FAST NUCES

Campus Network Simulation

Computer Networks Semester Project

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Objectives

Purpose:

To simulate a scalable, multi-building campus network that provides dynamic IP assignment, VLAN segmentation, NAT for internet access, and inter-building communication using Cisco routers and switches.

Goals:

- Efficient IP allocation with DHCP.
- VLAN-based segmentation for logical group separation.
- NAT configuration for private-to-public address translation.
- Reliable routing between buildings using RIP.

Technologies Used

- **Hardware Simulations**:
  - Cisco Packet Tracer
- **Devices**:
  - Cisco 2911 Routers
  - Cisco 3560 (multilayer) and 2960 Switches
- **Protocols**:
  - DHCP
  - NAT
  - RIP (v2)
- **Subnetting and IP Addressing**: Class C network ranges

Implementation Details

Design and Approach

Hierarchical topology with a main router connecting to:

- Eight VLAN-segments switches for students and staff (denoting multiple departments like CS, AI, DS, etc.).
- A secondary router managing an additional building (denoting Library and LRC).
- A cloud router serving as the internet gateway.

Key configurations

DHCP Configuration

Assigned IP ranges to each VLAN, department, and building.

```
Router#show running-config | section dhcp
ip dhcp pool admin-pool
network 192.168.1.0 255.255.255.0
default-router 192.168.1.1
dns-server 192.168.1.1
ip dhcp pool cs-pool
network 192.168.2.0 255.255.255.0
default-router 192.168.2.1
dns-server 192.168.2.1
ip dhcp pool ds-pool
network 192.168.3.0 255.255.255.0
default-router 192.168.3.1
dns-server 192.168.3.1
ip dhcp pool ai-pool
network 192.168.4.0 255.255.255.0
default-router 192.168.4.1
dns-server 192.168.4.1
ip dhcp pool ee-pool
network 192.168.5.0 255.255.255.0
default-router 192.168.5.1
dns-server 192.168.5.1
ip dhcp pool ce-pool
network 192.168.6.0 255.255.255.0
default-router 192.168.6.1
dns-server 192.168.6.1
ip dhcp pool mgm-pool
network 192.168.7.0 255.255.255.0
default-router 192.168.7.1
dns-server 192.168.7.1
ip dhcp pool it-pool
network 192.168.8.0 255.255.255.0
default-router 192.168.8.1
dns-server 192.168.8.1
```

NAT Configuration

Configured on the main router to enable public-private IP translation.

```
Router(config)# interface GigabitEthernet0/0.10
Router(config-if)# ip nat inside
Router(config-if)# exit
Router(config)# interface GigabitEthernet0/0.20
Router(config-if)# ip nat inside
Router(config-if)# exit

Repeated the same for all the remaining vlan subinterfaces (upto .80)

Router(config)# interface Serial0/1/0
Router(config-if)# ip nat outside
Router(config-if)# exit
Router(config)# ip nat inside source list 1 interface Serial0/1/0 overload
Router(config)# access-list 1 permit 192.168.1.0 0.0.15.255
```

Routing (RIP v2)

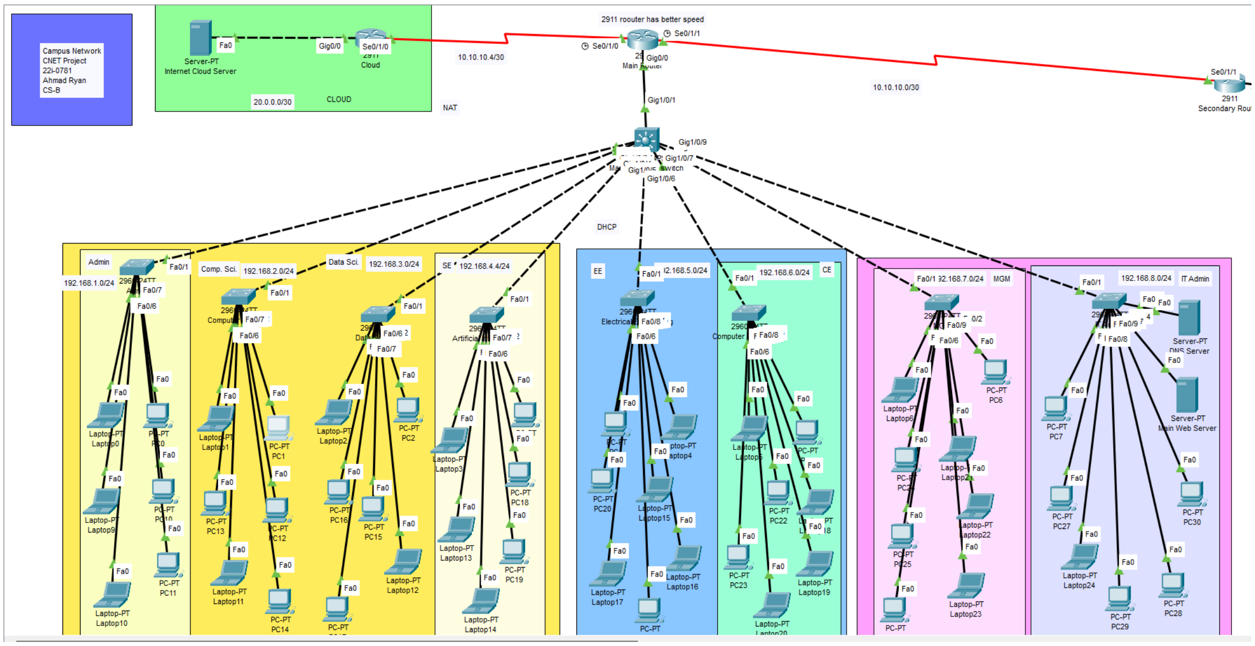
Connected all subnets across routers for seamless inter-building communication.

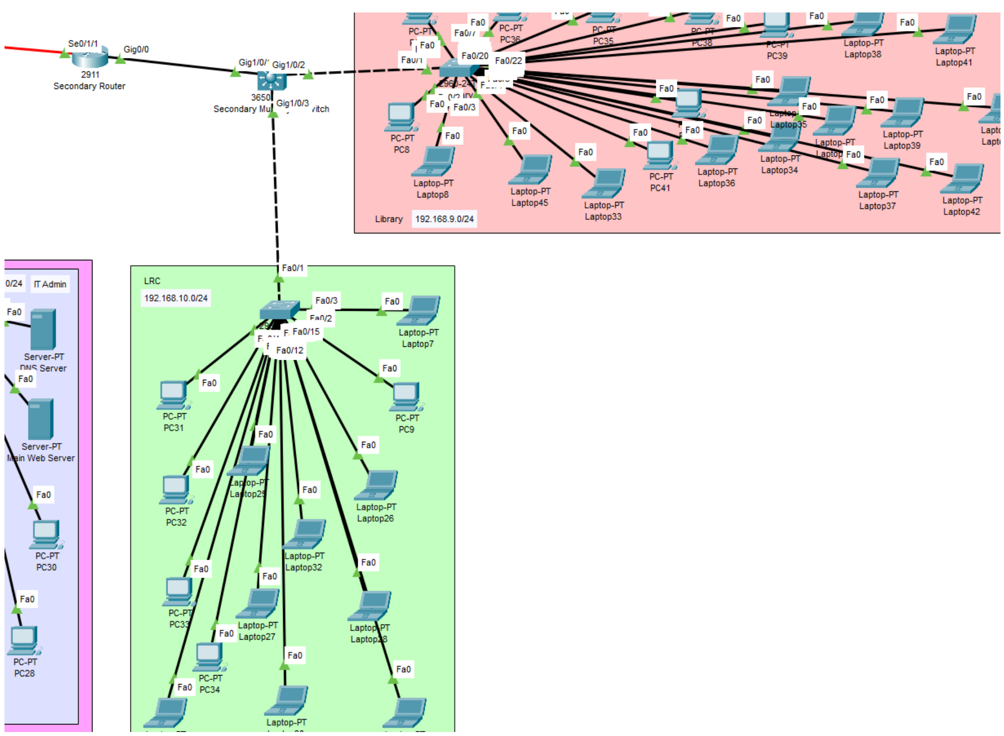
```
Router#show running-config | section router rip
router rip
version 2
network 10.0.0.0
network 192.168.1.0
network 192.168.2.0
network 192.168.3.0
network 192.168.4.0
network 192.168.5.0
network 192.168.6.0
network 192.168.7.0
network 192.168.8.0

Router#show ip route rip
10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
R 20.0.0.0/8 [120/1] via 10.10.10.6, 00:00:19, Serial0/1/0
192.168.8.0/24 is variably subnetted, 2 subnets, 2 masks
R 192.168.9.0/24 [120/1] via 10.10.10.2, 00:00:11, Serial0/1/1
R 192.168.10.0/24 [120/1] via 10.10.10.2, 00:00:11, Serial0/1/1
```

Full IP Configuration

```
Router#show running-config | section router rip
router rip
version 2
network 10.0.0.0
network 192.168.1.0
network 192.168.2.0
network 192.168.3.0
network 192.168.4.0
network 192.168.5.0
network 192.168.6.0
network 192.168.7.0
network 192.168.8.0
Router#show running-config | include ip
ip dhcp pool admin-pool
ip dhcp pool cs-pool
ip dhcp pool ds-pool
ip dhcp pool ai-pool
ip dhcp pool ee-pool
ip dhcp pool ce-pool
ip dhcp pool mgm-pool
ip dhcp pool it-pool
no ip cef
no ipv6 cef
no ip address
ip nat inside
ip address 192.168.1.1 255.255.255.0
ip nat inside
ip address 192.168.2.1 255.255.255.0
ip nat inside
ip address 192.168.3.1 255.255.255.0
ip nat inside
ip address 192.168.4.1 255.255.255.0
ip nat inside
ip address 192.168.5.1 255.255.255.0
ip nat inside
ip address 192.168.6.1 255.255.255.0
ip nat inside
ip address 192.168.7.1 255.255.255.0
ip nat inside
ip address 192.168.8.1 255.255.255.0
ip nat inside
no ip address
no ip address
ip address 10.10.10.5 255.255.255.252
ip nat outside
ip address 10.10.10.1 255.255.255.252
no ip address
router rip
ip nat inside source list 1 interface Serial0/1/0 overload
ip classless
ip flow-export version 9
```

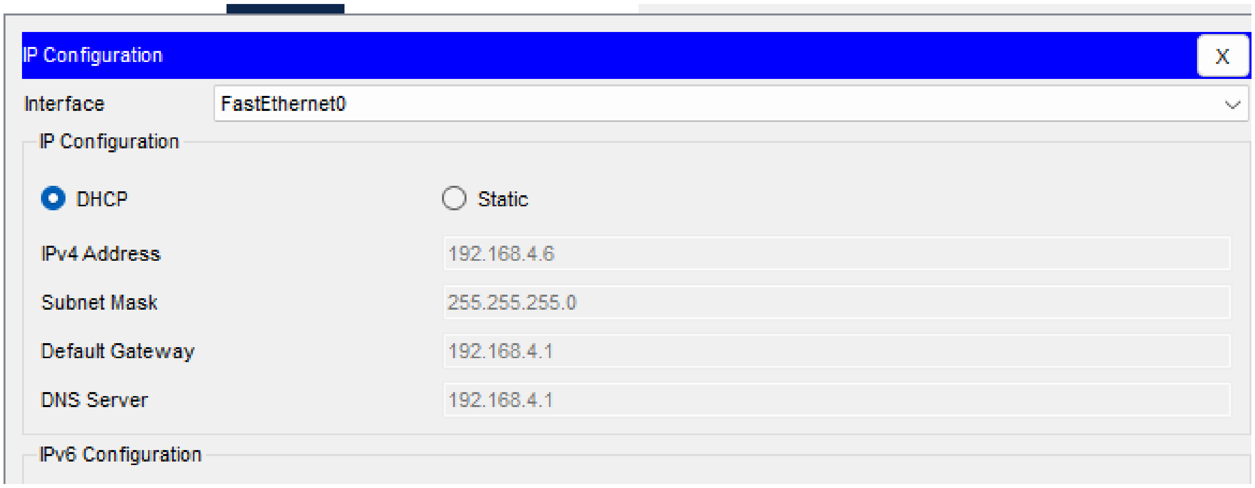
Screenshots





Results and Testing

DHCP Result (AND/OR) Test



VLANs brief

```
Switch>en
Switch#show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Gig1/0/10, Gig1/0/11, Gig1/0/12, Gig1/0/13
                                                Gig1/0/14, Gig1/0/15, Gig1/0/16, Gig1/0/17
                                                Gig1/0/18, Gig1/0/19, Gig1/0/20, Gig1/0/21
                                                Gig1/0/22, Gig1/0/23, Gig1/0/24, Gig1/1/1
                                                Gig1/1/2, Gig1/1/3, Gig1/1/4
10   VLAN0010                         active    Gig1/0/2
20   VLAN0020                         active    Gig1/0/3
30   VLAN0030                         active    Gig1/0/4
40   VLAN0040                         active    Gig1/0/5
50   VLAN0050                         active    Gig1/0/6
60   VLAN0060                         active    Gig1/0/7
70   VLAN0070                         active    Gig1/0/8
80   VLAN0080                         active    Gig1/0/9
1002 fddi-default                     active
1003 token-ring-default               active
1004 fddinet-default                  active
1005 trnet-default                    active
Switch#
```

NAT Table

NAT Table for Main Router

Protocol	Inside Global	Inside Local	Outside Local	Outside Global
icmp	10.10.10.5:1	192.168.5.6:1	20.0.0.2:1	20.0.0.2:1
icmp	10.10.10.5:4	192.168.5.8:4	20.0.0.2:4	20.0.0.2:4
icmp	10.10.10.5:7	192.168.8.4:7	20.0.0.2:7	20.0.0.2:7

Routing Table

Routing Table for Main Router

Type	Network	Port	Next Hop IP	Metric
C	10.10.10.0/30	Serial0/1/1	---	0/0
L	10.10.10.1/32	Serial0/1/1	---	0/0
C	10.10.10.4/30	Serial0/1/0	---	0/0
L	10.10.10.5/32	Serial0/1/0	---	0/0
R	20.0.0.0/8	Serial0/1/0	10.10.10.6	120/1
C	192.168.1.0/24	GigabitEthernet0/0.10	---	0/0
L	192.168.1.1/32	GigabitEthernet0/0.10	---	0/0
C	192.168.2.0/24	GigabitEthernet0/0.20	---	0/0
L	192.168.2.1/32	GigabitEthernet0/0.20	---	0/0
C	192.168.3.0/24	GigabitEthernet0/0.30	---	0/0
L	192.168.3.1/32	GigabitEthernet0/0.30	---	0/0
C	192.168.4.0/24	GigabitEthernet0/0.40	---	0/0
L	192.168.4.1/32	GigabitEthernet0/0.40	---	0/0
C	192.168.5.0/24	GigabitEthernet0/0.50	---	0/0
L	192.168.5.1/32	GigabitEthernet0/0.50	---	0/0
C	192.168.6.0/24	GigabitEthernet0/0.60	---	0/0

Ping Tests

Command Prompt

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.8.4

Pinging 192.168.8.4 with 32 bytes of data:

Reply from 192.168.8.4: bytes=32 time=3ms TTL=127
Reply from 192.168.8.4: bytes=32 time<1ms TTL=127
Reply from 192.168.8.4: bytes=32 time<1ms TTL=127
Reply from 192.168.8.4: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.8.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 3ms, Average = 0ms

C:\>192.168.10.8
Invalid Command.

C:\>ping 192.168.10.8

Pinging 192.168.10.8 with 32 bytes of data:

Request timed out.
Reply from 192.168.10.8: bytes=32 time=15ms TTL=126
Reply from 192.168.10.8: bytes=32 time=30ms TTL=126
Reply from 192.168.10.8: bytes=32 time=14ms TTL=126

Ping statistics for 192.168.10.8:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 14ms, Maximum = 30ms, Average = 19ms

C:\>
```

Challenges and Learnings

Challenges:

- Debugging NAT when translations were not appearing initially.
- Correctly defining access lists for NAT configurations.
- Managing VLAN configurations across multiple switches.

Learnings:

- Understanding the relationship between DHCP and NAT.
- How to troubleshoot router configurations using Cisco commands.
- Subnetting techniques for efficient IP allocation.

Conclusion

The campus network simulation effectively demonstrated the design and implementation of a multi-building network, showcasing core networking concepts such as DHCP for dynamic IP allocation, VLAN segmentation for traffic isolation, RIP for inter-building routing, and NAT for enabling internet access to private subnets.

The successful configuration of these features reflects a robust and scalable network architecture, capable of handling real-world campus scenarios. This project not only solidified foundational networking skills but also provided hands-on experience with troubleshooting and optimizing configurations. Future improvements could include the integration of advanced protocols like OSPF for greater efficiency, adding redundancy for fault tolerance, and implementing security measures such as ACLs to enhance network protection.