路由阶段 - 中大型局域网（交换机+路由器：网络层 L3）

一、实验目的

1. 学习中大型局域网组网
2. 学习使用网络层设备 - 路由器
3. 学习配置 DHCP 服务实现 IP 自动获取
4. 学习 OSPF 组网

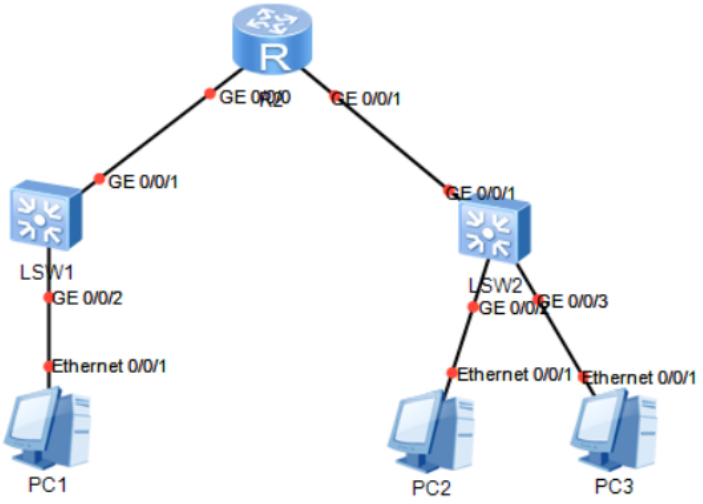
二、实验内容

1. 使用 L2 交换机 + 路由器 组网
2. 多台路由器组网

三、实验步骤

3.1 使用 L2 交换机 + 路由器 组网

网络拓扑



配置

```
dhcp enable
vlan batch 10 20
```

```
interface g 0/0/0
portswitch  # 由 L3 端口切换为 L2 端口
port link-type trunk
port trunk allow-pass vlan 10
q

interface Vlanif 10
ip address 10.25.10.1 255.255.255.0
dhcp select interface

interface g 0/0/1
portswitch
port link-type trunk
port trunk allow-pass vlan 10 20
q

interface Vlanif 20
ip address 10.25.20.1 255.255.255.0
dhcp select interface
```

Vlan

```
[Huawei-GigabitEthernet0/0/0]dis vlan
* : management-vlan
----------------------
The total number of vlans is : 3
VLAN ID Type         Status   MAC Learning Broadcast/Multicast/Unicast Property
--------------------------------------------------------------------------------
1       common       enable   enable       forward   forward   forward default
10      common       enable   enable       forward   forward   forward default
20      common       enable   enable       forward   forward   forward default
```

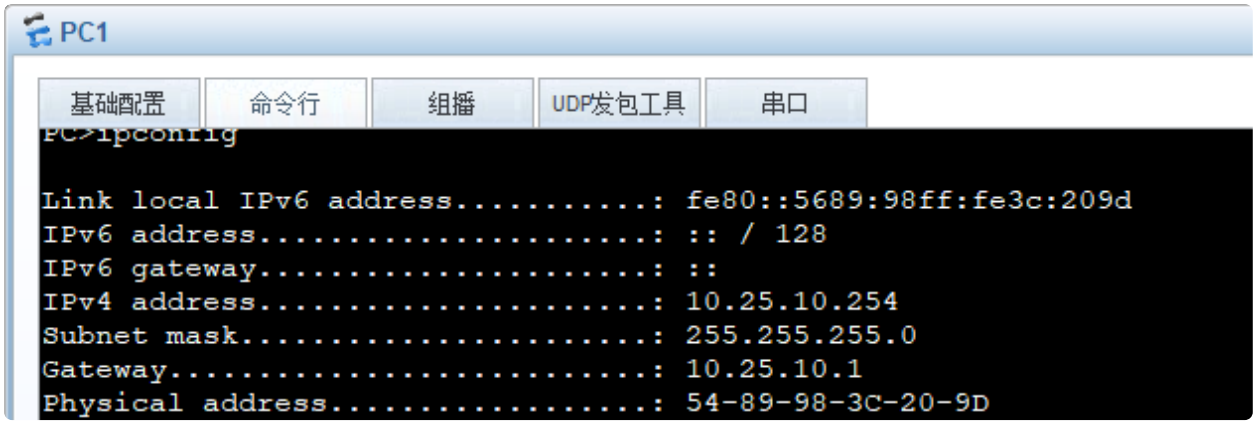
DHCP 地址池

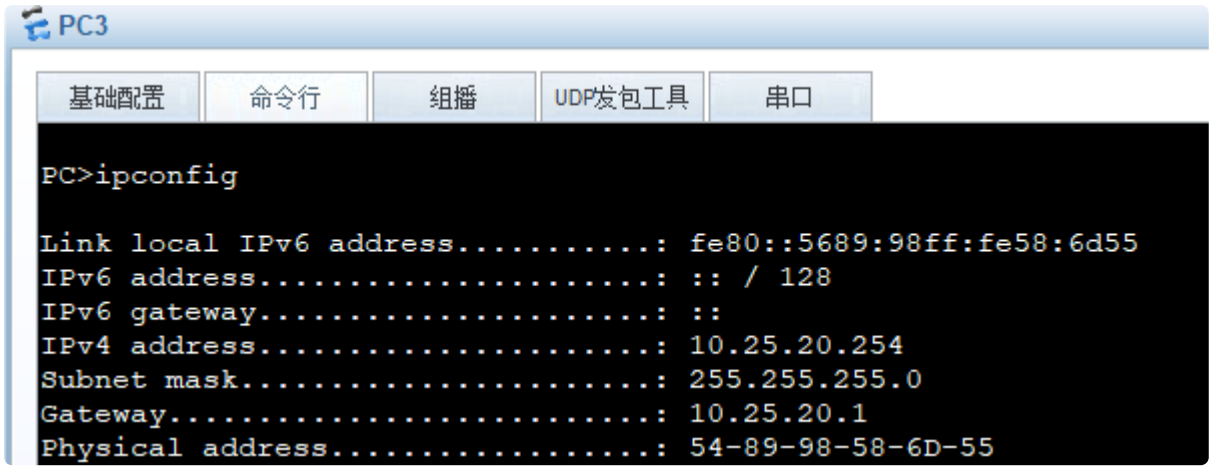
```
[Huawei-GigabitEthernet0/0/0]dis ip pool
  ------------------------------------------------------------------------------
  Pool-name      : Vlanif10
  Pool-No        : 0
  Position       : Interface       Status           : Unlocked
  Gateway-0      : 10.25.10.1
  Mask           : 255.255.255.0
  VPN instance   : --

  ------------------------------------------------------------------------------
  Pool-name      : Vlanif20
  Pool-No        : 1
  Position       : Interface       Status           : Unlocked
  Gateway-0      : 10.25.20.1
  Mask           : 255.255.255.0
  VPN instance   : --


  IP address Statistic
    Total       :506
    Used        :3          Idle        :503
    Expired     :0          Conflict    :0          Disable   :0
```

PC 机可以自动获取 IP 地址





PC 机互 Ping 连通性测试

PC1

基础配置 | 命令行 | 组播 | UDP发包工具 | 串口

```
PC>
PC>ping  10.25.20.254

Ping 10.25.20.254: 32 data bytes, Press Ctrl_C to break
From 10.25.20.254: bytes=32 seq=1 ttl=127 time=125 ms
From 10.25.20.254: bytes=32 seq=2 ttl=127 time=94 ms
From 10.25.20.254: bytes=32 seq=3 ttl=127 time=78 ms
From 10.25.20.254: bytes=32 seq=4 ttl=127 time=78 ms
From 10.25.20.254: bytes=32 seq=5 ttl=127 time=94 ms

--- 10.25.20.254 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 78/93/125 ms

PC>ping 10.25.10.253

Ping 10.25.10.253: 32 data bytes, Press Ctrl_C to break
From 10.25.10.253: bytes=32 seq=1 ttl=128 time=63 ms
From 10.25.10.253: bytes=32 seq=2 ttl=128 time=78 ms
From 10.25.10.253: bytes=32 seq=3 ttl=128 time=79 ms
From 10.25.10.253: bytes=32 seq=4 ttl=128 time=78 ms
From 10.25.10.253: bytes=32 seq=5 ttl=128 time=78 ms

--- 10.25.10.253 ping statistics ---
```

DHCP 交互过程分析

35	51.141000	0.0.0.0	255.255.255.255	DHCP	410 DHCP Discover - Transaction ID 0x1956
36	51.172000	10.25.10.1	10.25.10.254	DHCP	342 DHCP Offer - Transaction ID 0x1956
37	52.219000	HuaweiTechno_91:51:…	Spanning-tree-(for-…	STP	119 MST. Root = 32768/0/4c:1f:cc:91:51:f9 Cost = 0 Port = 0x8002
38	53.141000	0.0.0.0	255.255.255.255	DHCP	410 DHCP Request - Transaction ID 0x1956
39	53.172000	10.25.10.1	10.25.10.254	DHCP	342 DHCP ACK - Transaction ID 0x1956
40	54.141000	HuaweiTechno_3c:20:…	Broadcast	ARP	60 Gratuitous ARP for 10.25.10.254 (Request)

查看路由器路由情况

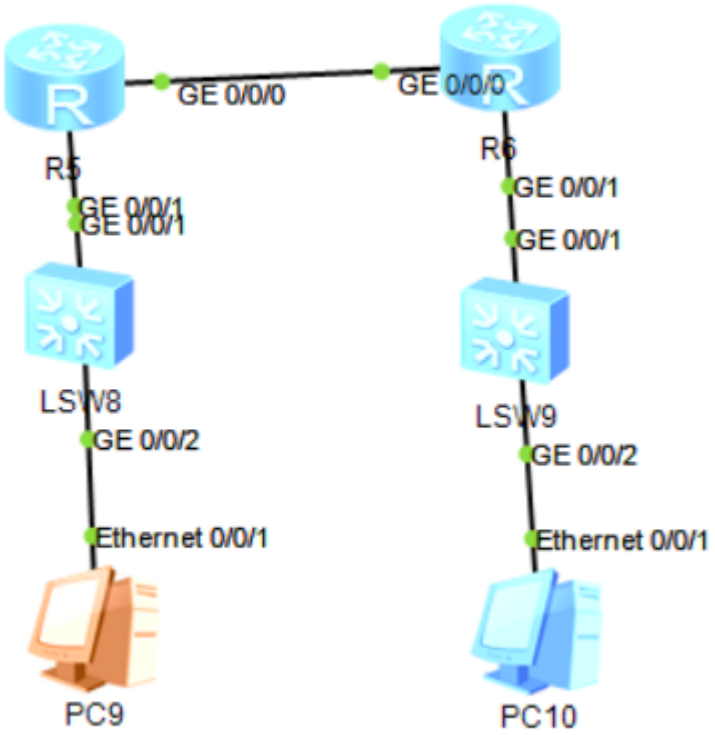
```
<Huawei>dis ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 9        Routes : 9

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

     10.25.10.0/24  Direct  0    0           D   10.25.10.1      Vlanif10
     10.25.10.1/32  Direct  0    0           D   127.0.0.1       Vlanif10
   10.25.10.253/32  Direct  0    0           D   10.25.10.253    Vlanif10
   10.25.10.254/32  Direct  0    0           D   10.25.10.254    Vlanif10
     10.25.20.0/24  Direct  0    0           D   10.25.20.1      Vlanif20
     10.25.20.1/32  Direct  0    0           D   127.0.0.1       Vlanif20
   10.25.20.254/32  Direct  0    0           D   10.25.20.254    Vlanif20
      127.0.0.0/8   Direct  0    0           D   127.0.0.1       InLoopBack0
      127.0.0.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
```

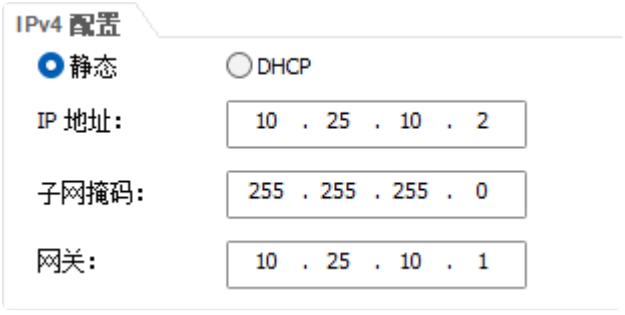
3.3 多台路由器组网

网络拓扑

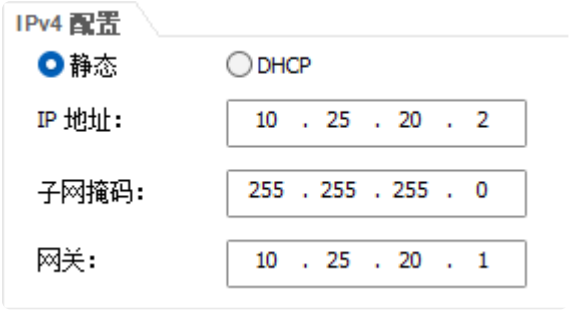


各设备配置信息：

PC9



PC10



R5

```
[Huawei]dis ospf brief

        OSPF Process 1 with Router ID 10.25.100.255
                OSPF Protocol Information
```

```
Interface: 10.25.10.1 (GigabitEthernet0/0/1)
Cost: 1       State: DR        Type: Broadcast    MTU: 1500
Priority: 1
Designated Router: 10.25.10.1
Backup Designated Router: 0.0.0.0
Timers: Hello 10 , Dead 40 , Poll  120 , Retransmit 5 , Transmit Delay 1

Interface: 10.25.100.1 (GigabitEthernet0/0/0)
Cost: 1       State: BDR       Type: Broadcast    MTU: 1500
Priority: 1
Designated Router: 10.25.100.2
Backup Designated Router: 10.25.100.1
Timers: Hello 10 , Dead 40 , Poll  120 , Retransmit 5 , Transmit Delay 1
```

R6

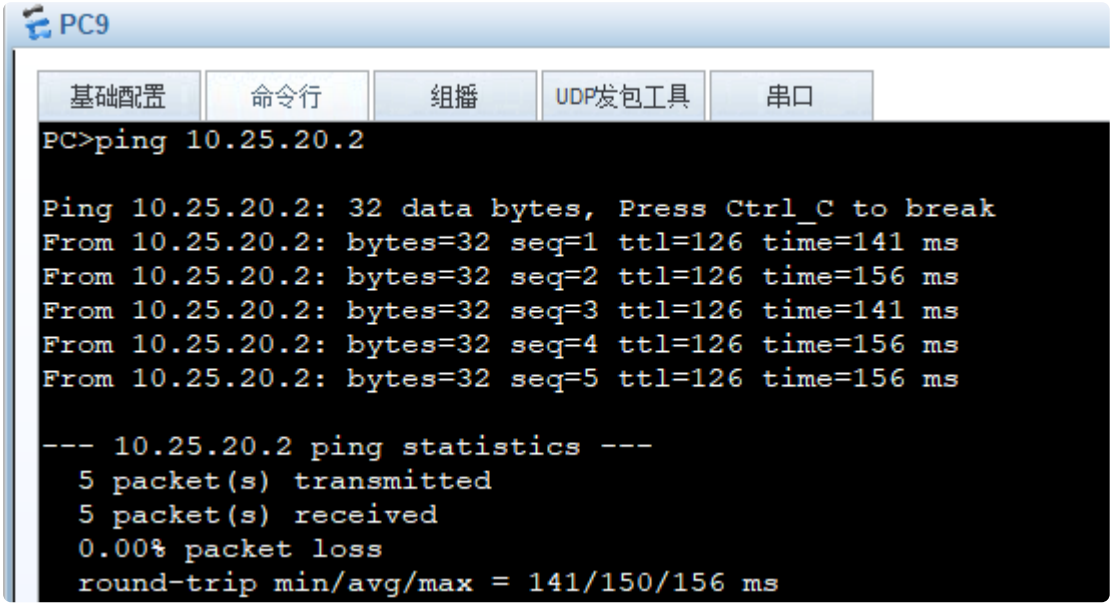
```
[Huawei]dis ospf brief

       OSPF Process 1 with Router ID 10.25.100.254
             OSPF Protocol Information
```

```
Interface: 10.25.10.1 (GigabitEthernet0/0/1)
Cost: 1       State: DR        Type: Broadcast    MTU: 1500
Priority: 1
Designated Router: 10.25.10.1
Backup Designated Router: 0.0.0.0
Timers: Hello 10 , Dead 40 , Poll  120 , Retransmit 5 , Transmit Delay 1

Interface: 10.25.100.1 (GigabitEthernet0/0/0)
Cost: 1       State: BDR       Type: Broadcast    MTU: 1500
Priority: 1
Designated Router: 10.25.100.2
Backup Designated Router: 10.25.100.1
Timers: Hello 10 , Dead 40 , Poll  120 , Retransmit 5 , Transmit Delay 1
```

PC 机可以互 ping



PC10

基础配置 | 命令行 | 组播 | UDP发包工具 | 串口

```
PC>ping 10.25.10.2

Ping 10.25.10.2: 32 data bytes, Press Ctrl_C to break
From 10.25.10.2: bytes=32 seq=1 ttl=126 time=172 ms
From 10.25.10.2: bytes=32 seq=2 ttl=126 time=156 ms

--- 10.25.10.2 ping statistics ---
  2 packet(s) transmitted
  2 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 156/164/172 ms
```

查看路由器路由情况

R5

```
[Huawei]dis ip route
[Huawei]dis ip rout
[Huawei]dis ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 7        Routes : 7

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

     10.25.10.0/24  Direct  0    0           D   10.25.10.1      GigabitEthernet
0/0/1
     10.25.10.1/32  Direct  0    0           D   127.0.0.1       GigabitEthernet
0/0/1
     10.25.20.0/24  OSPF    10   2           D   10.25.100.2     GigabitEthernet
0/0/0
    10.25.100.0/30  Direct  0    0           D   10.25.100.1     GigabitEthernet
0/0/0
    10.25.100.1/32  Direct  0    0           D   127.0.0.1       GigabitEthernet
0/0/0
      127.0.0.0/8   Direct  0    0           D   127.0.0.1       InLoopBack0
      127.0.0.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
```

R6

```
[Huawei]dis ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 7        Routes : 7

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

     10.25.10.0/24  OSPF    10   2           D   10.25.100.1     GigabitEthernet
0/0/0
     10.25.20.0/24  Direct  0    0           D   10.25.20.1      GigabitEthernet
0/0/1
     10.25.20.1/32  Direct  0    0           D   127.0.0.1       GigabitEthernet
0/0/1
    10.25.100.0/30  Direct  0    0           D   10.25.100.2     GigabitEthernet
0/0/0
    10.25.100.2/32  Direct  0    0           D   127.0.0.1       GigabitEthernet
0/0/0
      127.0.0.0/8   Direct  0    0           D   127.0.0.1       InLoopBack0
      127.0.0.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
```

四、实验体会

3.1 使用 L2 交换机 + 路由器 组网

1. PC 机/路由器接口 IP 的网段如何规划?

    1. Vlan: 10 20
    2. Interface Gateway
        1. Vlanif10: 10.25.10.1
        2. Vlanif20: 10.25.20.1
    3. IP Pool
        1. Vlanif10: 10.25.10.0/24
        2. Vlanif20: 10.25.20.0/24

```
------------------------------------------------------------------------------
Pool-name      : Vlanif10
Pool-No        : 0
Position       : Interface       Status          : Unlocked
Gateway-0      : 10.25.10.1
Mask           : 255.255.255.0
VPN instance   : --

------------------------------------------------------------------------------
Pool-name      : Vlanif20
Pool-No        : 1
Position       : Interface       Status          : Unlocked
Gateway-0      : 10.25.20.1
Mask           : 255.255.255.0
VPN instance   : --
```

2. DHCP 可以分配哪几个关键的网络参数?

    DHCP（动态主机配置协议）可以分配以下关键的网络参数:

    - IP 地址
    - 子网掩码 (Subnet Mask)
    - 默认网关 (Default Gateway)
    - DNS 服务器 (DNS Server)
    - 租约时间 (Lease Time)

3. 路由器是怎样实现 3 个网段转发的? 路由中看到的下一跳是什么意思?

    路由器通过路由表实现不同网段之间的转发。路由表中记录了到达不同网络的路径信息，包括:

    - 目的网络地址
    - 子网掩码
    - 下一跳 (Next Hop) 地址

- 出接口

“下一跳”是指数据包到达目标网络的下一个路由器的 IP 地址。路由器根据路由表决定将数据包发往哪个下一跳地址，以便最终到达目的网络。

4. 路由器看到的直连路由有什么意义？什么时候会产生？

直连路由是指路由器直接连接的网络，这些网络是路由器接口所处的网段。直连路由的意义在于它们不需要经过其他路由器即可到达，是最优路径。

直连路由会在以下情况下产生：

- 路由器接口被配置了 IP 地址并启用。
- 路由器接口连接到了某个网络。

直连路由的存在使得路由器可以快速高效地转发数据包到这些网络。

3.3 多台路由器组网

1. 路由器间直接相同网段需要使用多少位掩码？

路由器间直接相同网段通常使用 30 位掩码 (255.255.255.252)。这样可以节省 IP 地址资源，只需要 4 个 IP 地址即可满足两个路由器之间的连接。

2. 每台设备器 OSPF 配置有哪些状态？
   - **Down**：接口没有被启用或 OSPF 协议没有运行。
   - **Init**：OSPF Hello 包已经发送，但还没有接收到对方的 Hello 包。
   - **Two-Way**：OSPF 已经与邻居建立双向通信。
   - **ExStart**：开始邻居关系的初始化。
   - **Exchange**：正在交换数据库描述（DBD）包。
   - **Loading**：正在请求和接收 LSA（Link State Advertisement）。
   - **Full**：OSPF 邻居关系完全建立，链路状态数据库已经同步。

3. 拔掉接口 1，网络中网关 1 路由存在吗？

```
[Huawei]
Jun 11 2024 15:14:16-08:00 Huawei %%01PHY/1/PHY(l)[20]:    GigabitEthernet0/0/1:
 change status to down
Jun 11 2024 15:14:16-08:00 Huawei %%01IFNET/4/LINK_STATE(l)[21]:The line protoco
l IP on the interface GigabitEthernet0/0/1 has entered the DOWN state.
[Huawei]
[Huawei]dis ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 5        Routes : 5

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

     10.25.20.0/24  OSPF    10   2           D   10.25.100.2     GigabitEthernet
0/0/0
    10.25.100.0/30  Direct  0    0           D   10.25.100.1     GigabitEthernet
0/0/0
    10.25.100.1/32  Direct  0    0           D   127.0.0.1       GigabitEthernet
0/0/0
      127.0.0.0/8   Direct  0    0           D   127.0.0.1       InLoopBack0
      127.0.0.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
```

> 如图，拔掉后路由消失。

4. 拔掉 PC 1 接口，网络中网关 1 路由存在吗？

```
[Huawei]dis ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 7        Routes : 7

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

     10.25.10.0/24  Direct  0    0           D   10.25.10.1      GigabitEthernet
0/0/1
     10.25.10.1/32  Direct  0    0           D   127.0.0.1       GigabitEthernet
0/0/1
     10.25.20.0/24  OSPF    10   2           D   10.25.100.2     GigabitEthernet
0/0/0
    10.25.100.0/30  Direct  0    0           D   10.25.100.1     GigabitEthernet
0/0/0
    10.25.100.1/32  Direct  0    0           D   127.0.0.1       GigabitEthernet
0/0/0
      127.0.0.0/8   Direct  0    0           D   127.0.0.1       InLoopBack0
      127.0.0.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
```

> 如图，拔掉后路由还在 😀