



سيسكو في 6 ساعات



الكورس

يختصر أكثر من مائة ساعة
يركز على احتياجات المهندسين
في سوق العمل

© 2020
All Rights Reserved
Second Edition
حقوق النشر والترجمة محفوظة

- OSPF

- OSPF Tables

- Neighbors Table :

Hello (10s)
wait (40s)

- Database Table :

Dijkstra Algorithm

$$\text{Cost} = \frac{100}{\text{BW}}$$

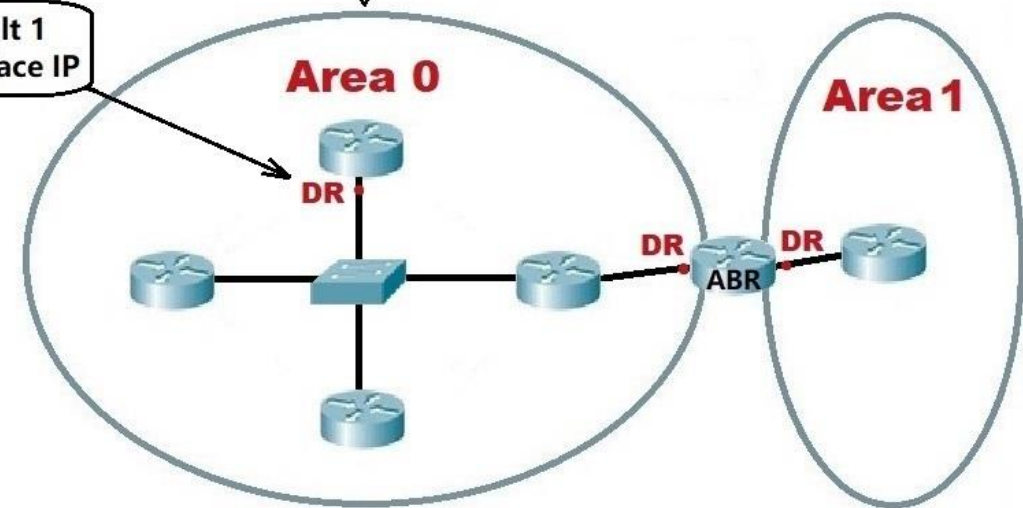
- Routing Table :

Lowest Cost (FastEthernet **Cost = 1**)
Update the change → **DR**

```

Enable Ospf      Process ID      Wildcard mask
R1(config)# router Ospf 1
R1(config-router)# network 10.0.0.0 0.255.255.255 Area 0
    
```

Priority Default 1
Router-ID interface IP

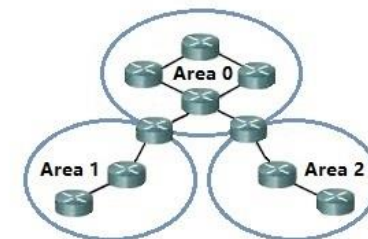


- OSPF

- Key points

- **OSPF** : Open Shortest Path First
- Open standard Protocol (used by all vendors)
- It is **Link State** protocol (works based on the status of links)
- Administrative distance (**110**)
- Must have **Area 0**, which is called **backbone area**
- All other areas must connect to this **Area 0**
- Updates are Sents when there is **change** in the Route
- Use **Dijkstra** Algorithm , which is also known as Shortest Path First (**SPF**) to find the best path.
- OSPF Supports only Equal cost load-balancing
- **OSPFv2** for IPv4 , while **OSPFv3** for IPv6

| OSPF |
|--------------------------|
| VLSM |
| No limit on hop count |
| Multicast |
| 224.0.0.5 to all routers |
| 224.0.0.6 to all DR |
| Authentication (Md5) |



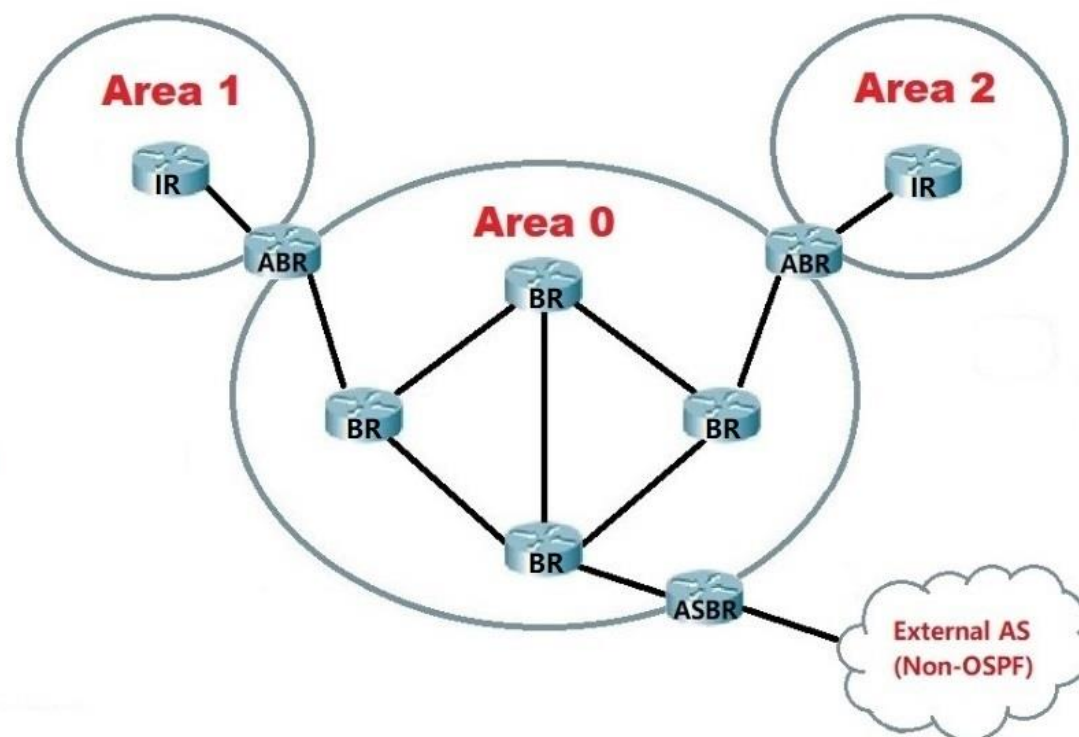
- OSPF

- Area

- **Area** : is a grouping of networks
- **Goal** : to Minimize the routing table
- **Area 0** must exist and it called the backbone area
- **Multiple areas** must connect to area 0
- **Areas** can be any number up to **2.4 billion**
- Requires a **Hierarchical Design (summarization)**
- **Updates** are made within area
- In general, Maximum Router in any area **50 routers**

Note :

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



- OSPF

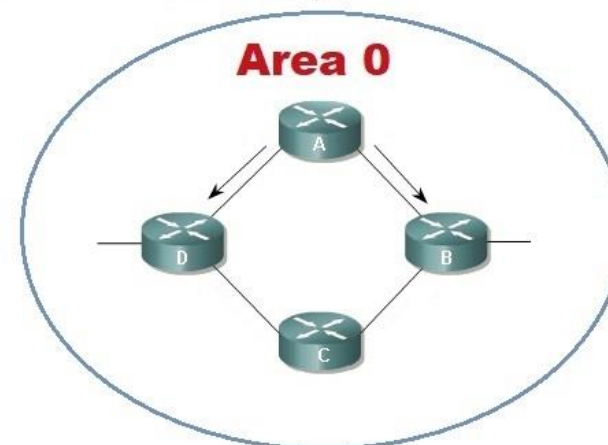
- Process IDs

- **Process IDs** can be any number from **0** to **65535**
- **OSPF Process IDs** can be different on each router and still communicate ,(Not like EIGRP)

- Wildcard Mask

- **Subnet mask** used to identify the network
- **wildcard mask** used to identify ip or group of ip addresses
- There are two basic rules of a wildcard mask.
 - 0-bit = match**
 - 1-bit = don't care**
- wildcard mask tells the router what bits in ip address to match
- **Target a host** 192.5.5.10 : wild card mask **0.0.0.0**
- **Target a Network / 24** : wild card mask **0.0.0.255**
- **Target all IP address** : wild card mask **255.255.255.255**
mean don't care all bits (means all IP addresses will be Accepted)

```
R1(config)# router Ospf 1
R1(config-router)# network 10.0.0.0 0.255.255.255 area 0
```



255.255.255.255

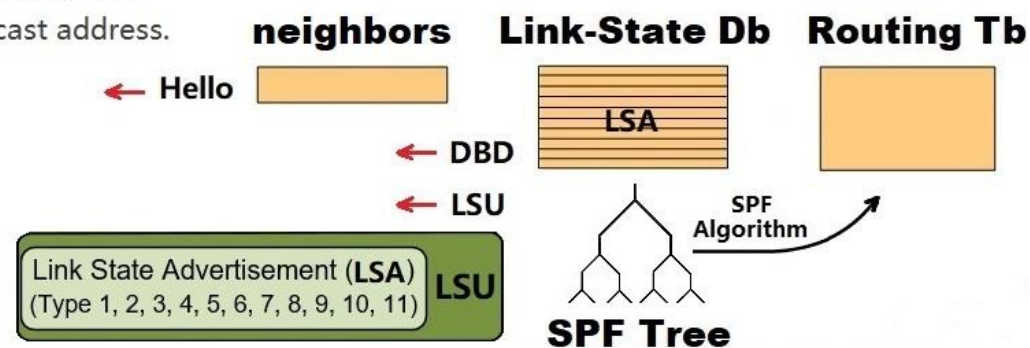
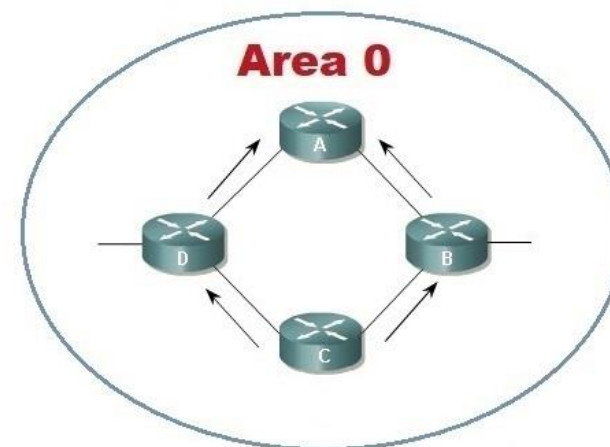
- **255. 0 . 0 . 0** (Subnet mask)

0 .255.255.255 (wildcard mask)

- OSPF

- How OSPF Works

- OSPF communicates with neighbors by **Hello** packet in the same area to build a **Neighbors Table**
- OSPF communicates by **DBD** packet to start build **Database Table**, Known as **Link-State Database (LSDB)**
- OSPF uses **Dijkstra SPF** Algorithm on Database to creates a hierarchical map of the networks and to find the best path
- OSPF stores the best path in **Routing Table**
- When the status of the link changes, OSPF sends **LSU** Packet with **Link Status Advertisement (LSA)** update using multicast address.

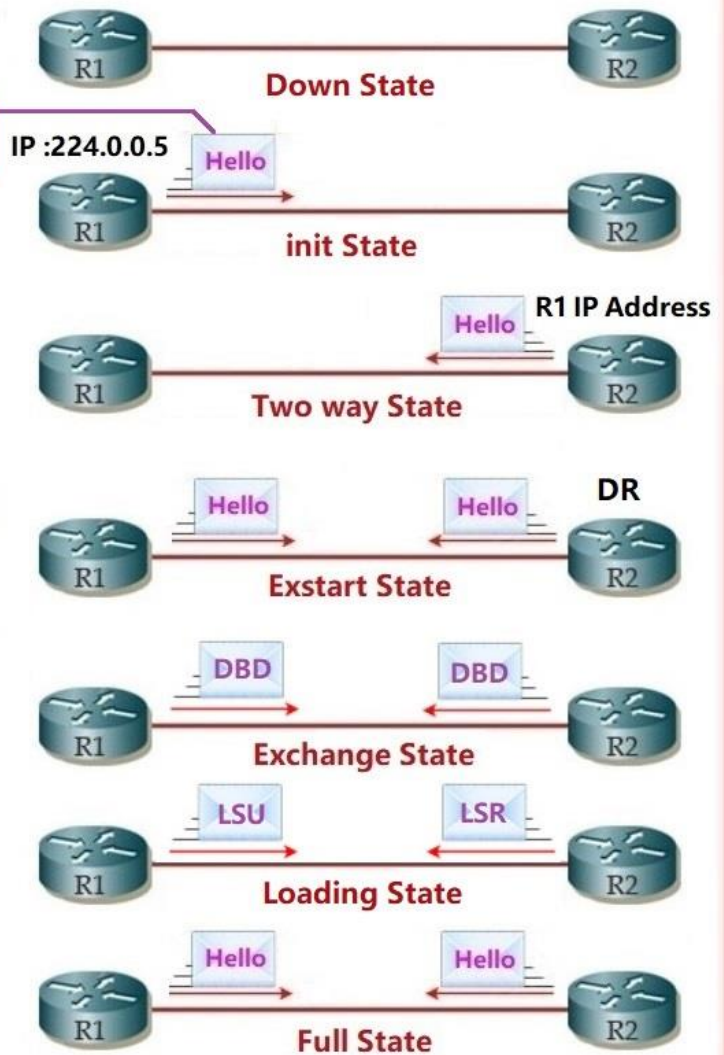


- OSPF

- OSPF Packet Types

- **Hello** : To identify neighbors and build relationship as keepalives ,
To be a neighbors must be :
 - Same **Area ID**
 - Same **Subnet mask**
 - Same **Hello timer and Dead interval**
 - Same **Authentication password**
- * **Hello Timer** : sends hello every **10** seconds to check the neighbors
- * **Dead Interval** : wait **4** times of Hello timer (**40s**) before considering that neighbor dead
- **Database Descriptor (DBD)** : It is a summary of the Full Database (**LSDB**) it called Link State Database
- **Links State Acknowledgement (LSAck)** : Acknowledgement for all OSPF packets except the Hello packet.
- **Link State Request (LSR)** : It is a request to other routers for some information about route .
- **Link State Update (LSU)** : Contains **LSA** information requested in the **LSR**.

Area ID , mask , Hello t , Dead interval, password
Router ID , Priority , DR & BDR IPs ,neighbors



- OSPF

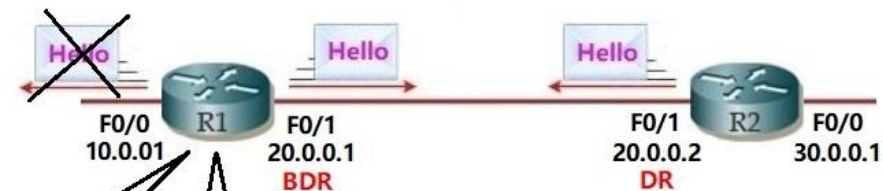
- OSPF Update

- **Periodic Hello** : Send every 10s to check the neighbor
- **Triggered** : Send the change in the table , to DR & BDR only

R1# show ip ospf interface

```
FastEthernet0/0 is up, line protocol is up
Internet address is 10.0.0.1/8, Area 0
Process ID 1, Router ID 20.0.0.1, Network Type BROADCAST, Cost: 1
Transmit Delay is 1 sec, State WITING, Priority 1
No designated router on this network
No backup designated router on this network
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
No Hellos (Passive interface)
```

```
FastEthernet0/1 is up, line protocol is up
Internet address is 20.0.0.1/8, Area 0
Process ID 1, Router ID 20.0.0.1, Network Type BROADCAST, Cost: 1
Designated Router (ID) 30.0.0.1, Interface address 20.0.0.2
Backup Designated Router (ID) 20.0.0.1, Interface address 20.0.0.1
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:01
```



R1# debug ip ospf events

```
00:40:10: OSPF: Rcv hello from 30.0.0.1 area 0 from F0/1 20.0.0.2
00:40:20: OSPF: Rcv hello from 30.0.0.1 area 0 from F0/1 20.0.0.2
00:40:30: OSPF: Rcv hello from 30.0.0.1 area 0 from F0/1 20.0.0.2
```

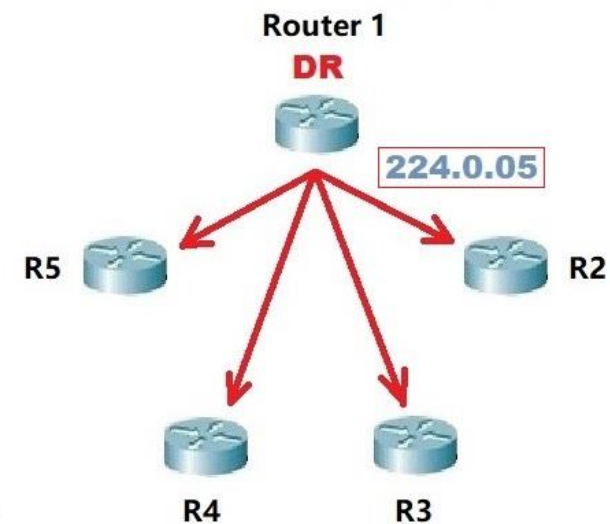
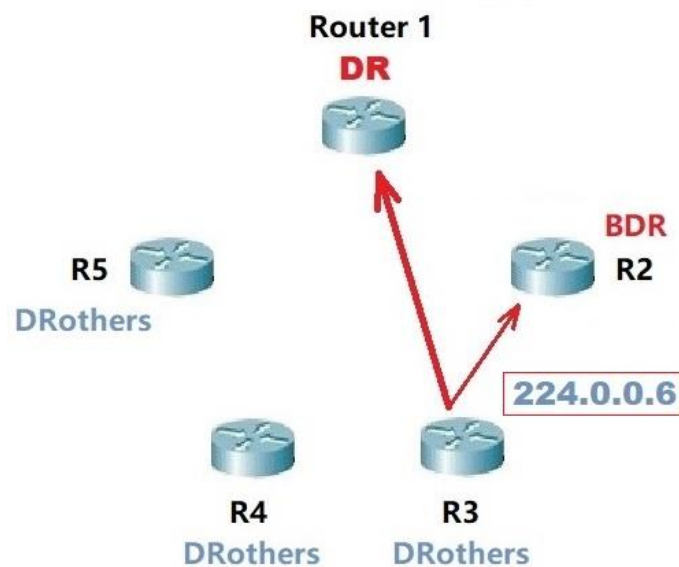
R1# no debug all

- OSPF

- OSPF DR and BDR

DR (Designated Router)

BDR (Backup Designated Router)



- OSPF

- OSPF DR and BDR

Who becomes DR ?

* highest priority

- Priority **0** means can not be a **DR**
- Default priority **1** (range is 0-255)
- Highest priority wins **DR** (1-255)

```
R1(config)# interface f0/0
R1(config-if)# IP ospf Priority 100
R1# clear ip ospf process
```

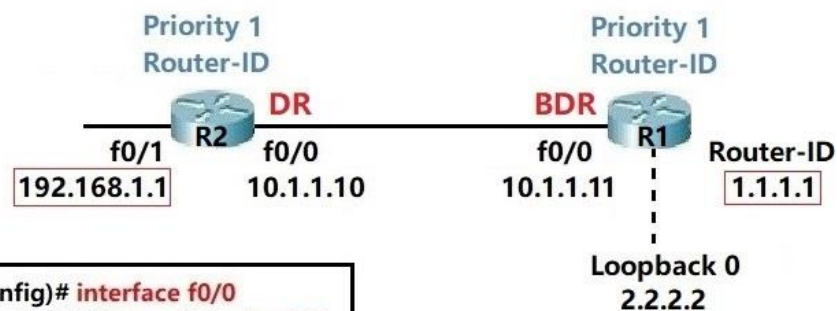
* highest Router-ID

- Manually Router-ID
- highest loopback IP
- highest interface IP

```
R1(config)# router Ospf 1
R1(config-router)# Router-ID 1.1.1.1
```

```
R1(config)# interface Loopback 0
R1(config-if)# IP address 2.2.2.2 255.255.255.255
```

```
R1(config)# interface f0/0
R1(config-if)# IP address 10.1.1.11 255.255.255.0
R1(config-if)# no shutdown
```

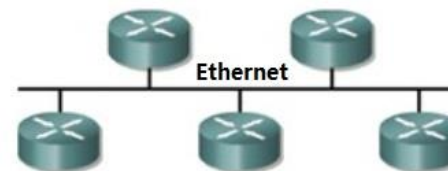


- OSPF

- OSPF Networks Types

OSPF Automatically Recognize three type of networks

BMA
Broadcast multi-access



Need **DR** , Hello **10s**

NBMA
non-broadcast multi-access



Need **DR** , Hello **30s**

Point - to - Point



No **DR** , Hello **10s**

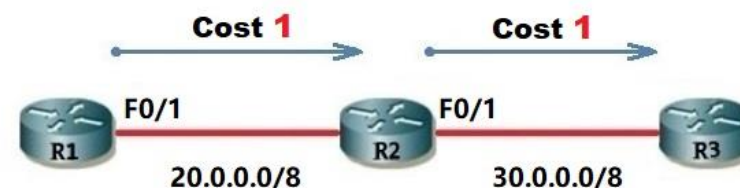
- OSPF

- OSPF Metric

- OSPF use **Dijkstra** Algorithm , to find the best path (**Lowest cost**)

$$\text{Cost} = \frac{100}{\text{Bandwidth (Mbps)}}$$

| interface | Bandwidth | Cost |
|------------------|------------|------|
| Serial 64 | 64 kbps | 1563 |
| Serial T1 | 1.544 Mbps | 64 |
| Ethernet | 10 Mbps | 10 |
| FastEthernet | 100 Mbps | 1 |
| Gigabit Ethernet | 1 Gbps | 1 |



```
R1# show ip route
Codes: C - connected, R-RIP, D-EIGRP, O-OSPF
O 30.0.0.0/8 [110 / 2 ] via 20.0.0.1, 00:00:00, F0/1
```

```
R1(config)# interface f0/1
R1(config-if)# bandwidth 10000 (10,000 kilo=10M)

R1# show ip route
Codes: C - connected, R-RIP, D-EIGRP, O-OSPF
O 30.0.0.0/8 [110 / 11 ] via 20.0.0.1, 00:00:13, F0/1
```

- OSPF

- OSPF Tables



-Neighbors Table : Contains the Neighbor information.

-Database Table : Contains all possible routes in this area known as the Link state Database (**LSDB**)

-Routing Table : Contains the best path to reach each

R1# **show ip Ospf neighbors**

| Neighbor ID | Pri | State | Dead Time | Address | Interface |
|-------------|-----|-------------------------------------|-----------|----------|-----------|
| 30.0.0.1 | 1 | FULL/DR FULL/BDR 2way/DRother | 00:00:32 | 20.0.0.2 | F0/1 |

R1# **show ip Ospf database**

OSPF Router with ID (20.0.0.1) (Process ID 1)

| Router Link States (Area 0) | | | | | |
|-----------------------------|------------|------|------------|----------|------|
| Link ID | ADV Router | Age | Seq# | Checksum | Link |
| 20.0.0.1 | 20.0.0.1 | 1069 | 0x80000004 | 0x00756c | 2 |
| 30.0.0.1 | 30.0.0.1 | 1069 | 0x80000004 | 0x00a216 | 2 |

There are 2 Routers in area 0 and every router has 2 link

| Net Link States (Area 0) | | | | | |
|--------------------------|------------|------|------------|----------|--|
| Link ID | ADV Router | Age | Seq# | Checksum | |
| 20.0.0.2 | 30.0.0.1 | 1069 | 0x80000001 | 0x009062 | |

Show the router-ID of DR in this link

R1# **show ip route**

Codes: C - connected, S - static, R - RIP, D - EIGRP, O - OSPF

| | | | |
|---|------------|------------------------|-----------------|
| C | 10.0.0.0/8 | is directly connected, | FastEthernet0/0 |
| C | 20.0.0.0/8 | is directly connected, | FastEthernet0/1 |
| O | 30.0.0.0/8 | [110/2] via 20.0.0.2, | 00:19:36, F0/1 |

- Summarization

- Advantage

- Make routing table small
- Reduce Processor workload
- Reduce memory usage

- 2 Type :

- Auto-Summarization : in RIP and EIGRP
 - * Return the mask in to the default Class
- Manual Summarization :
 - * Used in OSPF and IS-IS
 - * Done in OSPF by command

```
ABR(config)# router Ospf 100
ABR(config-router)# network 10.1.0.0 0. 0.255.255 area 0
ABR(config-router)# network 10.2.0.0 0. 0.255.255 area 1
```

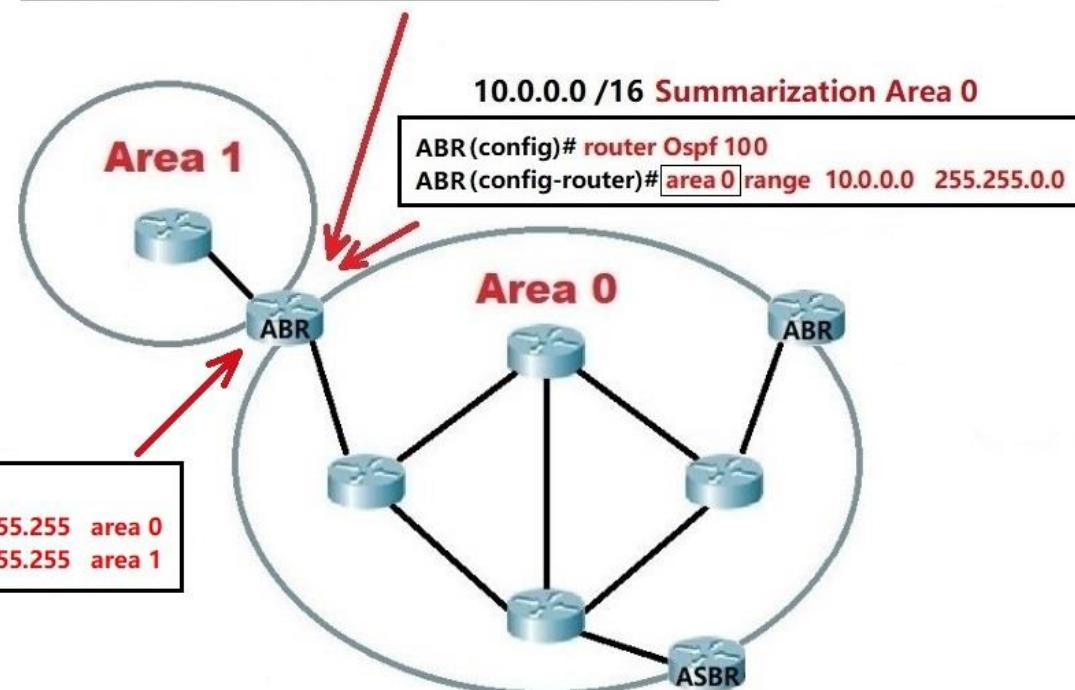
```
10.1.1.0 /24
10.1.2.0 /24
10.1.3.0 /24
10.1.4.0 /24
```

10.1.0.0 /16 Summarization Area 1

```
ABR(config)# router Ospf 100
ABR(config-router)# area 1 range 10.1.0.0 255.255.0.0
```

10.0.0.0 /16 Summarization Area 0

```
ABR (config)# router Ospf 100
ABR (config-router)# area 0 range 10.0.0.0 255.255.0.0
```



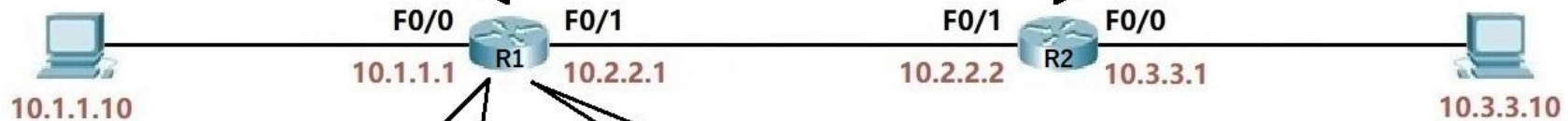
- OSPF

```
R1(config)# router Ospf 1
R1(config-router)# network 10.1.1.0 0.0.0.255 area 0
R1(config-router)# network 10.2.2.0 0.0.0.255 area 0

R1(config-router)# passive-interface f0/0
R1(config-router)# no auto-summary
```

```
R2(config)# router Ospf 1
R2(config-router)# network 10.2.2.0 0.0.0.255 area 0
R2(config-router)# network 10.3.3.0 0.0.0.255 area 0

R2(config-router)# passive-interface f0/0
```



```
R1# show ip protocols
Routing Protocol is "ospf 1"
Router ID 10.2.2.1
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Maximum path: 4

Routing for Networks:
10.1.1.0 0.0.0.255 area 0
10.2.2.0 0.0.0.255 area 0

Routing Information Sources:
Gateway Distance Last Update
10.2.2.1 110 00:06:55
10.3.3.1 110 00:06:55
Distance: (default is 110)
```

```
R1# show ip route
C 10.1.1.0/8 is directly connected, FastEthernet0/0
C 10.2.2.0/8 is directly connected, FastEthernet0/1
O 10.3.3.0/8 [110/2] via 10.2.2.2, 00:19:36, F0/1

R1#show ip Ospf neighbors
Neighbor ID Pri State Dead Time Address Interface
10.3.3.1 1 FULL/DR 00:00:32 10.2.2.2 F0/1

R1#show ip Ospf database
OSPF Router with ID (10.2.2.1) (Process ID 1)
Router Link States (Area 0)
Link ID ADV Router Age Seq# Checksum Link
10.2.2.1 10.2.2.1 1069 0x80004 0x00756c 2
10.3.3.1 10.3.3.1 1069 0x80004 0x00a216 2
```

```
R1# debug ip ospf events
R1# no debug all
```

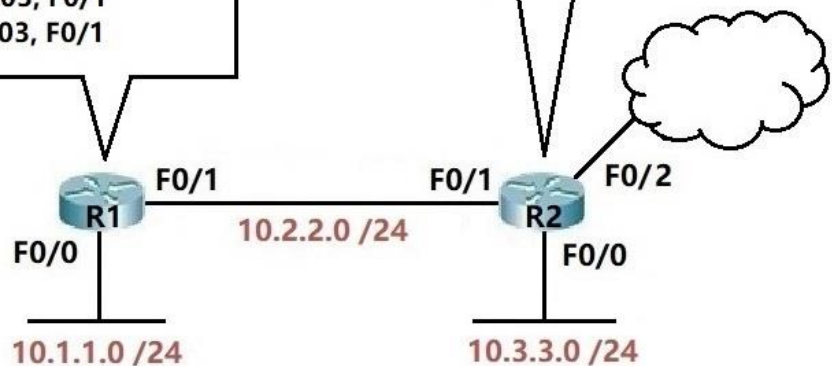
- OSPF

- Internet

```
R1# show ip route
Codes: C - connected, S - static, R - RIP, D - EIGRP, O - OSPF,
      E1 - OSPF external type 1, E2 - OSPF external type 2
C 10.1.1.0/24 is directly connected, F0/0
C 10.2.2.0/24 is directly connected, F0/1
O 10.3.3.0/24 [110/2] via 10.2.2.2, 00:00:03, F0/1
O*E2 0.0.0.0/0 [110/1] via 10.2.2.2, 00:00:03, F0/1
```

```
R2(config)# IP route 0.0.0.0 0.0.0.0 F0/2
```

```
R2(config)# router Ospf 1
R2(config-router)# network 10.2.2.0
R2(config-router)# network 10.3.3.0
R2(config-router)# default-information originate
```



OSPF Commands

```
R1(config)# router Ospf 1
R1(config-router)# Router-ID 1.1.1.1
```

```
R1(config)# router Ospf 1
R1(config-router)# network 10.1.1.0 0.0.0.255 area 0
R1(config-router)# network 10.2.2.0 0.0.0.255 area 0
```

```
R1(config)# router Ospf 1
R1(config-router)# passive-interface f0/1
```

```
R1# show ip protocols

Routing Protocol is "ospf 1"
  Router ID 10.2.2.1
  Number of areas in this router is 1. 1 normal
  Maximum path: 4

  Routing for Networks:
    10.1.1.0 0.0.0.255 area 0
    10.2.2.0 0.0.0.255 area 0
  passive-interface :
    fastEthernet 0/0
  Routing Information Sources:
  Gateway         Distance      Last Update
  10.2.2.1         110           00:06:55
  10.3.3.1         110           00:06:55
  Distance: (default is 110)
```

```
R1# show ip route
R1# show ip Ospf neighbors
R1# show ip Ospf database
```

```
R1# show ip Ospf interface

FastEthernet0/1 is up, line protocol is up
Internet address is 10.2.2.1/24, Area 0
Process ID 1, Router ID 10.2.2.1
Network Type BROADCAST, Cost: 1
Transmit Delay is 1 sec, State BDR, Priority 1
Designated Router (ID) 10.3.3.1, Interface 10.2.2.2
Backup Designated Router (ID) 10.2.2.1, Interface 10.2.2.1
Timer intervals Hello 10, Dead 40, Wait 40, Retransmit 5
Hello due in 00:00:01
```

```
R1(config)# interface f0/1
R1(config-if)# bandwidth 10000
```

```
R1(config)# interface f0/1
R1(config-if)# IP ospf Priority 100
```

```
R1(config)# interface f0/1
R1(config-if)# IP ospf hello-interval 15
```