中国科学技术大学计算机学院

网络系统实验报告

实验二

静态和动态路由配置

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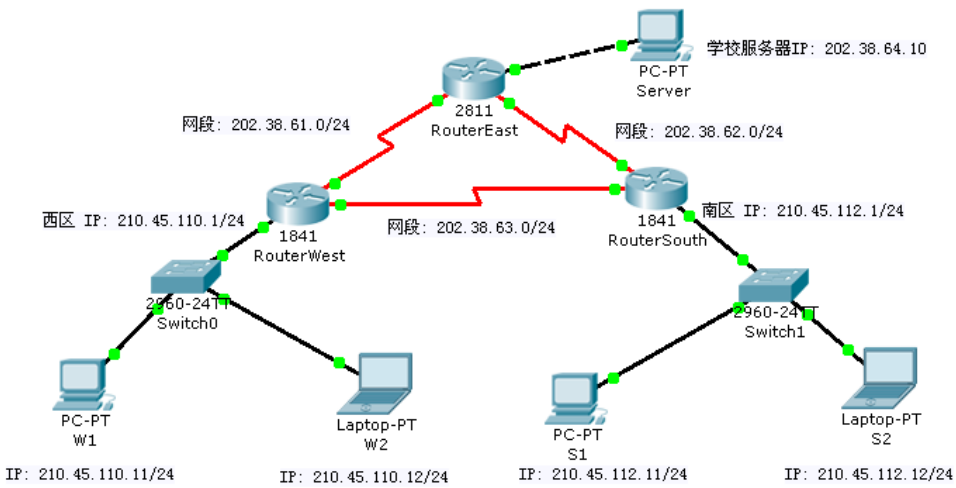
一、 实验目的

- 掌握静态路由的配置
- 掌握 RIP 的配置
- 掌握 OSPF 的配置

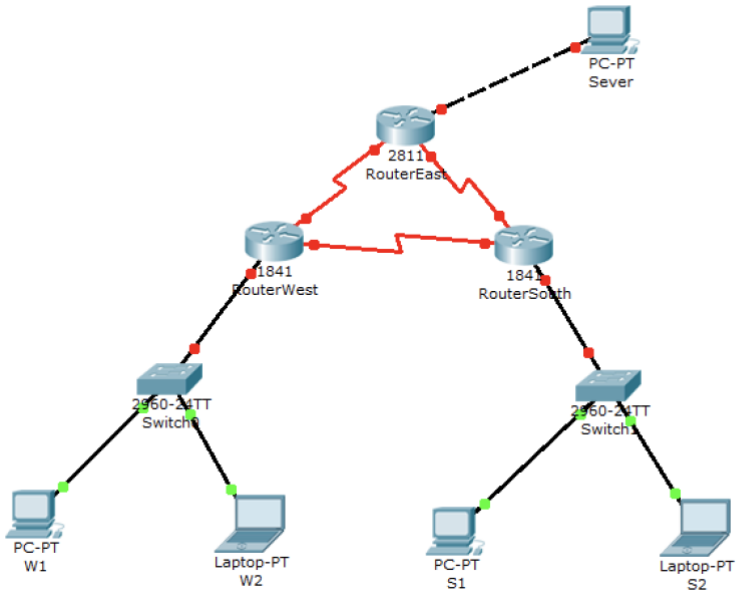
二、 实验环境

- 模拟软件 Cisco Packet Tracer 5.2
- 实验器材：Cisco 2811 路由器 1 台，Cisco 1841 交换机 2 台，2960 交换机 2 台，PC 机 5 台，连接线若干。
- 网络拓扑图如下：西区两台主机 W1、W2 通过交换机 Switch0 连接至西区路由器 RouteWest，南区两台主机 S1、S2 通过交换机 Switch1 连接至南区路由器 RouterSouth，东区学校服务器 Server 直接连接至路由器 RouterEast，三台路由器通过串行链路相连。



三、 实验过程

1. 按上图连接好网络拓扑图并配置好主机的 IP 后，回答问题【1】



- 每台主机相互 ping，查看哪些主机可以连通，哪些不可以？为什么？

  答：W1 和 W2 连通，S1 和 S2 连通，因为 W1、W2 和 S1、S2 各自在同一网段中，W 和 S 在不同网段，由于路由器未配置，因此无法连通不同网段的主机。

- 每台主机相互 tracert，跟踪数据报使用的路由，查看是在哪里出的问题？

  答：以 W1 为例，从 W1 分别 tracert W2 和 Sever 后可以看到，W1 到 W2 不经过任何路由器即可达，W1 到 Sever，以及 S1，S2，均不可达。

```
PC>tracert 210.45.110.12

Tracing route to 210.45.110.12 over a maximum of 30 hops:

  1    16 ms     16 ms     16 ms     210.45.110.12

Trace complete.

PC>tracert 202.38.64.10

Tracing route to 202.38.64.10 over a maximum of 30 hops:

  1    *         *         *         Request timed out.
  2    *         *
```

2. 配置各个路由器的 IP 地址，回答问题【2】

- 配置完路由器 IP 地址后，回答【问题 2】：每台主机相互 ping，查看哪些主机可以连通，哪些不可以？为什么？

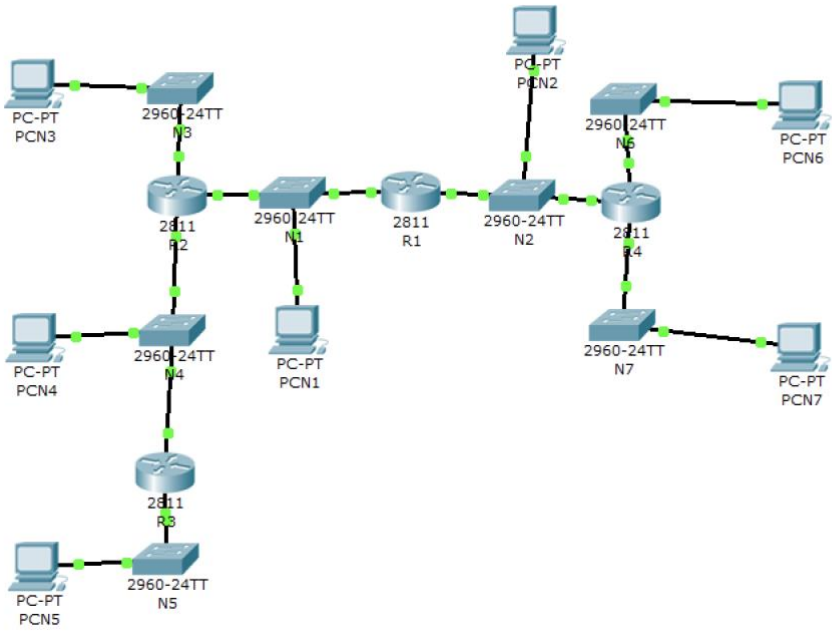
  答：以 PC-W1 为例，同样也是只能连通由交换机相连的同一网段的主机，这是因为虽然配置了路由器的 IP 地址，但没有配置静态路由/动态路由。

```
Router>enable
Router#conf
Router#configure te
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface fastEthernet 0/0
Router(config-if)#ip address 210.45.110.1 255.255.255.0
Router(config-if)#no shutdown

%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state t
o up
Router(config-if)#exit
Router(config)#interface serial 0/0/0
Router(config-if)#ip address 202.38.61.11 255.255.255.0
Router(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/0/0, changed state to down
Router(config-if)#exit
Router(config)#
```

```
PC>ping 202.38.64.10

Pinging 202.38.64.10 with 32 bytes of data:

Reply from 210.45.110.1: Destination host unreachable.
Reply from 210.45.110.1: Destination host unreachable.
Reply from 210.45.110.1: Destination host unreachable.
Reply from 210.45.110.1: Destination host unreachable.

Ping statistics for 202.38.64.10:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

PC>ping 210.45.112.11

Pinging 210.45.112.11 with 32 bytes of data:

Reply from 210.45.110.1: Destination host unreachable.
Reply from 210.45.110.1: Destination host unreachable.
Reply from 210.45.110.1: Destination host unreachable.
Reply from 210.45.110.1: Destination host unreachable.
```

3. 按照课件介绍连接拓扑下一页 PPT 中的拓扑，并配置各主机和路由器的 IP 地址（需自行添加网络末梢终端）。分别配置静态路由、RIP 路由、OSPF 路由，并用“show ip route”观察路由表。

连线后网络拓扑图如下所示：



配置好静态路由后，在 R1 终端内输入命令 show ip route 可以看到：

```
Router>show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, 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, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    130.10.0.0/16 is directly connected, FastEthernet0/1
C    130.11.0.0/16 is directly connected, FastEthernet0/0
S    195.2.4.0/24 [1/0] via 130.10.0.1
S    195.2.5.0/24 [1/0] via 130.10.0.1
S    195.2.6.0/24 [1/0] via 130.10.0.1
S    205.5.5.0/24 [1/0] via 130.11.0.1
S    205.5.6.0/24 [1/0] via 130.11.0.1
```

配置好 RIP 后，在 R2 终端内输入命令 show ip route、show ip protocols、show ip rip database 可以看到下图，从图中可以看到路由协议位 RIP，每 30 秒更新一次，为 3 个网络提供路由，距离默认为 120。在 database 可以看到 195.2.6.0、130.11.0.0 等网络的路由路径。

```
Router#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, 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, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    130.10.0.0/16 is directly connected, Ethernet0/0/0
R    130.11.0.0/16 [120/1] via 130.10.0.2, 00:00:23, Ethernet0/0/0
C    195.2.4.0/24 is directly connected, FastEthernet0/0
C    195.2.5.0/24 is directly connected, FastEthernet0/1
R    195.2.6.0/24 [120/1] via 195.2.5.2, 00:00:02, FastEthernet0/1
R    205.5.5.0/24 [120/2] via 130.10.0.2, 00:00:23, Ethernet0/0/0
R    205.5.6.0/24 [120/2] via 130.10.0.2, 00:00:23, Ethernet0/0/0

Router#show ip protocols
Routing Protocol is "rip"
Sending updates every 30 seconds, next due in 9 seconds
Invalid after 180 seconds, hold down 180, flushed after 240
Outgoing update filter list for all interfaces is not set
Incoming update filter list for all interfaces is not set
Redistributing: rip
Default version control: send version 1, receive any version
  Interface             Send  Recv  Triggered RIP  Key-chain
  FastEthernet0/0       1     2 1
  FastEthernet0/1       1     2 1
  Ethernet0/0/0         1     2 1
Automatic network summarization is in effect
Maximum path: 4
Routing for Networks:
        130.10.0.0
        195.2.4.0
        195.2.5.0
Passive Interface(s):
Routing Information Sources:
        Gateway         Distance      Last Update
        130.10.0.2           120      00:00:23
        195.2.5.2            120      00:00:00
Distance: (default is 120)
Router#show ip rip database
130.10.0.0/16     directly connected, Ethernet0/0/0
130.11.0.0/16
    [1] via 130.10.0.2, 00:00:14, Ethernet0/0/0
195.2.4.0/24      directly connected, FastEthernet0/0
195.2.5.0/24      directly connected, FastEthernet0/1
195.2.6.0/24
    [1] via 195.2.5.2, 00:00:18, FastEthernet0/1
205.5.5.0/24
    [2] via 130.10.0.2, 00:00:14, Ethernet0/0/0
205.5.6.0/24
    [2] via 130.10.0.2, 00:00:14, Ethernet0/0/0
```

按照 PPT 上流程配置 OSPF：

```
Router(config)#router ospf 1
Router(config-router)#router-id 1.1.1.1
Router(config-router)#network 130.10.0.0 0.0.255.255 area 0
Router(config-router)#network 130.11.0.0 0.0.255.255 area 0
Router(config-router)#exit
Router(config)#
```

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配置好 OSPF 后，在 R1 终端内输入命令 show ip protocols、show ip ospf 、show ip ospf interface 可以看到有关路由器配置 ospf 后的一些基本信息：

```
Router#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, 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, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    130.10.0.0/16 is directly connected, FastEthernet0/0
C    130.11.0.0/16 is directly connected, FastEthernet0/1
O    195.2.4.0/24 [110/2] via 130.10.0.1, 00:05:53, FastEthernet0/0
O    195.2.5.0/24 [110/11] via 130.10.0.1, 00:05:53, FastEthernet0/0
Router#

Router#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 1.1.1.1
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    130.10.0.0 0.0.255.255 area 0
    130.11.0.0 0.0.255.255 area 0
  Routing Information Sources:
    Gateway         Distance      Last Update
    130.10.0.1           110      00:06:10
  Distance: (default is 110)
```

```
Router#show ip ospf
%OSPF: Router process 2 is not running, please configure a router-id
 Routing Process "ospf 1" with ID 1.1.1.1
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
 Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 External flood list length 0
    Area BACKBONE(0)
        Number of interfaces in this area is 2
        Area has no authentication
        SPF algorithm executed 2 times
        Area ranges are
        Number of LSA 3. Checksum Sum 0x01e292
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
```

Ospf interface 解析：第一行为接口状态，正常工作时两个都需要 up。第二行表示接口地址和所在区域为 area0。第三行显示了进程 ID 和路由 ID，cost 表示花销值，可以通过公式计算。后面还显示了传输延迟，为 1s，StateDR 表示在这个广播型网络中，它与所有的路由建立邻接关系。

```
Router#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet address is 130.10.0.2/16, Area 0
  Process ID 1, Router ID 1.1.1.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 1.1.1.1, Interface address 130.10.0.2
  Backup Designated Router (ID) 2.2.2.2, Interface address 130.10.0.1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:02
  Index 1/1, 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 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 2.2.2.2  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)
FastEthernet0/1 is up, line protocol is up
  Internet address is 130.11.0.2/16, Area 0
  Process ID 1, Router ID 1.1.1.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 1.1.1.1, Interface address 130.11.0.2
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:03
  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 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
```

配置好 OSPF 后，在 R3 终端内输入命令 show ip ospf neighbor、show ip ospf database 可以看到下图。show ip ospf neighbor 显示的是邻接路由器的 ID、优先级、状态、死机时间、地址和接口。死机时间是路由器等待从相邻收到 OSPF Hello 信息 包在宣称相邻之前下来的时间余留。 在广播和点到点媒体， 默认停止间隔是 40 秒。在非广播和点对多点链路，默认停 止间隔是 120 秒。在上述示例，死机时间是 36 秒。

```
Router#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
2.2.2.2           1   FULL/DR         00:00:36    195.2.5.1       FastEthernet0/
0
Router#show ip ospf database
            OSPF Router with ID (3.3.3.3) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
2.2.2.2         2.2.2.2         346         0x80000005 0x00b5e3 3
3.3.3.3         3.3.3.3         331         0x80000003 0x003f86 2
1.1.1.1         1.1.1.1         245         0x80000004 0x00e21b 2
4.4.4.4         4.4.4.4         245         0x80000004 0x0081b6 3

                Net Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum
130.10.0.2      1.1.1.1         442         0x80000001 0x001c81
195.2.5.1       2.2.2.2         346         0x80000001 0x00d968
130.11.0.2      1.1.1.1         245         0x80000002 0x00f377
```

- 表一中，路由器的 IP 地址分配是否存在浪费现象？若存在，请给出一种节省 IP 的分配方案。

存在浪费现象，以/24 位子网掩码为例，节省 IP 的分配方案可为如下表所示：

Device	**Interfaces**		**IP**
	From	**To**	
RouterWest	**Serial 0/0/0 (DTE)**	**RouterEast, Serial 0/0/0**	**202.38.61.11/24**
	Serial 0/0/1 (DCE)	**RouterSouth, Serial 0/0/1**	**202.38.63.11/24**
	FastEthernet 0/0	**Switch0**	**202.38.65.1/24**
RouterSouth	**Serial 0/0/0 (DTE)**	**RouterEast, Serial 0/0/1**	**202.38.62.11/24**
	Serial 0/0/1 (DTE)	**RouterWest, Serial 0/0/1**	**202.38.63.12/24**
	FastEthernet 0/0	**Switch1**	**202.38.66.1/24**

RouterEast	**Serial 0/0/0 (DCE)**	**RouterWest, Serial 0/0/0**	**202.38.61.1/24**
	Serial 0/0/1 (DCE)	**RouterSouth, Serial 0/0/0**	**202.38.62.1/24**
	FastEthernet 0/0	**PC Server**	**202.38.64.1/24**

- 每人从本次实验中大胆思考一个课堂上没有讲到的疑问，并小心谨慎求证，求证过程开放，不限制任何工具，提示：可以用各类软件如“openet”，“wireshark”等。

为什么第一个总是丢包？

答：是因为第一个包根本就没有发出去，用抓包软件抓包时可以发现只能够抓到 ping 包的后面四个 echo，reply。由于第一个包还没有 ARP 解析，也就是没有对应的目的 mac 地址，在尚无 mac 地址的情况下，系统内核是不会发包的，路由器在一段链路中是使用 mac 地址的。无目的 mac 地址的数据包就不会发出。所以不知道目的 mac 地址，首先先发 ARP 解析 mac 地址，同时第一个包还没有发出去就被自己 kill 了。后续的包因为有了对应的 mac 地址才能顺利发出。

```
PC>ping 210.45.112.11

Pinging 210.45.112.11 with 32 bytes of data:

Request timed out.
Reply from 210.45.112.11: bytes=32 time=22ms TTL=126
Reply from 210.45.112.11: bytes=32 time=43ms TTL=126
Reply from 210.45.112.11: bytes=32 time=40ms TTL=126

Ping statistics for 210.45.112.11:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 22ms, Maximum = 43ms, Average = 35ms

PC>
```