



Complex Engineering Problem

Title: Complete Design of a Network for Software House

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Course Title: Computer Networks

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Introduction

Requirements

This lab is about implementing the network of a software company. Requirements are as follows.

The software house consists of 3 building each in a different city

- Corporate building
- Administration building
- Programming Building

Each of the buildings has the following features.

Corporate Building

- The corporate office has 8 offices with each office having a computer, wireless printer and laptop.
- The Mail Server for the office is placed in this building
- **Class A** IP addressing in this building (static IP addressing)

Administration Building

- The administration office has 10 offices with each office having a computer and mobile. The office also has 2 wireless printers.
- This building also has a storage server.
- The web server is placed in this building.
- **Class B** IP addressing in this building (static IP addressing)

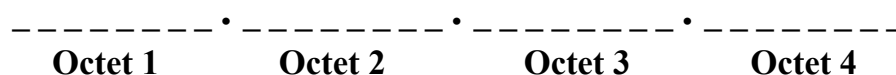
Programming Building

- This building has 30 computers connected to a LAN. (Static IP addressing)
- This building also has 3 wireless access points to connect wireless devices.
- This building also has a storage server, web cache and DHCP server (DHCP services only used for wireless devices).
- **Class C** IP addressing in this building

Classful Addressing

IP address is a unique identity that is provided to every device of the network as it's physical address. Simple analogy for better understanding is that the IP address corresponds to one's home address.

We know that ip addresses have two existing versions. One is IPv4 while the other one is IPv6. We will use and talk about IPv4 addressing. This is a **32 bit** address divided into **four octets**.



To use these octet efficiently and to have a number of IP addresses as per the need we use classful addressing. There are different classes but our concern is class A,B & C.

Class A

How is it distinguished?	First 1 bits of first octet are <u>0</u> * * * * *
Range	0 - 127
No of Networks	126
No of Hosts/network	$2^{24} - 2 = 16777216$
Subnet Mask	255.0.0.0

Class B

How is it distinguished?	First 2 bits of first octet are <u>1 0</u> * * * * *
Range	128 - 191
No of Networks	16384
No of Hosts/network	65534
Subnet Mask	255.255.0.0

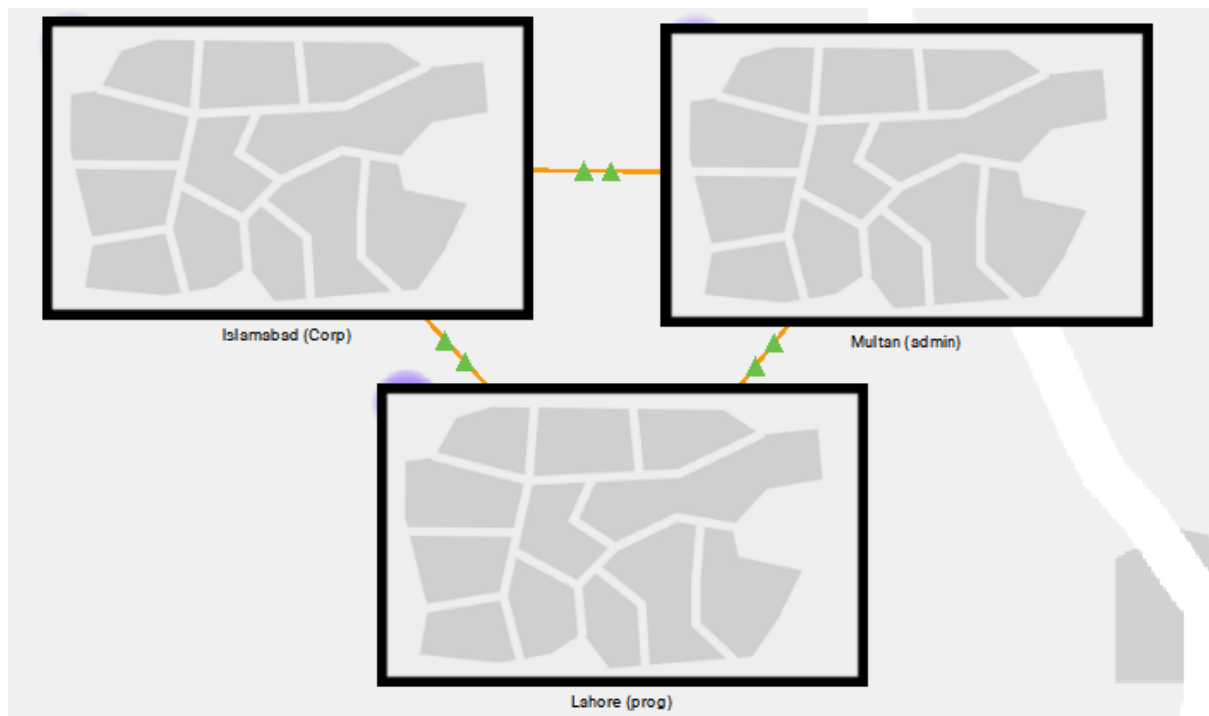
Class C

How is it distinguished?	First 3 bits of first octet are <u>1 1 0</u> * * * *
Range	192 - 223
No of Networks	2097152
No of Hosts/network	256
Subnet Mask	255.255.255.0

What IP network do I have used?

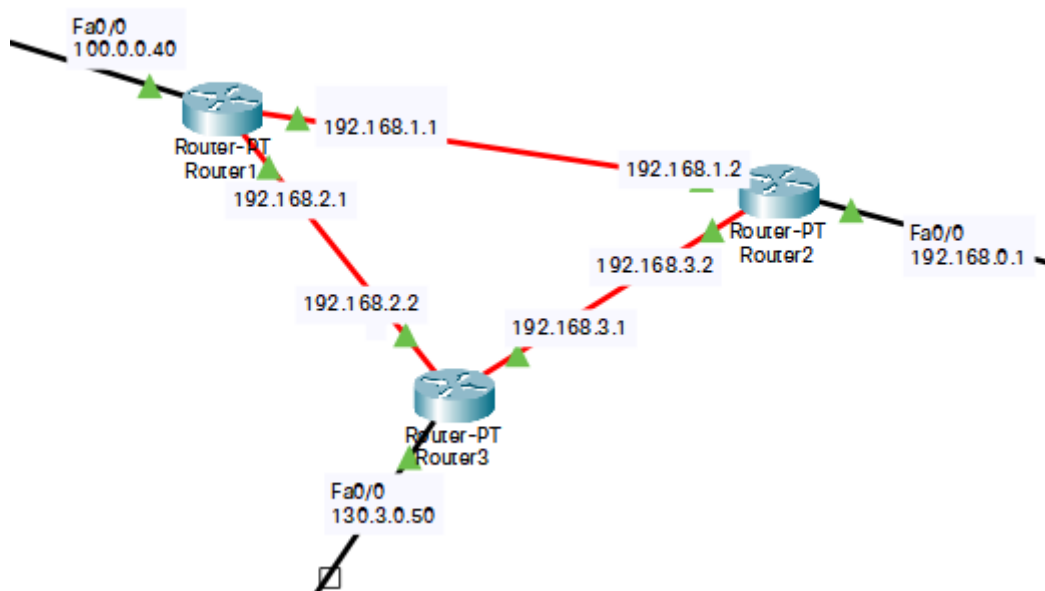
Class A (Corporate Building)	100.*.*.*
Class B (Administration Building)	130.3.*.*
Class C (Programing Building)	192.168.0.*

Whole Network



Routing/Forwarding Tables

Logical View of Connections Between Routers



Router 1

Network Address
192.168.0.0/24 via 192.168.1.2
130.3.0.0/16 via 192.168.2.2

Router 2

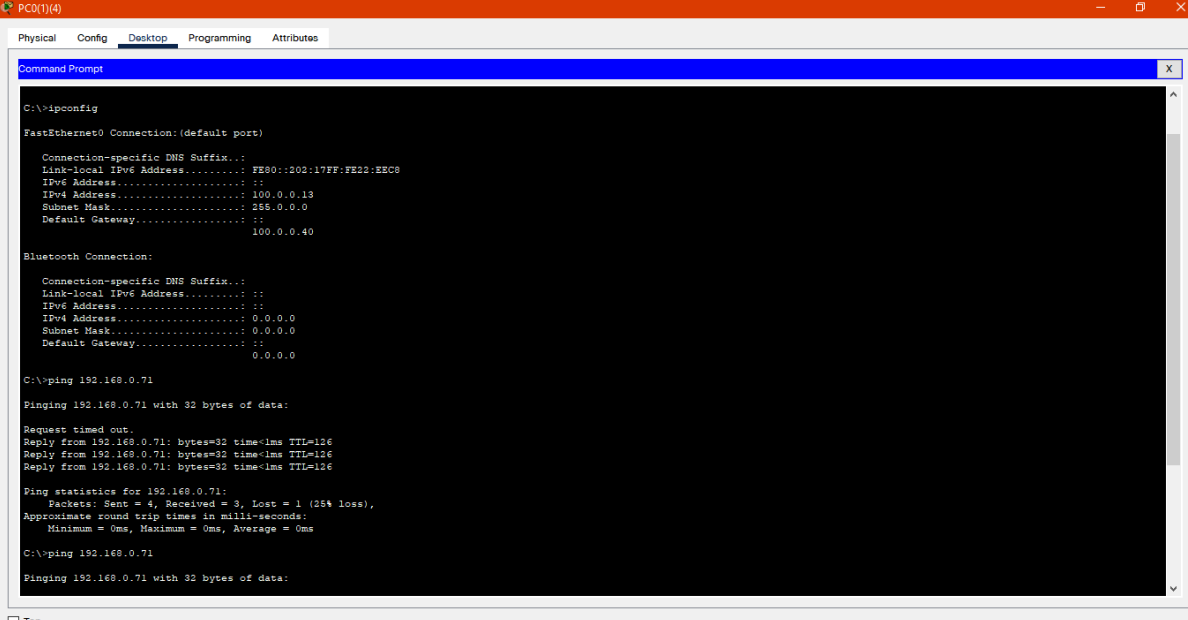
Network Address
100.0.0.0/8 via 192.168.1.1
130.3.0.0/16 via 192.168.3.1

Router 3

Network Address
100.0.0.0/8 via 192.168.2.1
192.168.0.0/16 via 192.168.3.2

Ping Between Different End Devices in Different Cities

Corporate to Programming



The screenshot shows a window titled "PC0(1)(4)" with tabs for Physical, Config, Desktop, Programming, and Attributes. The "Desktop" tab is active, displaying a Command Prompt window. The Command Prompt shows the output of the `ipconfig` command, displaying network configuration for the FastEthernet0 interface. It shows a link-local IPv6 address, an IPv4 address of 100.0.0.13, a subnet mask of 255.0.0.0, and a default gateway of 100.0.0.40. Below this, the output of the `ping 192.168.0.71` command is shown. The ping results indicate a 25% loss of packets, with 3 out of 4 packets received. The approximate round trip times in milliseconds are 0ms, 0ms, and 0ms.

```
C:\>ipconfig

FastEthernet0 Connection: (default port)

    Connection-specific DNS Suffix...: 
    Link-local IPv6 Address . . . . .: FE80::202:17FF:FE22:EEC8
    IPv6 Address . . . . .: ::
    IPv4 Address . . . . .: 100.0.0.13
    Subnet Mask . . . . .: 255.0.0.0
    Default Gateway . . . . .: 100.0.0.40

Bluetooth Connection:

    Connection-specific DNS Suffix...: 
    Link-local IPv6 Address . . . . .: ::
    IPv6 Address . . . . .: ::
    IPv4 Address . . . . .: 0.0.0.0
    Subnet Mask . . . . .: 0.0.0.0
    Default Gateway . . . . .: 0.0.0.0

C:\>ping 192.168.0.71

Pinging 192.168.0.71 with 32 bytes of data:

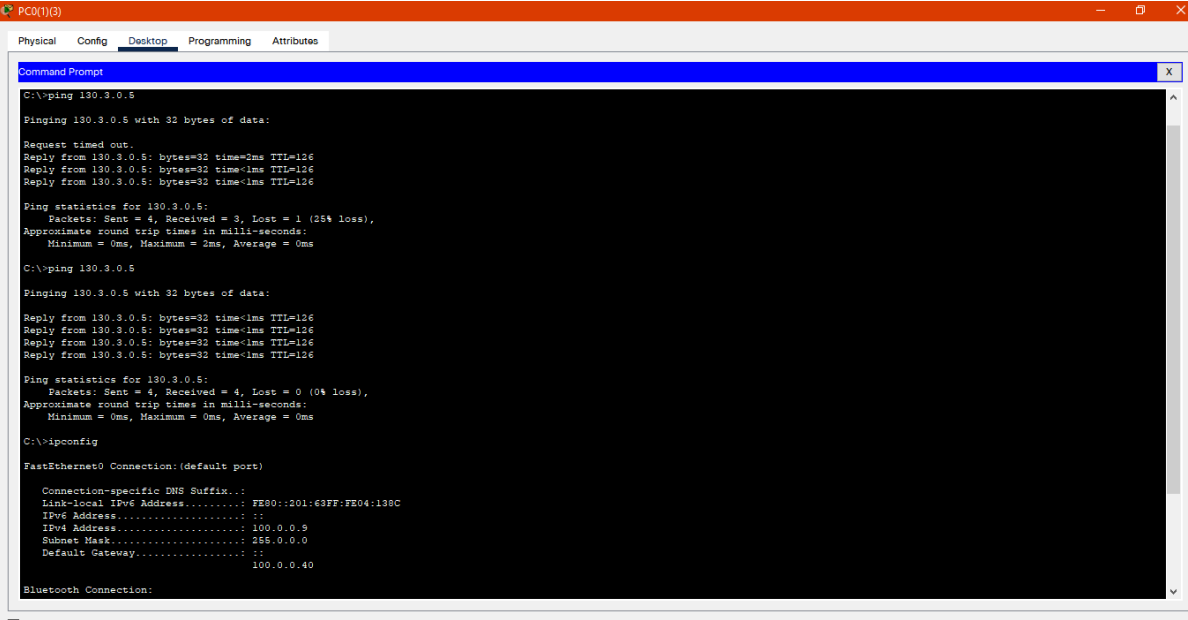
Request timed out.
Reply from 192.168.0.71: bytes=32 time=1ms TTL=126
Reply from 192.168.0.71: bytes=32 time=1ms TTL=126
Reply from 192.168.0.71: bytes=32 time=1ms TTL=126

Ping statistics for 192.168.0.71:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 192.168.0.71

Pinging 192.168.0.71 with 32 bytes of data:
```

Corporate to Administrative



The screenshot shows a window titled "PC0(1)(2)" with tabs for Physical, Config, Desktop, Programming, and Attributes. The "Desktop" tab is active, displaying a Command Prompt window. The Command Prompt shows the output of the `ping 130.3.0.5` command. The ping results indicate a 25% loss of packets, with 3 out of 4 packets received. The approximate round trip times in milliseconds are 0ms, 2ms, and 0ms. Below this, the output of the `ipconfig` command is shown, displaying network configuration for the FastEthernet0 interface. It shows a link-local IPv6 address, an IPv4 address of 100.0.0.9, a subnet mask of 255.0.0.0, and a default gateway of 100.0.0.40.

```
C:\>ping 130.3.0.5

Pinging 130.3.0.5 with 32 bytes of data:

Request timed out.
Reply from 130.3.0.5: bytes=32 time=2ms TTL=126
Reply from 130.3.0.5: bytes=32 time=1ms TTL=126
Reply from 130.3.0.5: bytes=32 time=1ms TTL=126

Ping statistics for 130.3.0.5:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 2ms, Average = 0ms

C:\>ping 130.3.0.5

Pinging 130.3.0.5 with 32 bytes of data:

Reply from 130.3.0.5: bytes=32 time=1ms TTL=126
Reply from 130.3.0.5: bytes=32 time=1ms TTL=126
Reply from 130.3.0.5: bytes=32 time=1ms TTL=126
Reply from 130.3.0.5: bytes=32 time=1ms TTL=126

Ping statistics for 130.3.0.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

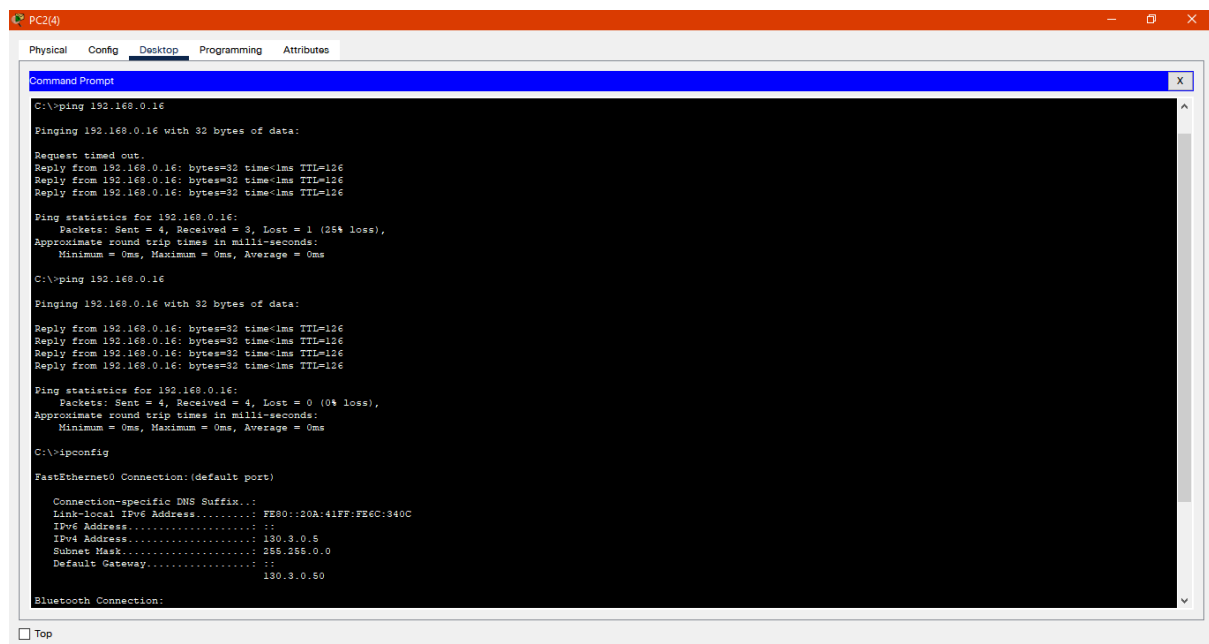
C:\>ipconfig

FastEthernet0 Connection: (default port)

    Connection-specific DNS Suffix...: 
    Link-local IPv6 Address . . . . .: FE80::201:63FF:FE04:130C
    IPv6 Address . . . . .: ::
    IPv4 Address . . . . .: 100.0.0.9
    Subnet Mask . . . . .: 255.0.0.0
    Default Gateway . . . . .: 100.0.0.40

Bluetooth Connection:
```

Administrative to Programing



```
C:\>ping 192.168.0.16

Pinging 192.168.0.16 with 32 bytes of data:

Request timed out.
Reply from 192.168.0.16: bytes=32 time<1ms TTL=126
Reply from 192.168.0.16: bytes=32 time<1ms TTL=126
Reply from 192.168.0.16: bytes=32 time<1ms TTL=126

Ping statistics for 192.168.0.16:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 192.168.0.16

Pinging 192.168.0.16 with 32 bytes of data:

Reply from 192.168.0.16: bytes=32 time<1ms TTL=126
Reply from 192.168.0.16: bytes=32 time<1ms TTL=126
Reply from 192.168.0.16: bytes=32 time<1ms TTL=126
Reply from 192.168.0.16: bytes=32 time<1ms TTL=126

Ping statistics for 192.168.0.16:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ipconfig

FastEthernet0 Connection: (default port)

    Connection-specific DNS Suffix...:
    Link-local IPv6 Address . . . . .: FE80::20A:41FF:FE6C:340C
    IPv6 Address. . . . .: ::
    IPv4 Address. . . . .: 130.3.0.5
    Subnet Mask . . . . .: 255.255.0.0
    Default Gateway . . . . .: ::
                                   130.3.0.50

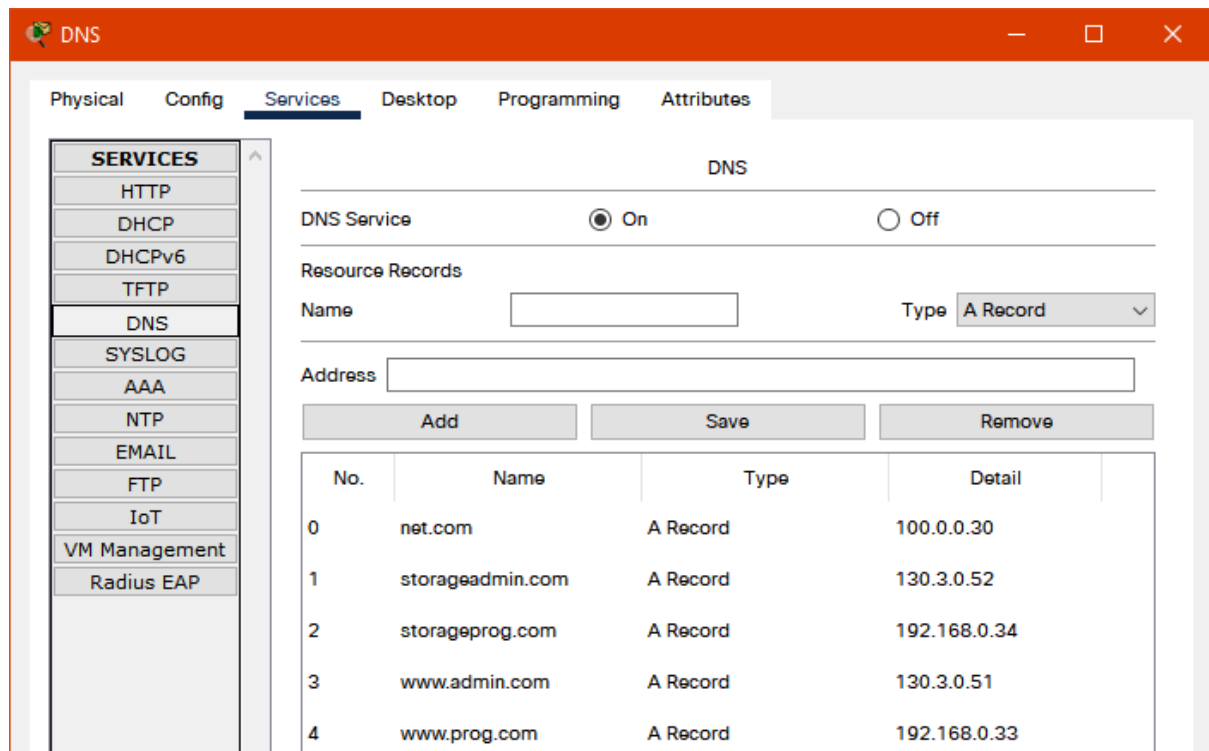
Bluetooth Connection:
```

Successful Email

We have an email server placed in the other city. For that we have established a successful router to router connections. For email we would use a DNS server so we can email easily.

Setting up the DNS

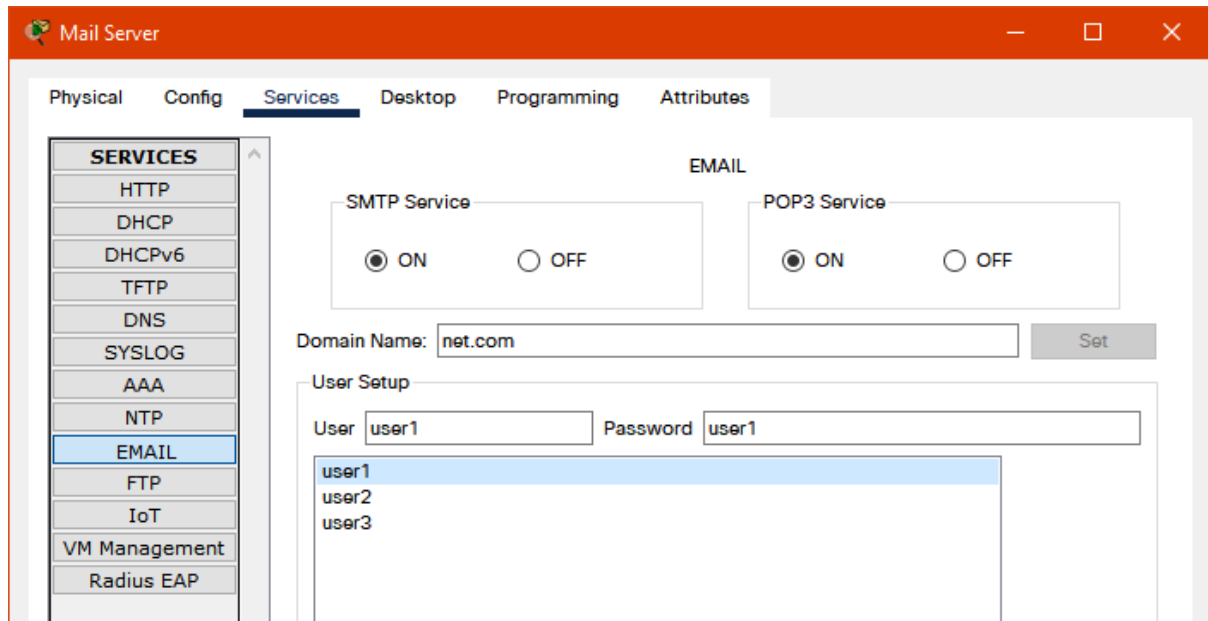
DNS is placed in Administrative Building having an IP address **130.3.0.55**



The screenshot shows the DNS configuration interface. On the left, a sidebar lists various services: HTTP, DHCP, DHCPv6, TFTP, DNS (selected), SYSLOG, AAA, NTP, EMAIL, FTP, IoT, VM Management, and Radius EAP. The main area is titled 'DNS' and shows the 'DNS Service' is turned 'On'. Below this, there is a 'Resource Records' section with a 'Name' field, a 'Type' dropdown set to 'A Record', and an 'Address' field. At the bottom, there is a table of configured records.

No.	Name	Type	Detail
0	net.com	A Record	100.0.0.30
1	storageadmin.com	A Record	130.3.0.52
2	storageprog.com	A Record	192.168.0.34
3	www.admin.com	A Record	130.3.0.51
4	www.prog.com	A Record	192.168.0.33

Setting up the Mail Server

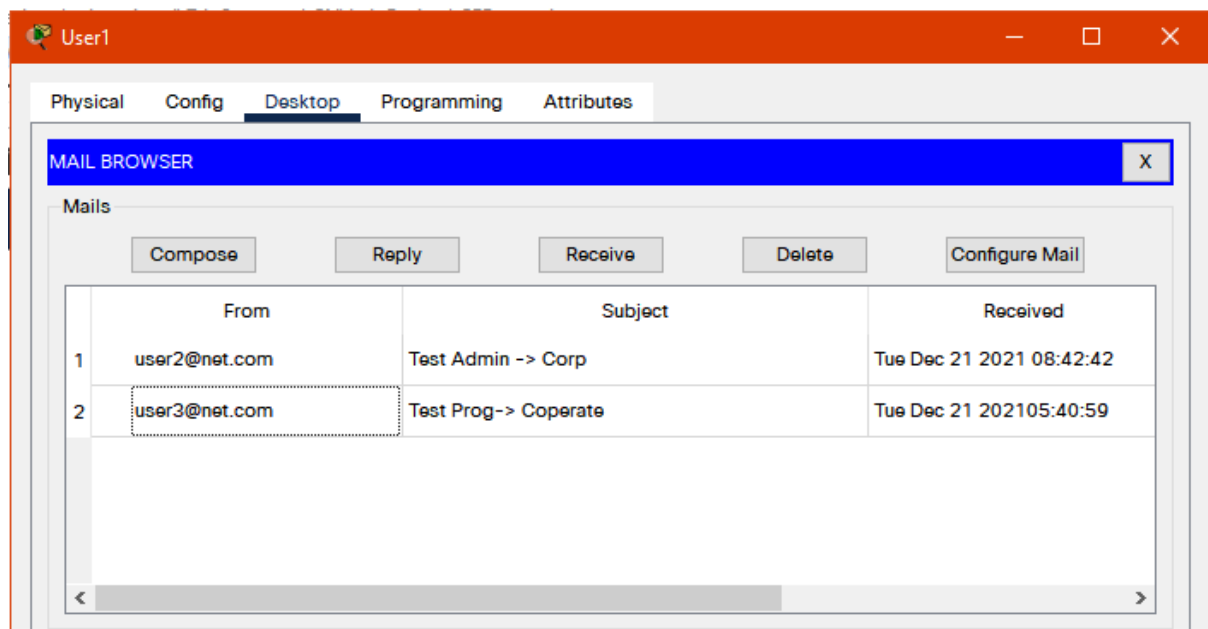


User1 is in Corporate Building

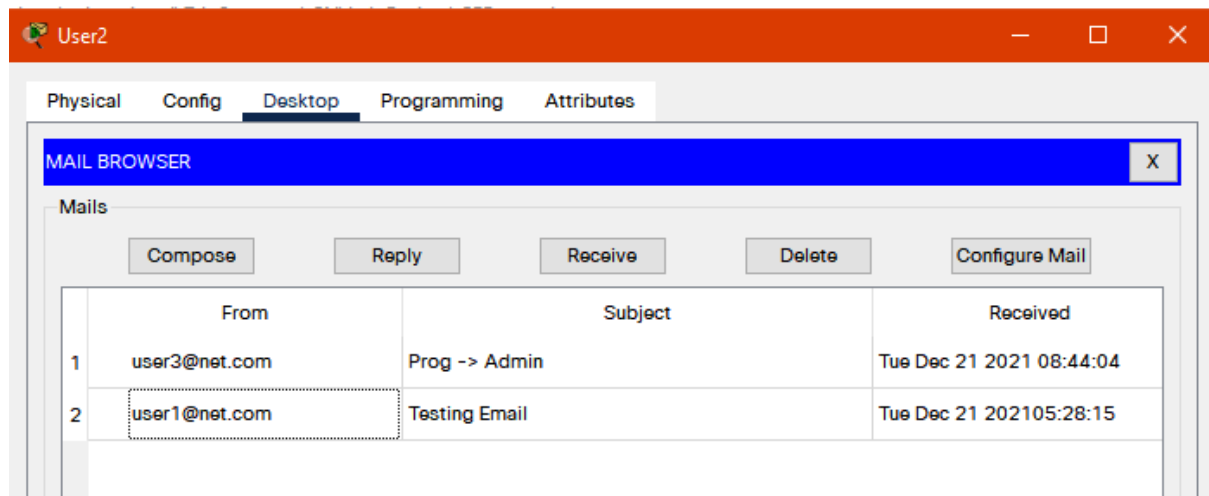
User2 is in Administrative Building

User3 is in Programming Building

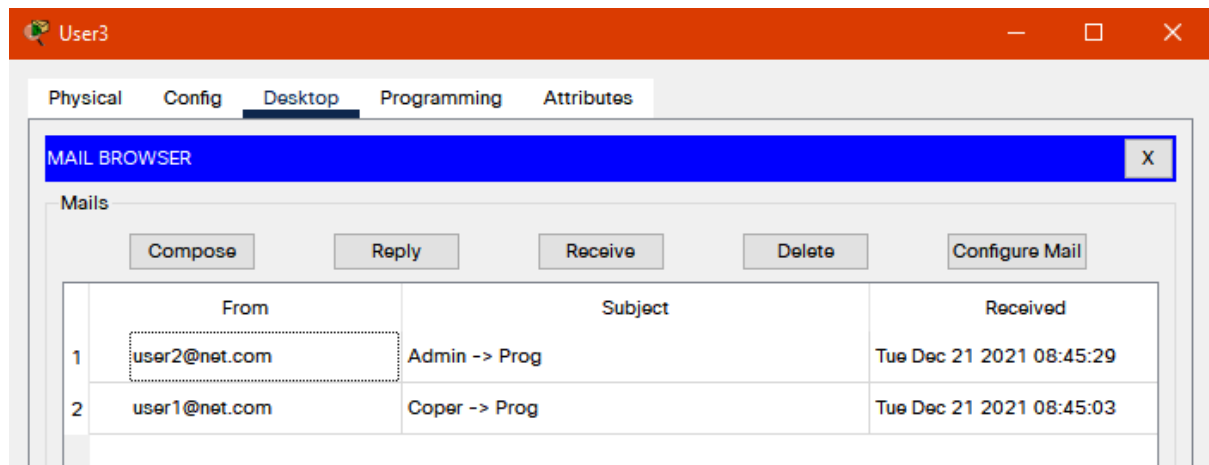
Inbox of User1



Inbox of User2



Inbox of User3






Successful ISMP

User1 is in Corporate Building

User2 is in Administrative Building

User3 is in Programming Building

Fire	Last Status	Source	Destination	Type
	Successful	User1	User2	ICMP
	Successful	User1	User3	ICMP
	Successful	User3	User2	ICMP

Successful FTP

Setting up the FTP

FTP

Service ☒ On ☐ Off

User Setup

Username Password

☐ Write ☐ Read ☐ Delete ☐ Rename ☐ List

	Username	Password	Permission
1	cisco	cisco	RWDNL
2	user1	user1	RWDNL
3	user2	user2	RWDNL
4	user3	user3	RWDNL

From User1 accessing 130.3.0.52

```
C:\>ftp 130.3.0.52
Trying to connect...130.3.0.52
Connected to 130.3.0.52
220- Welcome to PT Ftp server
Username:user1
331- Username ok, need password
Password:
230- Logged in
(passive mode On)
```

From User2 accessing 192.168.0.33

```
C:\>ftp 192.168.0.33
Trying to connect...192.168.0.33
Connected to 192.168.0.33
220- Welcome to PT Ftp server
Username:cisco
331- Username ok, need password
Password:
230- Logged in
(passive mode On)
```

Potential Point of Weakness

Assigning IPs manually

Assigning IPs manually isn't a feasible and convenient task.

Misuse of Class A, B & C Addressing

Class A can have **16777216** number of users/network, and **Class B** can have **65534** number of users/network. While they have been used in office buildings. Office Buildings would not have that number of users. So there is a waste of a huge number of IPs.

On the other hand, **Class C** is used in the building in which there are 30 computers with 3 access points. The presence of access points tells that there could be multiple users while Class C can facilitate **256** users/network only. So we could face a deficiency of IP addresses.

Estimated Cost

Device Name	Quantity	Model	Price/Piece	Total (PKR)
Router	3	ISR 900	44000	132000
Switches	7	C 2960	36540	255780
Access Points	5		30000	150000
Servers	3	APIC-SERVER-M1-RF	1545000	4635000
Total Price (PKR)				5172780

Device Name	Links
Router	https://www.router-switch.com/cisco-900-routers-price.html
Switches	https://www.router-switch.com/ws-c2960-24tt-l-p-429.html
Access Points	https://www.mbcommunication.com.pk/101-wireless-access-point
Servers	https://itprice.com/cisco-gpl/server-%20pt

Suggestions

Use of IP addresses

It would be good if we use Class C in offices that have fixed end devices and no access points. Class B could be used in the buildings with access points.

Use of DHCP

Instead of manually assigning the IP addresses, DHCP should be used.