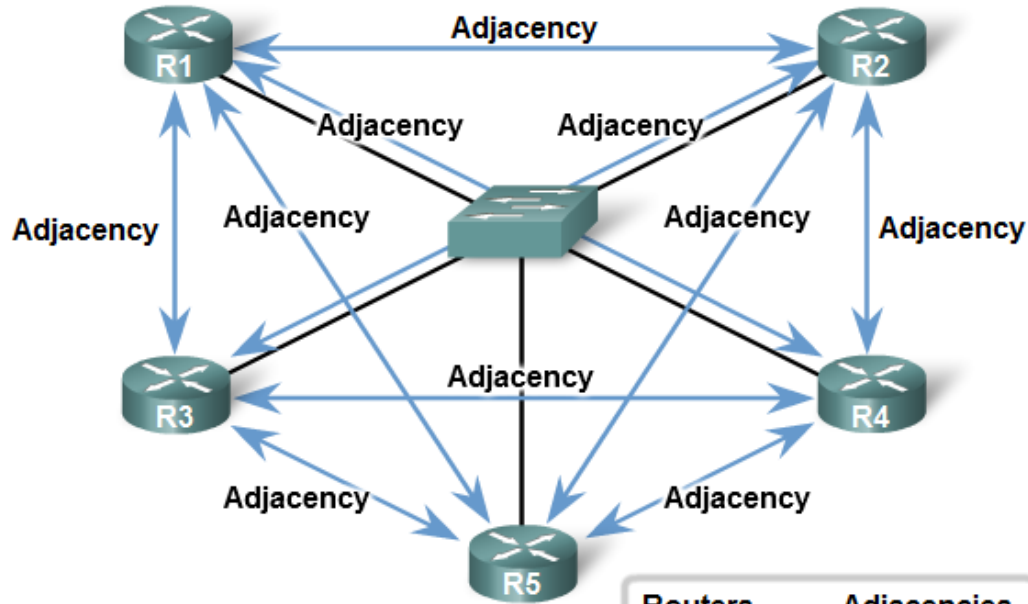
Nema odabira DR i BDR



Bira se DR i BDR

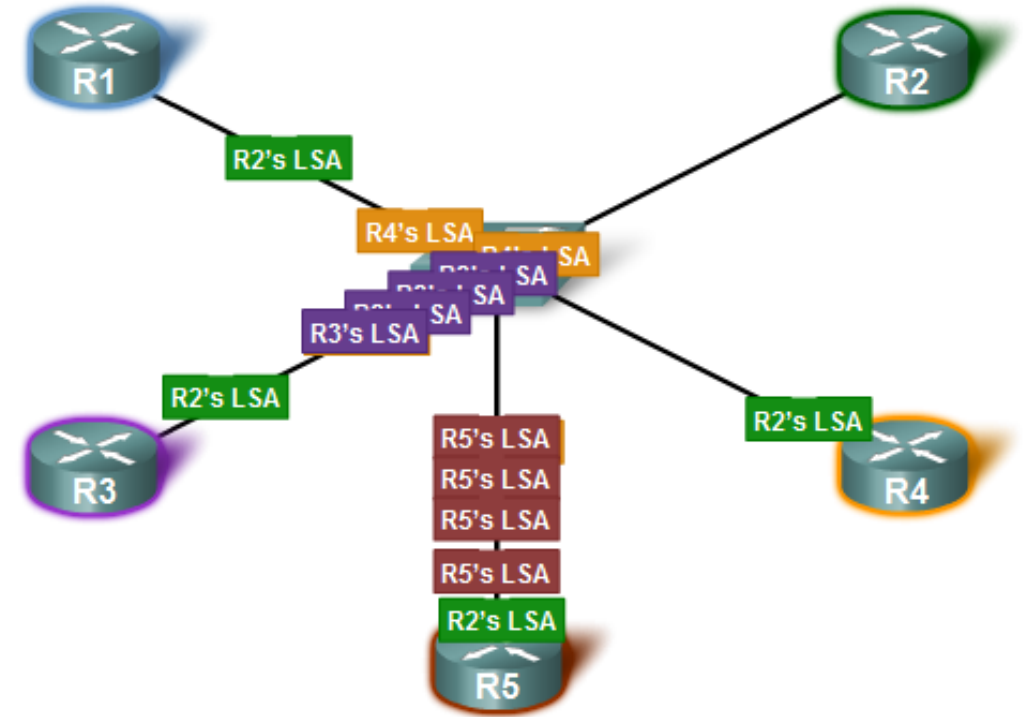


Broadcast mreže



Routers	Adjacencies
n	$\frac{n(n-1)}{2}$
5	10
10	45
20	190
100	4,950

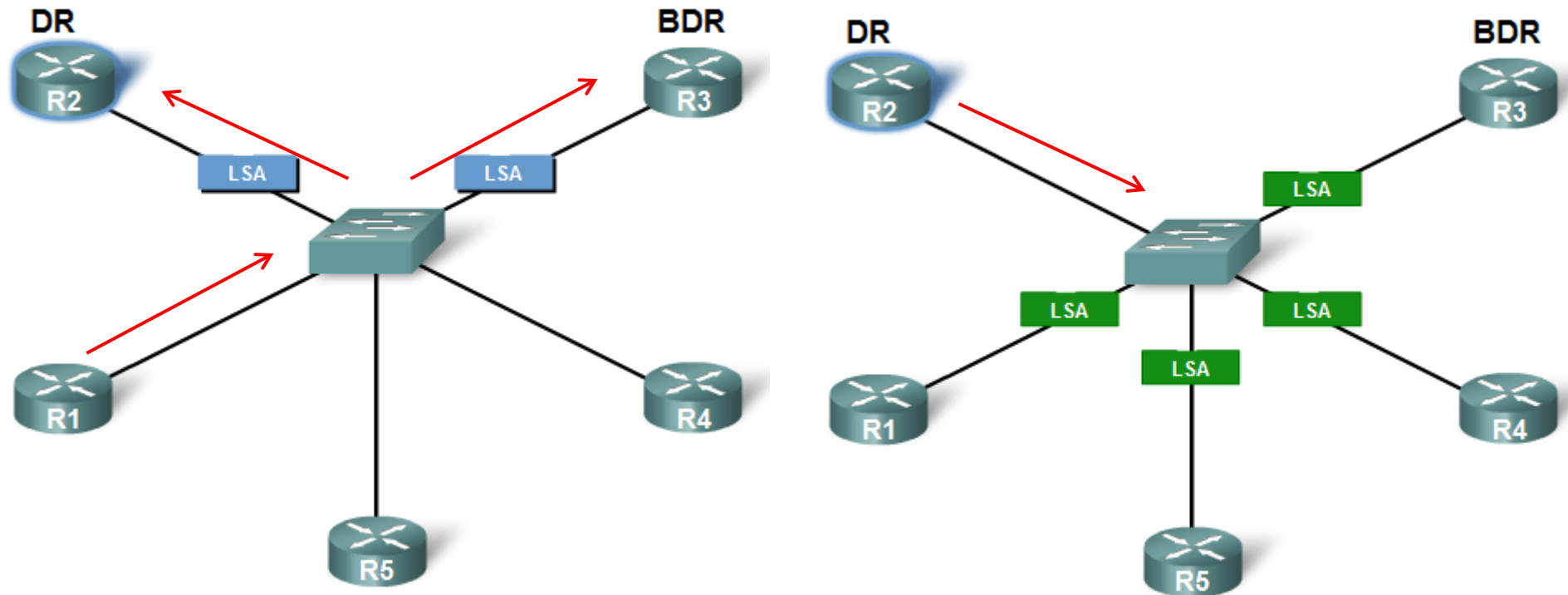
Number of Adjacencies = $\frac{n(n-1)}{2}$
 n = number of routers
Example: 5 routers $(5 - 1)/2 = 10$ adjacencies



Problemi ovakvih mreža su:

1. Veliki broj uspostavljenih veza "Adjacency"
2. Poplava (LSA Flooding) LSA (Link State Advertisement) paketa

Broadcast Networks DR i BDR



- R1 šalje LSA samo prema DR i BDR na njihove multicast adrese 224.0.0.6
- Zatim DR šalje svim ruterima na 224.0.0.5

Odabir DR i BDR

- Na Point-to-Point linkovima nema odabira DR i BDR, svi updatei se šalju na 224.0.0.5

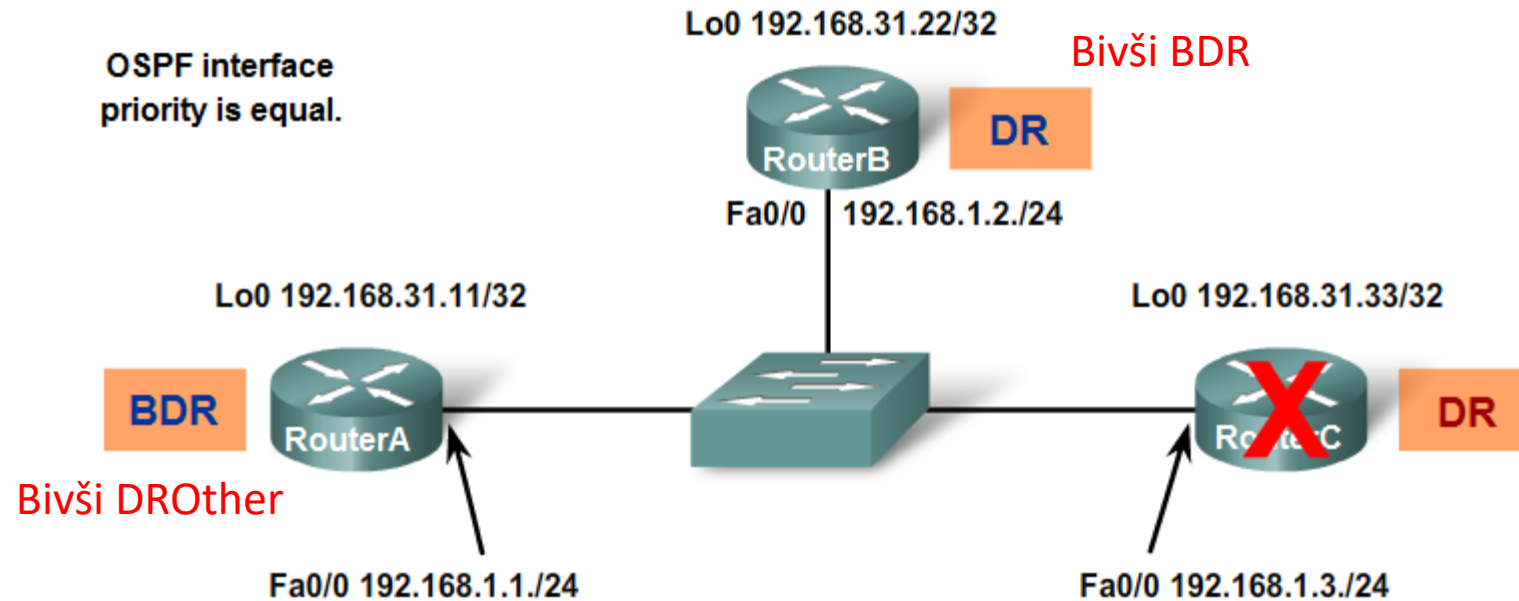
Odabir DR i BDR se vrši na slijedeći način:

- Ruter s **najvišim OSPF prioritetom** na sučelju shared segmenta (po defaultu priority je 1 tako da taj dio nema utjecaj na odabir DR i BDR) *ako je **priority 0** tada taj ruter ne sudjeluje u odabiru DR i BDR!*
- Ako je Priority jednak tada se u obzir uzima **najviši Router-ID**

- Ako je u mreži odabran DR, ni jedna novi ruter bez obzira na viši priority ili Router-ID neće utjecati na stanje (radi stabilnosti mreže)
- Ako otkáže DR, jedino BDR može postati DR, ni jedan drugi ruter bez obzira na Priority ili Router-ID (radi stabilnosti mreže)
- Ako se ruter koji je bio DR vrati u mrežu također neće utjecati na stabilno stanje

Otkaz DR

Princip je da se ne narušava stabilna topologija (kao izbori)

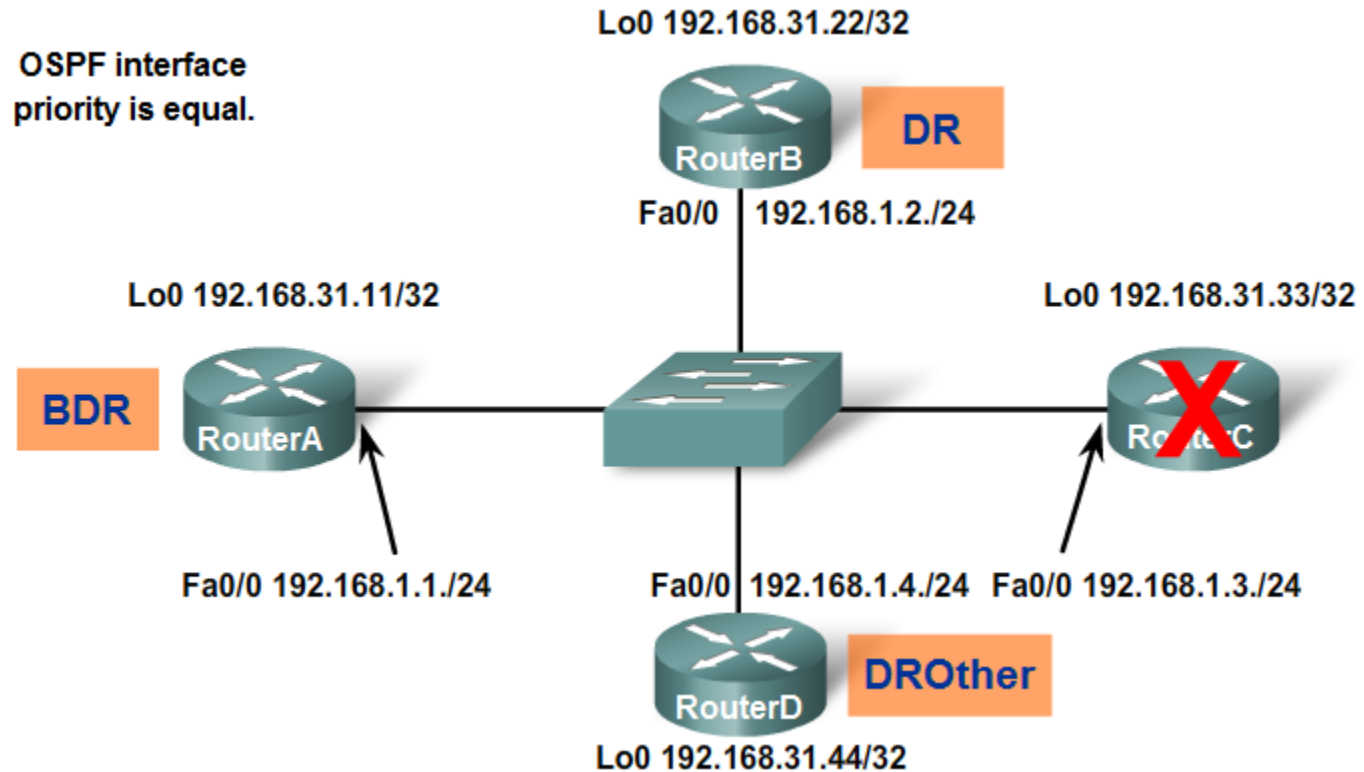


```
RouterA#show ip ospf interface fastethernet 0/0
FastEthernet0/0 is up, line protocol is up
Internet Address 192.168.1.1/24, Area 0
Process ID 1, Router ID 192.168.31.11, Network Type BROADCAST, Cost: 1
Transmit Delay is 1 sec, State DROTHER, Priority 1
Designated Router (ID) 192.168.31.33, Interface address 192.168.1.3
Backup Designated router (ID) 192.168.31.22, Interface address 192.168.1.2
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
```

Ovo znači da ovaj ruter (RouterA) nije ni DR ni BDR

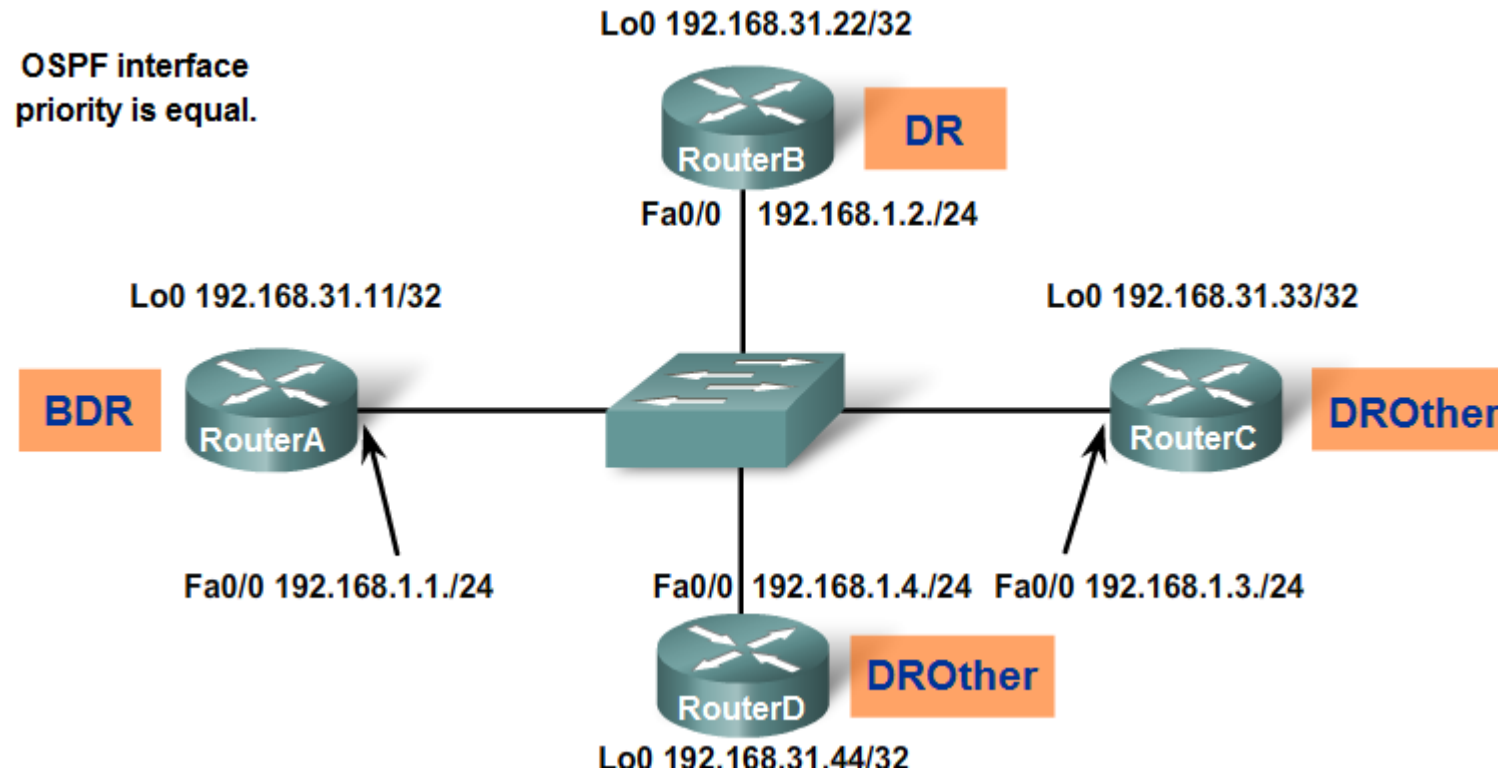
Dodaje se novi ruter

Princip je da se ne narušava stabilna topologija (kao izbori)



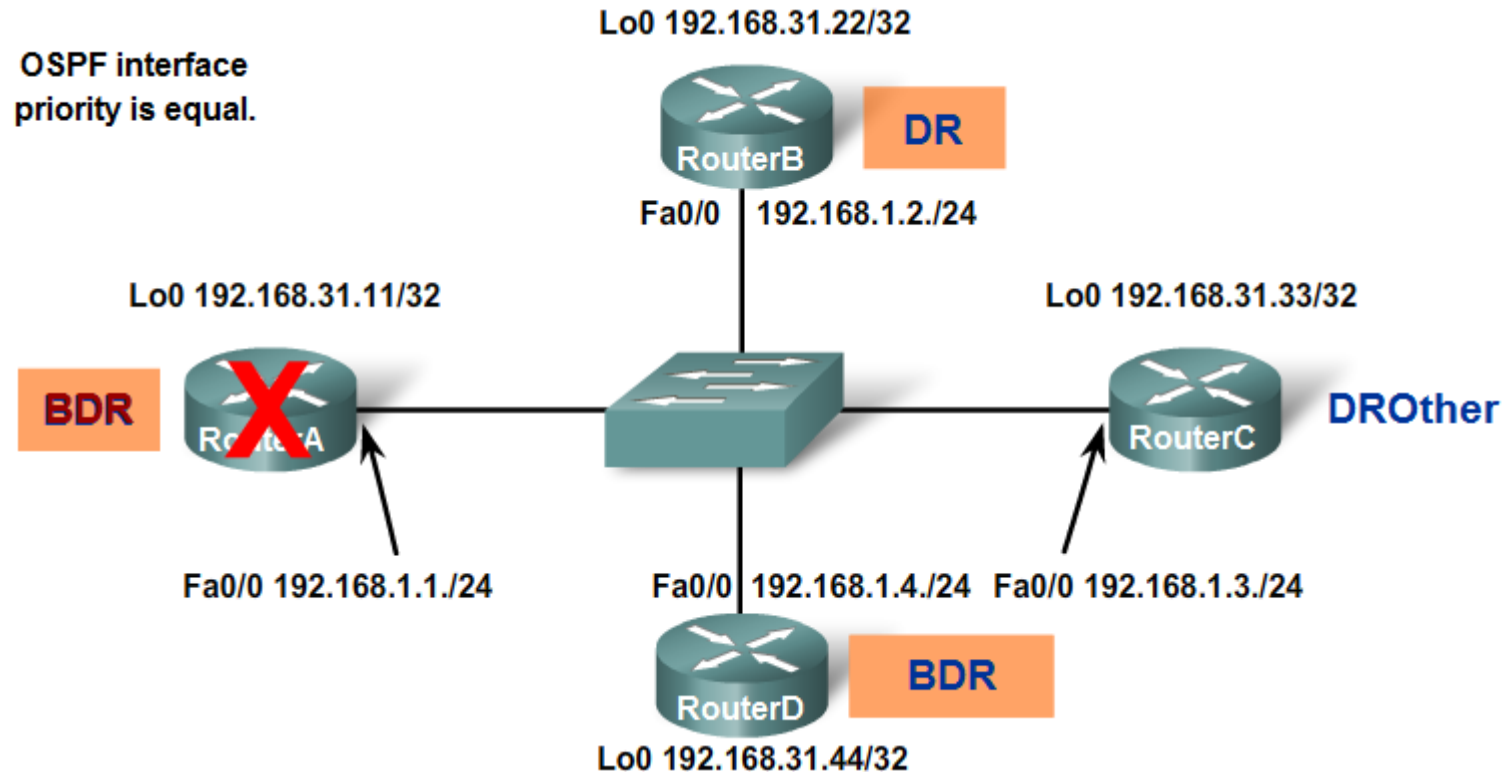
Vratio se stari DR

Princip je da se ne narušava stabilna topologija (kao izbori)



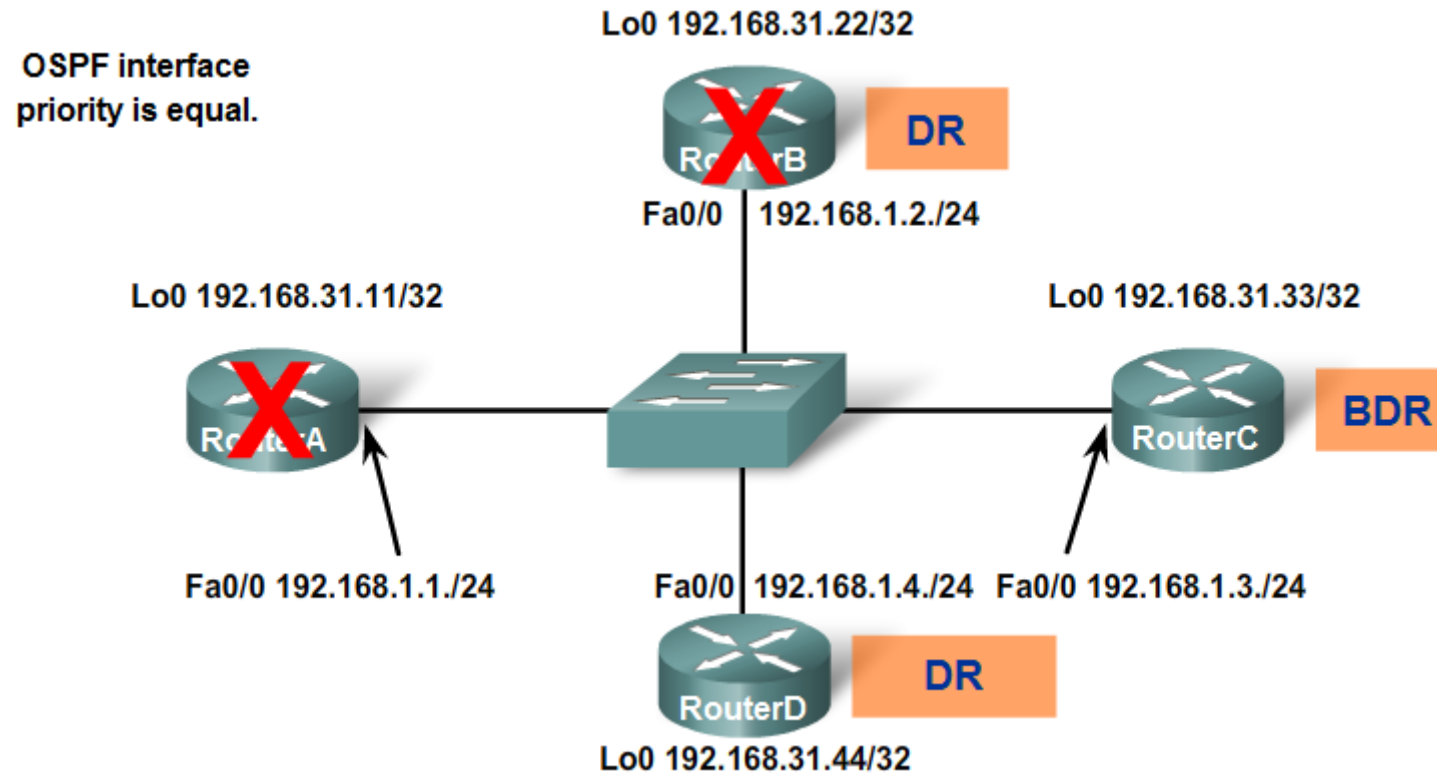
Otkaz BDR

Princip je da se ne narušava stabilna topologija (kao izbori)

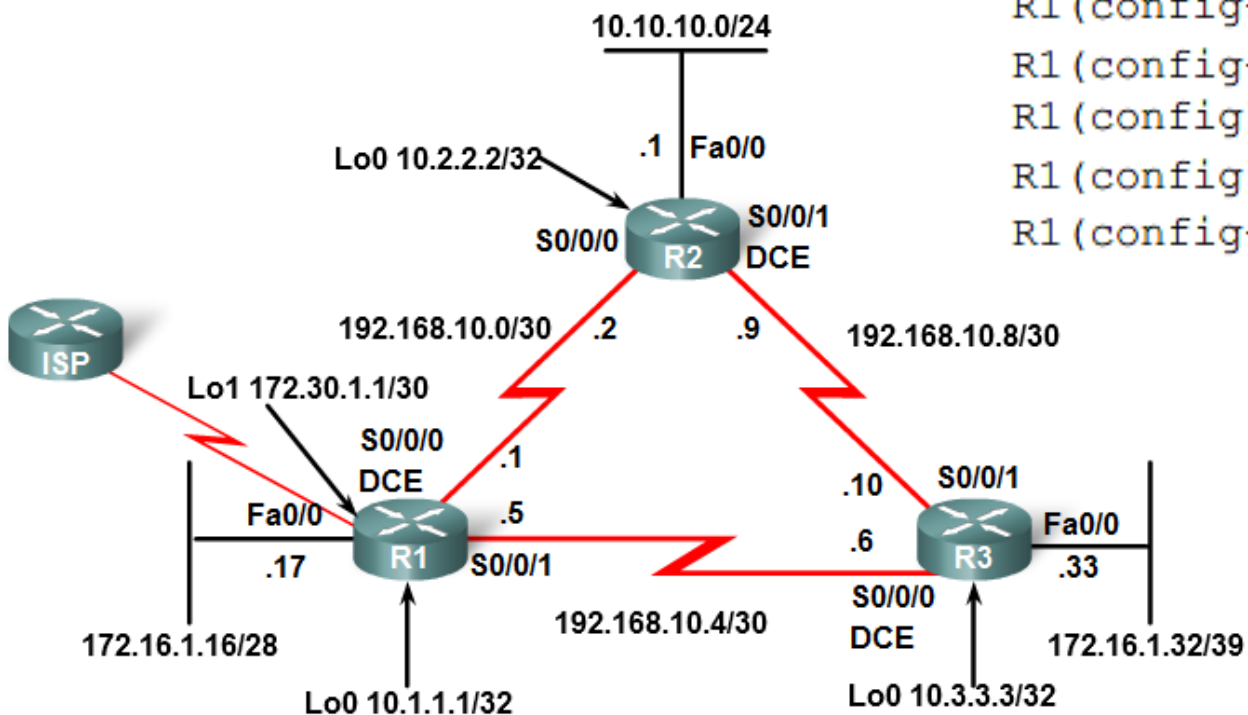


Novi DR otkazuje

Princip je da se ne narušava stabilna topologija (kao izbori)



Redistribucija Default rute



```
R1 (config) #interface loopback 1
R1 (config-if) #ip add 172.30.1.1 255.255.255.252
R1 (config-if) #exit
R1 (config) #ip route 0.0.0.0 0.0.0.0 loopback 1
R1 (config) #router ospf 1
R1 (config-router) #default-information originate
```

Uvijek kada želimo da se u OSPF ubaci default putanja bez obzira na izvor (npr. Redistribucija iz EIGRP ili RIP)

```
C 10.2.2.2/32 is directly connected, Loopback0
C 10.10.10.0/24 is directly connected, FastEthernet0/0
O*E2 0.0.0.0/0 [110/1] via 192.168.10.10, 00:00:13, Serial0/0/1
```


Redistribucija nekog usmjerničkog protokola (RIP, EIGRP)

Ako u OSPF redistribuiramo npr. RIP ili EIGRP rute tada moramo dodati naredbu "subnets" kako bi OSPF redistribuirao mreže bez obzira na subnet masku. Ako to ne upišemo tada OSPF redistribuira samo mreže koje imaju subnet masku klase (A,B,C)

Npr.

Bez naredbe **subnets** neće proći **172.16.1.0 /24** ili **10.1.1.0/25**, ali hoće proći **10.0.0.0/8** ili **172.16.0.0/16**

```
Router(config-router)#redistribute eigrp 1 subnets
```

Auto-cost reference-bandwidth

```
R1#show ip route
Codes: <some code output omitted>
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       E1 - OSPF external type 1, E2 - OSPF external type 2

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

   192.168.10.0/30 is subnetted, 3 subnets
C       192.168.10.0 is directly connected, Serial0/0/0
C       192.168.10.4 is directly connected, Serial0/0/1
O       192.168.10.8 [110/1171] via 192.168.10.6, 00:00:58, Serial0/0/1
   172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
O       172.16.1.32/29 [110/391] via 192.168.10.6, 00:00:58, Serial0/0/1
C       172.16.1.16/28 is directly connected, FastEthernet0/0
   172.30.0.0/30 is subnetted, 1 subnets
C       172.30.1.0 is directly connected, Loopback1
   10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O       10.10.10.0/24 [110/1172] via 192.168.10.6, 00:00:58, Serial0/0/1
```

```
R1(config-router)#auto-cost reference-bandwidth 10000
% OSPF: Reference bandwidth is changed.
Please ensure reference bandwidth is consistent across all routers
```

```
R1#show ip route
Codes: <some code output omitted>
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       E1 - OSPF external type 1, E2 - OSPF external type 2

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

   192.168.10.0/30 is subnetted, 3 subnets
C       192.168.10.0 is directly connected, Serial0/0/0
C       192.168.10.4 is directly connected, Serial0/0/1
O       192.168.10.8 [110/104597] via 192.168.10.6, 00:01:33, Serial0/0/1
   172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
O       172.16.1.32/29 [110/39162] via 192.168.10.6, 00:01:33, Serial0/0/1
C       172.16.1.16/28 is directly connected, FastEthernet0/0
   172.30.0.0/30 is subnetted, 1 subnets
C       172.30.1.0 is directly connected, Loopback1
   10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O       10.10.10.0/24 [110/65635] via 192.168.10.2, 00:01:33, Serial0/0/0
```

Auto-cost reference-bandwidth

```
R1(config-router)#auto-cost reference-bandwidth 10000
% OSPF: Reference bandwidth is changed.
      Please ensure reference bandwidth is consistent across all routers
R1#show ip route
Codes: <some code output omitted>
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       E1 - OSPF external type 1, E2 - OSPF external type 2

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

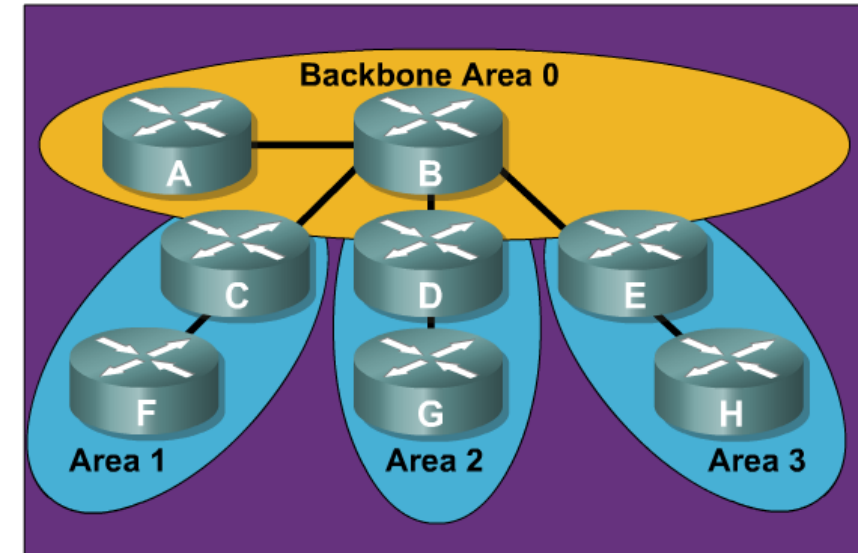
      192.168.10.0/30 is subnetted, 3 subnets
C       192.168.10.0 is directly connected, Serial0/0/0
C       192.168.10.4 is directly connected, Serial0/0/1
O       192.168.10.8 [110/104597] via 192.168.10.6, 00:01:33, Serial0/0/1
      172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
O       172.16.1.32/29 [110/39162] via 192.168.10.6, 00:01:33, Serial0/0/1
C       172.16.1.16/28 is directly connected, FastEthernet0/0
      172.30.0.0/30 is subnetted, 1 subnets
C       172.30.1.0 is directly connected, Loopback1
      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O       10.10.10.0/24 [110/65635] via 192.168.10.2, 00:01:33, Serial0/0/0
```



OSPF AREA

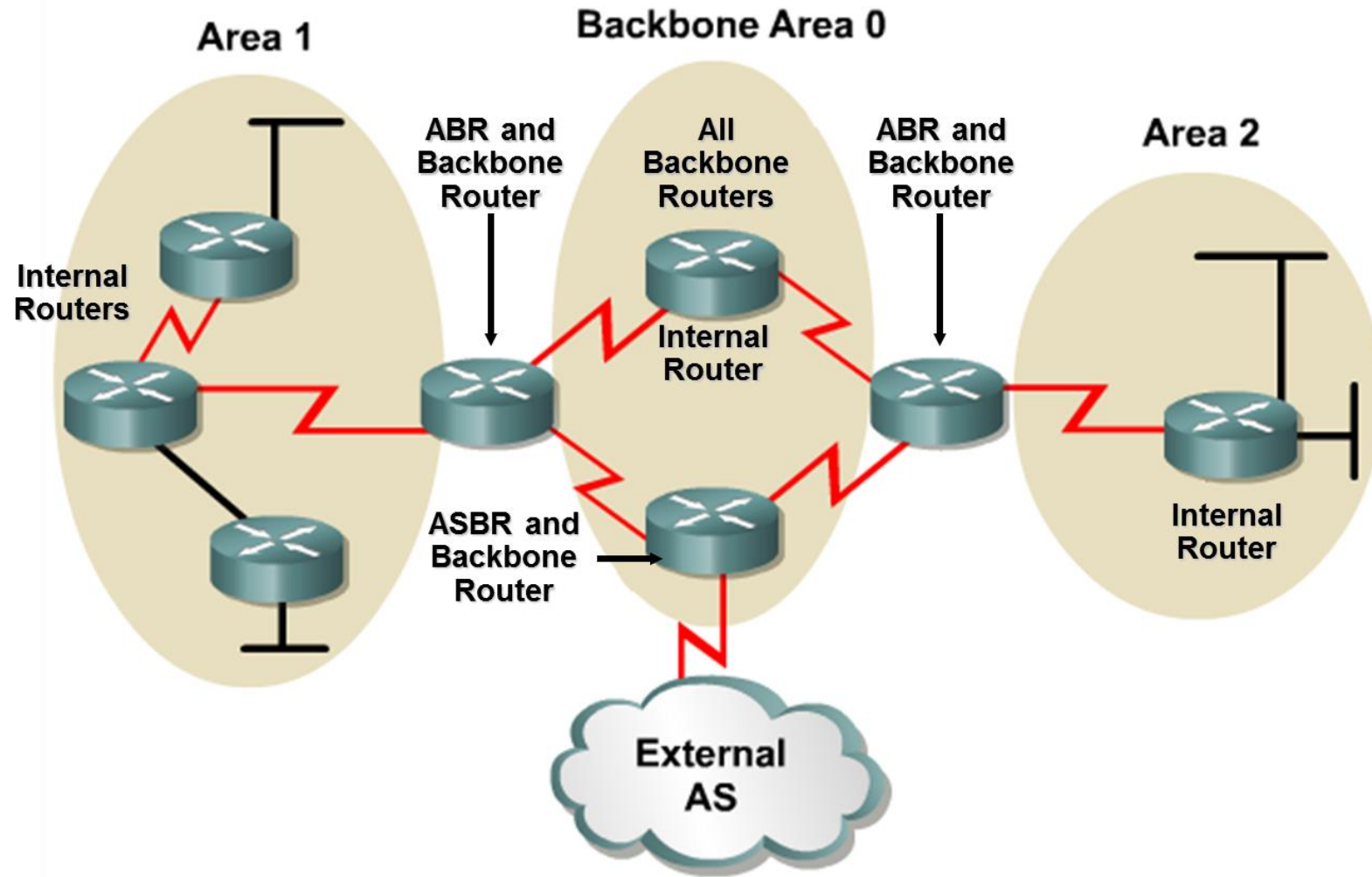
- Kako bi se minimizirao broj osvježavanja u mreži i broj usmjernika koji te poruke primaju, cijela OSPF topologija se dijeli u više područja
- Karakteristike OSPF područja uključuju:
 - Minimiziranje usmjerničkih tablica
 - Lokalizacija utjecaja promjena u topologiji na jedno područje
 - Razmjena LSA paketa završava na granici jednog područja
 - Zahtijeva hijerarhijski dizajn

- **Backbone Area**
- **Regular (Standard) Areas**

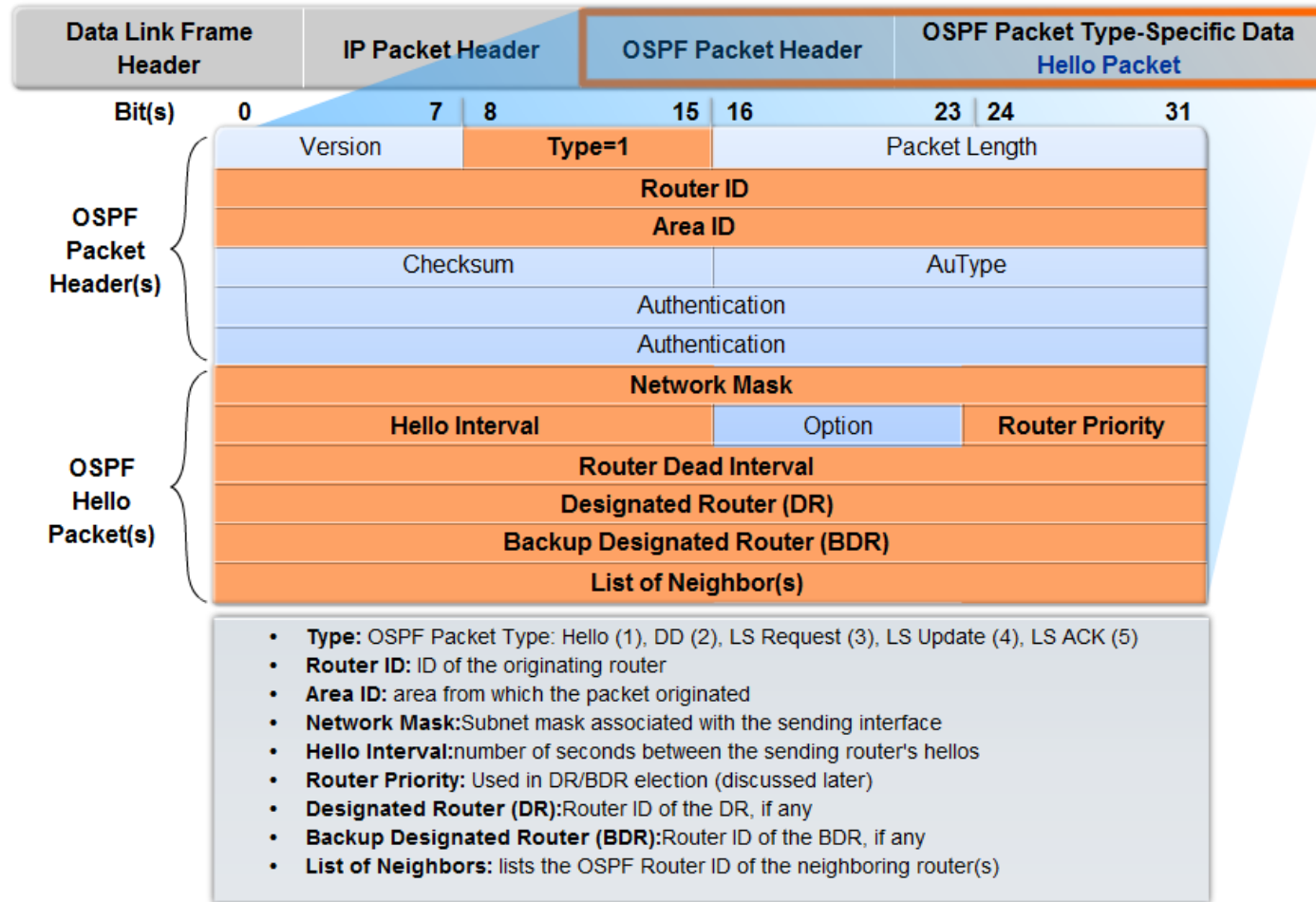


- Za optimalne performanse u mreži preporuka je da:
 - Područje ne sadrži više od 50 usmjernika.
 - Usmjernik se ne nalazi u više od 3 područja
 - Svaka Area je jedno područje u kojem se flodaju LSA-ovi.

OSPF tipovi usmjernika



Format OSPF poruke



- **Version #:** verzija OSPF protokola koji se koristi. RFC 2328 OSPF verzija 2
- **Type:** Tip OSPF paketa (Hello, Database Description, Link State Request, Link State Update, and Link State Ack)
- **Packet Length:** veličina cijelog OSPF paketa
- **Router ID:** 32-bit polje sadrži router-ID (IP adresa rutera)-izvor paketa
- **Area ID:** 32-bit polje definira kojoj AREA paket pripada. Većina OSPF paketa su povezani s jednom AREA (Oni koji idu kroz virtualni link imaju oznaku 0)
- **Checksum:** 16 bit polje sadrži CRC (Cyclic Redundancy Check).
- **AuType:** 16-bit polje definira vrstu autentikacije koja se koristi (None, Simple Password, message digest algorithm 5 (MD5))
- **Authentication:** 8 bytova veliko polje koristi se za autentikaciju

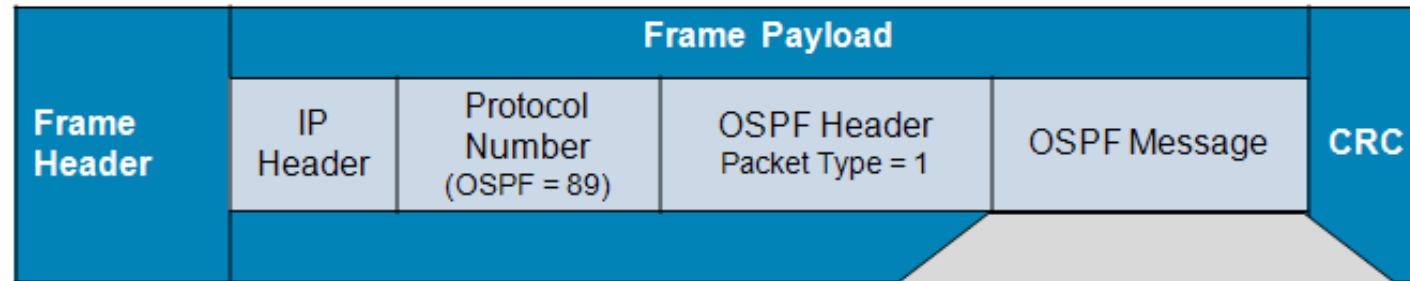
OSPF paketi

OSPF poruke sadrže različite tipove informacije u ovisnosti o tipu paketa:

Tip paketa	Sadrži
Tip 1 - Hello	Sadrži listu poznatih susjeda.
Tip 2 - DBD	Sadrži sažetak LSDB baze, koja sadrži popis poznatih usmjernika (IDs)
Tip 3 - LSR	Sadrži zahtjev za svim informacijama od pojedinog usmjernika iz baze.
Tip 4 - LSU	Sadrži cijele LSA pakete, više njih može biti ukomponirano u jedan „update” paket.
Tip 5 - LSAck	Podatkovno polje je prazno.

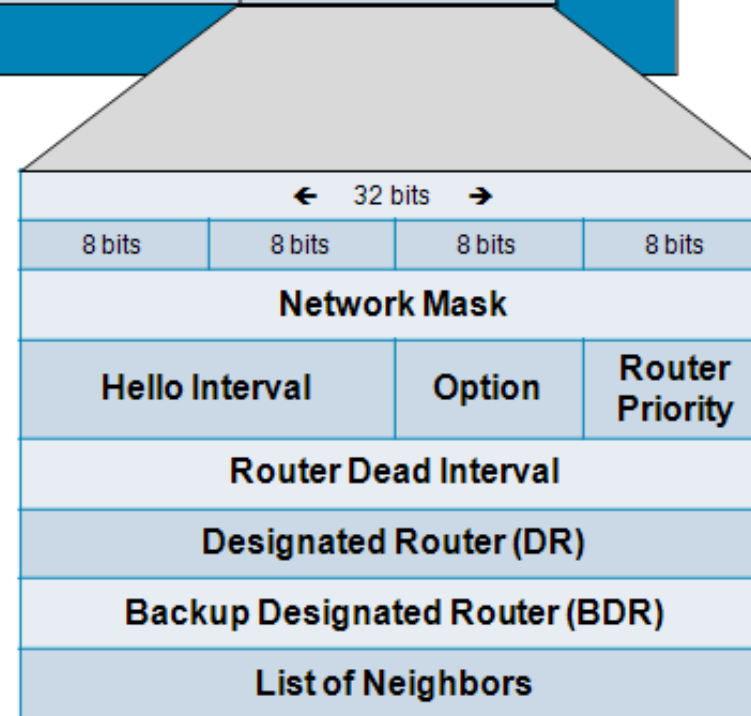
- **Hello**- Otkrivanje susjeda i uspostava susjedskih odnosa
- **DBD** (Database Description)-Za provjeru sinkoriziranosti baza između (OSPF) usmjernika
- **LSR** (Link State Request)-Zahtjev za specifičnim zapisima (stanjima linkova)
- **LSU** (Link state Update) paketi sadrže **više tipova LSA (Link State Advertisement)-update**
- **LSAck** (Link State Acknowledgement)-potvrda

OSPF - Hello paket



- Parametri koji se moraju slagati:

- Hello & Dead interval
- Network type
- Area ID
- Authentication type & password
- Stub area flag
- Network mask



OSPF ostali paketi

- OSPF DBD (Database description) paket:
 - Sadrži šturi opis LSDB baze i koristi se da prijarni usmjernik može vidjeti koje mreže susjedni usmjernik ima
 - Link-state baza mora biti identična na svim usmjernicima unutar istog područja kako bi SPF algoritam na svakom usmjerniku mogao točno izračunati svaku putanju
- OSPF LSR (Link State Request) paket:
 - LSR paketi se koriste kako bi usmjernik zatražio detaljne informacije (cijele LSA-ove) za pojedine dijelove baze
- LSU paketi (Link-State Update) se koriste:
 - Kao odgovor na LSR paket i kao slanje nove informacije o promjeni u topologiji
- LSU paketi sadrže različite tipove LSA (Link State Advertisement)
 - LSU paketi sadrže čitave LSA obavijesti
 - Više pojedinačnih LSA obavijesti stane u jedan LSU paket
- LSAack (Link State Acknowledgment) paket se šalje:
 - Kada je zaprimljen LSU paket. Usmjernik šalje LSAack da potvrdi prijem paketa
 - LSAack podatkovno polje je prazno

OSPF Link state updates (LSU)

Type	Packet Name	Description
1	Hello	Discovers neighbors and builds adjacencies between them
2	DBD	Checks for database synchronization between router
3	LSR	Requests specific link-state records from router to router
4	LSU	Sends specifically requested link-state records
5	LSAck	Acknowledges the other packet types

The acronyms LSA and LSU are often used interchangeably.

An LSU contains one or more LSAs.

LSAs contain route information for destination networks.

LSA specifics are discussed in CCNP.

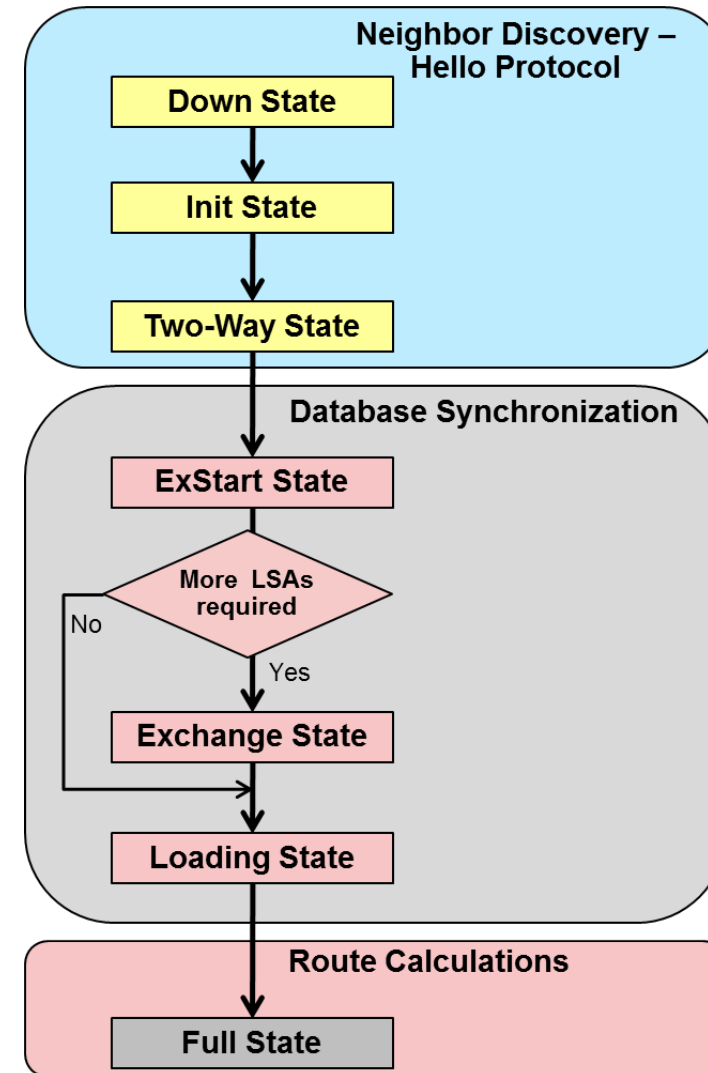
LSA Type	Description
1	Router LSAs
2	Network LSAs
3 or 4	Summary LSAs
5	Autonomous System External LSAs
6	Multicast OSPF LSAs
7	Defined for Not-So-Stubby Areas
8	External Attributes LSA for Border Gateway Protocol(BGP)
9,10,11	Opaque LSAs

OSPF Link state updates (LSU)

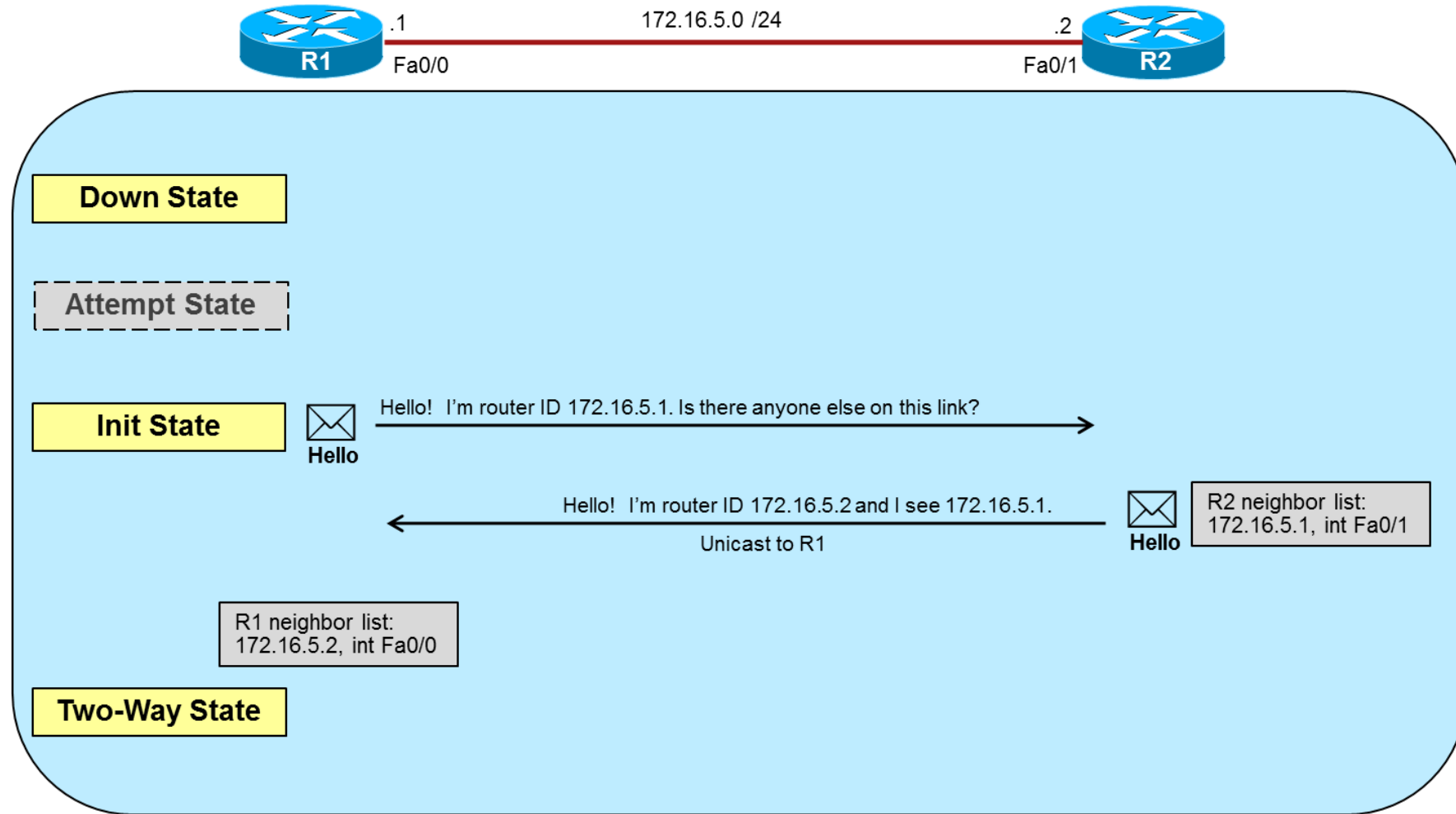
OSPF paketi		LSA	Opis
Tip	Naziv		
1	Hello	1	Služi ruterima za slanje stanja svojih linkova koji su im direktno spojeni, svaki ruter ih generira (to su u biti informacije o mrežama koje ruter ima direktno spojene), U routing tablici imaju oznaku "O"
2	DBD	2	Koristi se na Broadcast i Non-Broadcast mrežama i šalje ga DR na određeni segment (updatea sve ostale rutere na segmentu), U routing tablici imaju oznaku "O"
3	LSR	3	Pojavljaju se kad imamo više AREA, generira ga ABR kad treba prebaciti informacije o rutama iz jedne AREA u drugu, U routing tablici imaju oznaku "O IA"
4	LSU	4	Ovaj tip LSA ubacuje ABR u AREA koje nemaju ASBR usmjernik. U AREA u kojoj se nalazi ASBR ne postoji ovaj LSA, već se koristi tip 1, U routing tablici imaju oznaku "O IA"
5	LSAck	5	Ovaj tip LSA su vanjske rute ubačene u OSPF...npr default-information originate, U routing tablici imaju oznaku "O E1 ili O E2"
		6	<i>Multicast OSPF</i>
		7	Ovo je poseban tip LSA koji se koristi u područjima (AREA) poput NSSA i Totally-Stubby NSSA, predstavlja vanjske rute koje ulaze u takva područja, tip 7 se zadržava samo unutar takvih područja, ABR prevodi tip 7 u tip 5, U routing tablici imaju oznaku "O N1 ili O N2"
		8	<i>Koristi se kod redistribucije s BGP protokolom</i>
		9,10,11	<i>Za buduću upotrebu</i>

OSPF stanja

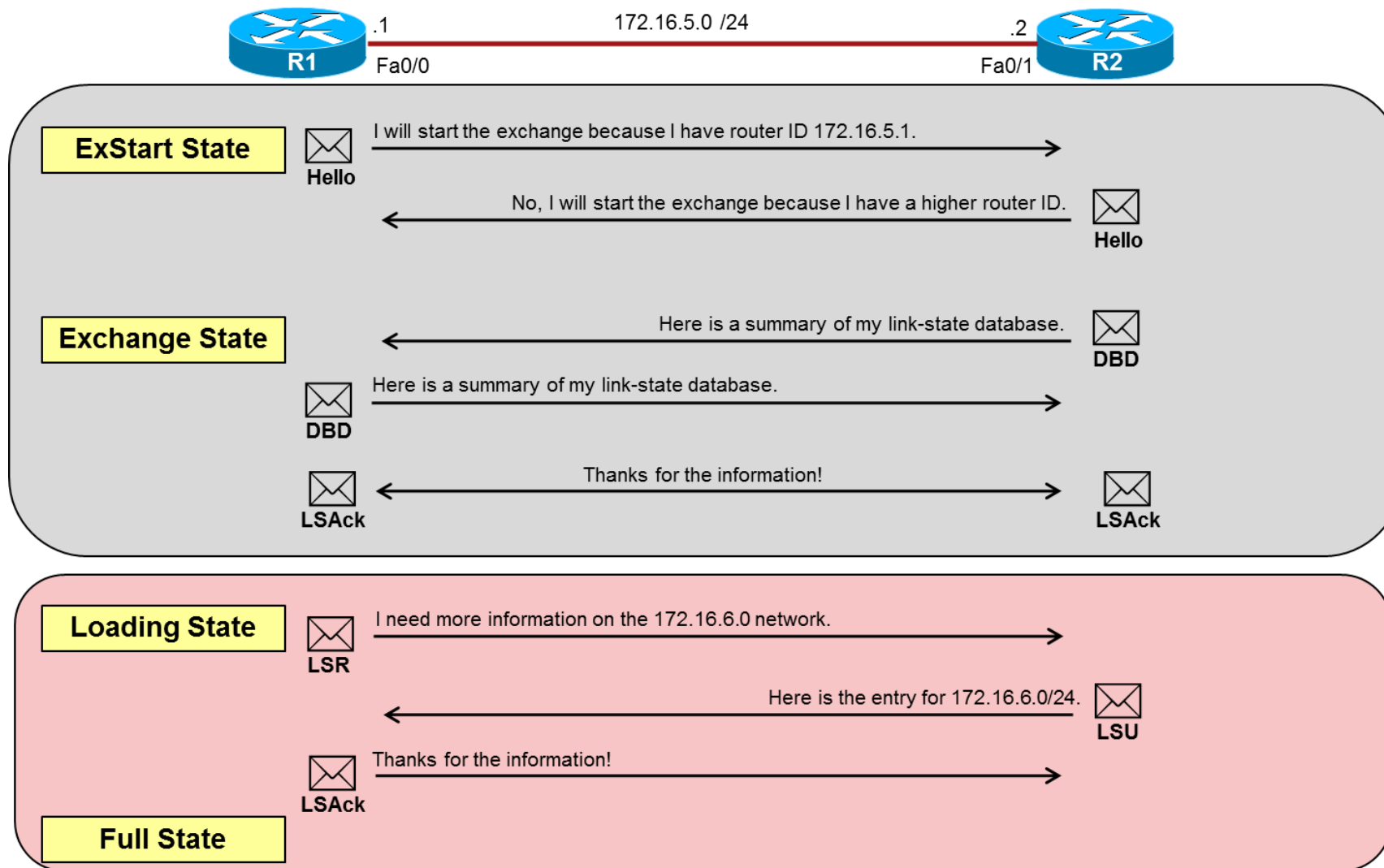
- Nakon što se usmjernik spoji na mrežu, pokušava se povezati sa svojim susjednim usmjernicima
- Da bi se uspio povezati, prolazi kroz različita stanja koristeći 5 različitih tipova OSPF paketa



OSPF stanja

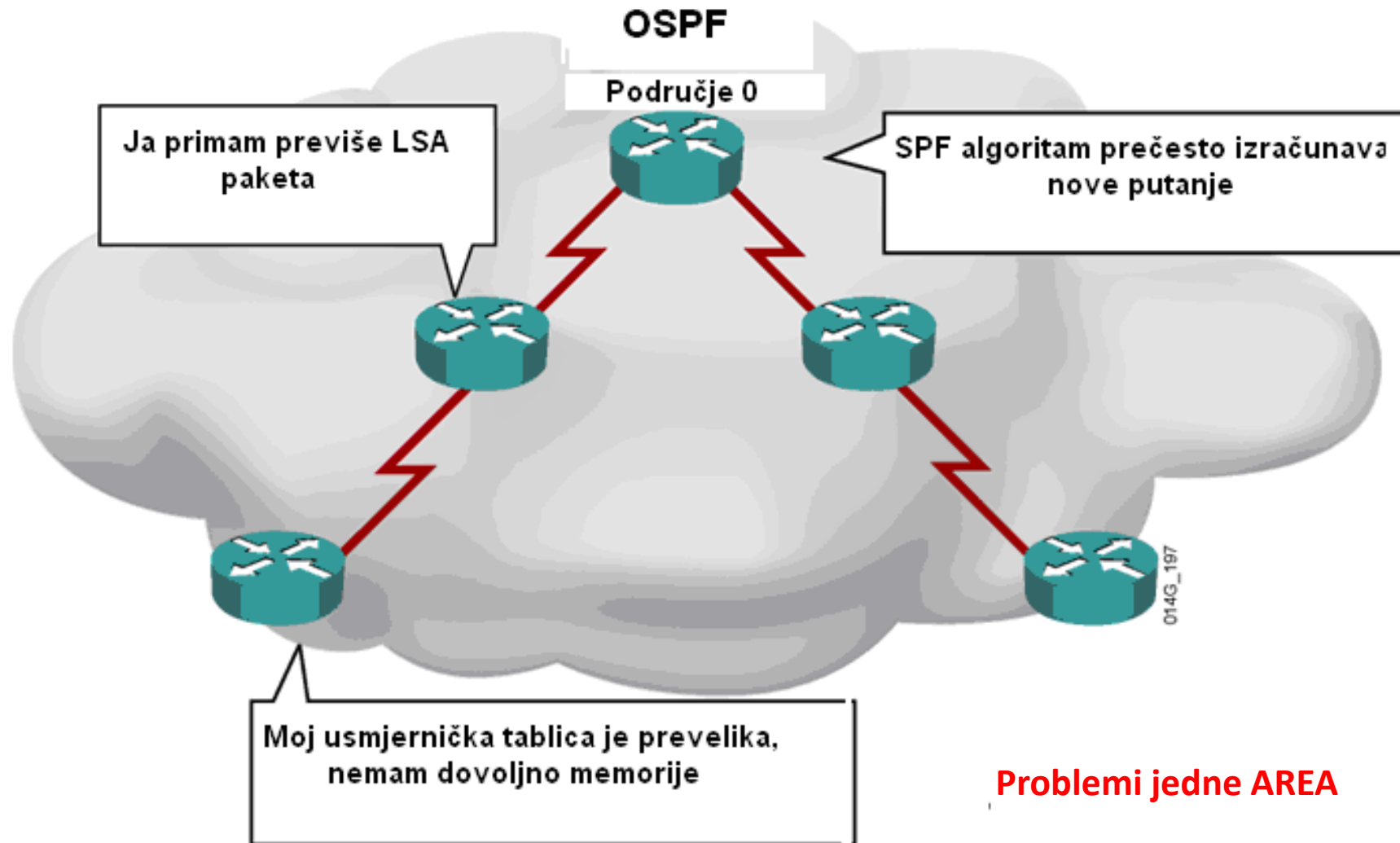


OSPF stanja





MULTIAREA OSPF



MULTIAREA OSPF

- Svako područje je logička grupa usmjernika koji imaju istu topologiju mreže
- Unutar svakog područja se pokreće SPF algoritam nezavisno
- Između područja se razmjenjuju samo sažete putanje
- **Područje 0** je glavno područje (**backbone area**, transit area)
- Područje 0 je centralno područje na prvom nivou
- **Sva ostala područja** priključena su na područje 0 i nalaze se na drugom nivou

MULTIAREA OSPF

➤ Interni usmjernik (*Internal Router*)

- usmjernik čija su sva sučelja u istom području
- usmjernici unutar istog područja imaju istu tablicu topologije

➤ Usmjernik osnovnog područja (*BR - Backbone Router*)

- usmjernik koji se nalazi u području 0 i ima najmanje jedno sučelje spojeno u području 0
- usmjernici u osnovnom području prosljeđuju informacije ABR usmjernicima iz drugih područja.
- razmjena informacija između područja uvijek ide kroz područje 0.
- područje može imati jedan ili više ABR usmjernika

➤ Usmjernik na granici područja (ABR – Area Border Router)

- ✓ ima sučelja spojena na više područja
- ✓ održava tablicu topologije za svako područje u kojemu se nalazi
- ✓ usmjerava promet u druga područja ili iz drugih područja.
- ✓ granica je između dva područja
- ✓ sažima informacije iz područja u kojemu se nalazi i šalje samo sažete informacije u druga područja
- ✓ prosljeđuje informacije o mrežama u osnovno područje (područje 0)

MULTIAREA OSPF

- **Usmjernik na granici autonomnog sustava** (ASBR ili Autonomous System boundary router)
- Usmjernik na granici autonomnog sustava (*ASBR ili Autonomous System border router*)
 - ✓ ima bar jedno sučelje spojeno na drugi autonomni sustav
 - ✓ drugi autonomni sustav može biti mreža koja nije OSPF
 - ✓ unosi ne-OSPF informacije u OSPF domenu i obrnuto
- proces unosa ne-OSPF informacija u OSPF domenu i obrnuto se zove **redistribucija putanja**.

OSPF Link state updates (LSU)

Type	Packet Name	Description
1	Hello	Discovers neighbors and builds adjacencies between them
2	DBD	Checks for database synchronization between router
3	LSR	Requests specific link-state records from router to router
4	LSU	Sends specifically requested link-state records
5	LSAck	Acknowledges the other packet types

The acronyms LSA and LSU are often used interchangeably.

An LSU contains one or more LSAs.

LSAs contain route information for destination networks.

LSA specifics are discussed in CCNP.

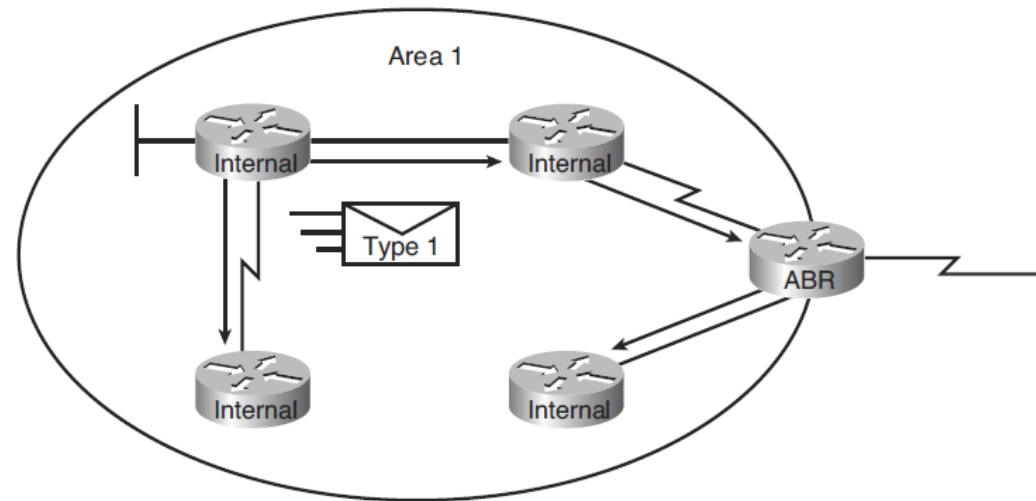
LSA Type	Description
1	Router LSAs
2	Network LSAs
3 or 4	Summary LSAs
5	Autonomous System External LSAs
6	Multicast OSPF LSAs
7	Defined for Not-So-Stubby Areas
8	External Attributes LSA for Border Gateway Protocol(BGP)
9,10,11	Opaque LSAs

OSPF Link state updates (LSU)

OSPF paketi		LSA	Opis
Tip	Naziv		
1	Hello	1	Služi ruterima za slanje stanja svojih linkova koji su im direktno spojeni, svaki ruter ih generira (to su u biti informacije o mrežama koje ruter ima direktno spojene), U routing tablici imaju oznaku "O"
2	DBD	2	Koristi se na Broadcast i Non-Broadcast mrežama i šalje ga DR na određeni segment (updatea sve ostale rutere na segmentu), U routing tablici imaju oznaku "O"
3	LSR	3	Pojavljaju se kad imamo više AREA, generira ga ABR kad treba prebaciti informacije o rutama iz jedne AREA u drugu, U routing tablici imaju oznaku "O IA"
4	LSU	4	Ovaj tip LSA ubacuje ABR u AREA koje nemaju ASBR usmjernik. U AREA u kojoj se nalazi ASBR ne postoji ovaj LSA, već se koristi tip 1, U routing tablici imaju oznaku "O IA"
5	LSAck	5	Ovaj tip LSA su vanjske rute ubačene u OSPF...npr default-information originate, U routing tablici imaju oznaku "O E1 ili O E2"
		6	<i>Multicast OSPF</i>
		7	Ovo je poseban tip LSA koji se koristi u područjima (AREA) poput NSSA i Totally-Stubby NSSA, predstavlja vanjske rute koje ulaze u takva područja, tip 7 se zadržava samo unutar takvih područja, ABR prevodi tip 7 u tip 5, U routing tablici imaju oznaku "O N1 ili O N2"
		8	<i>Koristi se kod redistribucije s BGP protokolom</i>
		9,10,11	<i>Za buduću upotrebu</i>

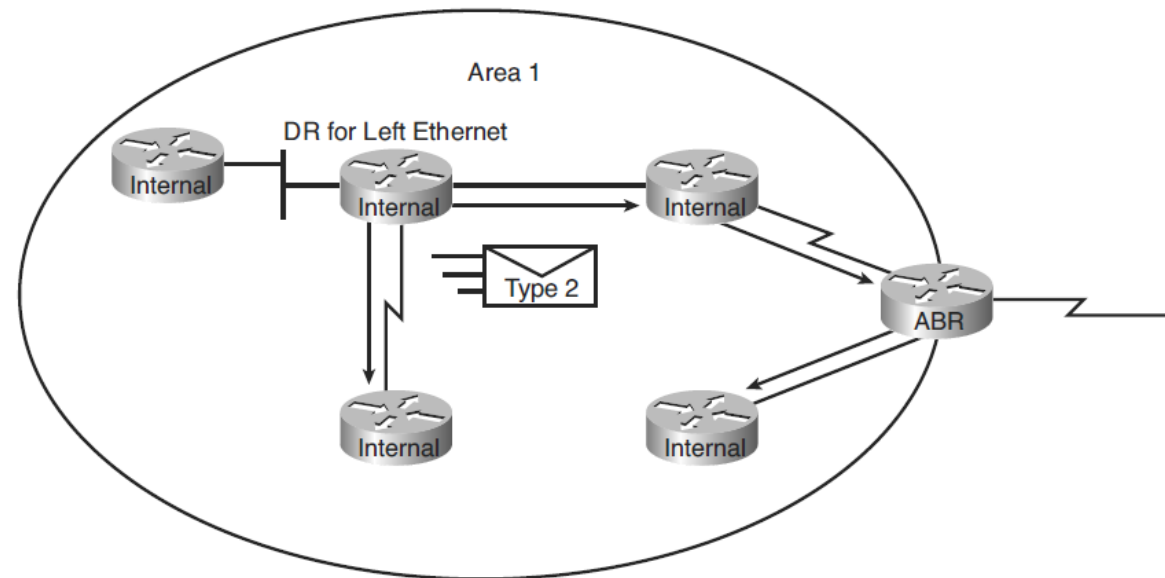
LSA Type 1: Router LSA

- Ovaj tip LSA generiraju usmjernici i njime opisuju svoju direktno spojenu mrežu, kao unutar-područnu rutu
 - Šalje se jedino unutar područja gdje je generiran i ne prolazi ABR
 - LSA uključuje listu svih direktno spojenih linkova koji su označeni sa ID-em usmjernika koji ih oglašava
 - U usmjerničkoj tabeli ovaj tip rute je označen sa „O”



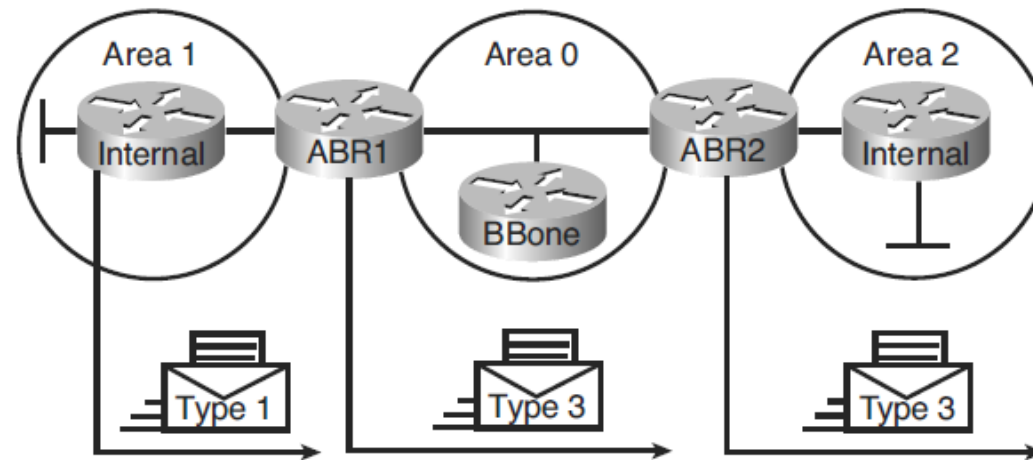
LSA Type 2: Network LSA

- LSA type 2 se koristi za oglašavanje L2 broadcast (ethernet) elemenata u mreži i oglašavaju ih DR usmjernici
 - Šalje se jedino unutar područja gdje je generiran i ne prolazi ABR
 - Link-state ID je DR
 - Ovaj tip rute je označen sa „O”



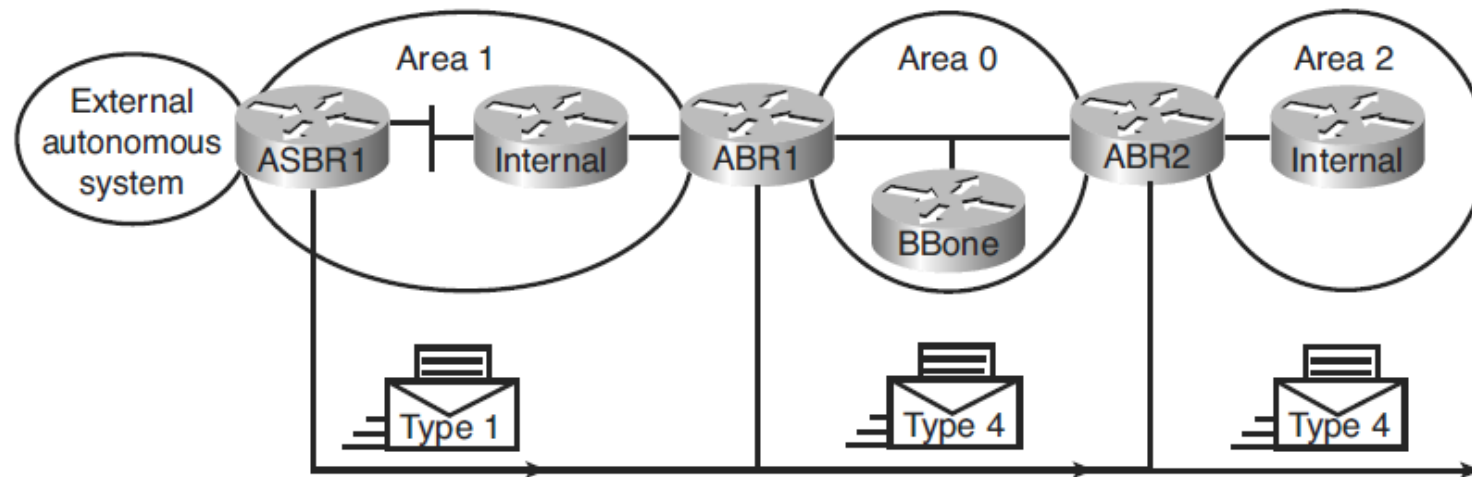
LSA Type 3: Summary LSA

- LSA type 3 oglašavju ABR usmjernici
 - Svaki ABR usmjernik koji zaprimi ovu informaciju, prosljeđuje je dalje kroz cijeli autonomni sustav
 - Predefinirano, rute nisu sumarizirane i Type 3 LSA je generiran za svaki subnet
 - Link-state ID je adresa oglašene mreže
 - Ovaj tip rute je označen sa „O IA”



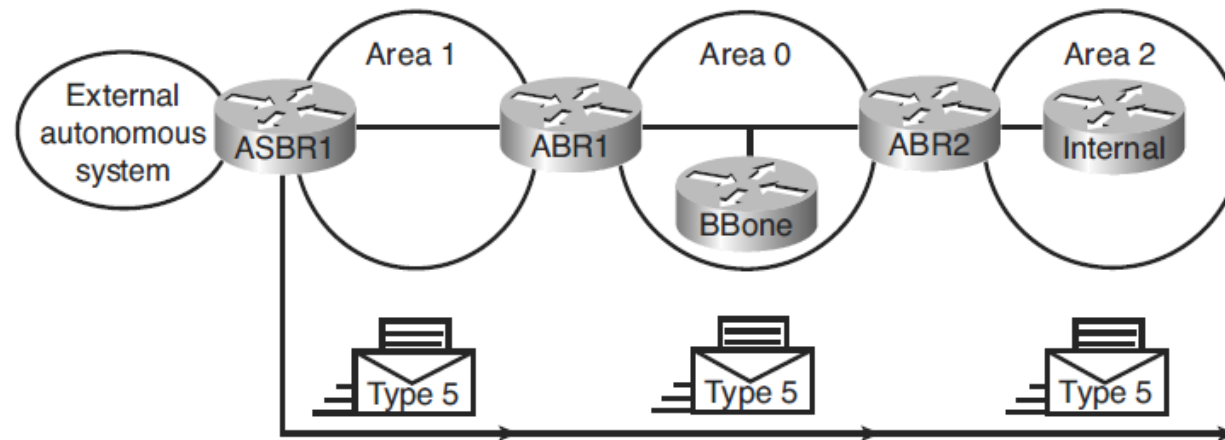
LSA Type 4: Summary LSA

- LSA Type 4 je generiran od strane ABR kako bi oglasio ASBR u svom području, prema svim ostalim područjima unutar autonomnog sustava
 - Svaki ABR usmjernik koji zaprimi ovu informaciju, prosljeđuje je dalje kroz cijeli autonomni sustav
 - Link-state ID je ID ASBR usmjernika
 - Ovaj tip rute je označen sa „O IA”



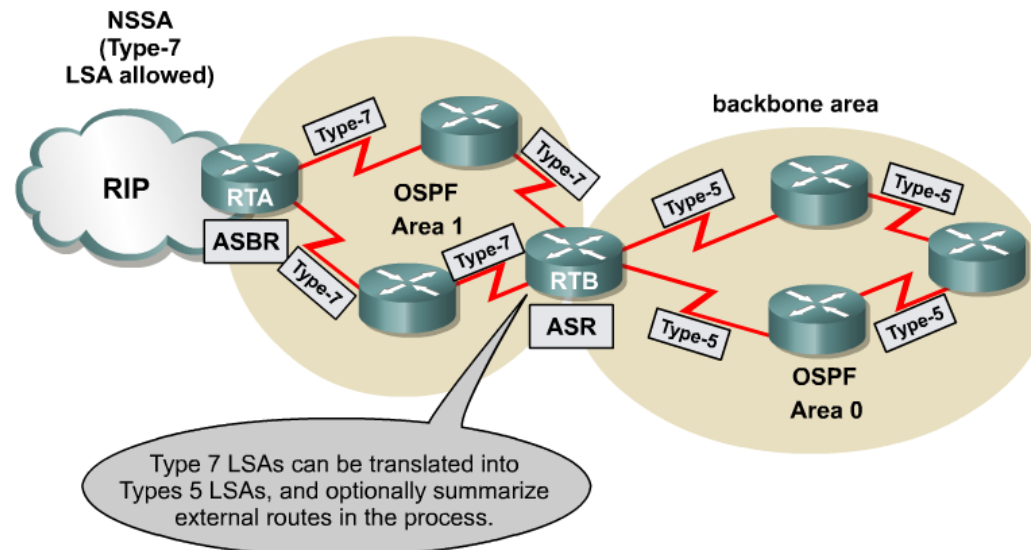
LSA Type 5: External LSA

- LSA Type 5 je generiran od strane ASBR usmjernika kako bi oglasio mreže iz drugog autonomnog sustava
 - Type 5 LSA oglašava ASBR dok ih svi ABR prosljeđuju kroz autonomni sustav
 - Link-state ID je adresa vanjske mreže
 - Ovaj tip rute je označen sa „**O E1**” ili „**O E2**”



LSA Type 7: NSSA LSA

- LSA Type 7 je generiran od strane ASBR unutar područja (AREA) kao što su: NSSA (Not-to-stubby-area) i Totally-Stubby NSSA, kako bi se opisale rute redistribuirane unutar NSSA.
 - LSA type 7 se prevodi u LSA type 5 na prvom ABR usmjerniku i kao Type 5 ostaju kroz ostatak OSPF domene
 - U usmjerničkoj tabeli ovaj tip rute je označen sa „O N1” ili „O N2”

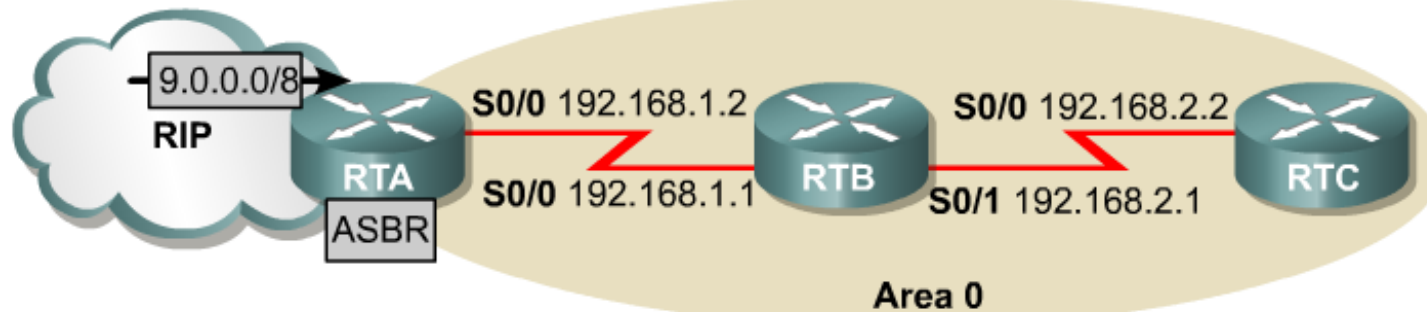


OSPF Tipovi putanja

- Putanje unutar područja (***Intra-area route***) „O” u usmjerničkoj tablici
 - opisuje putanju do odredišta unutar jednog područja.
 - koriste se LSA paketi tipa 1 i 2.
- Putanje između područja (***Inter-area route***) „O IA” u usmjerničkoj tablici
 - opisuje putanju do odredišta u nekom drugom području, ali unutar iste OSPF domene
 - koriste se LSA paketi tipa 3 i 4
- Vanjske putanje tipa 1 (***External route type 1***) „O E1” u usmjerničkoj tablici
 - opisuje putanje do odredišta u drugom autonomnom sustavu
 - koriste se LSA paketi tipa 5
 - Cost rute se povećava prolaskom kroz mrežu
- Vanjske putanje tipa 2 (***External route type 2***) „O E2” u usmjerničkoj tablici
 - opisuje putanje do odredišta u drugom autonomnom sustavu
 - Razlika između tipa 1 i tipa 2 je u načinu izračuna mjere kvalitete puta do odredišta
 - Ovo je default tip putanje i cost rute se ne povećava prolaskom kroz mrežu
 - Vanjske putanje koje ulaze u NSSA područje imaju oznake N1 i N2

ASBR (Autonomous System boundary router) E1 route

```
RTB#show ip route
<output omitted>
O E1 9.0.0.0/8 [110/410] via 192.168.1.2, 00:00:05, Serial0/0
C   192.168.1.0/24 is directly connected, Serial0/0
C   192.168.2.0/24 is directly connected, Serial0/1
```

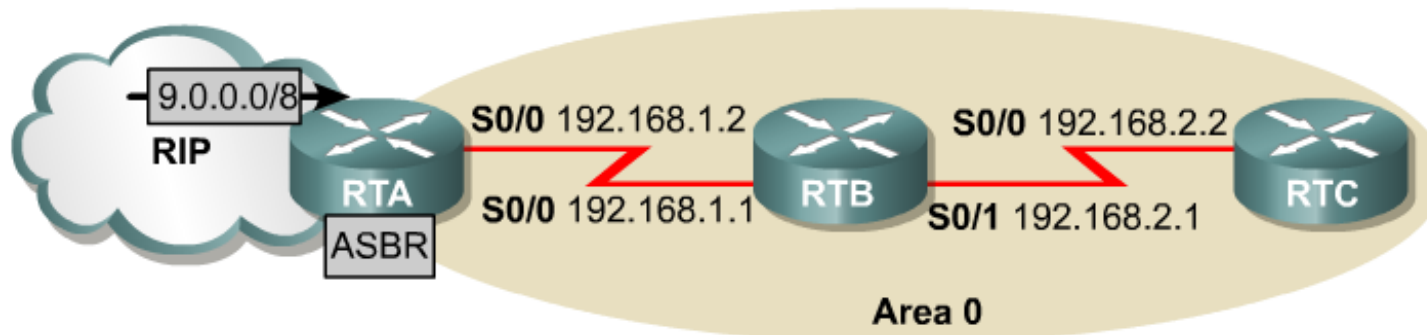


```
RTC#show ip route
<output omitted>
O E1 9.0.0.0/8 [110/1191] via 192.168.2.1, 00:00:47, Serial0/0
O   192.168.1.0/24 [110/1171] via 192.168.2.1, 00:04:50, Serial0/0
C   192.168.2.0/24 is directly connected, Serial0/0
```

- Kod E1 ruta, metrika se uvećava kako ruta putuje kroz OSPF domenu

ASBR (Autonomous System boundary router) E2 rute

```
RTB#show ip route
<output omitted>
O E2 9.0.0.0/8 [110/20] via 192.168.1.2, 00:00:07, Serial0/0
C   192.168.1.0/24 is directly connected, Serial0/0
C   192.168.2.0/24 is directly connected, Serial0/1
```

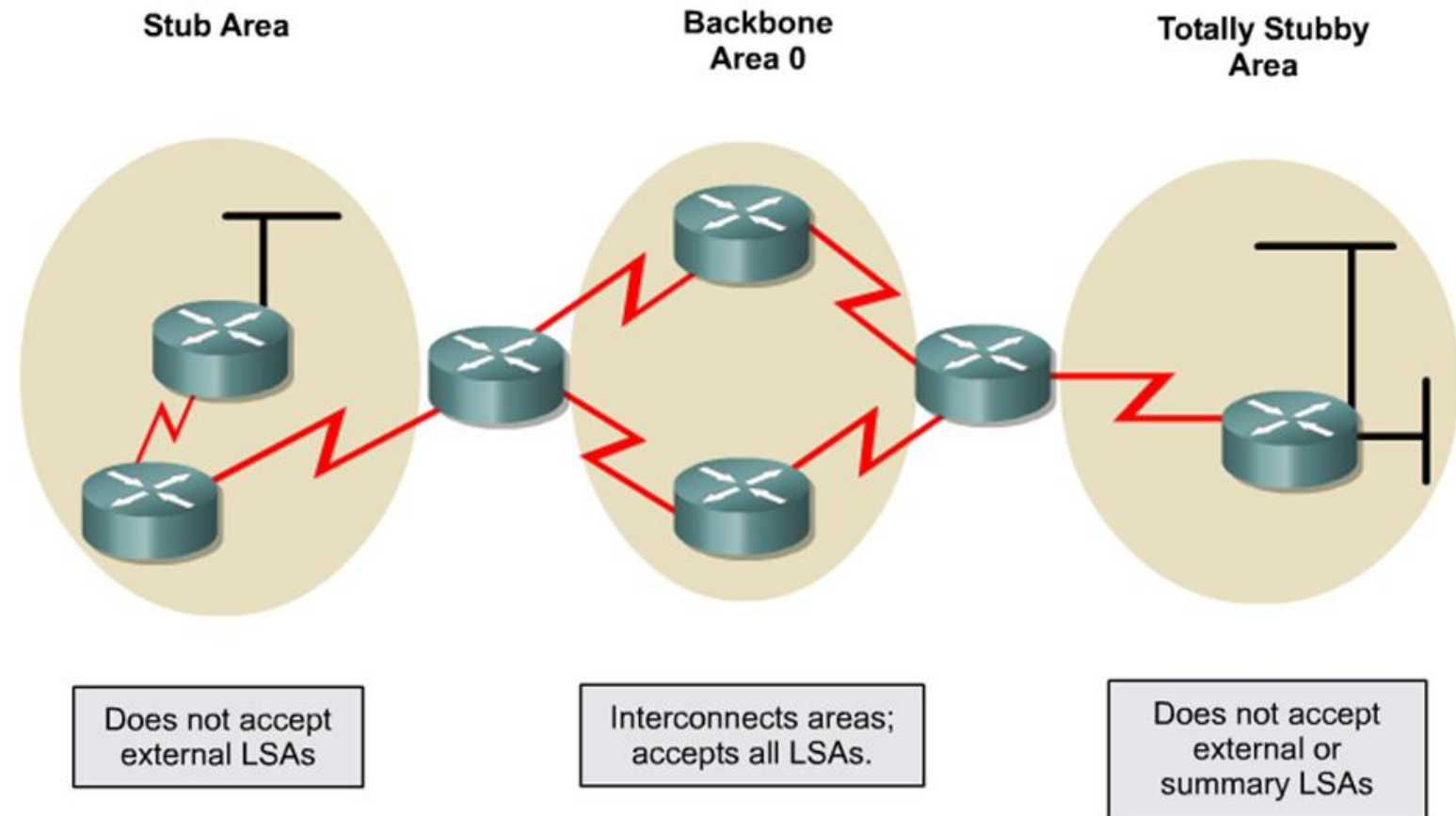


```
RTC#show ip route
<output omitted>
O E2 9.0.0.0/8 [110/20] via 192.168.2.1, 00:00:46, Serial0/0
O   192.168.1.0/24 [110/1171] via 192.168.2.1, 00:03:09, Serial0/0
C   192.168.2.0/24 is directly connected, Serial0/0
```

- Kod E2 ruta, metrika se ne mjenja kako ruta putuje kroz OSPF domenu
- E2 je predefiniran odabir na ASBR usmjernicima

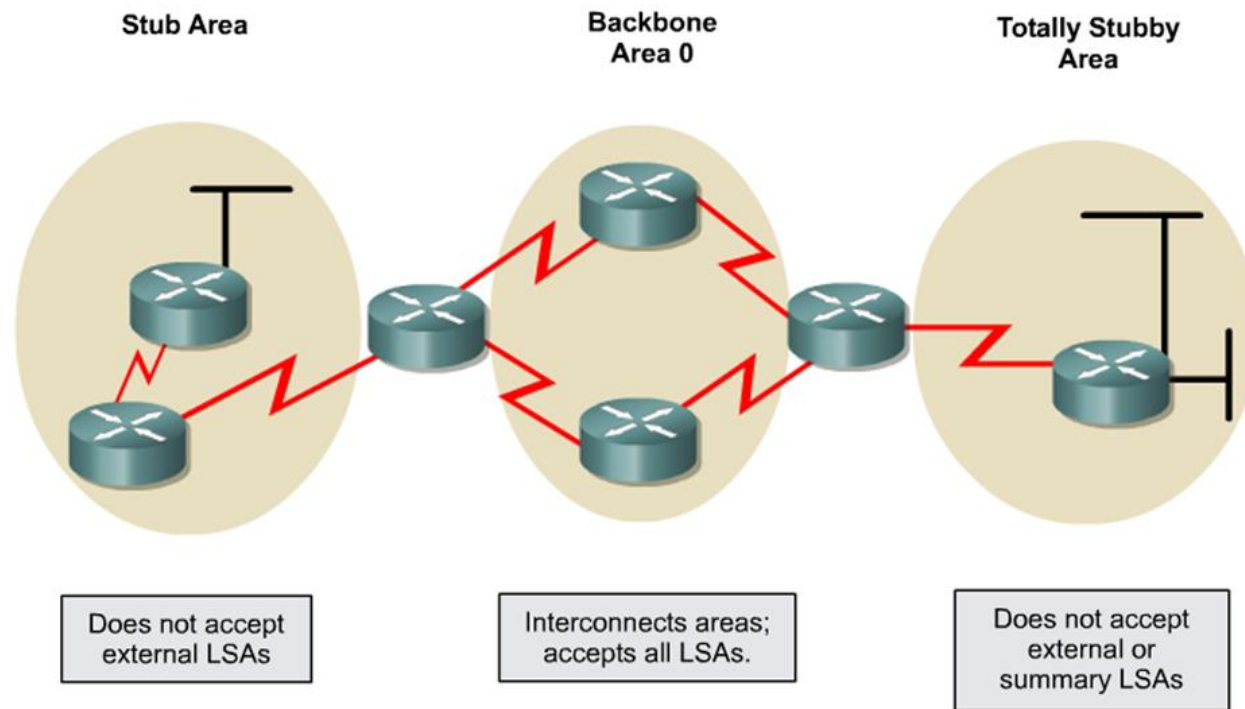
Specijalni tipovi područja

- OSPF standardna područja mogu biti i jedna od četiri tipa krajnjih (engl. Stub) područja:
 - Stub area
 - Totally stubby area
 - NSSA
 - Totally stubby NSSA



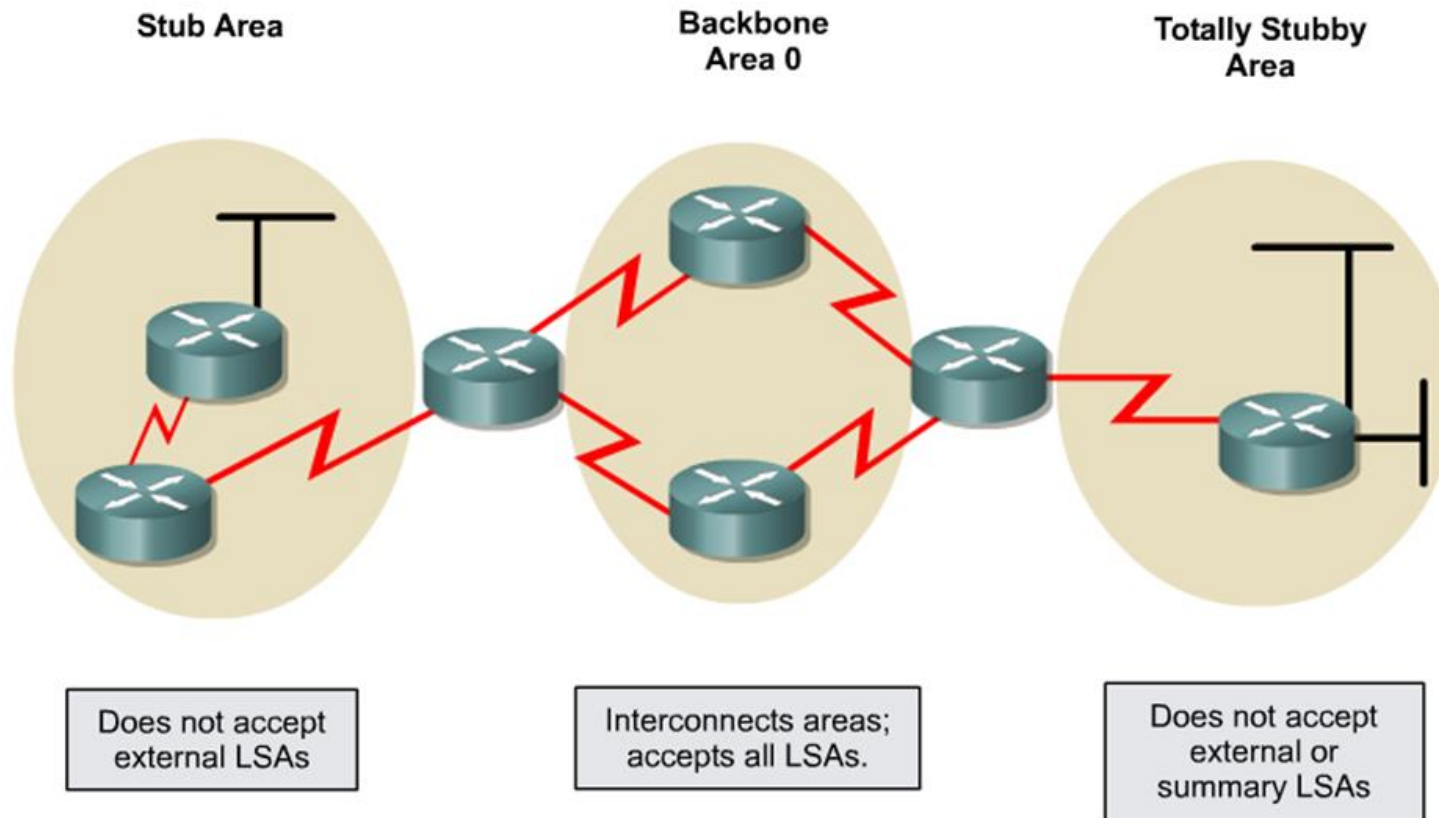
Stub area

- Stub područje ne prima nikakve eksterne rute, odnosno LSA-ove Type 4 i Type 5.
- ABR usmjernik u „Stub” područje prosljeđuje Type 3 LSA-ove i predefiniranu rutu.



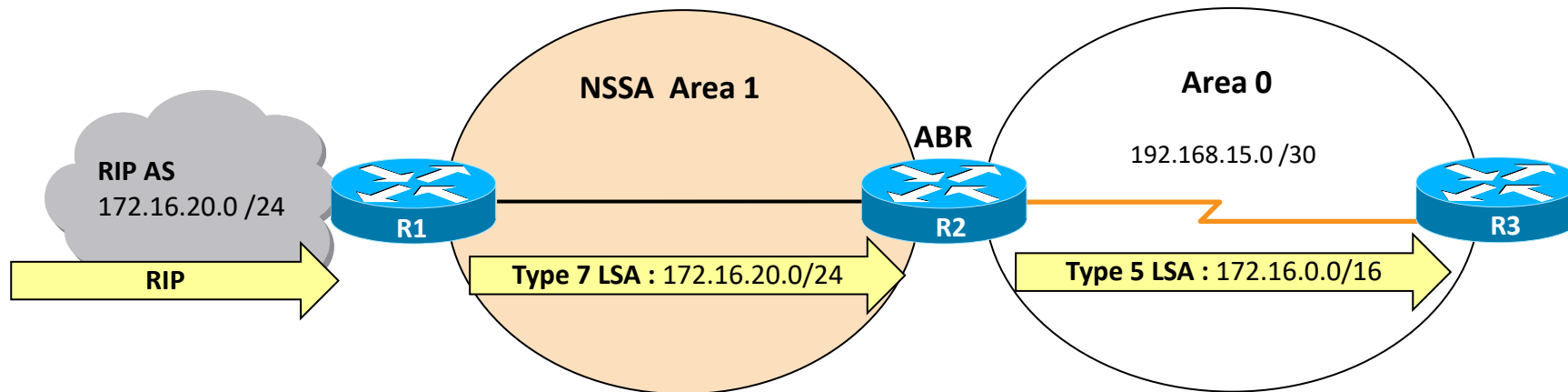
Totally Stubby Area

- Ovaj tip područja je definirao cisco i podržavaju ga samo cisco usmjernici
- ABR u područje ne prosleđuju LSA-ove Type 3, Type 4 niti Type 5, šalje se samo i jedino predefinirana rutu, prema tom ABR usmjerniku.

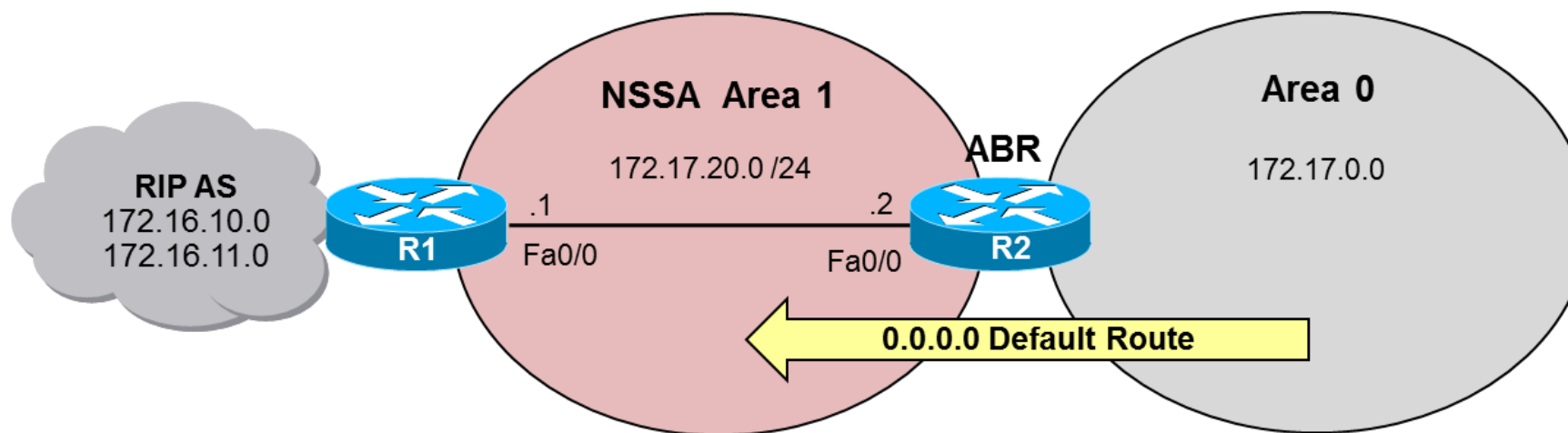


Not-So-Stubby Area (NSSA)

- Slično kao i „Stub” područja uz tu razliku što je područje spojeno na neku drugu vanjsku usmjerničku domenu.
- Unutar područja nisu dozvoljeni eksterne rute Type 4 i Type 5
- Rute koje ulaze u NSSA područje iz vana, označene su kao Type 7, te se na prvom ABR prevode u Type 5 LSA

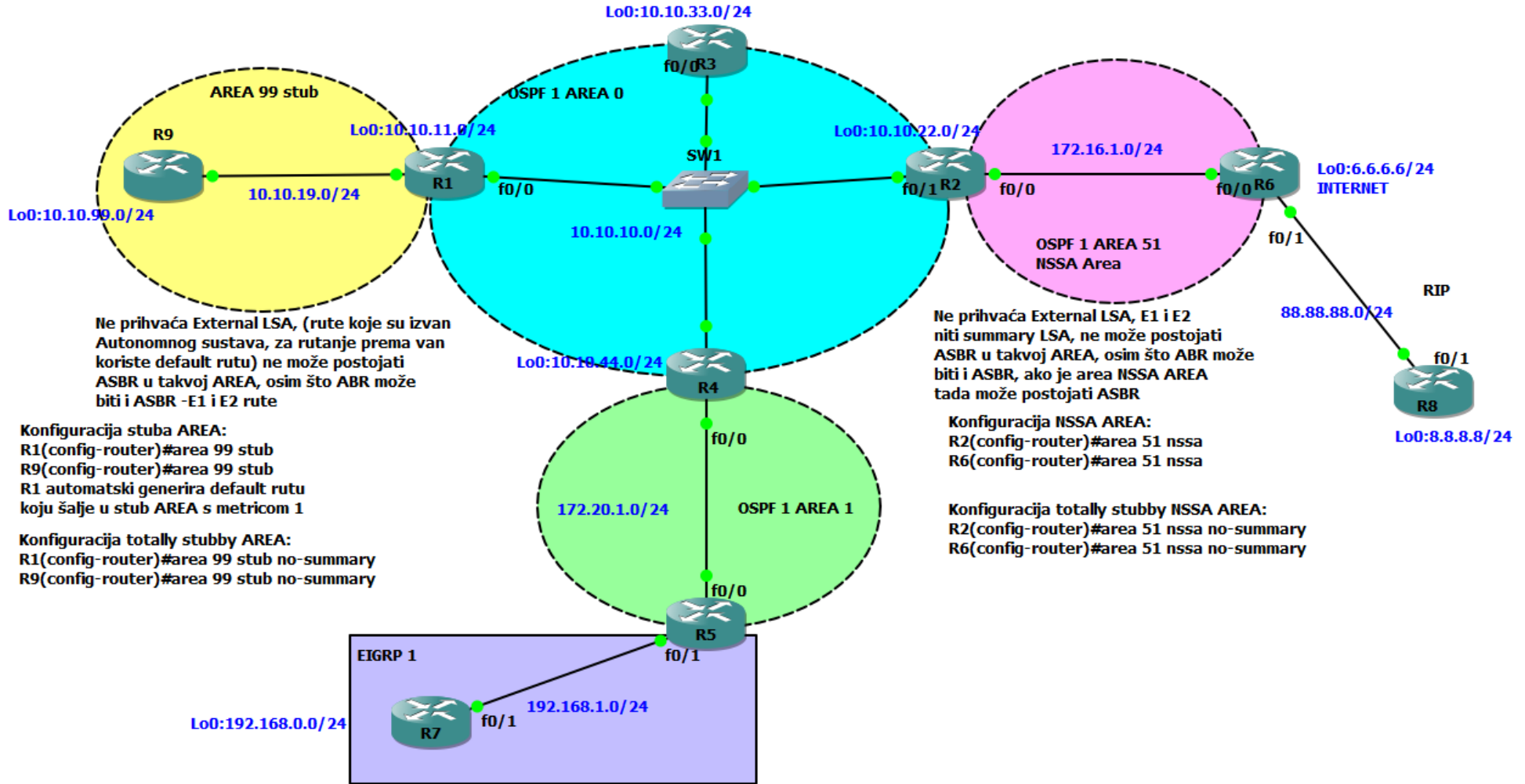


Totally Stubby NSSA-Cisco



- Ciscovo rješenje za NSSA
- Područje ne prima eksterne rute (Type 4 & Type 5), niti rute iz drugih područja (Type 3)
- ABR usmjernik ubacuje predefiniranu rutu i jedino se ona prosljeđuje u ovaj tip područja
- Uz predefiniranu rutu, nalaze se još i Type 7 NSSA eksterne rute

Primjer AREA tipova



Ne prihvaća External LSA, (rute koje su izvan Autonomnog sustava, za rutanje prema van koriste default rutu) ne može postojati ASBR u takvoj AREA, osim što ABR može biti i ASBR -E1 i E2 rute

Konfiguracija stuba AREA:
R1(config-router)#area 99 stub
R9(config-router)#area 99 stub
R1 automatski generira default rutu koju šalje u stub AREA s metricom 1

Konfiguracija totally stubby AREA:
R1(config-router)#area 99 stub no-summary
R9(config-router)#area 99 stub no-summary

Ne prihvaća External LSA, E1 i E2 niti summary LSA, ne može postojati ASBR u takvoj AREA, osim što ABR može biti i ASBR, ako je area NSSA AREA tada može postojati ASBR

Konfiguracija NSSA AREA:
R2(config-router)#area 51 nssa
R6(config-router)#area 51 nssa

Konfiguracija totally stubby NSSA AREA:
R2(config-router)#area 51 nssa no-summary
R6(config-router)#area 51 nssa no-summary

Cisco proprietary verzije su: Totally stubby AREA i Totally stubby NSSA AREA

Primjer AREA tipova

```
R4(config)#router ospf 1
R4(config-router)#network 10.10.10.0 0.0.0.255 area 0
R4(config-router)#network 172.16.1.0 0.0.0.255 area 1
```

AREA 0 i
Standardna AREA

```
R5(config)#router ospf 1
R5(config-router)#network 172.20.1.0 0.0.0.255 area 1
R5(config-router)#default-information originate
```

Standardna AREA

```
R2(config-router)#network 10.10.10.0 0.0.0.255 area 0
R2(config-router)#network 172.16.1.0 0.0.0.255 area 51
R2(config-router)#area 51 nssa
```

AREA 0 i NSSA

```
R2(config-router)#network 10.10.10.0 0.0.0.255 area 0
R2(config-router)#network 172.16.1.0 0.0.0.255 area 51
R2(config-router)#area 51 nssa no-summary
```

AREA 0 i
NSSA totally stubby AREA

CISCO PROPRIATERY

```
R1(config-router)#network 10.10.10.0 0.0.0.255 area 0
R1(config-router)#network 10.10.19.0 0.0.0.255 area 99
R1(config-router)#area 99 stub
```

AREA 0 i
Stub AREA

```
R1(config-router)#network 10.10.10.0 0.0.0.255 area 0
R1(config-router)#network 10.10.19.0 0.0.0.255 area 99
R1(config-router)#area 99 stub no-summary
```

AREA 0 i
totally stubby AREA

CISCO PROPRIATERY

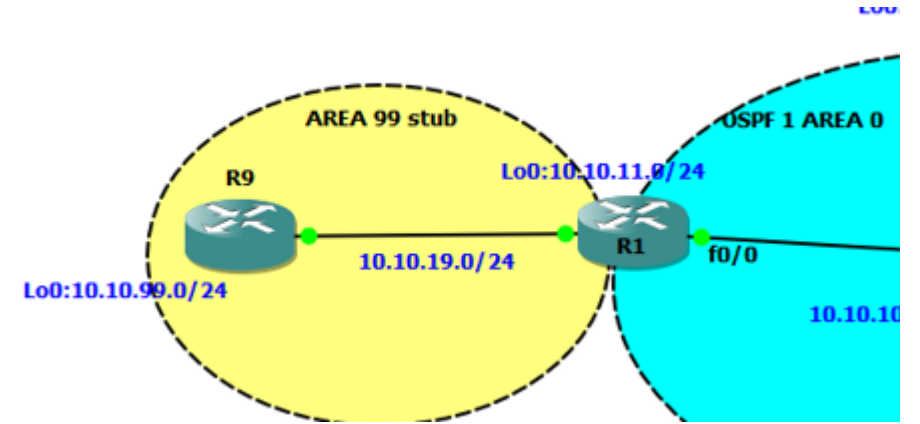
Konfiguracija Stub tipa area-STANDARD

```
R1(config-router)#area 99 stub
```

```
R9#show ip route
```

Gateway of last resort is 10.10.19.1 to network 0.0.0.0

```
172.16.0.0/24 is subnetted, 1 subnets
O IA 172.16.1.0 [110/30] via 10.10.19.1, 00:32:50, FastEthernet0/1
172.20.0.0/24 is subnetted, 1 subnets
O IA 172.20.1.0 [110/30] via 10.10.19.1, 00:53:54, FastEthernet0/1
10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA 10.10.11.1/32 [110/11] via 10.10.19.1, 00:53:54, FastEthernet0/1
O IA 10.10.10.0/24 [110/20] via 10.10.19.1, 00:53:54, FastEthernet0/1
C 10.10.19.0/24 is directly connected, FastEthernet0/1
O IA 10.10.33.1/32 [110/21] via 10.10.19.1, 00:53:55, FastEthernet0/1
O IA 10.10.34.0/24 [110/21] via 10.10.19.1, 00:53:55, FastEthernet0/1
C 10.10.99.0/24 is directly connected, Loopback0
O*IA 0.0.0.0/0 [110/11] via 10.10.19.1, 00:53:55, FastEthernet0/1
```



Konfiguracija Stub tipa area-Cisco Pronriateru

Totally stubby Area

```
R1(config-router)#area 99 stub no-summary
```

```
R9#sh ip ro
```

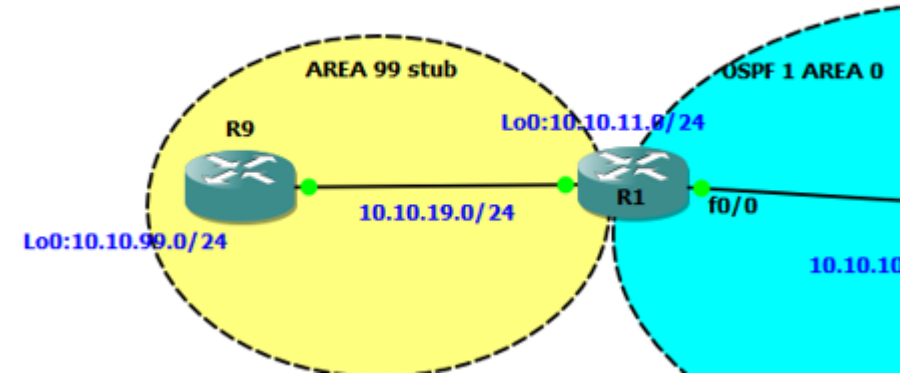
Gateway of last resort is 10.10.19.1 to network 0.0.0.0

10.0.0.0/24 is subnetted, 2 subnets

C 10.10.19.0 is directly connected, FastEthernet0/1

C 10.10.99.0 is directly connected, Loopback0

O*IA 0.0.0.0/0 [110/11] via 10.10.19.1, 00:00:06, FastEthernet0/1



Konfiguracija NSSA tipa area-STANDARD

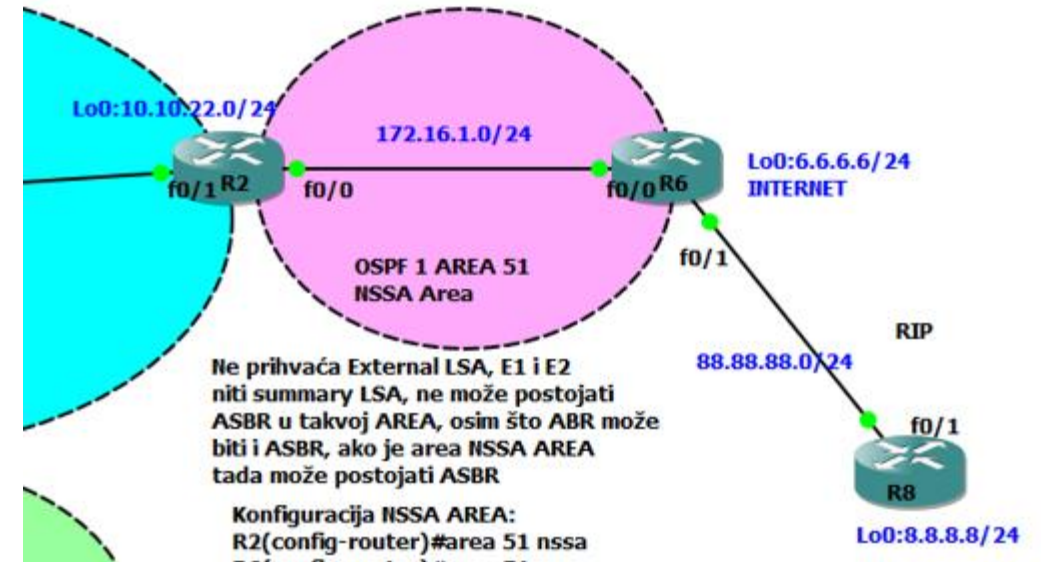
```
R2(config-router)#area 51 nssa
```

```
R2(config-router)#area 51 nssa default-information originate
```

```
R6# show ip route
```

Gateway of last resort is 172.16.1.2 to network 0.0.0.0

```
6.0.0.0/24 is subnetted, 1 subnets
C    6.6.6.0 is directly connected, Loopback0
172.16.0.0/24 is subnetted, 1 subnets
C    172.16.1.0 is directly connected, FastEthernet0/0
172.20.0.0/24 is subnetted, 1 subnets
O IA 172.20.1.0 [110/30] via 172.16.1.2, 00:00:04, FastEthernet0/0
8.0.0.0/24 is subnetted, 1 subnets
R    8.8.8.0 [120/1] via 88.88.88.8, 00:00:18, FastEthernet0/1
10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA 10.10.11.1/32 [110/21] via 172.16.1.2, 00:00:06, FastEthernet0/0
O IA 10.10.10.0/24 [110/20] via 172.16.1.2, 00:00:06, FastEthernet0/0
O IA 10.10.19.0/24 [110/30] via 172.16.1.2, 00:00:06, FastEthernet0/0
O IA 10.10.33.1/32 [110/21] via 172.16.1.2, 00:00:06, FastEthernet0/0
O IA 10.10.34.0/24 [110/21] via 172.16.1.2, 00:00:06, FastEthernet0/0
O IA 10.10.99.1/32 [110/31] via 172.16.1.2, 00:00:06, FastEthernet0/0
88.0.0.0/24 is subnetted, 1 subnets
C    88.88.88.0 is directly connected, FastEthernet0/1
O*N2 0.0.0.0/0 [110/1] via 172.16.1.2, 00:00:05, FastEthernet0/0
```



Konfiguracija NSSA tipa area-Cisco proprietary

Totally stubby NSSA Area

```
R2(config-router)#area 51 nssa no-summary
```

```
R6#show ip route
```

Gateway of last resort is 172.16.1.2 to network 0.0.0.0

6.0.0.0/24 is subnetted, 1 subnets

C 6.6.6.0 is directly connected, Loopback0

172.16.0.0/24 is subnetted, 1 subnets

C 172.16.1.0 is directly connected, FastEthernet0/0

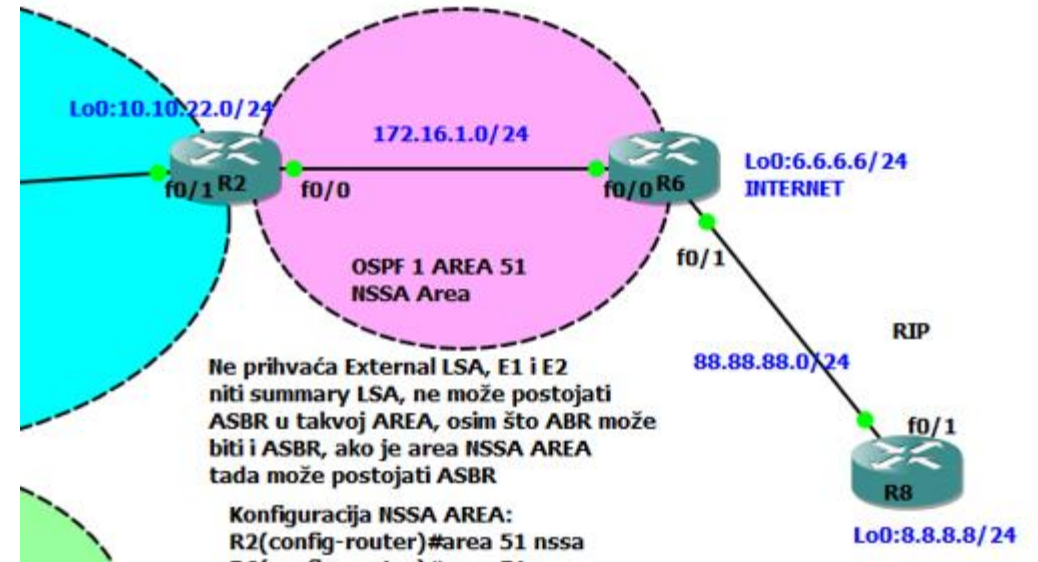
8.0.0.0/24 is subnetted, 1 subnets

R 8.8.8.0 [120/1] via 88.88.88.8, 00:00:20, FastEthernet0/1

88.0.0.0/24 is subnetted, 1 subnets

C 88.88.88.0 is directly connected, FastEthernet0/1

O*IA 0.0.0.0/0 [110/11] via 172.16.1.2, 00:00:08, FastEthernet0/0



NSSA-izvor default rute

R2#sh ip ro

Gateway of last resort is 172.16.1.6 to network 0.0.0.0

```
172.16.0.0/24 is subnetted, 1 subnets
C    172.16.1.0 is directly connected, FastEthernet0/0
172.20.0.0/24 is subnetted, 1 subnets
O IA 172.20.1.0 [110/20] via 10.10.10.4, 00:05:03, FastEthernet0/1
8.0.0.0/24 is subnetted, 1 subnets
O N2 8.8.8.0 [110/20] via 172.16.1.6, 00:05:03, FastEthernet0/0
10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
O    10.10.11.1/32 [110/11] via 10.10.10.1, 00:05:03, FastEthernet0/1
C    10.10.10.0/24 is directly connected, FastEthernet0/1
O IA 10.10.19.0/24 [110/20] via 10.10.10.1, 00:05:04, FastEthernet0/1
C    10.10.22.0/24 is directly connected, Loopback0
O    10.10.33.1/32 [110/11] via 10.10.10.3, 00:05:04, FastEthernet0/1
O    10.10.34.0/24 [110/11] via 10.10.10.3, 00:05:04, FastEthernet0/1
O IA 10.10.99.1/32 [110/21] via 10.10.10.1, 00:05:04, FastEthernet0/1
O E2 192.168.0.0/24 [110/20] via 10.10.10.4, 00:05:04, FastEthernet0/1
88.0.0.0/24 is subnetted, 1 subnets
O N2 88.88.88.0 [110/20] via 172.16.1.6, 00:05:04, FastEthernet0/0
O E2 192.168.1.0/24 [110/20] via 10.10.10.4, 00:05:04, FastEthernet0/1
O*N1 0.0.0.0/0 [110/11] via 172.16.1.6, 00:01:24, FastEthernet0/0
```

Totally stubby NSSA Area kao izvor default rute

Na R6:

```
router ospf 1
```

```
log-adjacency-changes
```

```
area 51 nssa default-information-originate metric-type 1
```

```
redistribute rip subnets
```

```
network 172.16.1.0 0.0.0.255 area 51
```

NSSA-izvor default rute

R2#sh ip ro

Gateway of last resort is 172.16.1.6 to network 0.0.0.0

```
172.16.0.0/24 is subnetted, 1 subnets
C    172.16.1.0 is directly connected, FastEthernet0/0
172.20.0.0/24 is subnetted, 1 subnets
O IA 172.20.1.0 [110/20] via 10.10.10.4, 00:05:03, FastEthernet0/1
8.0.0.0/24 is subnetted, 1 subnets
O N2 8.8.8.0 [110/20] via 172.16.1.6, 00:05:03, FastEthernet0/0
10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
O    10.10.11.1/32 [110/11] via 10.10.10.1, 00:05:03, FastEthernet0/1
C    10.10.10.0/24 is directly connected, FastEthernet0/1
O IA 10.10.19.0/24 [110/20] via 10.10.10.1, 00:05:04, FastEthernet0/1
C    10.10.22.0/24 is directly connected, Loopback0
O    10.10.33.1/32 [110/11] via 10.10.10.3, 00:05:04, FastEthernet0/1
O    10.10.34.0/24 [110/11] via 10.10.10.3, 00:05:04, FastEthernet0/1
O IA 10.10.99.1/32 [110/21] via 10.10.10.1, 00:05:04, FastEthernet0/1
O E2 192.168.0.0/24 [110/20] via 10.10.10.4, 00:05:04, FastEthernet0/1
88.0.0.0/24 is subnetted, 1 subnets
O N2 88.88.88.0 [110/20] via 172.16.1.6, 00:05:04, FastEthernet0/0
O E2 192.168.1.0/24 [110/20] via 10.10.10.4, 00:05:04, FastEthernet0/1
O*N2 0.0.0.0/0 [110/1] via 172.16.1.6, 00:01:24, FastEthernet0/0
```

Totally stubby NSSA Area kao izvor default rute

Na R6:

```
router ospf 1
```

```
log-adjacency-changes
```

```
area 51 nssa default-information-originate
```

```
redistribute rip subnets
```

```
network 172.16.1.0 0.0.0.255 area 51
```

Oglašavanje predefiniranih ruta

- Oglašavanje predefiniranih ruta **ovisi o tipu područja**
- Za standardna područja:
 - Usmjernici ne kreiraju predefiniranu rutu automatski
 - Za generiranje predefinirane rute, koristi se naredba default-information originate
- Za stub i totally stubby područja:
 - **ABR automatski generira predefiniranu rutu**, ručno generiranje sa naredbom default-information originate nije potrebno.
- Za NSSA područja:
 - **ABR generira predefiniranu rutu**, ali ne automatski već sa naredbom area area-id nssa default-information-originate

OSPF sažimanje putanja

- Sažimanje između područja (*Interarea summarization*)
 - ovaj tip sažimanja se događa na ABR usmjernicima
 - sažimaju se samo putanje unutar svakog od područja
 - ne sažimaju se putanje izvan autonomnog sustava dobivene redistribucijom
- Sažimanje vanjskih putanja (*External route summarization*)
 - sažimaju se putanje koje su ubačene u OSPF domenu redistribucijom
 - samo ASBR usmjernik sažima vanjske putanje

OSPF sažimanje putanja

R9#show ip route

Gateway of last resort is 10.10.19.1 to network 0.0.0.0

172.16.0.0/24 is subnetted, 7 subnets

- O IA 172.16.12.0 [110/21] via 10.10.19.1, 00:00:08, FastEthernet0/1
- O IA 172.16.13.0 [110/21] via 10.10.19.1, 00:00:08, FastEthernet0/1
- O IA 172.16.14.0 [110/21] via 10.10.19.1, 00:00:08, FastEthernet0/1
- O IA 172.16.15.0 [110/21] via 10.10.19.1, 00:00:08, FastEthernet0/1
- O IA 172.16.10.0 [110/21] via 10.10.19.1, 00:00:08, FastEthernet0/1
- O IA 172.16.11.0 [110/21] via 10.10.19.1, 00:00:08, FastEthernet0/1
- O IA 172.16.1.0 [110/30] via 10.10.19.1, 00:00:09, FastEthernet0/1

172.20.0.0/24 is subnetted, 1 subnets

- O IA 172.20.1.0 [110/30] via 10.10.19.1, 00:08:25, FastEthernet0/1

10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks

- O IA 10.10.11.1/32 [110/11] via 10.10.19.1, 00:08:25, FastEthernet0/1
- O IA 10.10.10.0/24 [110/20] via 10.10.19.1, 00:08:25, FastEthernet0/1
- C 10.10.19.0/24 is directly connected, FastEthernet0/1
- O IA 10.10.33.1/32 [110/21] via 10.10.19.1, 00:08:26, FastEthernet0/1
- O IA 10.10.34.0/24 [110/21] via 10.10.19.1, 00:08:26, FastEthernet0/1
- C 10.10.99.0/24 is directly connected, Loopback0
- O*IA 0.0.0.0/0 [110/11] via 10.10.19.1, 00:08:26, FastEthernet0/1

OSPF sažimanje putanja

```
R2(config-router)# area 51 range 172.16.0.0 255.255.0.0
```

```
R9#show ip route
```

Gateway of last resort is 10.10.19.1 to network 0.0.0.0

```
O IA 172.16.0.0/16 [110/21] via 10.10.19.1, 00:00:13, FastEthernet0/1
```

```
172.20.0.0/24 is subnetted, 1 subnets
```

```
O IA 172.20.1.0 [110/30] via 10.10.19.1, 00:10:10, FastEthernet0/1
```

```
10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
```

```
O IA 10.10.11.1/32 [110/11] via 10.10.19.1, 00:10:10, FastEthernet0/1
```

```
O IA 10.10.10.0/24 [110/20] via 10.10.19.1, 00:10:10, FastEthernet0/1
```

```
C 10.10.19.0/24 is directly connected, FastEthernet0/1
```

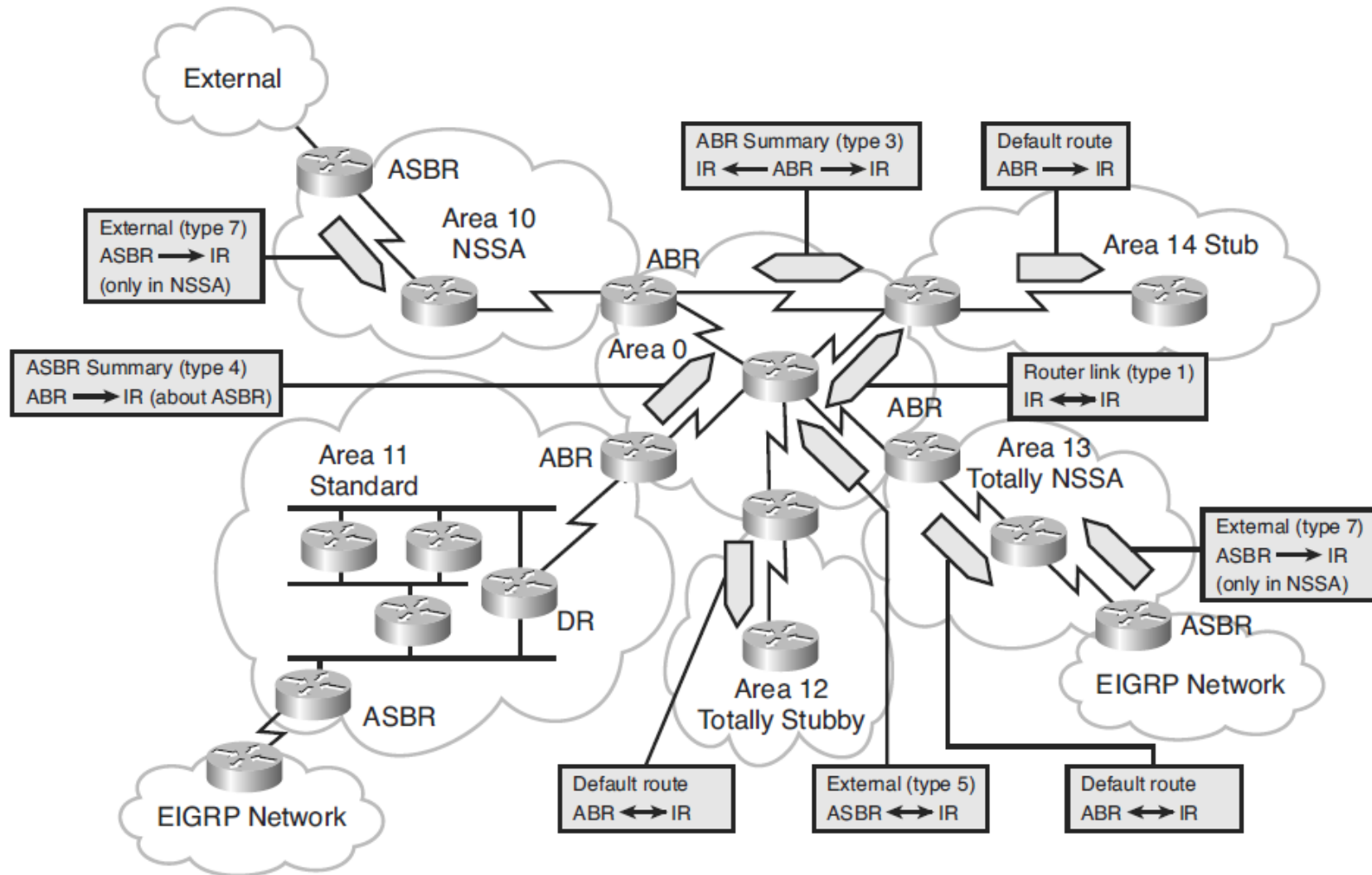
```
O IA 10.10.33.1/32 [110/21] via 10.10.19.1, 00:10:11, FastEthernet0/1
```

```
O IA 10.10.34.0/24 [110/21] via 10.10.19.1, 00:10:11, FastEthernet0/1
```

```
C 10.10.99.0/24 is directly connected, Loopback0
```

```
O*IA 0.0.0.0/0 [110/11] via 10.10.19.1, 00:10:11, FastEthernet0/1
```


OSPF mreža - primjer



IR = Internal Router

