《计算机网络》实验报告

信息 学院 计算机系统结构 专业 2024 级

实验时间 2024 年 11 月 30 日

姓名 李昊 学号 12024115051

实验名称 高级计算机网络与分布式计算期中综合设计

实验成绩

一、实验目的

本次实验需要利用 Packet Tracer 模拟器实现网络环境，包括路由器、交换机、主机和相关网络设备的配置，考察学生综合运用网络设备、配置和网络设计等的综合能力。

灵活运用所学习的计算机网络相关知识，要求设计一个包含路由器、交换机和主机的多层次网络中，实现静态路由、RIP 和 OSPF 等路由算法，依次完成。

环境配置、测试、运行和提交验证等工作。

二、实验仪器设备及软件

仪器设备：PC

软件：Cisco Packet Tracer 8.2.2

三、实验方案

（一）子网划分（10%）

AAU 大学拟建设一个校园网基础设施，校园网使用 172.16.0.0/20 网络进行划分，请根据具体需求完成各网络 IP 地址划分，并完成相关配置。请在实验报告中给出具体的 IP 设置、控制代码和效果验证截图。

1、出口网络：校园网用 10Gbps 的 POS 技术与 Internet 相连，POS 接口的帧格式是 SDH，申请到的出口 IP 地址为 200.10.1.1/2，连接 ISP 路由器 IP

地址

为 200.10.1.2/2。

2、行政区：共 200 台计算机。

3、学院：共三个学院，信息学院使用 500 台计算机，材料学院和数理学院各使用 200 台计算机。

4、宿舍区：每个宿舍区预估 850 台计算机。

5、教学楼：共 100 台计算机。

6、图书馆：共 200 台计算机。

7、机房：容纳 100 台服务器。

8、WIFI 网络：使用 DHCP 自动分配 IP 地址。

（二）VLAN 划分（10%）

请选择恰当的设备，并完成物理线路连接。核心三层交换机划分 VLAN，供机房、行政楼、教学楼、图书馆、信息学院、材料学院、数理学院、楠苑宿舍、梓苑宿舍和 WIFI 网络使用。同样地，学院区和宿舍区均各使用一台交换机划分 VLAN 供不同学院和宿舍楼使用。

（三）OSPF 路由配置和静态路由配置（10%）

学院使用 OSPF 网络路由，默认路由设置从出口路由器访问 Internet 访问

（四）WIFI 网络配置（10%）

WIFI 重新进行内网设置，使用 192.168.0.0/22 进行划分，使用 DHCP 动态分配 IP 地址，可以供 1024 个用户同时接入使用。

（五）NAT 外网访问（10%）

在出口路由器设置 NAT，将内网 Internet 访问映射成为外网

（六）VPN 访问内网（10%）

在出口路由器配置 VPN 服务，可以从“互联网用户”访问内网图书馆资源。

（七）路由器双机热备 HSRP（10%）

实现核心交换区双机热备，冗余线路，避免单路差错致使网络崩溃。

（八）最小生成树协议 STP（10%）

实现最小生成树 STP，保证网络无环路存在。

（九）ACL 访问控制（10%）

1、宿舍区不可以访问行政楼和教学楼资源。

2、外网 VPN 接入后，不允许访问教学楼资源。

（十）HTTP、DNS 和邮件服务器配置（10%）

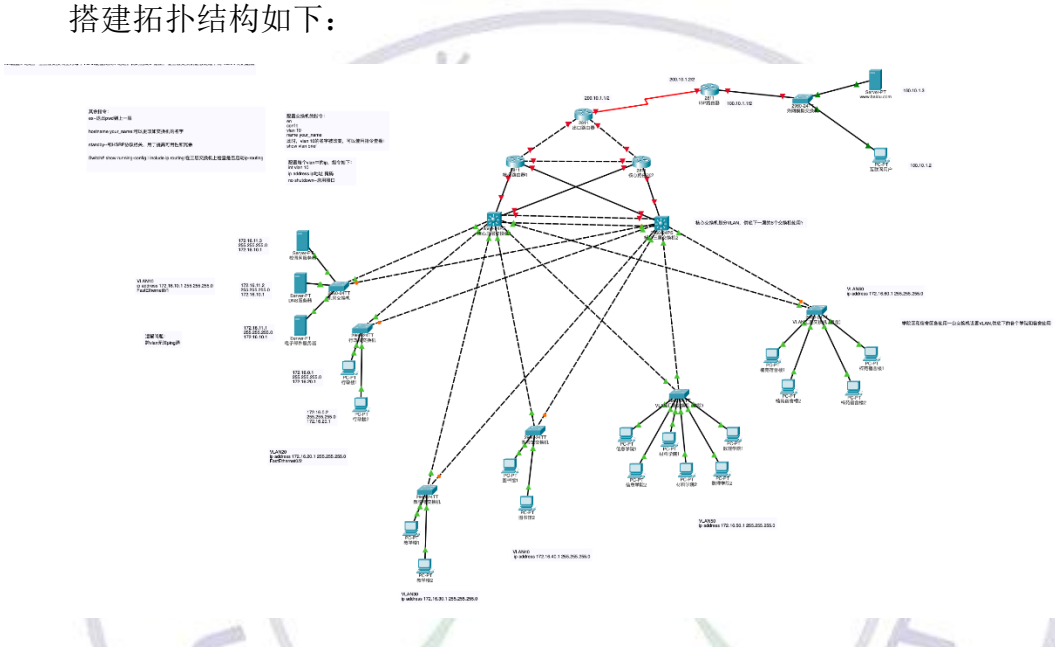
1、配置 A 大学校园网主页(http://www.aau.edu.cn/)。

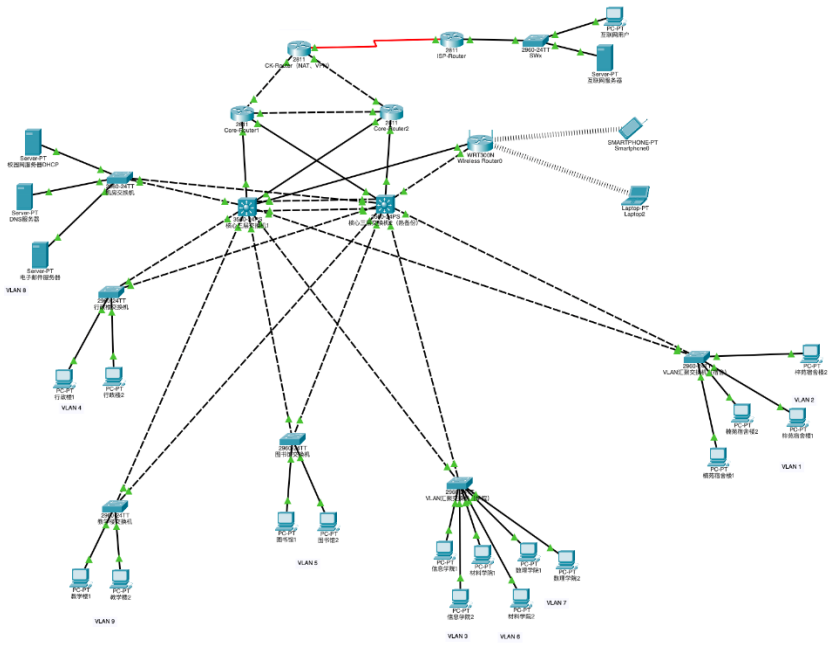
2、配置 DNS 域名解析，可以协助外网计算机解析校园网主页和邮件服务器。

3、配置邮件服务器，实现邮件收发(mail.aau.edu.cn)。

四、实验步骤

搭建拓扑结构如下：





配置各个 VLAN 并使用 show interface vlan id 进行查看：

```
Core-SW1#show interface vlan 0002
Vlan2 is up, line protocol is up
  Hardware is CPU Interface, address is 0001.4319.1301 (bia 0001.4319.1301)
  Internet address is 172.16.7.254/22
  MTU 1500 bytes, BW 100000 Kbit, DLY 1000000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 21:40:21, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     1682 packets input, 530955 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     563859 packets output, 0 bytes, 0 underruns
     0 output errors, 23 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

```
Core-SW1#show interface vlan 0003
Vlan3 is up, line protocol is up
  Hardware is CPU Interface, address is 0001.4319.1302 (bia 0001.4319.1302)
  Internet address is 172.16.9.254/23
  MTU 1500 bytes, BW 100000 Kbit, DLY 1000000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 21:40:21, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     1682 packets input, 530955 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     563859 packets output, 0 bytes, 0 underruns
     0 output errors, 23 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

```
Core-SW1#show interface vlan 0004
Vlan4 is up, line protocol is up
  Hardware is CPU Interface, address is 0001.4319.1303 (bia 0001.4319.1303)
  Internet address is 172.16.10.254/24
  MTU 1500 bytes, BW 100000 Kbit, DLY 1000000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 21:40:21, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     1682 packets input, 530955 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     563859 packets output, 0 bytes, 0 underruns
     0 output errors, 23 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

```
Core-SW1#show interface vlan 0005
Vlan5 is up, line protocol is up
  Hardware is CPU Interface, address is 0001.4319.1304 (bia 0001.4319.1304)
  Internet address is 172.16.11.254/24
  MTU 1500 bytes, BW 100000 Kbit, DLY 1000000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 21:40:21, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     1682 packets input, 530955 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     563859 packets output, 0 bytes, 0 underruns
     0 output errors, 23 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

```
Core-SW1#show interface vlan 0006
Vlan6 is up, line protocol is up
  Hardware is CPU Interface, address is 0001.4319.1305 (bia 0001.4319.1305)
  Internet address is 172.16.12.254/24
  MTU 1500 bytes, BW 100000 Kbit, DLY 1000000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 21:40:21, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     1682 packets input, 530955 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     563859 packets output, 0 bytes, 0 underruns
     0 output errors, 23 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

```
Core-SW1#show interface vlan 0007
Vlan7 is up, line protocol is up
  Hardware is CPU Interface, address is 0001.4319.1306 (bia 0001.4319.1306)
  Internet address is 172.16.13.254/24
  MTU 1500 bytes, BW 100000 Kbit, DLY 1000000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 21:40:21, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     1682 packets input, 530955 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     563859 packets output, 0 bytes, 0 underruns
     0 output errors, 23 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

```
Core-SW1#show interface vlan 0008
Vlan8 is up, line protocol is up
  Hardware is CPU Interface, address is 0001.4319.1307 (bia 0001.4319.1307)
  Internet address is 172.16.14.126/25
  MTU 1500 bytes, BW 100000 Kbit, DLY 1000000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 21:40:21, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     1682 packets input, 530955 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     563859 packets output, 0 bytes, 0 underruns
     0 output errors, 23 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

```
Core-SW1#show interface vlan 0009
Vlan9 is up, line protocol is up
  Hardware is CPU Interface, address is 0001.4319.1308 (bia 0001.4319.1308)
  Internet address is 172.16.14.254/25
  MTU 1500 bytes, BW 100000 Kbit, DLY 1000000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 21:40:21, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     1682 packets input, 530955 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicast)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     563859 packets output, 0 bytes, 0 underruns
     0 output errors, 23 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

使用指令：show ip route，查看三层交换机的网关和子网划分情况：

```
Core-SW1#
Core-SW1# show
Core-SW1#
Core-SW1#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 172.16.15.13 to network 0.0.0.0

     172.16.0.0/16 is variably subnetted, 17 subnets, 5 masks
C       172.16.0.0/22 is directly connected, Vlan1
C       172.16.4.0/22 is directly connected, Vlan2
C       172.16.8.0/23 is directly connected, Vlan3
C       172.16.10.0/24 is directly connected, Vlan4
C       172.16.11.0/24 is directly connected, Vlan5
C       172.16.12.0/24 is directly connected, Vlan6
C       172.16.13.0/24 is directly connected, Vlan7
C       172.16.14.0/25 is directly connected, Vlan8
C       172.16.14.128/25 is directly connected, Vlan9
O       172.16.15.0/30 [110/2] via 172.16.15.13, 00:07:54, FastEthernet0/1
O       172.16.15.4/30 [110/2] via 172.16.15.21, 00:07:54, FastEthernet0/2
```

静态路由配置方案：

在出口路由器上配置静态路由，将校园网内的所有子网指向核心路由器，确保校园网内设备能够通过核心路由器访问 Internet。配置默认路由，将所有未知目的地址的流量转发到 ISP 路由器，实现校园网与 Internet 的通信。

WIFI 网络配置方案：

在 WIFI 路由器上配置 DHCP 服务，启用 192.168.0.0/22 的地址池，设置地址租期、网关、DNS 服务器等参数，使连接 WIFI 的用户能够自动获取有效的 IP 地址。配置 WIFI 网络的 SSID（服务集标识符）和密码，确保 WIFI 网络的安全性。

NAT 配置方案：

在出口路由器上配置 NAT（网络地址转换），将内网设备的私有 IP 地址转换为出口的公网 IP 地址（200.10.1.1），使内网设备能够访问 Internet。采用动态 NAT 或 PAT（端口地址转换）技术，根据实际需求选择合适的转换方式，以提高公网 IP 地址的利用率。

VPN 配置方案：

在出口路由器上配置 VPN 服务，创建 VPN 用户账号和密码，设置 VPN 连接参数，如加密方式、认证方式等。配置 VPN 隧道，将外网用户的访问请求通过 VPN 隧道安全地转发到校园内网的图书馆资源服务器，确保外网用户能够访问内网图书馆资源。

HSRP 配置方案：

在核心交换区的核心路由器 1 和核心路由器 2 上配置 HSRP（热备份路由协议），设置虚拟 IP 地址（如 172.16.255.254）作为默认网关，供内网设备使用。配置 HSRP 的优先级、抢占模式等参数，确保在主路由器故障时备用路由器能够快速接管网络服务，实现核心交换区的双机热备，提高网络的可靠性。

STP 配置方案：

在整个校园网的交换机上启用 STP（最小生成树协议），自动检测和消除网络中的环路。通过选举根桥、根端口和指定端口等机制，构建无环路的网络拓扑结构，确保网络数据的稳定传输，防止广播风暴等网络故障的发生。

ACL 配置方案：

在核心三层交换机或路由器上配置 ACL（访问控制列表），根据实验要求限制宿舍区对行政楼和教学楼资源的访问。例如，创建拒绝宿舍区 IP 地址访问行政楼和教学楼子网的 ACL 规则，并应用到相应的接口上。配置 ACL 规则，限制外网 VPN 接入后对教学楼资源的访问，确保网络资源的安全访问和合理利用。

服务器配置方案：

在校园网服务器上安装 HTTP 服务软件（如 IIS 或 Apache），配置网站根目录，将 A 大学校园网主页（index.html 等文件）放置在根目录下。绑定服务器的 IP 地址和端口号，确保外网和内网用户能够通过 http://www.aau.edu.cn/访问校园网主页。在 DNS 服务器上安装 DNS 服务软件，创建正向查找区域，添

加校园网主页服务器（www.aau.edu.cn）和邮件服务器（mail.aau.edu.cn）的主机记录，将其对应的 IP 地址解析为相应的域名。配置 DNS 服务器的转发器，使其能够将无法解析的域名请求转发到外部 DNS 服务器（如 ISP 提供的 DNS 服务器），确保外网计算机能够正确解析校园网相关域名。

邮件服务器配置方案：

在邮件服务器上安装邮件服务软件，配置邮件域（aau.edu.cn）、用户账号和密码等参数。配置邮件服务器的 SMTP 和 POP3 服务，确保校园内用户能够正常收发邮件（mail.aau.edu.cn）。

五、实验结果及分析

子网划分：

使用指令 show vlan brief 在三层核心交换机上查看划分的信息：

```
Core-SW1>show
Core-SW1>show vlan brief

VLAN Name                              Status    Ports
---- --------------------------------- --------- -------------------------------
1    default                           active    Fa0/12, Fa0/13, Fa0/14, Fa0/15
                                                 Fa0/16, Fa0/17, Fa0/18, Fa0/19
                                                 Fa0/20, Fa0/21, Fa0/22, Fa0/23
                                                 Fa0/24, Gig0/1, Gig0/2
2    VLAN0002                          active
3    VLAN0003                          active
4    VLAN0004                          active
5    VLAN0005                          active
6    VLAN0006                          active
7    VLAN0007                          active
8    VLAN0008                          active
9    VLAN0009                          active
1002 fddi-default                      active
1003 token-ring-default                active
1004 fddinet-default                   active
1005 trnet-default                     active
Core-SW1>
```

OSPF 路由配置和静态路由配置：

在 en 模式下，使用指令 show running-config | include ospf 查看 OSPF 配置:

```
Core-SW1#show running-config | section ospf
router ospf 10
 log-adjacency-changes
 network 172.16.0.0 0.0.3.255 area 0
 network 172.16.4.0 0.0.3.255 area 0
 network 172.16.8.0 0.0.1.255 area 0
 network 172.16.10.0 0.0.0.255 area 0
 network 172.16.11.0 0.0.0.255 area 0
 network 172.16.12.0 0.0.0.255 area 0
 network 172.16.13.0 0.0.0.255 area 0
 network 172.16.14.0 0.0.0.127 area 0
 network 172.16.14.128 0.0.0.127 area 0
 network 172.16.15.12 0.0.0.3 area 0
 network 172.16.15.20 0.0.0.3 area 0
```

在 en 模式下，使用指令 show running-config | include ip route 查看路由表：

```
Core-SW1>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 172.16.15.13 to network 0.0.0.0

     172.16.0.0/16 is variably subnetted, 17 subnets, 5 masks
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C       172.16.4.0/22 is directly connected, Vlan2
C       172.16.8.0/23 is directly connected, Vlan3
C       172.16.10.0/24 is directly connected, Vlan4
C       172.16.11.0/24 is directly connected, Vlan5
C       172.16.12.0/24 is directly connected, Vlan6
C       172.16.13.0/24 is directly connected, Vlan7
C       172.16.14.0/25 is directly connected, Vlan8
C       172.16.14.128/25 is directly connected, Vlan9
O       172.16.15.0/30 [110/2] via 172.16.15.13, 00:26:43, FastEthernet0/1
O       172.16.15.4/30 [110/2] via 172.16.15.21, 00:26:43, FastEthernet0/2
```

其中，O 代表 OSPF 路由，C：直连路由；

WIFI 网络配置：

使用指令 show ip interface brief 查看各个交换机下的划分：

交换机 1：

```
Switch>show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/1        unassigned      YES manual up                    up
FastEthernet0/2        unassigned      YES manual up                    up
FastEthernet0/3        unassigned      YES manual up                    up
FastEthernet0/4        unassigned      YES manual up                    up
FastEthernet0/5        unassigned      YES manual up                    up
FastEthernet0/6        unassigned      YES manual up                    up
FastEthernet0/7        unassigned      YES manual down                  down
FastEthernet0/8        unassigned      YES manual down                  down
FastEthernet0/9        unassigned      YES manual down                  down
FastEthernet0/10       unassigned      YES manual down                  down
FastEthernet0/11       unassigned      YES manual down                  down
FastEthernet0/12       unassigned      YES manual down                  down
FastEthernet0/13       unassigned      YES manual down                  down
FastEthernet0/14       unassigned      YES manual down                  down
FastEthernet0/15       unassigned      YES manual down                  down
FastEthernet0/16       unassigned      YES manual down                  down
FastEthernet0/17       unassigned      YES manual down                  down
FastEthernet0/18       unassigned      YES manual down                  down
FastEthernet0/19       unassigned      YES manual down                  down
FastEthernet0/20       unassigned      YES manual down                  down
FastEthernet0/21       unassigned      YES manual down                  down
```

交换机 2：

```
Switch#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/1        unassigned      YES manual up                    up
FastEthernet0/2        unassigned      YES manual up                    up
FastEthernet0/3        unassigned      YES manual up                    up
FastEthernet0/4        unassigned      YES manual up                    up
FastEthernet0/5        unassigned      YES manual up                    up
FastEthernet0/6        unassigned      YES manual up                    up
FastEthernet0/7        unassigned      YES manual up                    up
FastEthernet0/8        unassigned      YES manual up                    up
FastEthernet0/9        unassigned      YES manual down                  down
FastEthernet0/10       unassigned      YES manual down                  down
FastEthernet0/11       unassigned      YES manual down                  down
FastEthernet0/12       unassigned      YES manual down                  down
FastEthernet0/13       unassigned      YES manual down                  down
FastEthernet0/14       unassigned      YES manual down                  down
FastEthernet0/15       unassigned      YES manual down                  down
FastEthernet0/16       unassigned      YES manual down                  down
FastEthernet0/17       unassigned      YES manual down                  down
FastEthernet0/18       unassigned      YES manual down                  down
FastEthernet0/19       unassigned      YES manual down                  down
FastEthernet0/20       unassigned      YES manual down                  down
FastEthernet0/21       unassigned      YES manual down                  down
```

交换机 3：

```
Switch>en
Switch#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/1        unassigned      YES manual up                    up
FastEthernet0/2        unassigned      YES manual up                    up
FastEthernet0/3        unassigned      YES manual up                    up
FastEthernet0/4        unassigned      YES manual up                    up
FastEthernet0/5        unassigned      YES manual down                  down
FastEthernet0/6        unassigned      YES manual down                  down
FastEthernet0/7        unassigned      YES manual down                  down
FastEthernet0/8        unassigned      YES manual down                  down
FastEthernet0/9        unassigned      YES manual down                  down
FastEthernet0/10       unassigned      YES manual down                  down
FastEthernet0/11       unassigned      YES manual down                  down
FastEthernet0/12       unassigned      YES manual down                  down
FastEthernet0/13       unassigned      YES manual down                  down
FastEthernet0/14       unassigned      YES manual down                  down
FastEthernet0/15       unassigned      YES manual down                  down
FastEthernet0/16       unassigned      YES manual down                  down
FastEthernet0/17       unassigned      YES manual down                  down
FastEthernet0/18       unassigned      YES manual down                  down
FastEthernet0/19       unassigned      YES manual down                  down
FastEthernet0/20       unassigned      YES manual down                  down
FastEthernet0/21       unassigned      YES manual down                  down
```

交换机 4：

```
Switch#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/1        unassigned      YES manual up                    up
FastEthernet0/2        unassigned      YES manual up                    up
FastEthernet0/3        unassigned      YES manual up                    up
FastEthernet0/4        unassigned      YES manual up                    up
FastEthernet0/5        unassigned      YES manual down                  down
FastEthernet0/6        unassigned      YES manual down                  down
FastEthernet0/7        unassigned      YES manual down                  down
FastEthernet0/8        unassigned      YES manual down                  down
FastEthernet0/9        unassigned      YES manual down                  down
FastEthernet0/10       unassigned      YES manual down                  down
FastEthernet0/11       unassigned      YES manual down                  down
FastEthernet0/12       unassigned      YES manual down                  down
FastEthernet0/13       unassigned      YES manual down                  down
FastEthernet0/14       unassigned      YES manual down                  down
FastEthernet0/15       unassigned      YES manual down                  down
FastEthernet0/16       unassigned      YES manual down                  down
FastEthernet0/17       unassigned      YES manual down                  down
FastEthernet0/18       unassigned      YES manual down                  down
FastEthernet0/19       unassigned      YES manual down                  down
FastEthernet0/20       unassigned      YES manual down                  down
FastEthernet0/21       unassigned      YES manual down                  down
```

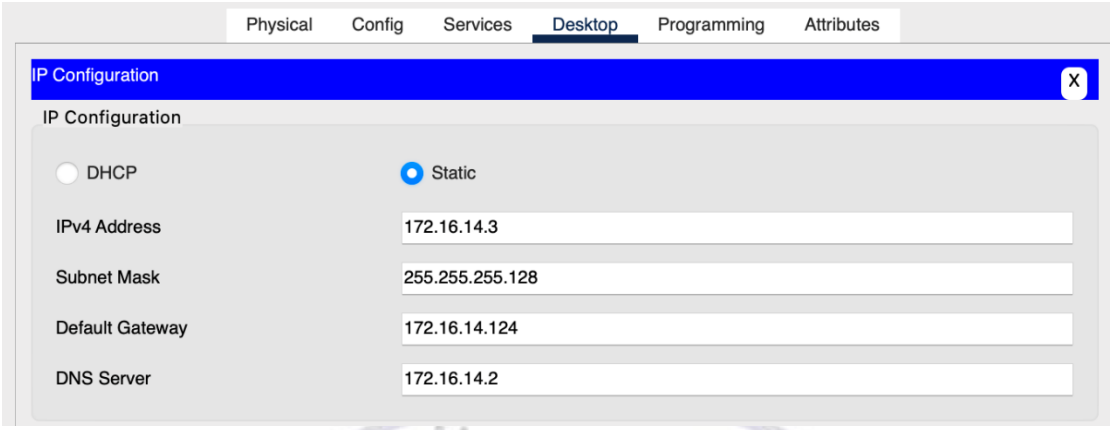
交换机 5：

```
Switch>en
Switch#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/1        unassigned      YES manual up                    up
FastEthernet0/2        unassigned      YES manual up                    up
FastEthernet0/3        unassigned      YES manual up                    up
FastEthernet0/4        unassigned      YES manual up                    up
FastEthernet0/5        unassigned      YES manual up                    up
FastEthernet0/6        unassigned      YES manual down                  down
FastEthernet0/7        unassigned      YES manual down                  down
FastEthernet0/8        unassigned      YES manual down                  down
FastEthernet0/9        unassigned      YES manual down                  down
FastEthernet0/10       unassigned      YES manual down                  down
FastEthernet0/11       unassigned      YES manual down                  down
FastEthernet0/12       unassigned      YES manual down                  down
FastEthernet0/13       unassigned      YES manual down                  down
FastEthernet0/14       unassigned      YES manual down                  down
FastEthernet0/15       unassigned      YES manual down                  down
FastEthernet0/16       unassigned      YES manual down                  down
FastEthernet0/17       unassigned      YES manual down                  down
FastEthernet0/18       unassigned      YES manual down                  down
FastEthernet0/19       unassigned      YES manual down                  down
FastEthernet0/20       unassigned      YES manual down                  down
FastEthernet0/21       unassigned      YES manual down                  down
```

交换机 6：

```
Switch>en
Switch#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
FastEthernet0/1        unassigned      YES manual up                    up
FastEthernet0/2        unassigned      YES manual up                    up
FastEthernet0/3        unassigned      YES manual up                    up
FastEthernet0/4        unassigned      YES manual up                    up
FastEthernet0/5        unassigned      YES manual down                  down
FastEthernet0/6        unassigned      YES manual down                  down
FastEthernet0/7        unassigned      YES manual down                  down
FastEthernet0/8        unassigned      YES manual down                  down
FastEthernet0/9        unassigned      YES manual down                  down
FastEthernet0/10       unassigned      YES manual down                  down
FastEthernet0/11       unassigned      YES manual down                  down
FastEthernet0/12       unassigned      YES manual down                  down
FastEthernet0/13       unassigned      YES manual down                  down
FastEthernet0/14       unassigned      YES manual down                  down
FastEthernet0/15       unassigned      YES manual down                  down
FastEthernet0/16       unassigned      YES manual down                  down
FastEthernet0/17       unassigned      YES manual down                  down
FastEthernet0/18       unassigned      YES manual down                  down
FastEthernet0/19       unassigned      YES manual down                  down
FastEthernet0/20       unassigned      YES manual down                  down
FastEthernet0/21       unassigned      YES manual down                  down
```

使用 PING 指令查看设备之间的连通性：




```
C:\>ping 172.16.14.3

Pinging 172.16.14.3 with 32 bytes of data:

Reply from 172.16.14.3: bytes=32 time<1ms TTL=128
Reply from 172.16.14.3: bytes=32 time<1ms TTL=128
Reply from 172.16.14.3: bytes=32 time<1ms TTL=128
Reply from 172.16.14.3: bytes=32 time<1ms TTL=128

Ping statistics for 172.16.14.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

NAT 外网访问：

使用指令：show running-config | include ip nat 查看当前的 NAT 表:

```
CK-Router>en
CK-Router#show running-config | include ip nat
 ip nat inside
 ip nat inside
 ip nat outside
ip nat pool DZC 200.10.1.3 200.10.1.6 netmask 255.255.255.240
ip nat inside source list 1 pool DZC
```

VPN 访问内网：

使用指令：show running-config | include crypto 查看 VPN 配置：

```
CK-Router#show running-config | include crypto
crypto isakmp policy 10
crypto isakmp client configuration group ynu
crypto ipsec transform-set vtrans esp-3des esp-sha-hmac
crypto dynamic-map dmap 10
crypto map vmap client authentication list vpn
crypto map vmap isakmp authorization list vpnuser
crypto map vmap client configuration address respond
crypto map vmap 10 ipsec-isakmp dynamic dmap
 crypto map vmap
```

路由器双机热备 HSRP：

使用指令：show standby 查看相应的 HSRP 配置信息：

```
Core-SW1#show standby
Vlan1 - Group 1
  State is Active
    7 state changes, last state change 00:00:28
  Virtual IP address is 172.16.3.252
  Active virtual MAC address is 0000.0C07.AC01
    Local virtual MAC address is 0000.0C07.AC01 (v1 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 0.537 secs
  Preemption enabled
  Active router is local
  Standby router is 172.16.3.253
  Priority 120 (configured 120)
    Track interface FastEthernet0/1 state Up decrement 10
    Track interface FastEthernet0/2 state Up decrement 10
  Group name is hsrp-Vl1-1 (default)
Vlan2 - Group 2
  State is Active
    8 state changes, last state change 00:00:38
  Virtual IP address is 172.16.7.252
  Active virtual MAC address is 0000.0C07.AC02
    Local virtual MAC address is 0000.0C07.AC02 (v1 default)
  Hello time 3 sec, hold time 10 sec
```

最小生成树协议 STP：

使用指令：show spanning-tree 查看 STP 的相关信息：

```
Core-SW1#show spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    24577
             Address     0001.4319.1316
             This bridge is the root
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    24577  (priority 24576 sys-id-ext 1)
             Address     0001.4319.1316
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time  20

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/6            Desg FWD 19        128.6    P2p
Fa0/7            Desg FWD 19        128.7    P2p
Fa0/8            Desg FWD 19        128.8    P2p
Fa0/9            Desg FWD 19        128.9    P2p
Fa0/10           Desg FWD 19        128.10   P2p
Fa0/11           Desg FWD 19        128.11   P2p
Po1              Desg FWD 12        128.27   Shr

VLAN0002
  Spanning tree enabled protocol ieee
  Root ID    Priority    24578
             Address     0001.4319.1316
             This bridge is the root
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    24578  (priority 24576 sys-id-ext 2)
             Address     0001.4319.1316
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
```

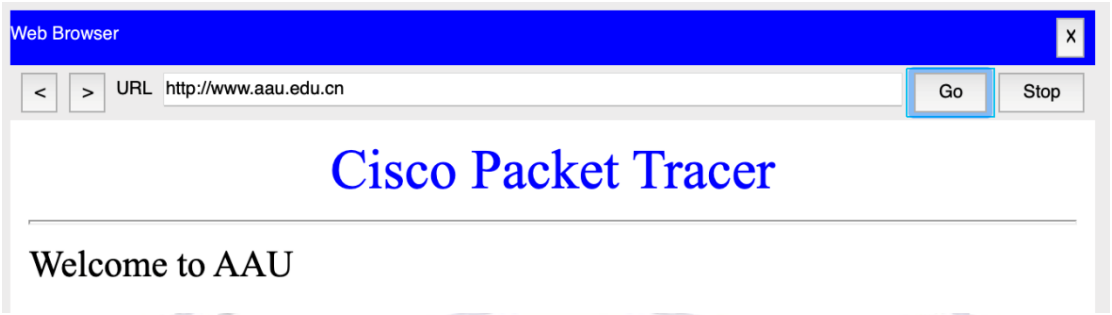
ACL 访问控制：

使用指令：show running-config | include access-list 查看访问控制列表:

```
Core-SW1#show running-config | include access-list
access-list 1 deny 172.16.0.0 0.0.7.255
access-list 1 permit any
access-list 2 deny 172.16.0.0 0.0.7.255
access-list 2 deny 172.16.15.128 0.0.0.127
access-list 2 permit any
```

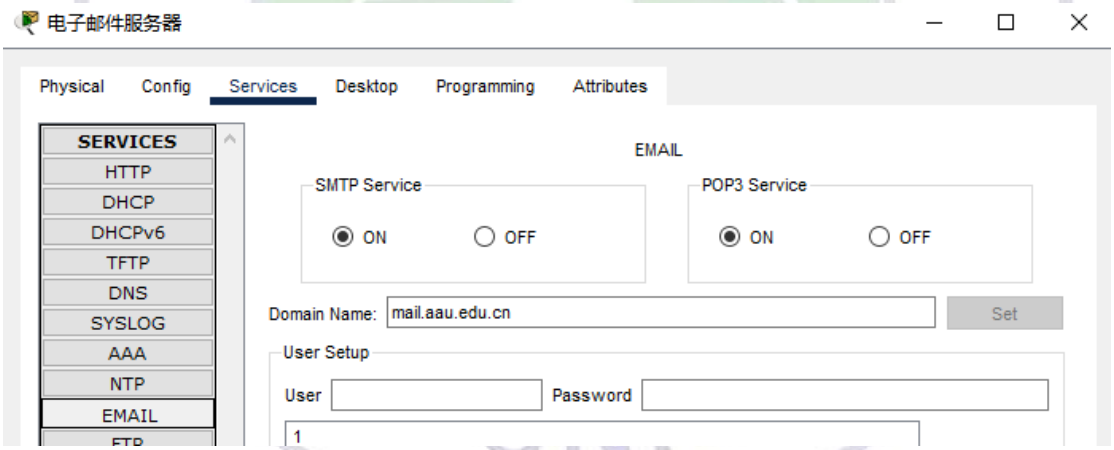
HTTP、DNS 和邮件服务器配置

校园网主页：

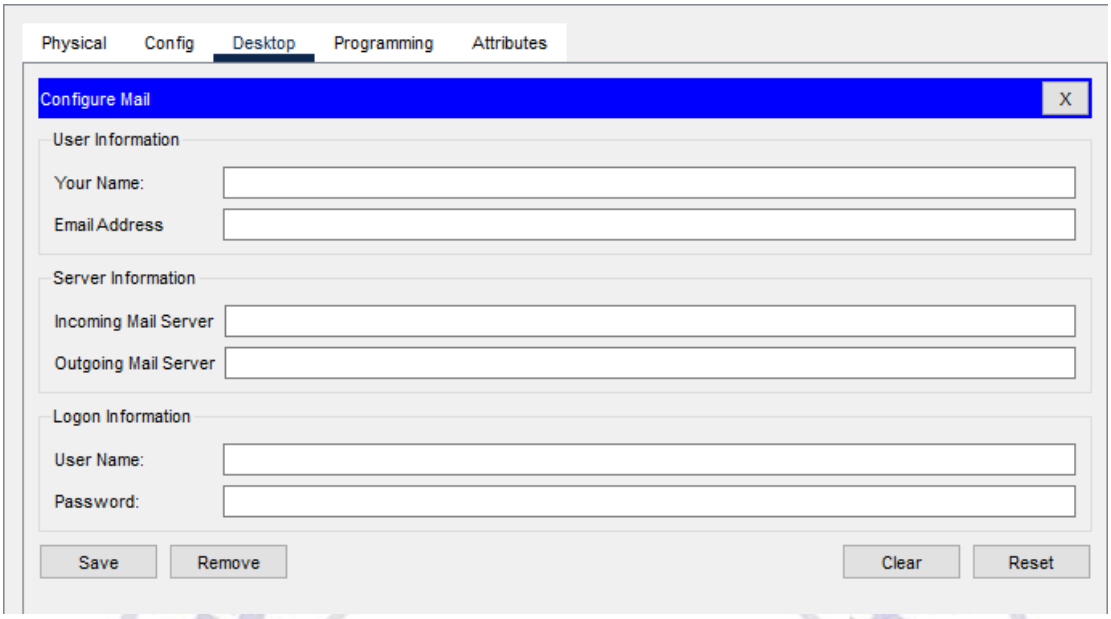


邮箱测试：

配置电子邮件服务器开启 EMAIL 功能，配置域名，注册用户：

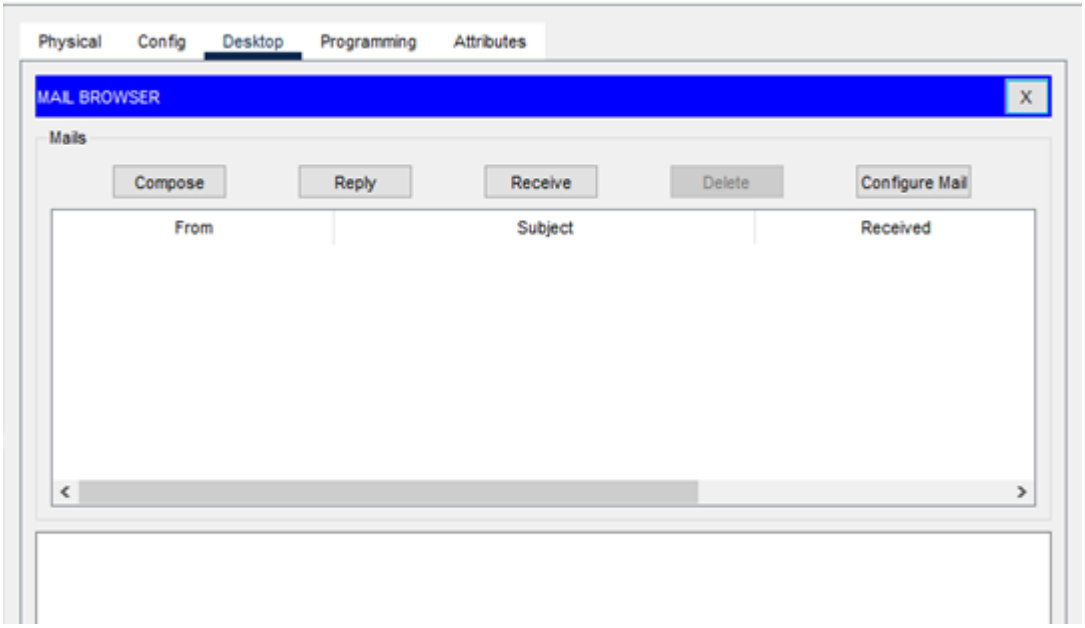


配置用户机的邮件功能：

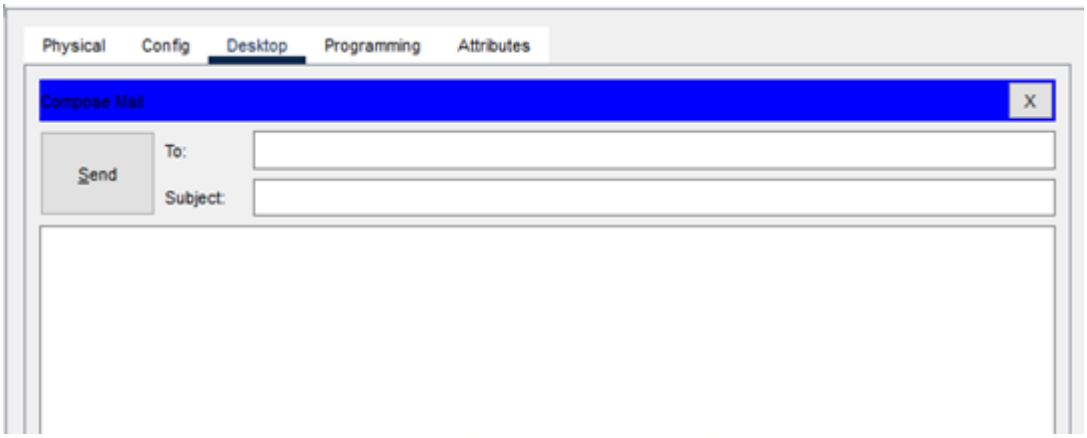


保存用户信息

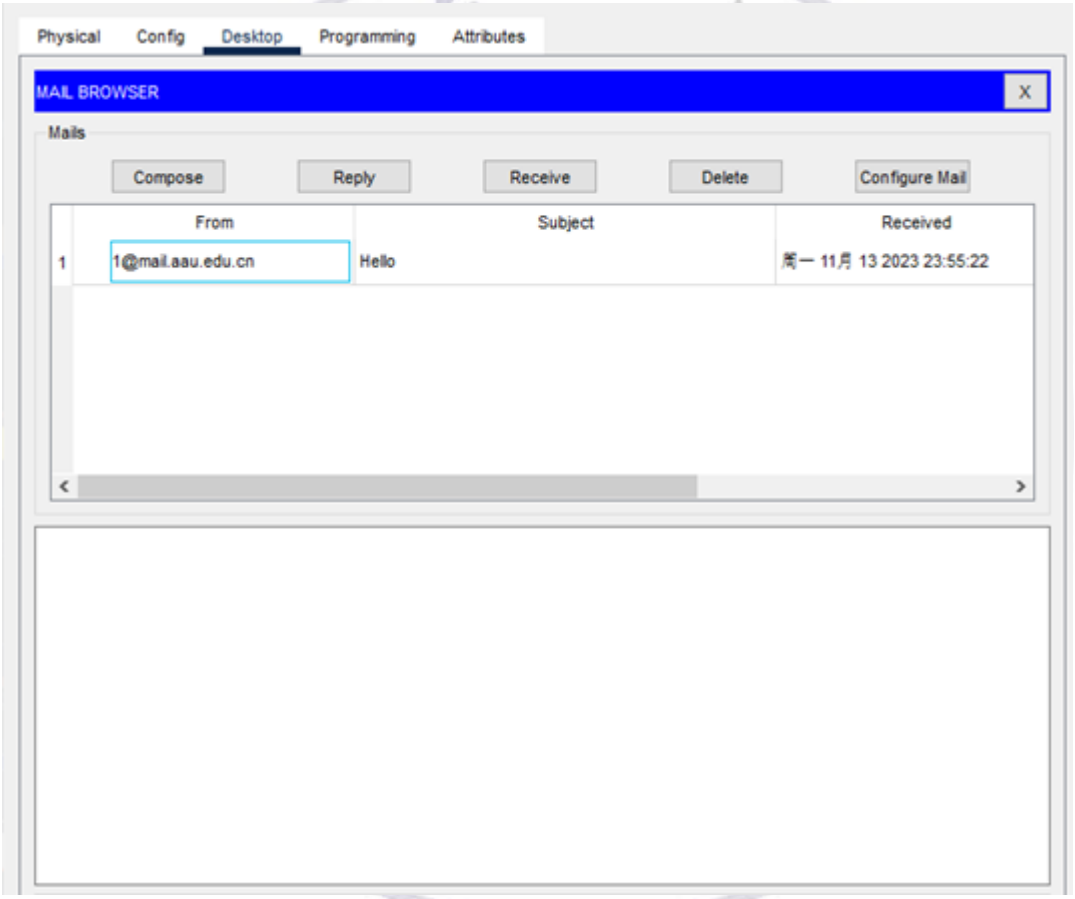
此后会进入如下页面：



发送邮件：



结收邮件：



六、实验总结及体会

通过本次实验，巩固了路由器配置的基本概念和操作步骤，体会到子网划分、VLAN 划分以及路由协议的选择在网络设计中的重要性。合理的子网划分能够优化 IP 地址的使用，并确保网络的高效性；VLAN 划分提高了网络的隔离性和安全性；路由协议则决定了数据流动的路径及其可靠性。VLAN 划分使得物理上连接在同一交换机上的设备可以通过逻辑方式划分到不同的虚拟局域

网中，从而形成独立的广播域。有助于减少广播风暴的影响，提高网络效率。在实验中，根据不同区域划分了多个 VLAN。每个 VLAN 代表一个逻辑分隔的网络，确保了不同功能区域的网络流量互不干扰。

仓库 URL

备份 URL：https://github.com/skyfuryonline/midTermTest/tree/master

七、教师评语