Computer Networks Project

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1 Project Assumptions

- The network is designed to simulate a dormitory environment where students, administrative staff, and security systems require distinct networks, drawing inspiration from the concepts discussed in Lecture 7 - Switching in IOS.
- The design segregates the network into three main VLANs:
  1. **VLAN 100 - Students:** Dedicated to student access.
  2. **VLAN 200 - Administration:** Used by administrative staff.
  3. **VLAN 300 - Security:** Supports security devices.
- The network setup includes the use of static routing, VLAN configurations, DHCP for automatic IP address allocation, and NAT to allow multiple devices to share a single public IP address for Internet access.

2 Network layout

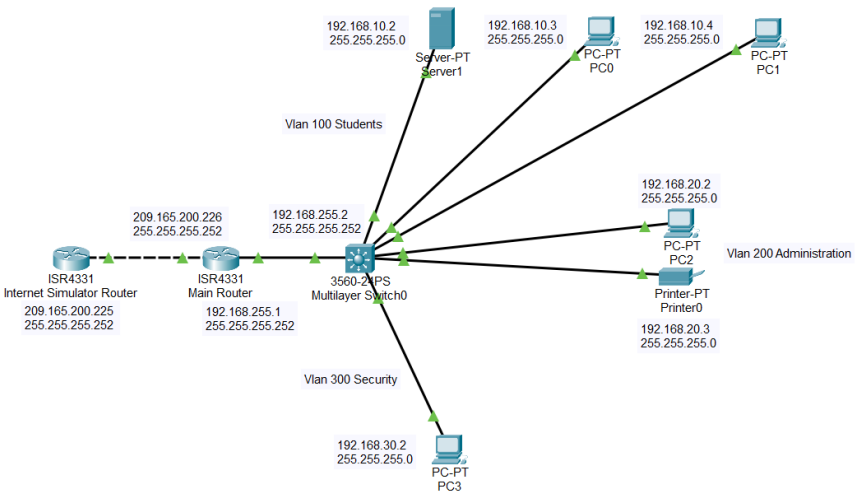

Figure 1: Network layout for the student dormitory

3 Description of Networks Operation

3.1 Internet Simulator Router

The Internet Simulator Router simulates a connection to internet, being part of network 1 of the project (209.165.200.224/30).

3.1.1 Network Connectivity and Configuration

- **Network Interface Configuration:** The Internet Simulator Router is directly connected to the Main Router through a static link.
- **Static Routing:** The Internet Simulator Router is configured with static routes to facilitate specific network operations:
    1. A static route to reach the network segment between the Main Router and the multilayer switch.
    2. Additional static routes that allow for communication with the VLAN network devices.

3.1.2 Internet Simulator Router Operation

To demonstrate the operational capabilities of the Internet Simulator Router, we do a test where the router pings an end device located within one of the VLANs (VLAN 100 - Students).

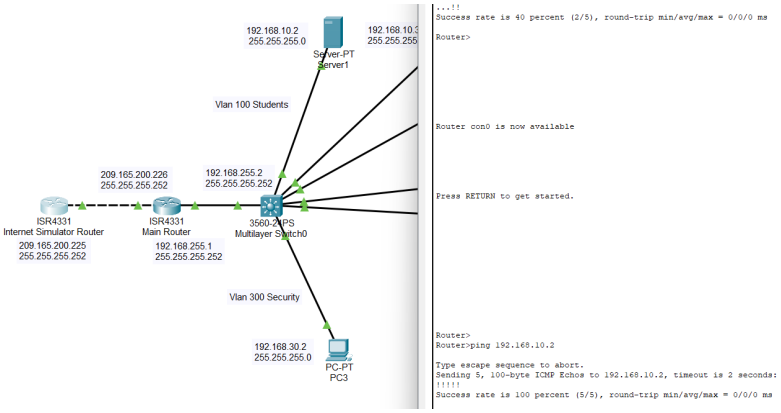

Figure 2: Ping test from the Internet Simulator Router to an end device in VLAN 100 (The Server).

Outcome and NAT Translation: The successful ping test confirms that the routing is correct. Additionally, the NAT process involves translating the internal private IP address of the end device into a public IP address.

```
Router>show ip nat statistics
Total translations: 4 (0 static, 4 dynamic, 4 extended)
Outside Interfaces: GigabitEthernet0/0/0
Inside Interfaces: GigabitEthernet0/0/1
Hits: 4  Misses: 22
Expired translations: 7
Dynamic mappings:
Router>show ip nat translations
Pro  Inside global     Inside local       Outside local      Outside global
icmp 209.165.200.226:1 192.168.10.2:1     209.165.200.225:1  209.165.200.225:1
icmp 209.165.200.226:2 192.168.10.2:2     209.165.200.225:2  209.165.200.225:2
icmp 209.165.200.226:3 192.168.10.2:3     209.165.200.225:3  209.165.200.225:3
icmp 209.165.200.226:4 192.168.10.2:4     209.165.200.225:4  209.165.200.225:4
```

Figure 3: NAT translation during the ping operation observed in Main Router

3.2 Main Router Configuration

The Main Router manages network traffic between the Internet Simulator Router and the internal VLANs configured on the multilayer switch. It also does NAT (Network Address Translation) to facilitate internet access for the devices within the VLANs.

3.2.1 Network Interface Configuration

The Main Router is equipped with two network interfaces:

- **Interface to the Internet Simulator Router:** Configured on the subnet 209.165.200.224/30, this interface is designated as the 'outside' interface for NAT.
- **Interface to the Multilayer Switch:** Configured on the subnet 192.168.255.0/30, this interface connects to the multilayer switch and it is designated as the 'inside' interface for NAT.
- **Routing between interfaces:** Static routes to the multilayer switch network segment and the Internet Simulator Router network.

```
Router>
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface gig 0/0/0
Router(config-if)#ip address 209.165.200.226 255.255.255.252
Router(config-if)#ip nat outside
Router(config-if)#no shutdown

Router(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0/0, changed state to up

Router(config-if)#end
Router#
%SYS-5-CONFIG_I: Configured from console by console
```

Figure 4: Example configuring NAT for outside interface.

3.2.2 NAT Configuration and Access Control

The Main Router is configured with NAT to translate the private IP addresses of internal network devices to a public IP address for internet access. The router uses an access list to control which devices are allowed NAT translation.

```
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#access-list 1 permit 192.168.10.0 0.0.0.255
Router(config)#access-list 1 permit 192.168.20.0 0.0.0.255
Router(config)#access-list 1 permit 192.168.30.0 0.0.0.255
Router(config)#ip nat inside source list 1 interface GigabitEthernet0/0/0 overload
Router(config)#end
```

Figure 5: Configured NAT access list on the Main Router showing permitted IP ranges.

3.3 Multilayer Switch Configuration

The multilayer switch in the student dormitory network segments the network into three separate VLANs and provides dynamic IP configuration through DHCP.

3.3.1 VLAN Configuration

The 3 VLANs:

- **VLAN 100 - Students:** FastEthernet ports 1 to 10.
- **VLAN 200 - Administration:** FastEthernet ports 11 to 20.
- **VLAN 300 - Security:** FastEthernet ports 21 to 24.

```
Switch#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#interface range FastEthernet0/11-20
Switch(config-if-range)#switchport mode access
Switch(config-if-range)#switchport access vlan 200
Switch(config-if-range)#end
Switch#
%SYS-5-CONFIG_I: Configured from console by console
conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#interface range FastEthernet0/20-24
Switch(config-if-range)#switchport mode access
Switch(config-if-range)#switchport access vlan 300
Switch(config-if-range)#end
Switch#
%SYS-5-CONFIG_I: Configured from console by console

Switch#show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Gig0/1, Gig0/2
100  Students                         active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                                Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                                Fa0/9, Fa0/10
200  Administration                   active    Fa0/11, Fa0/12, Fa0/13, Fa0/14
                                                Fa0/15, Fa0/16, Fa0/17, Fa0/18
                                                Fa0/19
300  Security                         active    Fa0/20, Fa0/21, Fa0/22, Fa0/23
                                                Fa0/24
```

Figure 6: VLAN configuration commands on the multilayer switch.

3.3.2 DHCP Configuration

The multilayer switch is also configured to provide DHCP to automatically assign IP addresses to devices in each VLAN.:

```
Router#ip dhcp pool VLAN200
         ^
% Invalid input detected at '^' marker.

Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#ip dhcp pool VLAN200
Router(dhcp-config)#network 192.168.20.0 255.255.255.0
Router(dhcp-config)#default-router 192.168.20.1
Router(dhcp-config)#dns-server 8.8.8.8
Router(dhcp-config)#end
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#ip dhcp pool VLAN300
Router(dhcp-config)#network 192.168.30.0 255.255.255.0
Router(dhcp-config)#default-router 192.168.30.1
Router(dhcp-config)#dns-server 8.8.8.8
Router(dhcp-config)#end
```

Figure 7: DHCP configuration on the multilayer switch.

3.3.3 IP Configuration for VLAN Interfaces

Each VLAN interface on the switch is configured with an IP address to enable inter-VLAN routing and network management:

- **VLAN 100 Interface IP:** 192.168.10.1/24
- **VLAN 200 Interface IP:** 192.168.20.1/24
- **VLAN 300 Interface IP:** 192.168.30.1/24

```
Switch(config-if)#ip address 192.168.20.1 255.255.255.0
Switch(config-if)#no shutdown
Switch(config-if)#end
Switch#
%SYS-5-CONFIG_I: Configured from console by console

Switch#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#interface vlan 300
Switch(config-if)#
%LINK-5-CHANGED: Interface Vlan300, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan300, changed state to up

Switch(config-if)#ip address 192.168.30.1 255.255.255.0
Switch(config-if)#no shutdown
Switch(config-if)#end
```

Figure 8: IP configuration for VLAN interfaces on the multilayer switch.

3.4 End Device Operation

End devices within the dormitory network include PCs, a printer, and a server that provides HTTP services. These devices are configured to dynamically receive IP addresses via DHCP and access web services hosted within the network.

3.4.1 DHCP Configuration for End Devices

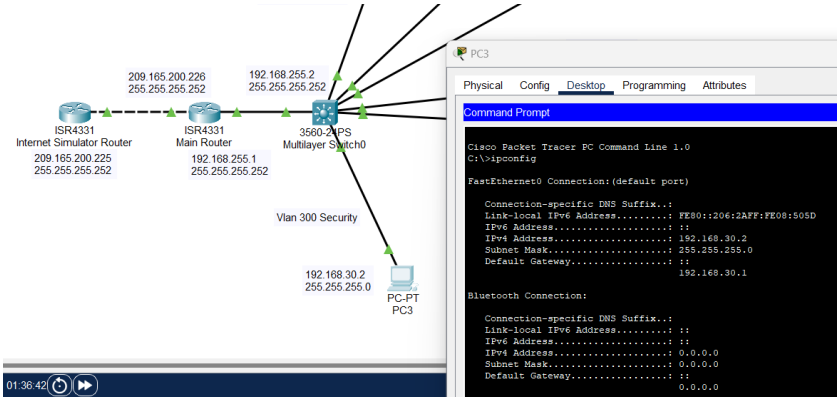

Figure 9: Output of ipconfig of an end device showing IP configuration.

3.4.2 HTTP Service Configuration on the Server

The server within VLAN 100 - Students is configured to provide HTTP services. This server hosts web pages accessible by all devices across the network.

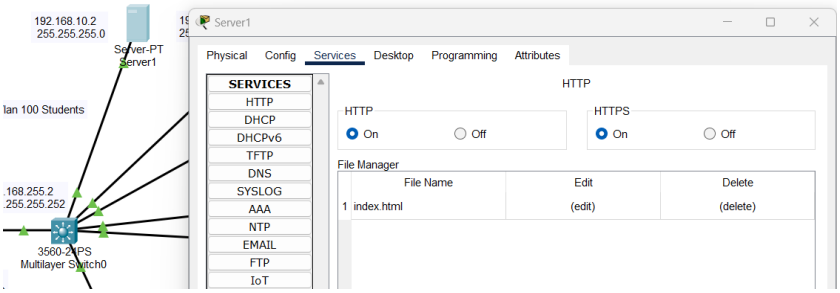

Figure 10: HTTP service configuration on the server.

3.4.3 Accessing HTTP Services from PCs

PCs within the same VLAN (VLAN 100) and other VLANs (e.g., VLAN 200 and VLAN 300) can access the HTTP services hosted on the server. This is done by inter-VLAN routing capabilities of the multilayer switch.

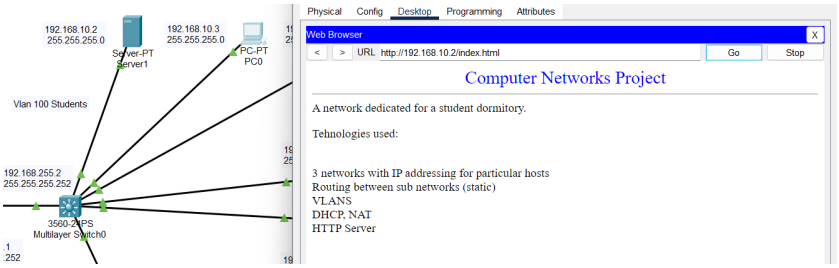

Figure 11: A PC accessing the HTTP service on the server via a web browser.

4 Summary

This project outlines the design and implementation of a segmented network for a student dormitory, featuring separate VLANs for students, administration, and security. The network utilizes DHCP for dynamic IP address allocation and includes a server configured to provide HTTP services. This setup exemplifies a practical application of a student dormitory.