# 计算机网络实验报告

警示

1.实验报告如有雷同，雷同各方当次实验成绩均以 0 分计。
2.当次小组成员成绩只计学号、姓名登录在下表中的。
3.在规定时间内未上交实验报告的，不得以其他方式补交，当次成绩按 0 分计。
4.实验报告文件以 PDF 格式提交。

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| 高宇 | 配置路由器 R1 和 PC1，分析结果完成部分实验报告 | | | | |

【实验题目】OSPF 路由协议实验

【实验目的】

掌握 OSPF 协议单区域的配置和使用方法。

【实验内容】

【实验内容】

(1) 完成路由器配置实验实例 7-3（P252）的“OSPF 单区域配置”，回答步骤 1、步骤 9 问题。

(2) 在（1）的基础上每台路由器上各加入一台电脑，画出新拓扑，然后：

(a) 检查任意两个 PC 之间是否可以 Ping 通，对一台主机 ping 其它主机的结果进行截屏。

(b) 采用#depug ip ospf 显示上面 OSPF 协议的运行情况，观察并保存 R1 发送和接收的 Update 分组(可以改变链路状态来触发)，注意其中 LSA 类型；观察有无 224.0.0.5、224.0.0.6 IP 地址，如有说明这两地址的作用。

**(c)** 显示并记录路由器 R1 数据库的 Router LSA，Network LSA，LS 数据库信息汇总

**# show ip ospf database router** ！ 显示 router LSA

**# show ip ospf database network** ！显示 network LSA

**# show ip ospf database database** ！显示 OSPF 链路状态数据库信息。

(d) 显示并记录邻居状态。

**# show ip ospf neighbor**

(e) 显示并记录 R1 的所有接口信息

#show ip ospf interface [接口名]

(f) 实验 7-4 (选做内容)

【实验要求】

重要信息信息需给出截图， 注意实验步骤的前后对比。

【实验记录】(如有实验拓扑请自行画出)

一、完成路由器配置实验实例 7-3（P252）的“OSPF 单区域配置”，回答步骤 1、步骤 9 问题。

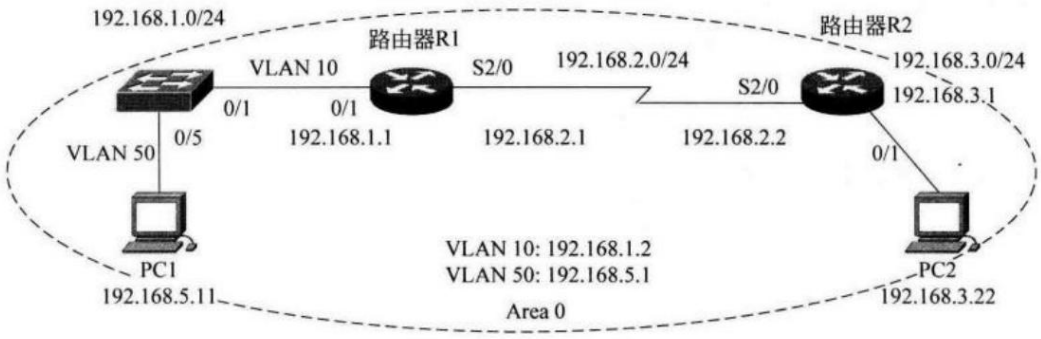



图 7-23 OSPF 单区域实验拓扑

步骤 1：

(1) 按拓扑图配置 PC1 和 PC2，并测试连通性

```
PS C:\Users\D502> ping 192.168.5.11

正在 Ping 192.168.5.11 具有 32 字节的数据:
请求超时。
请求超时。
请求超时。
请求超时。

192.168.5.11 的 Ping 统计信息:
    数据包: 已发送 = 4, 已接收 = 0, 丢失 = 4 (100% 丢失),
```

PC1 和 PC2 未连通

(2) 在路由器 R1（或 R2）执行 show ip route

路由器 R2 上执行 show ip route

```
26-RSR20-2(config)#show ip route

Codes:  C - connected, S - static, R - RIP, B - BGP
        O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default

Gateway of last resort is no set
```

步骤 2：三层交换机的基本配置

```
26-s5750-2#show ip route

Codes:  C - connected, S - static, R - RIP, B - BGP
        O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default

Gateway of last resort is no set
C    192.168.1.0/24 is directly connected, VLAN 10
C    192.168.1.2/32 is local host.
C    192.168.5.0/24 is directly connected, VLAN 50
C    192.168.5.1/32 is local host.
```

步骤 3：路由器 R1 的基本配置

```
26-RSR20-1#show ip route

Codes:  C - connected, S - static, R - RIP, B - BGP
        O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default

Gateway of last resort is no set
C     192.168.1.0/24 is directly connected, GigabitEthernet 0/1
C     192.168.1.1/32 is local host.
C     192.168.2.0/24 is directly connected, Serial 2/0
C     192.168.2.1/32 is local host.
```

步骤 4：路由器 R2 的基本配置

```
26-RSR20-2(config)#show ip route

Codes:  C - connected, S - static, R - RIP, B - BGP
        O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default

Gateway of last resort is no set
C     192.168.2.0/24 is directly connected, Serial 2/0
C     192.168.2.2/32 is local host.
C     192.168.3.0/24 is directly connected, GigabitEthernet 0/1
C     192.168.3.1/32 is local host.
```

步骤 5：配置 OSPF 路由协议。

交换机 S5750 配置 OSPF

```
26-s5750-2(config)#show ip route

Codes:  C - connected, S - static, R - RIP, B - BGP
        O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default

Gateway of last resort is no set
C     192.168.1.0/24 is directly connected, VLAN 10
C     192.168.1.2/32 is local host.
O     192.168.2.0/24 [110/51] via 192.168.1.1, 00:01:08, VLAN 10
O     192.168.3.0/24 [110/52] via 192.168.1.1, 00:00:54, VLAN 10
C     192.168.5.0/24 is directly connected, VLAN 50
C     192.168.5.1/32 is local host.
```

步骤 6：路由器 R1 配置 OSPF

```
26-RSR20-1#show ip route

Codes:  C - connected, S - static, R - RIP, B - BGP
        O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default

Gateway of last resort is no set
C    192.168.1.0/24 is directly connected, GigabitEthernet 0/1
C    192.168.1.1/32 is local host.
C    192.168.2.0/24 is directly connected, Serial 2/0
C    192.168.2.1/32 is local host.
O    192.168.3.0/24 [110/51] via 192.168.2.2, 00:00:14, Serial 2/0
O    192.168.5.0/24 [110/2] via 192.168.1.2, 00:02:55, GigabitEthernet 0/1
```

步骤 7：路由器 R2 配置 OSPF

```
26-RSR20-2(config)#show ip route

Codes:  C - connected, S - static, R - RIP, B - BGP
        O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default

Gateway of last resort is no set
O    192.168.1.0/24 [110/51] via 192.168.2.1, 00:01:12, Serial 2/0
C    192.168.2.0/24 is directly connected, Serial 2/0
C    192.168.2.2/32 is local host.
C    192.168.3.0/24 is directly connected, GigabitEthernet 0/1
C    192.168.3.1/32 is local host.
O    192.168.5.0/24 [110/52] via 192.168.2.1, 00:01:12, Serial 2/0
```

步骤 8：查看验证 3 台路由设备的路由表是否自动学习了其他网段的路由信息，请注意路由条目 O 项 show ip route 结果在上面步骤已记录

(1) 分析 S5750 的路由表，表中有 O 条目吗？如果有，是如何产生的？

可看到有两条 O 条目，因为交换机通过 OSPF 协议学习到下一跳地址为 R1 的 192.168.1.1 端口，到达 192.168.2.0/24 和 192.168.3.0/24 网段的转发路由

(2) 分析路由器 R1 的路由表，表中有 O 条目吗？如果有，是如何产生的？

可看到有两条 O 条目，分别为①交换机通过 OSPF 协议学习到下一跳地址为 192.168.1.2 的端口，到达 192.168.5.0/24 网段，出站接口为 0/1 的转发路由；②学习到下一跳地址为 192.168.2.2 的端口，到达 192.168.3.0/24 网段，出站接口为 S2/0 的转发路由

(3) 分析路由器 R2 的路由表，表中有 O 条目吗？如果有，是如何产生的？

可看到有两条 O 条目，分别为①交换机通过 OSPF 协议学习到下一跳地址为 192.168.2.1 的端口，到达 192.168.1.0/24 网段，出站接口为 S2/0 的转发路由；②学习到下一跳地址为 192.168.2.1 的端口，到达 192.168.5.0/24 网段，出站接口为 S2/0 的转发路由

步骤 9：测试网络连通性

(1) 将此时的路由表和步骤 0 的路由表比较，有什么结论？

步骤 0 中还没有对路由器和交换机进行配置，所以路由器的路由表均为空；

此时的路由表出现了 C 和 O 两种条目的路由信息。C 条目的路由信息代表网络设备直连的网段以及该网段与该设备连接的端口地址；O 条目的路由信息代表 OSPF 协议的路由转发路径。

(2) 分析 tracert PC1（或 PC2）的执行结果

```
PS C:\Users\D502> tracert 192.168.3.22

通过最多 30 个跃点跟踪
到 D52_77 [192.168.3.22] 的路由:

  1    <1 毫秒    <1 毫秒    <1 毫秒 192.168.5.1
  2    <1 毫秒    <1 毫秒    <1 毫秒 192.168.1.1
  3    42 ms     42 ms     41 ms  192.168.2.2
  4    47 ms     48 ms     48 ms  D52_77 [192.168.3.22]

跟踪完成。
```

tracert 跟踪路径与根据拓扑图预期结果一致。

(3) 捕获数据包，分析 OSPF 头部结构。OSPF 包在 PC1 或 PC2 上能捕获到吗？如果希望 2 台主机都能捕获到，请描述方法

都能捕获到，（PC1 截图如下，PC2 疏忽未截图，实验过程中 PC2 也能观察到 OSPF 包）

ospf

| No. | Time | Source | Destination | Protocol | Length | Info |
|---|---|---|---|---|---|---|
| 7 | 1.714770 | 192.168.5.1 | 224.0.0.5 | OSPF | 82 | Hello Packet |
| 18 | 10.715055 | 192.168.5.1 | 224.0.0.5 | OSPF | 82 | Hello Packet |
| 41 | 21.715134 | 192.168.5.1 | 224.0.0.5 | OSPF | 82 | Hello Packet |
| 45 | 31.715160 | 192.168.5.1 | 224.0.0.5 | OSPF | 82 | Hello Packet |
| 50 | 40.715004 | 192.168.5.1 | 224.0.0.5 | OSPF | 82 | Hello Packet |
| 63 | 51.715218 | 192.168.5.1 | 224.0.0.5 | OSPF | 82 | Hello Packet |
| 76 | 61.714901 | 192.168.5.1 | 224.0.0.5 | OSPF | 82 | Hello Packet |
| 105 | 70.714963 | 192.168.5.1 | 224.0.0.5 | OSPF | 82 | Hello Packet |
| 113 | 81.714967 | 192.168.5.1 | 224.0.0.5 | OSPF | 82 | Hello Packet |
| 120 | 91.715137 | 192.168.5.1 | 224.0.0.5 | OSPF | 82 | Hello Packet |

(4) 使用#debug ip ospf 命令显示上述 OSPF 协议的运行情况，观察并保存路由器 R1 发送和接收的 Update 分组（可以通过改变链路状态触发），注意其中 LSA 类型；观察有无 224.0.0.5、224.0.0.6 的 IP 地址，如有请说明两个地址的作用

下图为 R1 接收和发送的 Update 分组截图，观察到只有 224.0.0.5IP 地址，没有 224.0.0.6 地址，其中 224.0.0.6 是 DR/BDR 发送给其他路由器的组播地址，224.0.0.5 是非 DR/BDR 路由器发送给其他路由器的组播地址。

```
----------------------------------------------------
RECV[LS-Upd]: From 192.168.3.1 via Serial 2/0:192.168.2.1 (192.168.2.2 → 224.0.0.5), len = 88, cksum = 0x69c8
----------------------------------------------------
Header
  Version 2
  Type 4 (Link State Update)
  Packet Len 88
  Router ID 192.168.3.1
  Area ID 0.0.0.0
  Checksum 0x69c8
  AuType 0
Link State Update
  # LSAs 1
  LSA Header
    LS age 1
    Options 0x2
    LS type 1 (router-LSA)
    Link State ID 192.168.3.1
    Advertising Router 192.168.3.1
    LS sequence number 0x80000007
    LS checksum 0xb587
    length 60
  Router-LSA
    flags -|-|-
    # links 3
    Link ID 192.168.2.1
    Link Data 192.168.2.2
    Type 1, #TOS 0, metric 50
    Link ID 192.168.2.0
    Link Data 255.255.255.0
    Type 3, #TOS 0, metric 50
    Link ID 192.168.3.0
    Link Data 255.255.255.0
    Type 3, #TOS 0, metric 1
```

```
-----------------------------------------------------
NFSM[192.168.3.1-Serial 2/0]: Full (HelloReceived)
RECV[LS-Upd]: From 192.168.3.1 via Serial 2/0:192.168.2.1 (TwoWayMaintain)
LSA[0.0.0.0:Type1:192.168.3.1:(self)]: Instance(0x35702c38) created with Link State Update
LSA[0.0.0.0:Type1:192.168.3.1:192.168.3.1]: flood started
LSA[0.0.0.0:Type1:192.168.3.1:192.168.3.1]: Flooding via interface[GigabitEthernet 0/1:192.168.1.1]
LSA[0.0.0.0:Type1:192.168.3.1:192.168.3.1]: Flooding to neighbor[192.168.5.1]
LSA[0.0.0.0:Type1:192.168.3.1:192.168.3.1]: Added to neighbor[192.168.5.1]'s retransmit-list
LSA[0.0.0.0:Type1:192.168.3.1:192.168.3.1]: Sending update to interface[GigabitEthernet 0/1:192.168.1.1]
LSA[0.0.0.0:Type1:192.168.3.1:192.168.3.1]: Flooding via interface[Serial 2/0:192.168.2.1]
LSA[0.0.0.0:Type1:192.168.3.1:192.168.3.1]: Flooding to neighbor[192.168.3.1]
SPF[0.0.0.0]: Calculation timer scheduled (delay 1.000000 secs)
LSA[0.0.0.0:Type1:192.168.3.1:192.168.3.1]: Install router-LSA
SEND[LS-Upd]: 1 LSAs to destination 224.0.0.5
SEND[LS-Upd]: To 224.0.0.5 via GigabitEthernet 0/1:192.168.1.1, length 88
-----------------------------------------------------
Header
  Version 2
  Type 4 (Link State Update)
  Packet Len 88
  Router ID 192.168.2.1
  Area ID 0.0.0.0
  Checksum 0x6ac7
  AuType 0
Link State Update
  # LSAs 1
  LSA Header
    LS age 2
    Options 0x2
    LS type 1 (router-LSA)
    Link State ID 192.168.3.1
    Advertising Router 192.168.3.1
    LS sequence number 0x80000007
    LS checksum 0xb587
    length 60
  Router-LSA
    flags ⊣⊣-
    # links 3
    Link ID 192.168.2.1
    Link Data 192.168.2.2
    Type 1, #TOS 0, metric 50
    Link ID 192.168.2.0
    Link Data 255.255.255.0
    Type 3, #TOS 0, metric 50
    Link ID 192.168.3.0
    Link Data 255.255.255.0
    Type 3, #TOS 0, metric 1
-----------------------------------------------------
```

(5) 本实验有没有 DR/BDR（指派路由器/备份指派路由器）？如果有，请指出 DR 与 BDR 分别是哪个设备，讨论 DR/BDR 的选举规则和更新方法（通过拔线改变拓扑，观察 DR/BDR 的变化情况）；如没有，请说明原因。

交换机是 DR，路由器 R1 是 BDR。

DR 和 BDR 在非广播多路访问网络中进行选举，利用 Hello 报文内的 ID 值和优先权字段值确定，优先权更高的路由器选举为 DR，优先权相同则 ID 值更高的选举为 DR，优先权次高的选举为 BDR。拓扑图中显示路由器 R1 和 R2 之间为点对点的网络，不进行选举 DR/BDR，故选举发生在交换机和路由器 R1 上，根据优先权和 ID 字段决定 DR 为交换机，BDR 为路由器 R1.

交换机：

```
26-s5750-2(config)#show ip ospf neighbor

OSPF process 1, 1 Neighbors, 1 is Full:
Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.2.1       1   Full/BDR        00:00:33    192.168.1.1     VLAN 10
```

路由器 R1：

```
26-RSR20-1#show ip ospf neighbor

OSPF process 1, 2 Neighbors, 2 is Full:
Neighbor ID     Pri   State           BFD State  Dead Time   Address         Interface
192.168.5.1       1   Full/DR         -          00:00:29    192.168.1.2     GigabitEthernet 0/1
192.168.3.1       1   Full/ -         -          00:00:32    192.168.2.2     Serial 2/0
```

【实验思考】

(1) 如何查看 OSPF 协议发布的网段？

可通过抓包查看为 255.255.255.0

```
▾ OSPF Hello Packet
    Network Mask: 255.255.255.0
    Hello Interval [sec]: 10
  › Options: 0x02, (E) External Routing
    Router Priority: 1
    Router Dead Interval [sec]: 40
    Designated Router: 192.168.5.1
    Backup Designated Router: 0.0.0.0
```

(2) 关于 OSPF 反掩码：反掩码可以简单地理解成掩码取反，而且不允许出现不连续的 1 和 0.例如，可以是 0.0.0.11111111，但不可以是 0.0.0.11110011，也不可以是 0.0.0.11111100。反掩码总是奇数或 0，因为其最后一位总是 1，除非全部是 0。

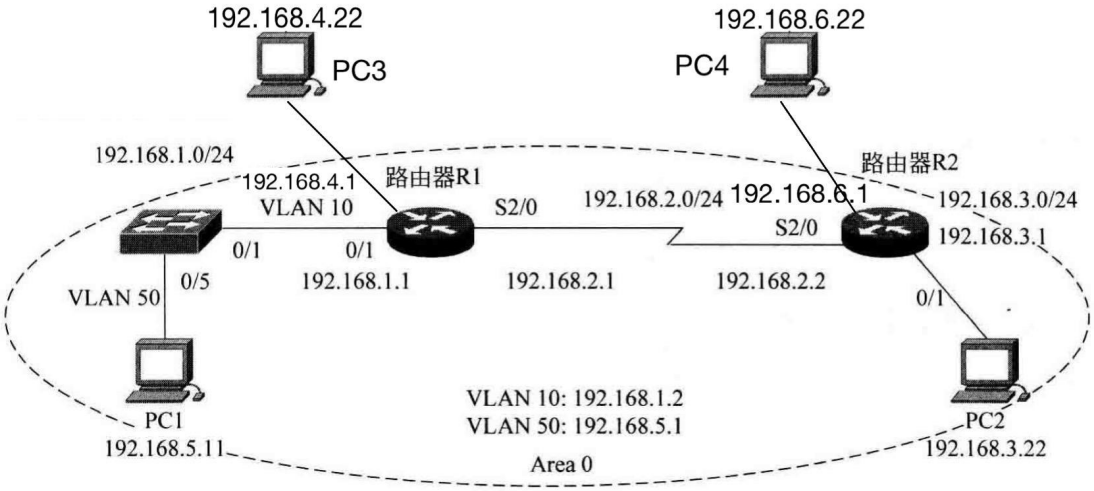
(3) 255.255.255.255 减去子网掩码就得出反掩码。例如：子网掩码是 255.255.255.252，则 255.255.255.255-255.255.255.252 得出反掩码是 0.0.0.3。请问：192.168.2.0/28 的反掩码是多少？

255.255.255.255 - 192.168.2.0 = 63.87.253.255

192.168.2.0/28 的反掩码是 63.87.253.255

二、在（1）的基础上每台路由器上各加入一台电脑，画出新拓扑，然后：

按如下拓扑图对路由器 R1、R2 和新增 PC 进行同样配置



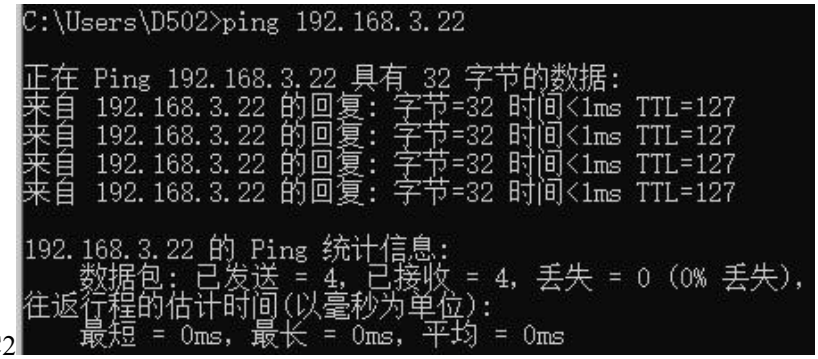

(a) 检查任意两个 PC 之间是否可以 Ping 通，对一台主机 ping 其它主机的结果进行截屏。

检查结果两个 PC 加入后都能互相 ping 通，以下为部分截图。

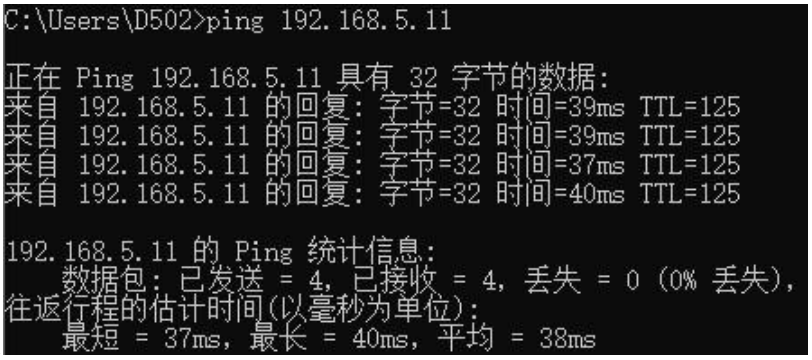
PC4 ping PC3

```
C:\Users\D502>ping 192.168.4.22

正在 Ping 192.168.4.22 具有 32 字节的数据:
来自 192.168.4.22 的回复: 字节=32 时间=37ms TTL=126
来自 192.168.4.22 的回复: 字节=32 时间=39ms TTL=126
来自 192.168.4.22 的回复: 字节=32 时间=37ms TTL=126
来自 192.168.4.22 的回复: 字节=32 时间=39ms TTL=126

192.168.4.22 的 Ping 统计信息:
    数据包: 已发送 = 4, 已接收 = 4, 丢失 = 0 (0% 丢失),
往返行程的估计时间(以毫秒为单位):
    最短 = 37ms, 最长 = 39ms, 平均 = 38ms
```

PC4 ping PC2




PC4 ping PC1




PC3 ping PC4


(b) 采用#depug ip ospf 显示上面 OSPF 协议的运行情况，观察并保存 R1 发送和接收的 Update 分组(可以改变链路状态来触发)，注意其中 LSA 类型；观察有无 224.0.0.5、224.0.0.6 IP 地址，如有说明这两地址的作用。

下图为 R1 发送和接收的 Update 分组截图，观察到只有 224.0.0.5IP 地址，没有 224.0.0.6 地址，其中 224.0.0.6 是 DR/BDR 发送给其他路由器的组播地址，224.0.0.5 是非 DR/BDR 路由器发送给其他路由器的组播地址。

```
SEND[LS-Upd]: To 224.0.0.5 via Serial 2/0:192.168.2.1, length 100
-----------------------------------------------------
Header
  Version 2
  Type 4 (Link State Update)
  Packet Len 100
  Router ID 192.168.2.1
  Area ID 0.0.0.0
  Checksum 0x3fe7
  AuType 0
Link State Update
  # LSAs 1
  LSA Header
    LS age 1
    Options 0x2
    LS type 1 (router-LSA)
    Link State ID 192.168.2.1
    Advertising Router 192.168.2.1
    LS sequence number 0x8000001e
    LS checksum 0x1c8f
    length 72
  Router-LSA
    flags -|-|-
    # links 4
    Link ID 192.168.1.0
    Link Data 255.255.255.0
    Type 3, #TOS 0, metric 1
    Link ID 192.168.3.1
    Link Data 192.168.2.1
    Type 1, #TOS 0, metric 50
    Link ID 192.168.2.0
    Link Data 255.255.255.0
    Type 3, #TOS 0, metric 50
    Link ID 192.168.4.0
    Link Data 255.255.255.0
    Type 3, #TOS 0, metric 1
```

```
RECV[LS-Upd]: From 192.168.5.1 via GigabitEthernet 0/1:192.168.1.1 (192.168.1.2 → 224.0.0.5), len = 108, cksum = 0xf029
-----------------------------------------------------
Header
  Version 2
  Type 4 (Link State Update)
  Packet Len 108
  Router ID 192.168.5.1
  Area ID 0.0.0.0
  Checksum 0xf029
  AuType 0
Link State Update
  # LSAs 2
  LSA Header
    LS age 1
    Options 0x2
    LS type 2 (network-LSA)
    Link State ID 192.168.1.2
    Advertising Router 192.168.5.1
    LS sequence number 0x80000001
    LS checksum 0x950d
    length 32
  Network-LSA
    Network Mask 255.255.255.0
    # Attached Routers 2
      Attached Router 192.168.5.1
      Attached Router 192.168.2.1
  LSA Header
    LS age 1
    Options 0x2
    LS type 1 (router-LSA)
    Link State ID 192.168.5.1
    Advertising Router 192.168.5.1
    LS sequence number 0x80000022
    LS checksum 0xc733
    length 48
  Router-LSA
    flags -|-|-
    # links 2
    Link ID 192.168.5.0
    Link Data 255.255.255.0
    Type 3, #TOS 0, metric 1
    Link ID 192.168.1.2
    Link Data 192.168.1.2
    Type 2, #TOS 0, metric 1
```

(c) 显示并记录路由器 R1 数据库的 Router LSA，Network LSA，LS 数据库信息汇总

**# show ip ospf database router** ！ 显示 router LSA

```
26-RSR20-1(config)#show ip ospf database router

           OSPF Router with ID (192.168.2.1) (Process ID 1)

               Router Link States (Area 0.0.0.0)

  LS age: 55
  Options: 0x2 (-|-|-|-|-|-|E|-)
  Flags: 0x0
  LS Type: router-LSA
  Link State ID: 192.168.2.1
  Advertising Router: 192.168.2.1
  LS Seq Number: 8000002b
  Checksum: 0x52df
  Length: 72
   Number of Links: 4

    Link connected to: a Transit Network
     (Link ID) Designated Router address: 192.168.1.2
     (Link Data) Router Interface address: 192.168.1.1
      Number of TOS metrics: 0
       TOS 0 Metric: 1

    Link connected to: another Router (point-to-point)
     (Link ID) Neighboring Router ID: 192.168.3.1
     (Link Data) Router Interface address: 192.168.2.1
      Number of TOS metrics: 0
       TOS 0 Metric: 50

    Link connected to: Stub Network
     (Link ID) Network/subnet number: 192.168.2.0
     (Link Data) Network Mask: 255.255.255.0
      Number of TOS metrics: 0
       TOS 0 Metric: 50

    Link connected to: Stub Network
     (Link ID) Network/subnet number: 192.168.4.0
     (Link Data) Network Mask: 255.255.255.0
      Number of TOS metrics: 0
       TOS 0 Metric: 1
```

```
  LS age: 56
  Options: 0x2 (-|-|-|-|-|-|E|-)
  Flags: 0x0
  LS Type: router-LSA
  Link State ID: 192.168.3.1
  Advertising Router: 192.168.3.1
  LS Seq Number: 80000021
  Checksum: 0xdbc6
  Length: 72
   Number of Links: 4

    Link connected to: another Router (point-to-point)
     (Link ID) Neighboring Router ID: 192.168.2.1
     (Link Data) Router Interface address: 192.168.2.2
      Number of TOS metrics: 0
       TOS 0 Metric: 50

    Link connected to: Stub Network
     (Link ID) Network/subnet number: 192.168.2.0
     (Link Data) Network Mask: 255.255.255.0
      Number of TOS metrics: 0
       TOS 0 Metric: 50

    Link connected to: Stub Network
     (Link ID) Network/subnet number: 192.168.3.0
     (Link Data) Network Mask: 255.255.255.0
      Number of TOS metrics: 0
       TOS 0 Metric: 1

    Link connected to: Stub Network
     (Link ID) Network/subnet number: 192.168.6.0
     (Link Data) Network Mask: 255.255.255.0
      Number of TOS metrics: 0
       TOS 0 Metric: 1
```

```
LS age: 249
Options: 0x2 (-|-|-|-|-|-|E|-)
Flags: 0x0
LS Type: router-LSA
Link State ID: 192.168.5.1
Advertising Router: 192.168.5.1
LS Seq Number: 80000022
Checksum: 0xc733
Length: 48
 Number of Links: 2

  Link connected to: Stub Network
   (Link ID) Network/subnet number: 192.168.5.0
   (Link Data) Network Mask: 255.255.255.0
    Number of TOS metrics: 0
     TOS 0 Metric: 1

  Link connected to: a Transit Network
   (Link ID) Designated Router address: 192.168.1.2
   (Link Data) Router Interface address: 192.168.1.2
    Number of TOS metrics: 0
     TOS 0 Metric: 1
```

(d) **# show ip ospf database network** ！显示 network LSA

```
26-RSR20-1(config)#show ip ospf database network

            OSPF Router with ID (192.168.2.1) (Process ID 1)

                Network Link States (Area 0.0.0.0)

  LS age: 340
  Options: 0x2 (-|-|-|-|-|-|E|-)
  LS Type: network-LSA
  Link State ID: 192.168.1.2 (address of Designated Router)
  Advertising Router: 192.168.5.1
  LS Seq Number: 80000001
  Checksum: 0x950d
  Length: 32
  Network Mask: /24
        Attached Router: 192.168.5.1
        Attached Router: 192.168.2.1
```

(e) **# show ip ospf database database** ！显示 OSPF 链路状态数据库信息。

```
26-RSR20-1(config)#show ip ospf database database

OSPF process 1:

Area 0.0.0.0 database summary:
Router Link States        : 3
Network Link States       : 1
Summary Link States       : 0
ASBR-Summary Link States  : 0
NSSA-external Link States: 0
Link-Local Opaque-LSA     : 0
Area-Local Opaque-LSA     : 0
Total LSA                 : 4

Process 1 database summary:
Router Link States        : 3
Network Link States       : 1
Summary Link States       : 0
ASBR-Summary Link States  : 0
AS External Link States   : 0
NSSA-external Link States: 0
Link-Local Opaque-LSA     : 0
Area-Local Opaque-LSA     : 0
AS-Global Opaque-LSA      : 0
Total LSA                 : 4
```

(f) 显示并记录邻居状态。

**# show ip ospf neighbor** 显示并记录 R1 的所有接口信息

```
26-RSR20-1(config)#show ip ospf neighbor

OSPF process 1, 2 Neighbors, 2 is Full:
Neighbor ID     Pri   State              BFD State  Dead Time   Address         Interface
192.168.5.1       1   Full/DR            -          00:00:37    192.168.1.2     GigabitEthernet 0/1
192.168.3.1       1   Full/ -            -          00:00:40    192.168.2.2     Serial 2/0
```

(g) #show ip ospf interface [接口名]

```
26-RSR20-1(config)#show ip ospf interface
GigabitEthernet 0/1 is up, line protocol is up
  Internet Address 192.168.1.1/24, Ifindex 4, Area 0.0.0.0, MTU 1500
  Matching network config: 192.168.1.0/24
  Process ID 1, Router ID 192.168.2.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 192.168.5.1, Interface Address 192.168.1.2
  Backup Designated Router (ID) 192.168.2.1, Interface Address 192.168.1.1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:09
  Neighbor Count is 1, Adjacent neighbor count is 1
  Crypt Sequence Number is 0
  Hello received 450 sent 468, DD received 27 sent 28
  LS-Req received 7 sent 7, LS-Upd received 26 sent 57
  LS-Ack received 46 sent 19, Discarded 0
GigabitEthernet 0/0 is up, line protocol is up
  Internet Address 192.168.4.1/24, Ifindex 5, Area 0.0.0.0, MTU 1500
  Matching network config: 192.168.4.0/24
  Process ID 1, Router ID 192.168.2.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.2.1, Interface Address 192.168.4.1
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:05
  Neighbor Count is 0, Adjacent neighbor count is 0
  Crypt Sequence Number is 0
  Hello received 0 sent 128, DD received 0 sent 0
  LS-Req received 0 sent 0, LS-Upd received 0 sent 0
  LS-Ack received 0 sent 0, Discarded 0
Serial 2/0 is up, line protocol is up
  Internet Address 192.168.2.1/24, Ifindex 37, Area 0.0.0.0, MTU 1500
  Matching network config: 192.168.2.0/24
  Process ID 1, Router ID 192.168.2.1, Network Type POINTOPOINT, Cost: 50
  Transmit Delay is 1 sec, State Point-To-Point
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:09
  Neighbor Count is 1, Adjacent neighbor count is 1
  Crypt Sequence Number is 0
  Hello received 467 sent 472, DD received 18 sent 23
  LS-Req received 5 sent 4, LS-Upd received 27 sent 69
  LS-Ack received 58 sent 24, Discarded 0
```

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