OSPF Network Types

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接口的网络类型（二层概念）

- 接口的网络类型属于二层概念与OSPF的网络类型无关
- Point-to-Point（HDLC, PPP, Frame Relay点到点子接口）
- Multi-access 多路访问网络，多路访问网络分以下两种
  - Broadcast 广播的多路访问网络（Ethernet, Token Ring, and FDDI）
  - Non-broadcast multi-access（NBMA）非广播的多路访问网络

    （Frame Relay物理接口和多点子接口, and X.25，ATM）

    所谓的NBMA就是不具备内部广播和多点传送能力的网络

OSPF Network Types： 三层的概念，影响SPF计算

The three types of networks defined by OSPF are:

- Point-to-point: A network that joins a single pair of routers.
- Broadcast: A multi-access broadcast network, such as Ethernet.
- Nonbroadcast multi-access (also called NBMA): A network that interconnects more than two routers but that has no broadcast capability. Frame Relay, ATM, and X.25 are examples of NBMA networks.
  - Five modes of OSPF operation are available for NBMA networks.
  - OSPF Network-type与接口类型无关，只是每种接口类型与OSPF网络类型有一个默认的对应关系而已。

OSPF Network types

- Point-to-Point（不存在DR选举，H 10 D 40）
- Broadcast （存在DR选举，H 10 D 40）
- NBMA （存在DR选举，H 30 D 120，必须手工指定邻居）
- Point-to-Multipoint （不存在DR选举，H 30 D 120，存在32位的主机路由）
- Point-to-Multipoint Nonbroadcast （不存在DR选举，H 30 D 120，必须手工指定邻居，存在32位的主机路由）

之前我们说了有5种，再加上2种：

- Loopback（Loopback 接口特有的类型，掩码总是32位,所以默认情况下在OSPF中学到环回口的路由都是32位）
- Virtual-link （和Point-to-Point相似）

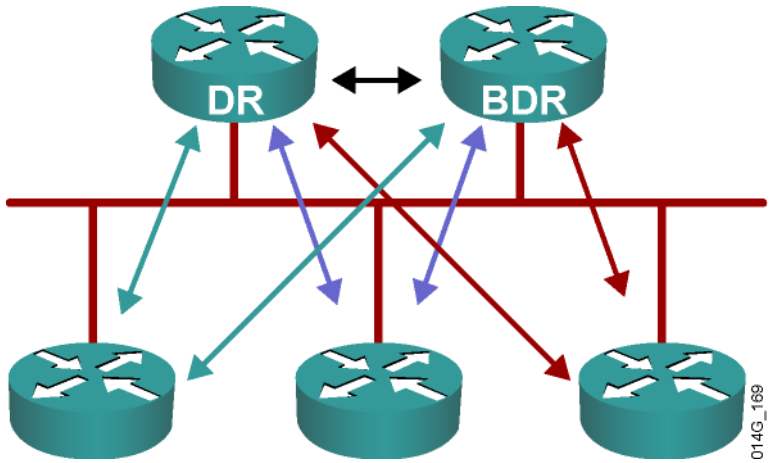
OSPF网络类型以及特点

网络类型	对应的默认接口类型	特点
loopback	Loopback	32位
Point-to-Point	HDLC/ppp/FR’s P2Psub-if	组播/non-DR
Broadcast	Ethernet	组播/DR
NBMA	FR Physical/FR Mpsub-if	单播/DR
P2MP	-------	-------
P2MP NBMA	-------	-------

Point-to-Point Links

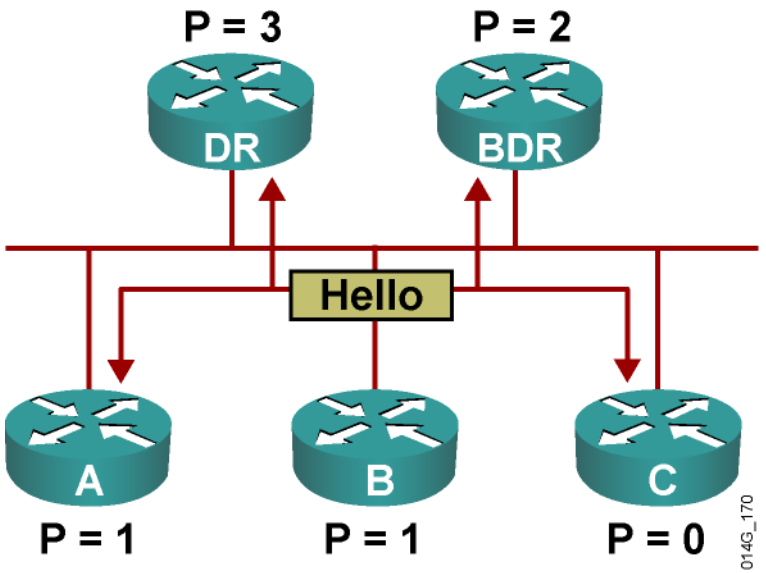
- Usually a serial interface running either PPP or HDLC.
- May also be a point-to-point subinterface running Frame Relay or ATM.
- No DR or BDR election required.
- OSPF autodetects this interface type.
- OSPF packets are sent using multicast 224.0.0.5.

Multiaccess Broadcast Network



- Generally these are, LAN technologies like Ethernet and Token Ring.
- DR and BDR selection are required.
- All neighbor routers form full adjacencies with the DR and BDR only.
- Packets to the DR and the BDR use 224.0.0.6.
- Packets from DR to all other routers use 224.0.0.5.

Electing the DR and BDR



- Hello packets are exchanged via IP multicast.
- The router with the highest OSPF priority is selected as the DR. The router with the second-highest priority value is the BDR.
- Use the OSPF router ID as the tiebreaker.
- The DR election is Nonpreemptive.

Setting Priority for DR Election

```
Router(config-if)#
ip ospf priority number
```

- This interface configuration command assigns the OSPF priority to an interface.
- Different interfaces on a router may be assigned different values.
- The default priority is 1. The range is from 0 to 255.
- 0 means the router cannot be the DR or BDR.
- A router that is not the DR or BDR is DROTHER.

DR

1. 在选举期内，优先级高的成为DR，其次的成为BDR；
2. 在选举期内，如果优先级一样，Router-ID高的成为DR，其次的成为BDR；
3. 在选举期外，不存在抢占性；
4. DR失效以后，BDR升级成为DR，重新选举BDR；
5. clear ip ospf process（重启OSPF进程）可以重选；
6. DR正常时，BDR只接收所有信息，转发LSA和同步LSDB的任务由DR完成，当DR故障时，BDR自动成为DR，完成原DR的工作，并选举新的BDR

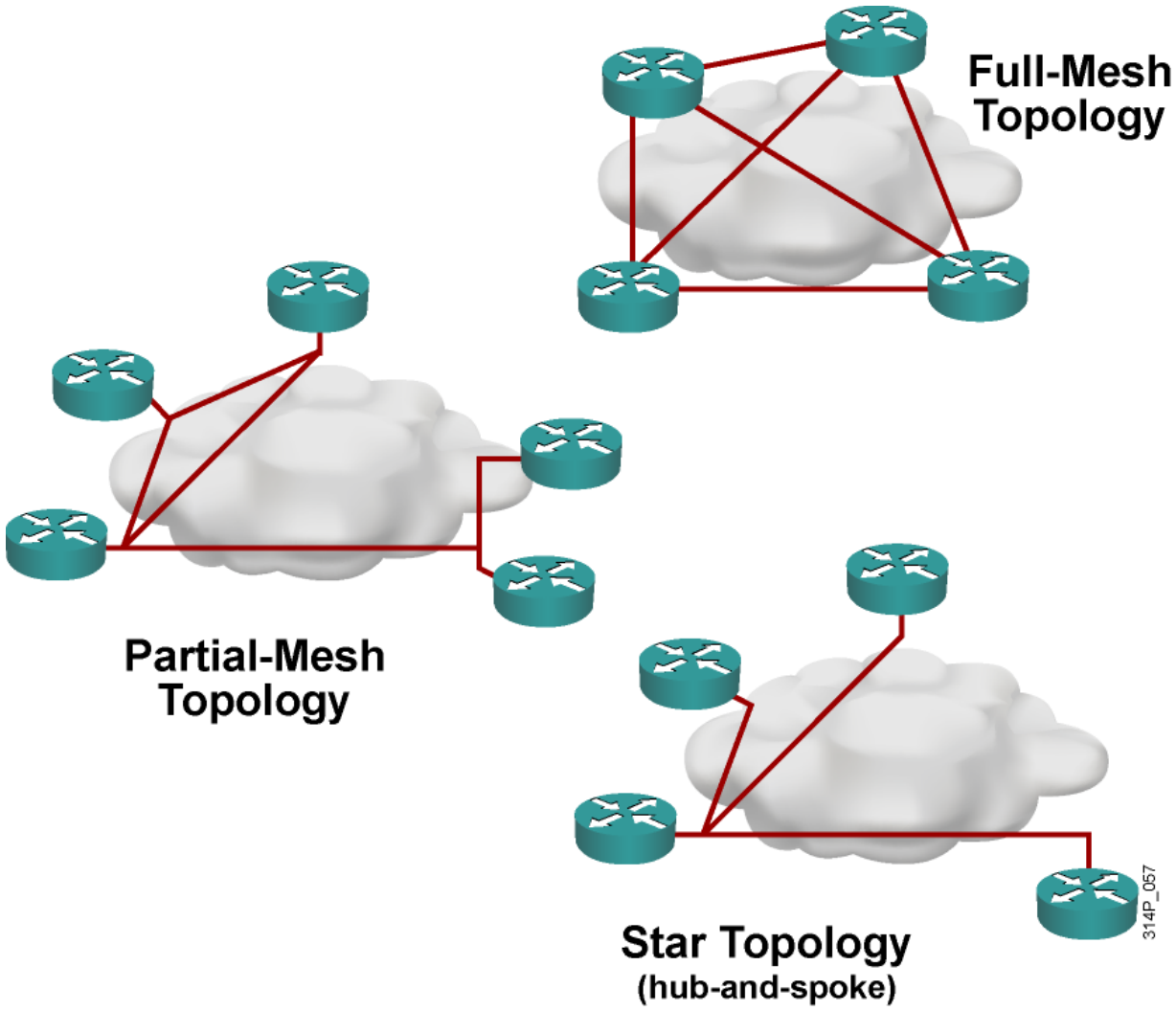
NBMA Topology

- A single interface interconnects multiple sites.
- NBMA topologies support multiple routers, but without broadcasting capabilities.

DR Election in NBMA Topology

- OSPF considers NBMA to be like other broadcast media.
- The DR and BDR need to have fully meshed connectivity with all other routers, but NBMA networks are not always fully meshed.
- The DR and BDR need a list of neighbors.
- OSPF neighbors are not automatically discovered by the router.

Frame Relay Topologies



OSPF over NBMA Topology Modes of Operation

- RFC 2328-compliant modes are as follows:
  - Nonbroadcast (NBMA)
  - Point-to-multipoint
- Additional modes from Cisco are as follows:
  - Point-to-multipoint nonbroadcast
  - Broadcast
  - Point-to-point

Selecting the OSPF Network Type for NBMA Networks

```
Router(config-if)#
ip ospf network [{broadcast | non-broadcast | point-to-
multipoint [non-broadcast] | point-to-point}]
```

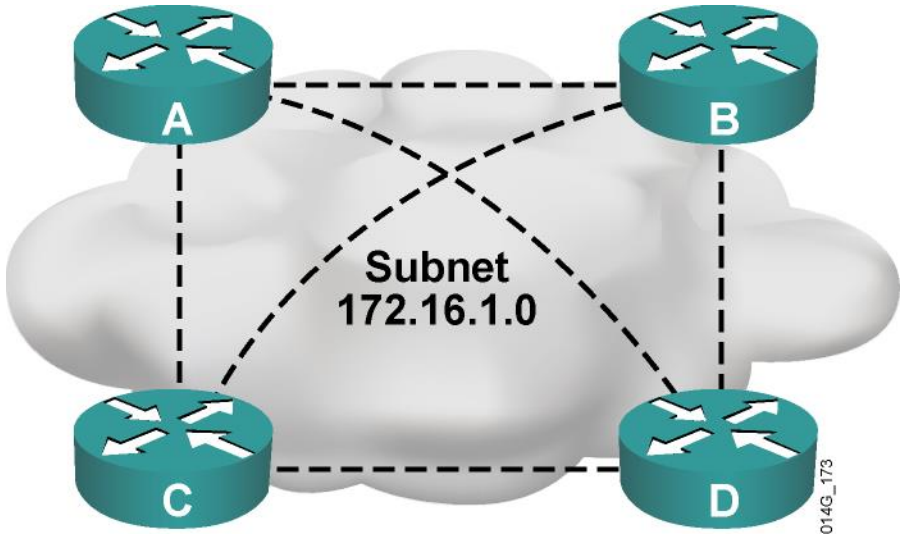
- **Defines OSPF network type**

Example: Broadcast Mode

```
Router(config)#interface serial 0/0/0
Router(config-if)#encapsulation frame-relay
Router(config-if)#ip ospf network broadcast
```

Nonbroadcast Mode (NBMA Mode)

- Treated as a broadcast network by OSPF (acts like a LAN).
- All serial ports are part of the same IP subnet.
- Frame Relay, X.25, and ATM networks default to nonbroadcast mode.
- Neighbors must be statically configured.
- Duplicates LSA updates.
- Complies with RFC 2328

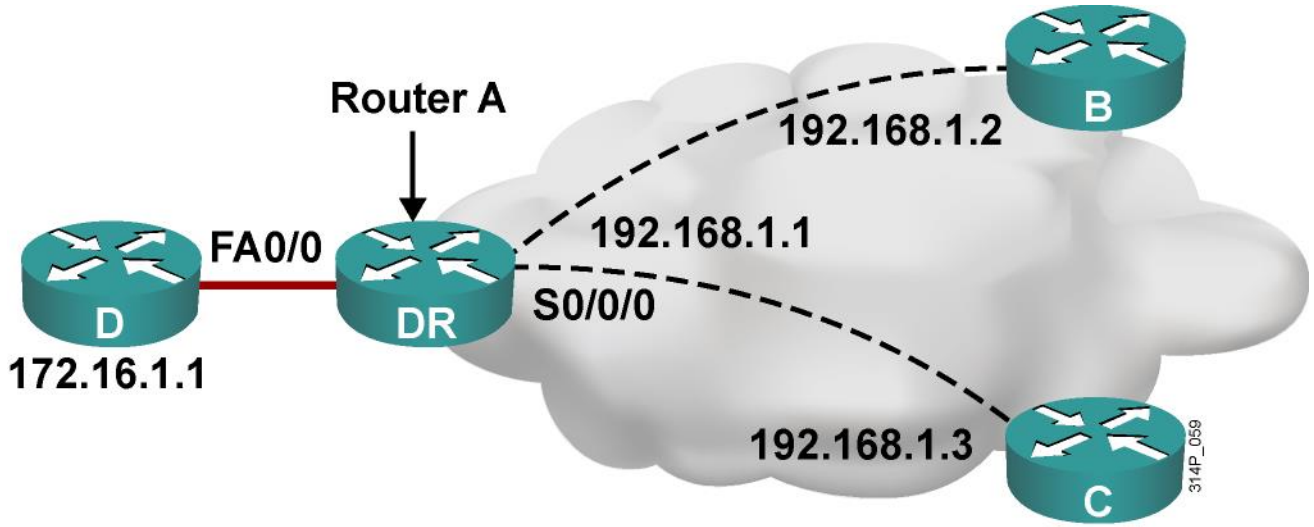


Using the neighbor Command

```
Router(config-router)#
neighbor ip-address [priority number] [poll-interval
number] [cost number] [database-filter all]
```

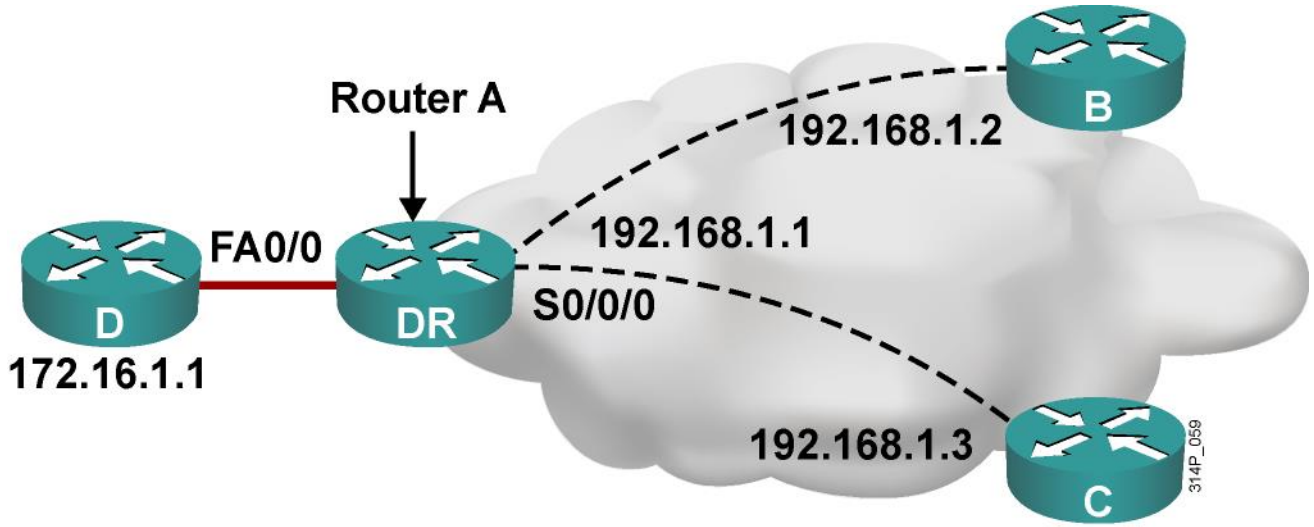
- Used to statically define neighbor relationships in an NBMA network
- 关键字Priority 是给邻居设置一个优先级
- Poll-interval 在邻居关系未达到Attemp状态之前的发包周期。默认是120s

neighbor Command Example




```
RouterA(config)# router ospf 100
RouterA(config-router)# network 192.168.0.0 0.0.255.255 area 0
RouterA(config-router)# neighbor 192.168.1.2 priority 0
RouterA(config-router)# neighbor 192.168.1.3 priority 0
RouterA(config-router)# network 172.16.0.0 0.0.255.255 area 0
```

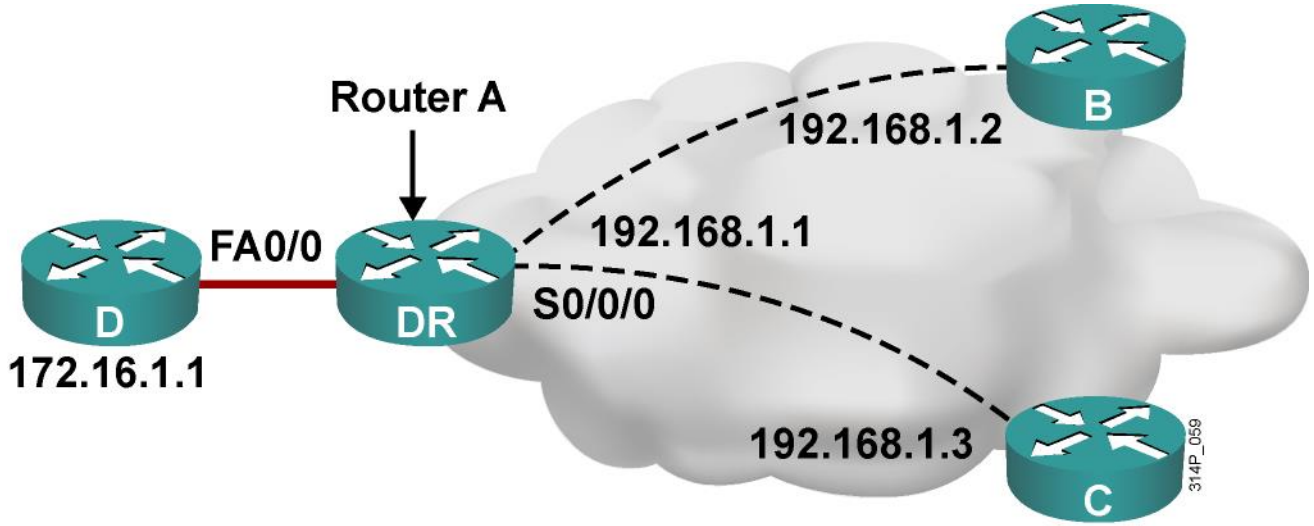
The show ip ospf neighbor Command




```
RouterA# show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.1.3     0     FULL/DROTHER    00:01:57    192.168.1.3     Serial0/0/0
192.168.1.2     0     FULL/DROTHER    00:01:33    192.168.1.2     Serial0/0/0
172.16.1.1      1     FULL/BDR        00:00:34    172.16.1.1      FastEthernet0/0
```

Point-to-Multipoint Mode



- The point-to-multipoint mode allows for NBMA networking.
- The point-to-multipoint mode fixes partial-mesh and star topologies.适用在部分互联和星型网络
- No DR is required and only a single subnet is used.
- A 30-second hello is used.
- This mode is RFC 2328-compliant.

Point-to-Multipoint Configuration

Router A

```
interface Serial0/0/0
 ip address 192.168.1.1 255.255.255.0
 encapsulation frame-relay
 ip ospf network point-to-multipoint
<output omitted>

router ospf 100
 log-adjacency-changes
 network 172.16.0.0 0.0.255.255 area 0
 network 192.168.0.0 0.0.255.255 area 0
```

Router C

```
interface Serial0/0/0
 ip address 192.168.1.3 255.255.255.0
 encapsulation frame-relay
 ip ospf network point-to-multipoint
 ip ospf priority 0
```

Point-to-Multipoint Example

```
RouterA#sh ip ospf int s0/0/0
Serial0/0/0 is up, line protocol is up
  Internet Address 192.168.1.1/24, Area 0
  Process ID 100, Router ID 192.168.1.1, Network Type POINT_TO_MULTIPOINT,
Cost: 781
  Transmit Delay is 1 sec, State POINT_TO_MULTIPOINT
  Timer intervals configured, Hello 30, Dead 120, Wait 120, Retransmit 5
    oob-resync timeout 120
    Hello due in 00:00:26
  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 2, Adjacent neighbor count is 2
    Adjacent with neighbor 192.168.1.3
    Adjacent with neighbor 192.168.1.2
  Suppress hello for 0 neighbor(s)
RouterA#
```

Point-to-Multipoint Nonbroadcast

- **Cisco extension to RFC-compliant point-to-multipoint mode**
- **Must statically define neighbors, like Nonbroadcast mode**
- **Like point-to-multipoint mode, DR and BDR not elected**
- **Used in special cases where neighbors cannot be automatically discovered**

Using Subinterfaces

```
Router(config)#
interface serial number.subinterface-number {multipoint |
point-to-point}
```

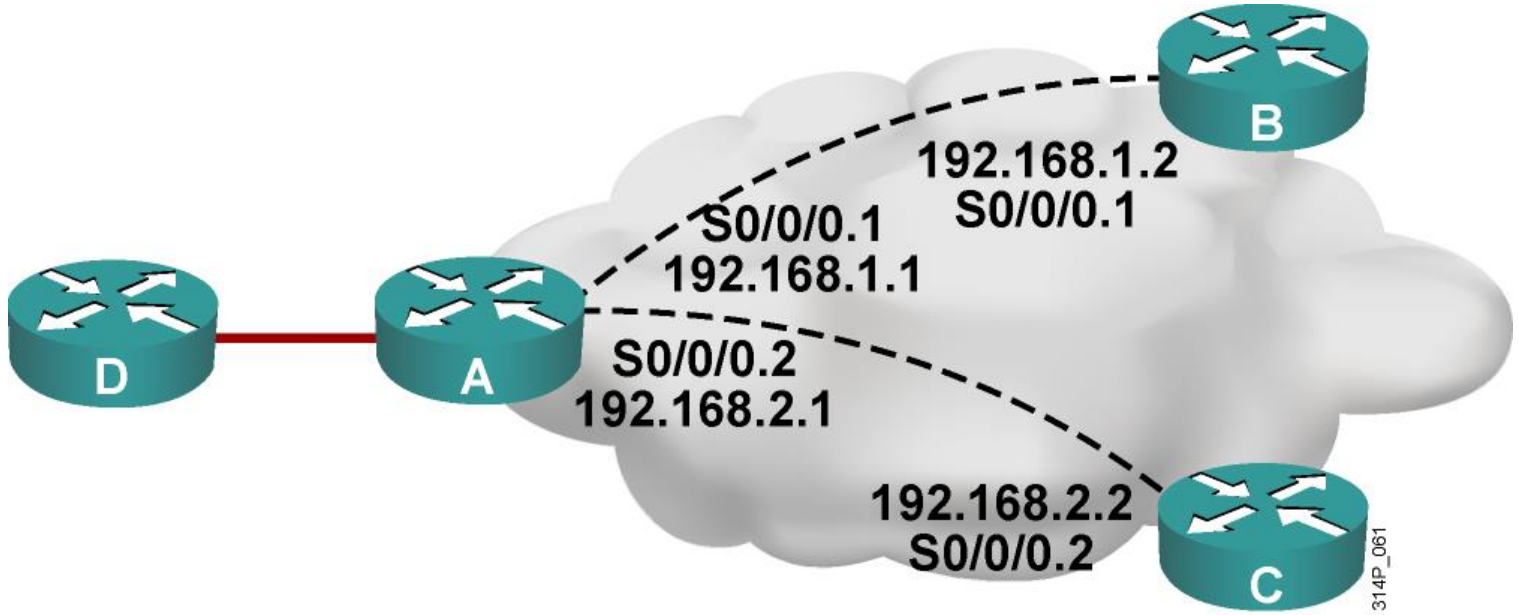
- The physical serial port becomes multiple logical ports.
- Each subinterface requires an IP subnet.

Point-to-Point Subinterfaces

```
Router(config)#
interface serial number.subinterface-number point-to-point
```

- Each PVC and SVC gets its own subinterface.
- OSPF point-to-point mode is the default on point-to-point Frame Relay subinterfaces.
  - No DR/BDR
  - Do not need to configure neighbors

Point-to-Point Subinterface Example



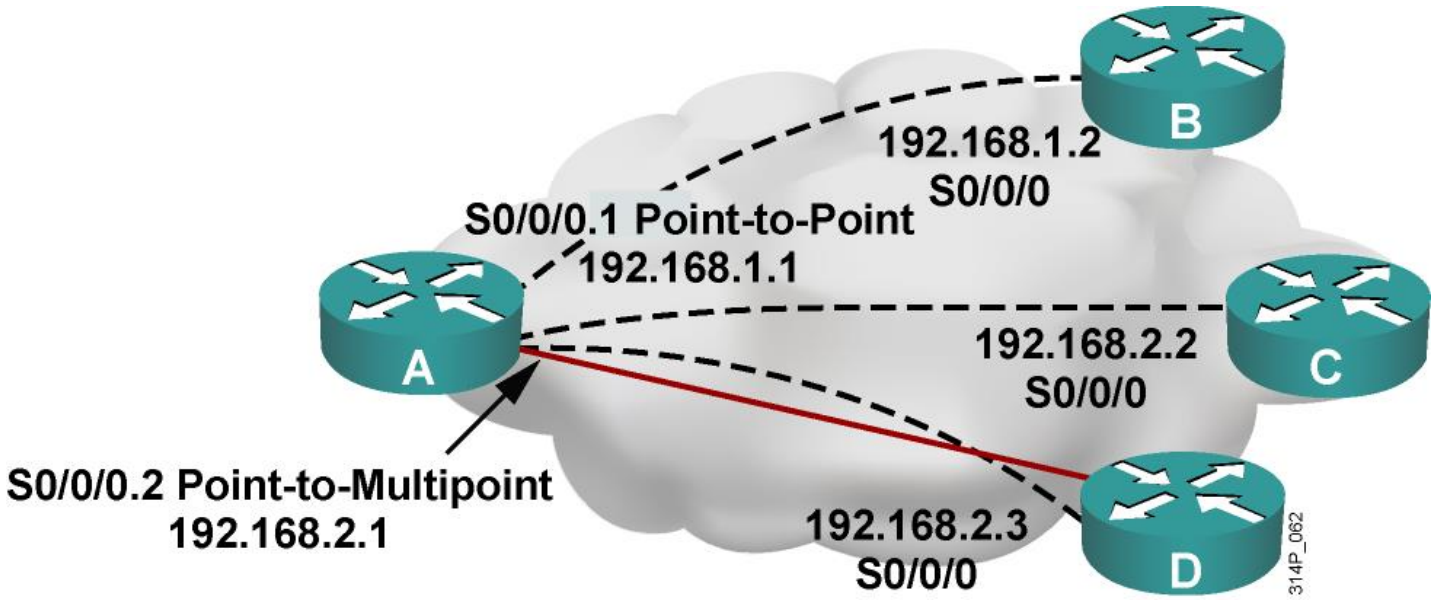
- PVCs are treated like point-to-point links.
- Each subinterface requires a subnet.

Multipoint Subinterfaces

```
Router(config)#
interface serial number.subinterface-number multipoint
```

- Multiple PVCs and SVCs are on a single subinterface.
- OSPF nonbroadcast mode is the default.
  - DR and BDR are required.
  - Neighbors need to be statically configured.

Multipoint Subinterface Example



- Single interface serial 0/0/0 has been logically separated into two subinterfaces: one point-to-point (S0/0/0.1) and one point-to-multipoint (S0/0/0.2).
- Each subinterface requires a subnet.
- OSPF defaults to point-to-point mode on point-to-point subinterfaces.
- OSPF defaults to nonbroadcast mode on point-to-multipoint subinterfaces.

OSPF over NBMA Topology Summary

OSPF Mode	NBMA Preferred Topology	Subnet Address	Hello Timer	Adjacency	RFC or Cisco
Broadcast	Full or partial mesh	Same	10 sec	Automatic, DR/BDR elected	Cisco
Nonbroadcast (NBMA)	Full or partial mesh	Same	30 sec	Manual configuration, DR/BDR elected	RFC
Point-to-multipoint	Partial-mesh or star	Same	30 Sec	Automatic, no DR/BDR	RFC
Point-to-multipoint nonbroadcast	partial-mesh or star	Same	30 sec	Manual configuration, no/DR/BDR	Cisco
Point-to-point	Partial-mesh or star, using subinterface	Different for Each Subinterface	10 sec	Automatic, no DR/BDR	Cisco

Creation of Adjacencies for Point-to-Point Mode

```
RouterA# debug ip ospf adj
OSPF: Interface Serial0/0/0.1 going Up
OSPF: Build router LSA for area 0, router ID 192.168.1.1, seq 0x80000023
OSPF: Rcv DBD from 192.168.1.2 on Serial0/0/0.1 seq 0xCF0 opt 0x52 flag 0x7 len 32
mtu 1500 state INIT
OSPF: 2 Way Communication to 192.168.1.2 on Serial0/0/0.1, state 2WAY
OSPF: Send DBD to 192.168.1.2 on Serial0/0/0.1 seq 0xF4D opt 0x52 flag 0x7 len 32
OSPF: NBR Negotiation Done. We are the SLAVE
OSPF: Send DBD to 192.168.1.2 on Serial0/0/0.1 seq 0xCF0 opt 0x52 flag 0x2 len 132
OSPF: Rcv DBD from 192.168.1.2 on Serial0/0/0.1 seq 0xCF1 opt 0x52 flag 0x3 len 132
mtu 1500 state EXCHANGE
OSPF: Send DBD to 192.168.1.2 on Serial0/0/0.1 seq 0xCF1 opt 0x52 flag 0x0 len 32
OSPF: Database request to 192.168.1.2
OSPF: sent LS REQ packet to 192.168.1.2, length 12
OSPF: Rcv DBD from 192.168.1.2 on Serial0/0/0.1 seq 0xCF2 opt 0x52 flag 0x1 len 32
mtu 1500 state EXCHANGE
OSPF: Exchange Done with 192.168.1.2 on Serial0/0/0.1
OSPF: Send DBD to 192.168.1.2 on Serial0/0/0.1 seq 0xCF2 opt 0x52 flag 0x0 len 32
OSPF: Synchronized with 192.168.1.2 on Serial0/0/0.1, state FULL
%OSPF-5-ADJCHG: Process 100, Nbr 192.168.1.2 on Serial0/0/0.1 from LOADING to FULL,
Loading Done
OSPF: Build router LSA for area 0, router ID 192.168.1.1, seq 0x80000024
```

Creation of Adjacencies for Broadcast Mode

```
RouterA# debug ip ospf adj
OSPF: Interface FastEthernet0/0 going Up
OSPF: Build router LSA for area 0, router ID 192.168.1.1,seq 0x80000008
OSPF: 2 Way Communication to 172.16.1.1 on FastEthernet0/0, state 2WAY
OSPF: end of Wait on interface FastEthernet0/0
<output omitted>

OSPF: Neighbor change Event on interface FastEthernet0/0
OSPF: DR/BDR election on FastEthernet0/0
OSPF: Elect BDR 172.16.1.1
OSPF: Elect DR 192.168.1.1
DR: 192.168.1.1 (Id)   BDR: 172.16.1.1 (Id)
OSPF: Rcv DBD from 172.16.1.1 on FastEthernet0/0 seq 0x14B 7 opt 0x52 flag 0x7
len 32  mtu 1500 state EXSTART
OSPF: First DBD and we are not SLAVE-if)#
OSPF: Send DBD to 172.16.1.1 on FastEthernet0/0 seq 0xDCE opt 0x52 flag 0x7
len 32
OSPF: Retransmitting DBD to 172.16.1.1 on FastEthernet0/0[1]
OSPF: Rcv DBD from 172.16.1.1 on FastEthernet0/0 seq 0xDCE
 opt 0x52 flag 0x2 len 152  mtu 1500 state EXSTART
<output omitted>
```

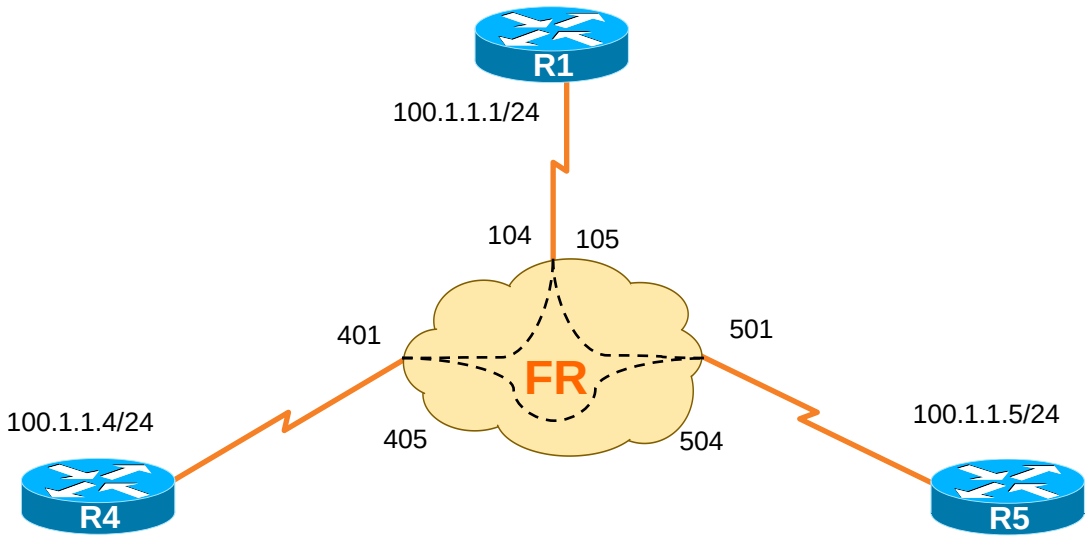
Summary

- OSPF defines three types of networks: point-to-point, broadcast, and NBMA
- On point-to-point links, adjacency is dynamic, uses multicast addresses, and has no DR or BDR.
- On broadcast links, adjacency is dynamic and includes election of a DR and BDR. All updates are sent to the DR, which forwards the updates to all routers.
- The router with the highest OSPF priority is selected as the DR. The router with the second-highest priority value is the BDR.
- By default on NBMA links, adjacency requires manual definition of neighbors for the DR and BDR because OSPF will consider the network similar to broadcast media.

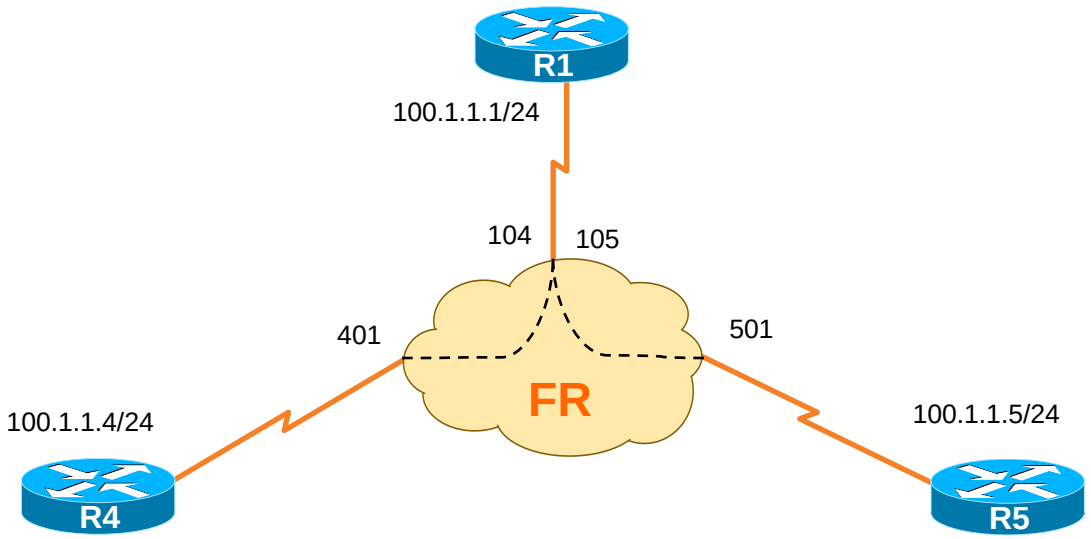
Summary (Cont.)

- The OSPF mode of operation on Frame Relay depends on the underlying Frame Relay network. OSPF mode options include nonbroadcast, broadcast, point-to-multipoint, point-to-multipoint nonbroadcast, and point-to-point.
- In nonbroadcast mode, a DR and BDR are elected, and neighbors must be statically configured.
- In point-to-multipoint mode, no DR and BDR are needed and neighbors are automatically discovered. In point-to-multipoint nonbroadcast mode, no DR and BDR are needed, but neighbors must be statically configured.
- A physical interface can be split into multiple logical interfaces called subinterfaces. Each subinterface requires an IP subnet.
- Using the debug ip ospf adj command enables you to see OSPF packet exchanges and the status of neighbor adjacencies.

实验


R1
100.1.1.1/24
104
105
401
501
FR
405
504
100.1.1.4/24
100.1.1.5/24
R4
R5

实验



Thank you.