2nd Year BSc (Hons) Cyber Security, 2025-26

Network Design Report for Frederick’s Warehouse

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Contents

Abstract

This report manifests the design and implementation of a network for Frederick's Warehouse in London and Manchester. Four offices and a factory workshop were linked through WAN on Cisco Packet Tracer as a simulation using RIPv2, DHCP, SSH, VLAN, CIDR. Tests confirmed successful inter-site communication

Introduction

As the network architect for Frederick's Warehouse which is a newly established warehousing solutions provider company, this report is generated to discuss the design for the network infrastructure for 4 offices (2 per city) across London and Manchester that the company has decided to open in these two cities. The management wants to set up 50 desks (including a factory workshop available on the site of one of the Manchester offices), showcasing both wired and wireless connectivity across the city to exchange data.

This report will discuss about the initiative undertook to design a network plan with justification to clarify certain scenarios along with areas of improvement required by this design.

This report also contains information on configuration of relevant devices and tests carried out to ensure proper connectivity is being met for all the devices on each desk. For designing this infrastructure, Cisco Packet Tracer has been leveraged.

Aim and objectives

The aim is to design a medium level WAN for Frederick's Warehouse across both the cities. The following needs were to be met when designing the network:

1. Figure of the entire layout of the network plan showing all the networking devices.
2. Password and SSH configuration details.
3. CIDR IP addressing scheme.
4. Implementation of network protocols and configuring them on the networking devices according to the layers of the TCP/IP, OSI Model such as RIP, VLAN, DHCP
5. Connectivity tests carried out on at least two routers and two PCs in different cities communicating.

Network Design

This section covers the network design. The devices that are taken into consideration to implement a WAN across both the cities are:

1. PCs for ensuring that wired devices are there on the networks when employees will work on-site.
2. Switches for ensuring to interconnect computers or devices on a network and filtering and forwarding data packets only to on or more devices for which the packet is intended across a network. (Arora, 2023)
3. Access Points have been used which are devices enabling wireless devices to connect to a wired network. They eliminate the need for physical cables, offering flexibility and convenience. (Cisco, n.d.)
4. Servers to store up data and provide DHCP services by creating a DHCP pool for easy IP addressing instead of relying on static IP configuration.
5. Laptops to justify that wireless connectivity can take place on a network like this
6. Routers to act as the default gateway which connects dissimilar networks. (Arora, 2023)

Per office, 8 PCs on desks and 2 laptops have been assigned to make up the approx. 10 open plan office cubicles (20 desks in both the cities) which can justify the overall requirement that offices require both wired and wireless connectivity. For the factory,10 laptops in place have been set up in addition to the Manchester Office A's desk side to fulfil the requirement that the workshop only requires wireless connectivity.

There are 4 switches i.e. 1 switch per office powering up the interconnectivity on the network. Decision was made to take the 2960 24TT IOS15 Cisco Switch because this switch has got multiple Fast and Gigabit Ethernet ports so multiple devices can be connected. Along with that, this switch is designed specifically for medium-sized businesses. (Cisco, 2009) Copper straight through wires is used to connect the devices like PCs to switches, APs to switches and switches to routers because copper straight through wire have the amazing feature of connecting different devices together.

The router used is the 2811 IOS15 Cisco Router which is considered a good choice for businesses and organizations looking for a reliable and versatile router. Routers are basically gateways and they provide the medium to connect different LANs to the WAN (in our case the Manchester and London office). There are 2 routers that are used (1 per city) instead of using 4 per city because in this scenario centralized routing algorithm can prove out to be better than a distributed routing algorithm. Inside an office, switches and access points handle the LAN. Offices aren't separate networks that need routing because Routers separate networks, not desks. Four routers would mean extra subnets, extra routing which would allow more room for mistakes and more interfaces to configure and more subnets to plan.

All the offices along with the factory workshop have been provided with an access point to provide wireless connectivity for the laptops. Access points are generally recommended over wireless routers because it is mostly used in large enterprises which have big offices and buildings and it covers more laptops, computers and smartphones. Access points can be placed where the signal is poor. (Geeks, 2025) Access points have been connected to the switch via copper straight through wire in all the offices. There is an extra AP in Manchester Office A which is used for connecting the wireless laptops used as a device to control the machinery in the workshop.

Placed 1 server per city (i.e. 2 servers in total) to provide a more sustainable and cheaper solution to the organization in storing and managing large amounts of data.

Following is the design of the network created on Cisco Packet Tracer:

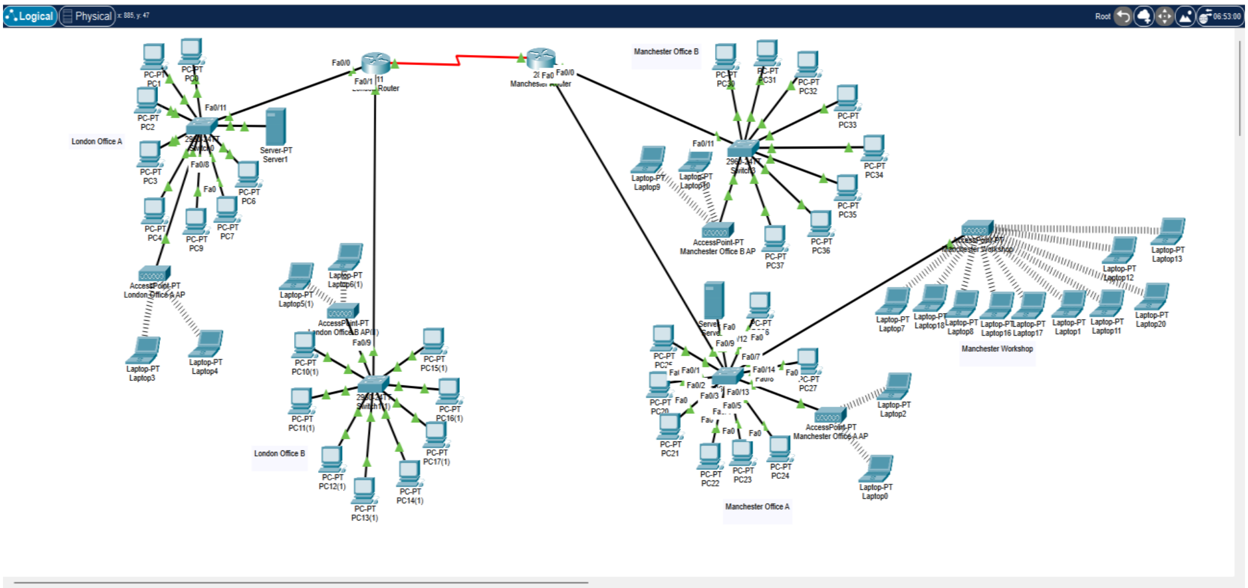


Figure 1: Network Design consisting of London and Manchester Offices A and B along with PCs, servers, laptops, routers and APs

Network Configuration and Connectivity Tests

This section talks about the processes undertaken to configure to get all the devices on the network talking to each other. The following things, as discussed above, were taken into consideration in setting up the entire network:

1. Classless Inter-Domain Routing (CIDR) IP addressing scheme
2. Password and Secure Shell (SSH) configuration
3. Routing Information Protocol (RIP)
4. Dynamic Host Configuration Protocol (DHCP)
5. Virtual Local Area Network (VLAN)
6. Connectivity testing demonstrating at least 2 routers and 2 PCs in different cities communicating as well as verification of RIP, DHCP and VLAN

CIDR IP addressing scheme

The following IP addressing was considered after calculating how many IP addresses can be assigned based on the subnet masking:

Network	Medium used	IP addressing
London Office A	Fast Ethernet	192.168.10.x/24
London Office B	Fast Ethernet	192.168.20.x/24

Manchester Office A	Fast Ethernet	192.168.30.x/24
Manchester Office B	Fast Ethernet	192.168.40.x/24
Factory Workshop	Fast Ethernet	192.168.30.x/24
Routers	Serial Interface	192.168.100.x/30

For the workshop, the IP addressing was chosen as similar to the Manchester Office A because both the facilities connect to the same Manchester Office A switch. In addition to that, cost of setting up the infrastructure and cabling was considered because this reduces the installation costs. Since the workshop is at the same geographical proximity and is a factory for a warehousing company, it felt convenient to keep it because shared subnet can produce single configuration change which can update both the office and factory workshop whenever operational needs are changed. This would also allow for simplicity rather than requiring updates across the RIP, multiple VLANs and a separate DHCP which would create a havoc.

In addition to that, a different subnetting was provided for the routers because if all offices shared the same subnet, the router would have no purpose of being leveraged as a gateway for inter-office communication.

Password and Secure Shell (SSH)

Password has been enabled on all the routers and switches. For the routers, the line console password consisting of vty, console, and aux was implemented along with secret password. For switches, secret passwords were enabled for all the offices. This was done to ensure port security was enabled wherever applicable to enhance security management.

```
Password:
Password:

RouterLon> enable
Password:
RouterLon#
```

Figure 2: Password for London Router

```
Password:
Password:

RouterMan> enable
Password:
RouterMan#
```

Figure 3: Password for Manchester Router

In addition to that, SSH (Secure Shell (SSH) protocol is a method for securely sending commands to a computer over an unsecured network. SSH uses cryptography to authenticate and encrypt connections between devices.) (Cloudflare, n.d.) was configured on routers for secure management since centralised management through the routers was sufficient for this scale and matched the organization’s requirements as stated out. Following screenshots prove the test to verify SSH:

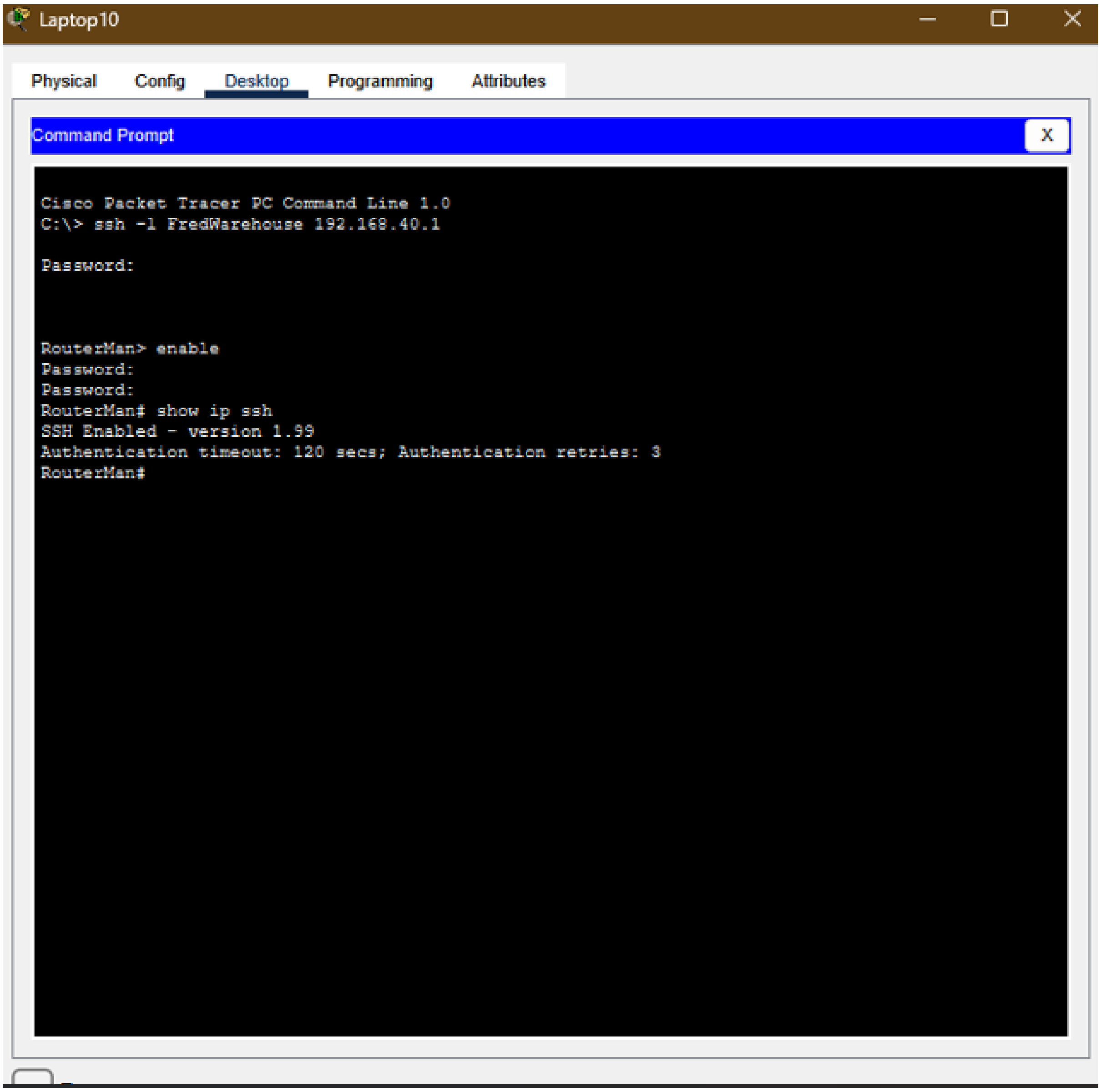


Figure 4: SSH configured on Manchester Router, successfully tested

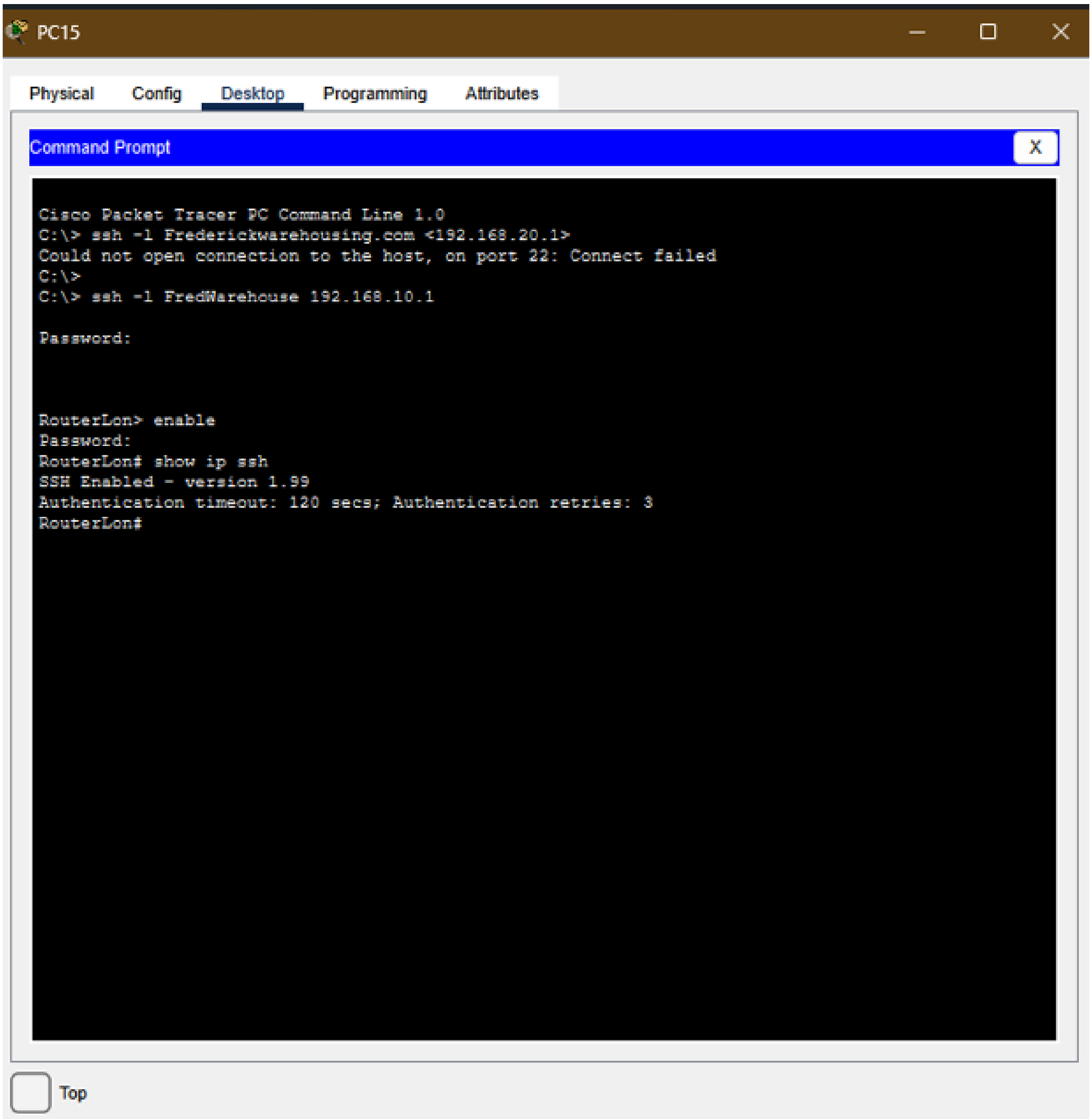


Figure 5: SSH configured on London Router, successfully tested

```
RouterLon> enable
RouterLon#config t
Enter configuration commands, one per line.  End with CNTL/Z.
RouterLon(config)#ip domain-name Frederick Warehousing.com
                                           ^
% Invalid input detected at '^' marker.

RouterLon(config)#ip domain-name Frederickwarehousing.com
RouterLon(config)# crypto key generate rsa
The name for the keys will be: RouterLon.Frederickwarehousing.com
Choose the size of the key modulus in the range of 360 to 4096 for your
  General Purpose Keys. Choosing a key modulus greater than 512 may take
  a few minutes.

How many bits in the modulus [512]: 2048
% Generating 2048 bit RSA keys, keys will be non-exportable...[OK]

RouterLon(config)# username FredWarehouse password NetworkLondon@_26
*Mar 1 8:35:28.474: %SSH-5-ENABLED: SSH 1.99 has been enabled
RouterLon(config)#
```

Figure 6: Implementation of SSH for London Router

```
RouterMan> enable
RouterMan# config t
Enter configuration commands, one per line.  End with CNTL/Z.
RouterMan(config)# enable secret NetworkManchester@26
RouterMan(config)# ip domain-name Frederickwarehousing.com
RouterMan(config)# crypto key generate rsa
The name for the keys will be: RouterMan.Frederickwarehousing.com
Choose the size of the key modulus in the range of 360 to 4096 for your
  General Purpose Keys. Choosing a key modulus greater than 512 may take
  a few minutes.

How many bits in the modulus [512]: 2048
% Generating 2048 bit RSA keys, keys will be non-exportable...[OK]

RouterMan(config)# username FredWarehouse privilege 15 secret NetworkManchester@_26
*Mar 1 9:3:43.392: %SSH-5-ENABLED: SSH 1.99 has been enabled
RouterMan(config)#
```
Figure 7: Implementation of SSH for Manchester Router

SSH is chosen over Telnet because in Telnet, data is transmitted in plain text, making it vulnerable to eavesdropping and man-in-the-middle attacks, hence SSH was chosen for the same. This will allow the data for Frederick's Warehouse to be secure under encryption and maintain efficiency. This also allows secure remote access which will enable the IT department to manage the routers remotely allowing scalability.

Routing Information Protocol (RIP)

The Routing Information Protocol (RIP) is designed to help routers determine the best path for sending data packets across a network. It uses hop count as its routing metric and is primarily used in small to medium-sized networks due to its scalability limitations. (Geeks, 2026) In this network design, RIP has been implemented instead of other routing protocols like OSPF because this is within the scope of requirements that the organization has posed. RIPv2 in this case was selected over static routing to avoid repetitive manual entries, support expansion, support classless addressing, making it suitable for the CIDR scheme.

Router for London has been chosen to carry out the DCE serial link clocking with the clock rate adjusted to 200000 bps which is a good speed to send out bits across both the serial links in both the cities. A bandwidth of 2000 bps has been assigned to both the routers. After setting up the interface connecting the offices and the serial interfaces connecting the router, implementation to RIP took place and is proven below:

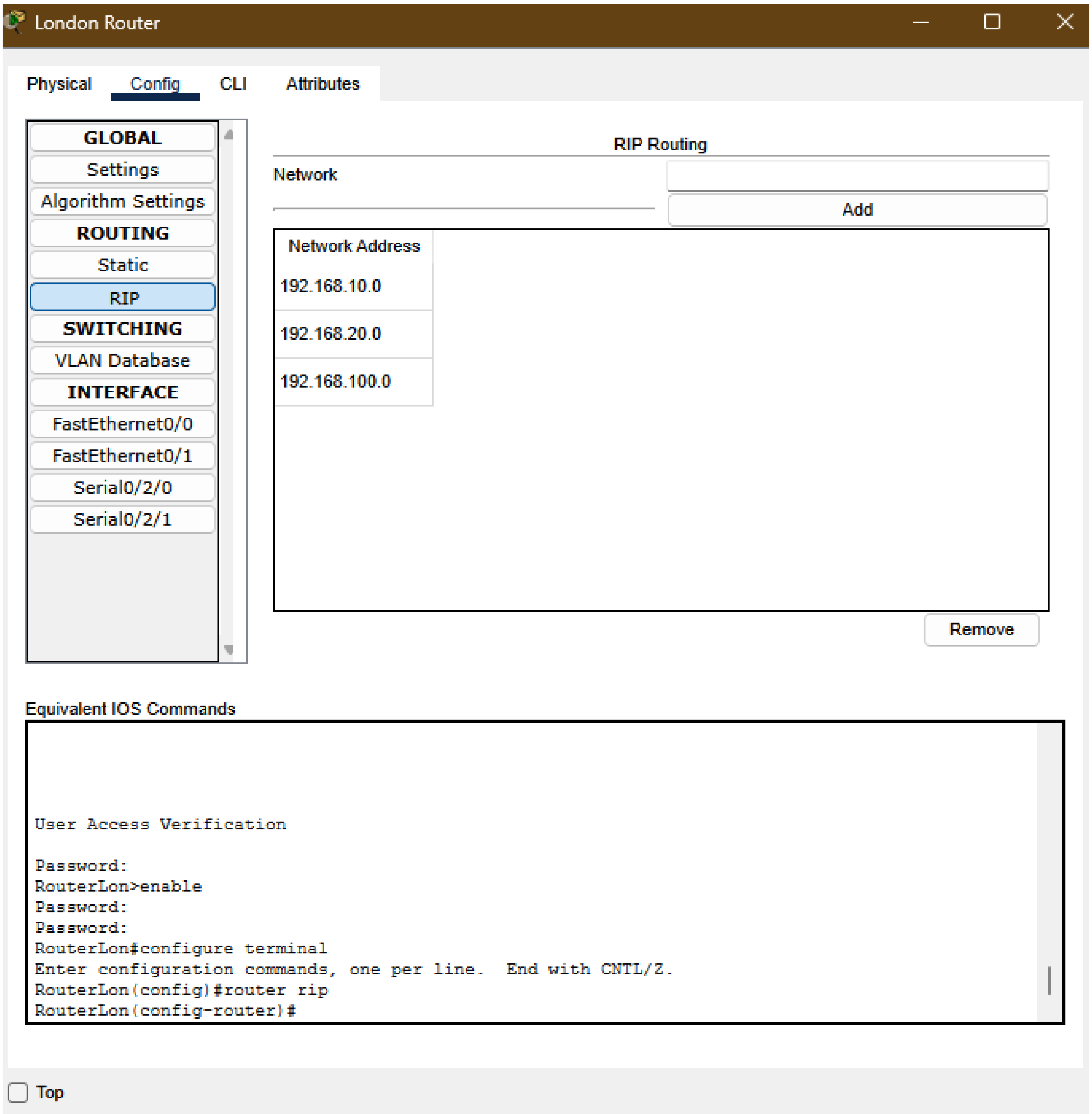


Figure 8: RIP for London Router being set up

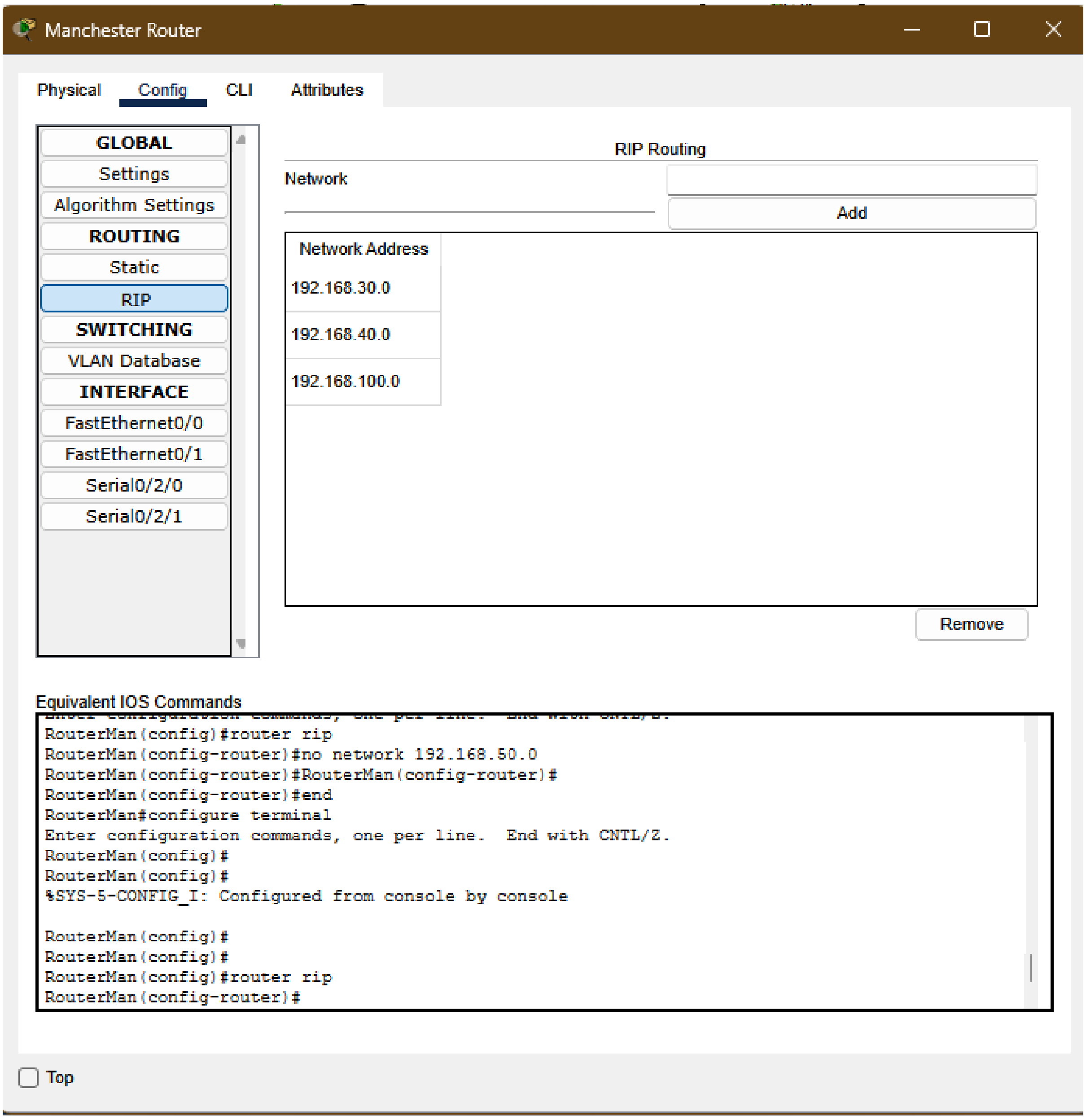


Figure 9: RIP implementation for Manchester Router

Dynamic Host Configuration Protocol (DHCP)

Dynamic Host Configuration Protocol (DHCP) is used to dynamically assign Internet Protocol (IP) addresses to each host on your organization's network. (Fortinet, n.d.) DHCP was chosen over static IP addressing because of its faster automation and reliability in providing the right IP addressing where static could go wrong manually and would take time for verification and assigning. DHCP can be implemented either on a router or on a server, but for Frederick’s warehouse, DHCP has been implemented on a server instead of choosing router because in larger networks with hundreds or thousands of devices, server-based DHCPs tend to offer superior scalability. They can manage a vast pool of IP addresses efficiently. As servers generally have more processing power and storage capacity than routers, hosting DHCP on a server potentially offers performance benefits, especially for large-scale deployments. (Johansson, 2023)

Server has been placed in both the cities with London Office A and Manchester Office, both having one to provide DHCP pool to both the offices in their respective cities. To extend DHCP pool to London Office B and Manchester Office B, DHCP relay was implemented to assign IP addressing using server via router. Following is the image that showcases the DHCP pool being assigned on the servers for the offices:

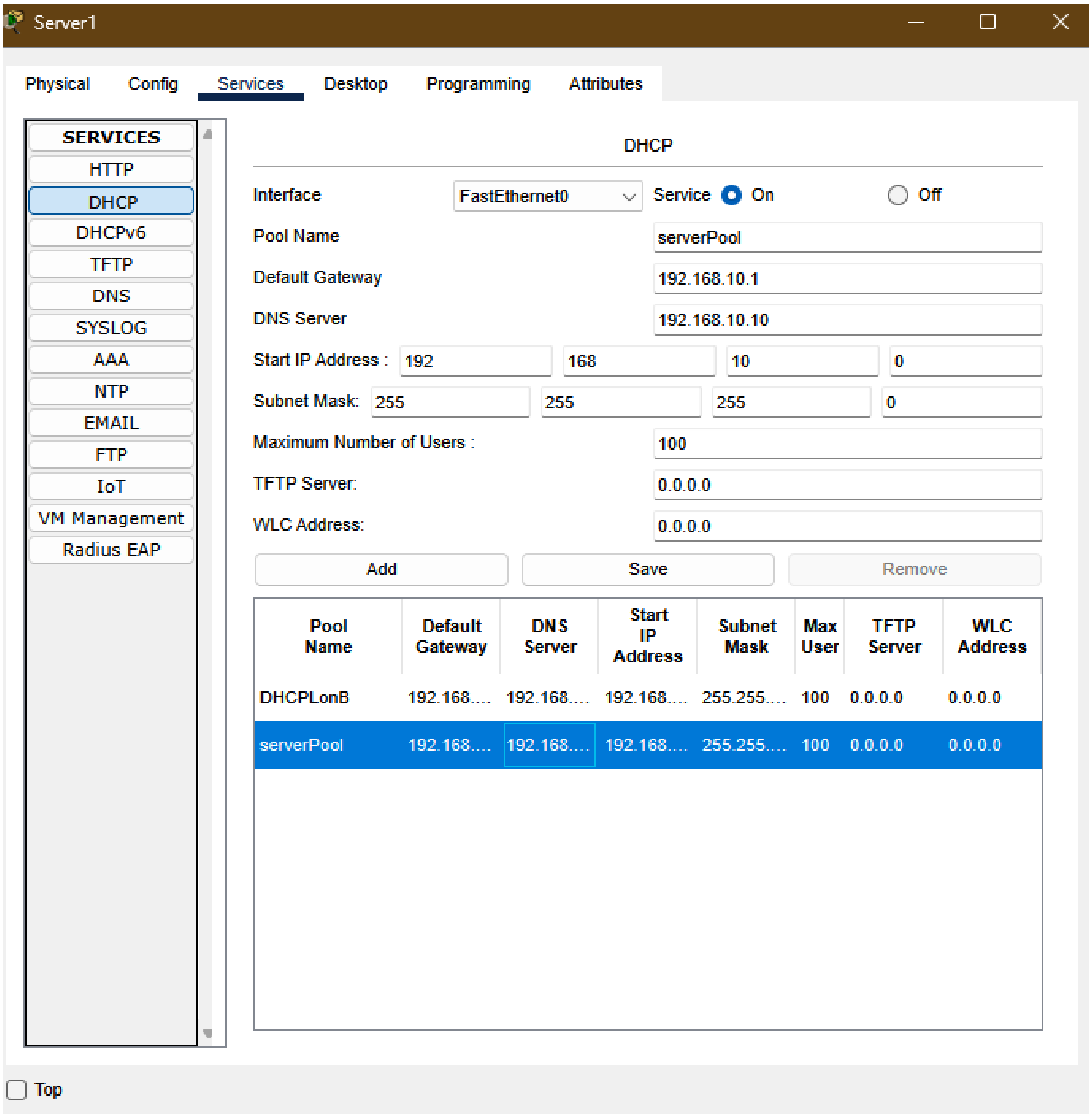


Figure 10: Implementation of DHCP pool for both offices on server for London

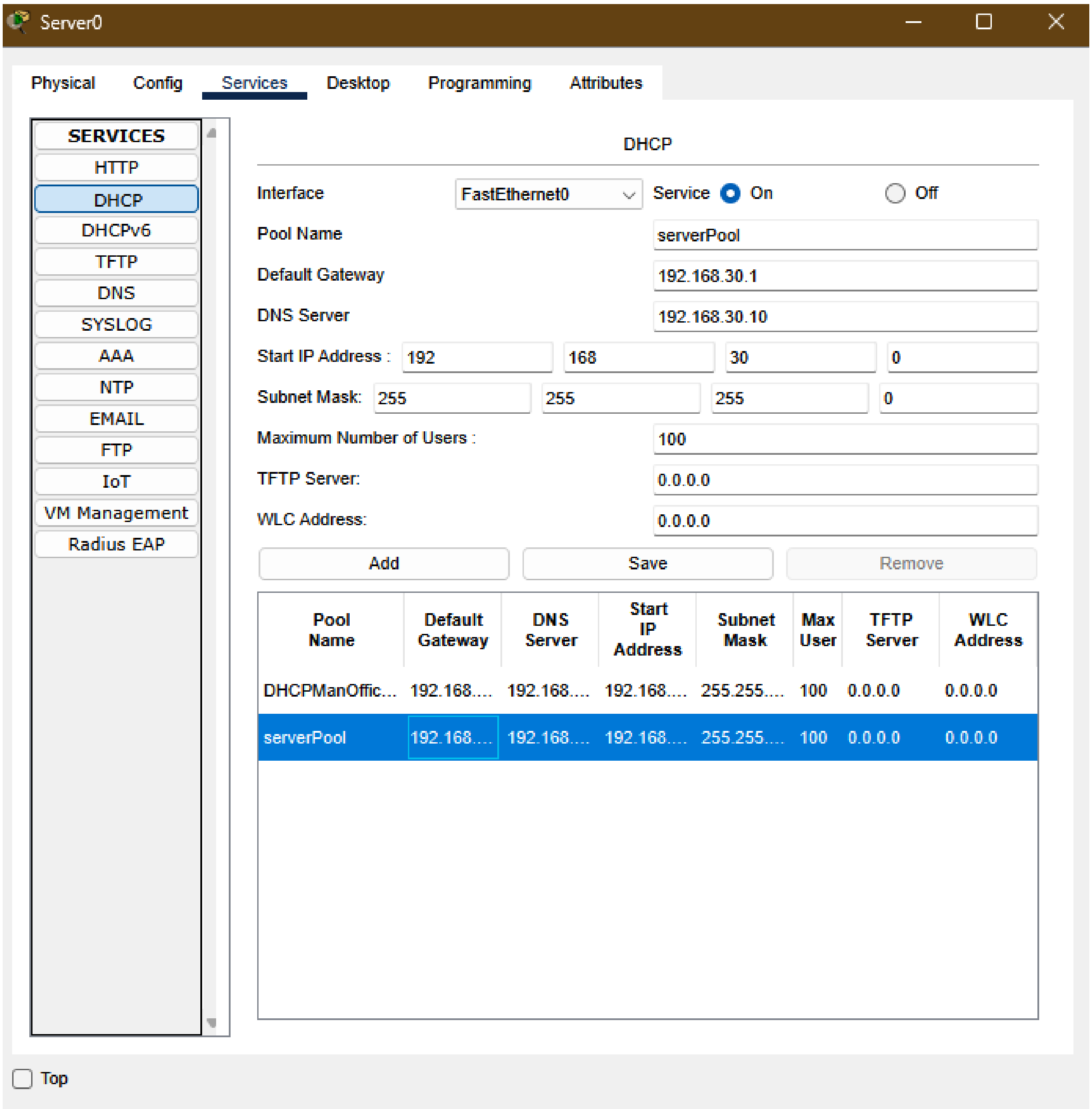


Figure 11: Implementation of DHCP pool for both offices on server for Manchester

Virtual Local Area Network (VLAN)

A Virtual Local Area Network (VLAN) is a logical segmentation of a Layer 2 (Data Link Layer) network that groups devices into separate logical networks independent of their physical location. (Geeks, 2026) VLANs are different for all 4 offices however the workshop is on the same VLAN as Manchester Office A. Following are the four VLANs implemented across the offices:

- VLAN 10 – London A
- VLAN 20 – London B
- VLAN 30 – Manchester A + Workshop
- VLAN 40 – Manchester B

VLANs in this case increase security by isolating user groups and provide the network with the departmental segmentation. This enables broadcast to be permitted to each site. Inter-VLAN communication has been devised through the routers to provide information across different VLANs.

The workshop was placed in the same VLAN as Manchester Office A because both operate on a same physical switch. Separating them into different VLANs would provide additional routing, DHCP pool, and configuration burden. The workshop relies on Manchester A office for connectivity to the server for inter-office communication; hence a single broadcast domain can simplify traffic flow and reduce the number of IP addresses along with different subnetting. Installation cost was also lowered and enabling simple warehousing operations. The configuration example is pasted below:

```
Switch> enable
Password:
Switch# config t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface range fa0/1-12
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 20
Switch(config-if-range)# exit
Switch(config)# int fa0/9
Switch(config-if)# switchport mode trunk

Switch(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/9, changed state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/9, changed state to up

Switch(config-if)# no shutdown
Switch(config-if)#
```

Figure 12: Implementation of VLAN in London Office B

```
Switch> enable
Password:
Switch# config t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# interface range f0/1-12
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 40
Switch(config-if-range)# int fa0/11
Switch(config-if)# switchport mode trunk

Switch(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/11, changed state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/11, changed state to up
```

Figure 13: Implementation of VLAN in Manchester Office B

Connectivity Test

To verify whether the devices are communicating, connection tests were carried out to confirm all the protocols, pings, configuration is set up well to transmit data. Connectivity was verified across the following dimensions:

- LAN reachability within each office (wired + wireless)
- VLAN operation
- DHCP address issuance to PCs and Laptops

- RIP route across London and Manchester
- Two city communication tests between desks

Screenshots for the tests are pasted in the Appendix section of this report.

Network Evaluation and Discussion

The design achieved its objectives. WAN communication is stable, DHCP pool made it easier to configure IP addresses automatically, RIP routing handled the process of transmitting data as a gateway to both the sites resulting in reducing manual maintenance. VLANs provided logical separation, enhancing only communications that are permitted. All offices show wired and wireless connectivity with APs providing advantage in powering up the laptops to access the network wirelessly. The design is matched with enterprise practices.

Although the functioning of all the devices across the network is flamboyant, there are several things that should be considered to provide a network that in future can be more scalable, secure, hardened for the use of production in warehouses, and minimal on redundancies and failures. These are:

- Additional warehouse factories or office departments can be added with the allocation of different roles and responsibilities which would allow more VLANs to be segmented and subnets and RIPv2 to come into place and enhance the security of the data flow based on what is permitted.
- Instead of having routers per city, implementation of routers per office should be considered because in this design, redundancy is there and to combat that, additional routers have to be purchased and install with Hot Standby Router Protocol (HSRP) or Virtual Router Redundancy Protocol (VRRP) to be configured to ensure that in case if any one of them fails, there is always the another router saved as a back up to let the communication channel through.
- Modern technologies like cloud/ISP and modem can be placed to provide internet access and backing up of data in case physical IT disruption takes place. This will also reduce WAN redundancy. (Rahim, 2024)

Conclusion

The network has been designed and tested successfully for Frederick's Warehouse across two cities and one workshop. The network consists of wired and wireless connectivity, VLANs, RIPv2, DHCP, CIDR IP addressing and secured SSH routers thus, enabling up link between all the devices. Connectivity tests demonstrated successful cross-city communication and confirmed that all assessment criteria were met. The solution for Frederick's Warehouse is apt to meet the present operation needs however, as the company expands and generates revenue, investments can be made to reduce redundancies, upgrade security, and purchase and install more advanced hardware devices with modern technologies to back up data more efficiently.

References

Arora, P., 2023. *Computer Science with Python.* s.l.:Sultan Chand.

Cisco, 2009. *Cisco Catalyst 2960 Series Switches.* [Online]
Available at: https://www.cisco.com/c/dam/en_us/solutions/small-business/products/routers-switches/catalyst-2960-series-switches/C45-484155-03_2960_AAG_v1b.pdf
[Accessed 13 January 2026].

Cisco, n.d. *What is a wireless access point?.* [Online]
Available at: https://www.cisco.com/site/us/en/learn/topics/small-business/what-is-an-access-point.html#tabs-35d568e0ff-item-4bd7dc8124-tab
[Accessed 13 January 2026].

Cloudflare, n.d. *What is SSH? | Secure Shell (SSH) protocol.* [Online]
Available at: https://www.cloudflare.com/learning/access-management/what-is-ssh/
[Accessed 14 January 2026].

Fortinet, n.d. *What is Dynamic Host Configuration Protocol (DHCP)?.* [Online]
Available at: https://www.fortinet.com/resources/cyberglossary/dynamic-host-configuration-protocol-dhcp
[Accessed 14 January 2026].

Geeks, G. f., 2025. *Difference between Access Point and Router.* [Online]
Available at: https://www.geeksforgeeks.org/computer-networks/difference-between-access-point-and-router/
[Accessed 13 January 2026].

Geeks, G. f., 2026. *Routing Information Protocol (RIP).* [Online]
Available at: https://www.geeksforgeeks.org/computer-networks/routing-information-protocol-rip/
[Accessed 14 January 2026].

Geeks, G. f., 2026. *Virtual LAN (VLAN).* [Online]
Available at: https://www.geeksforgeeks.org/computer-networks/virtual-lan-vlan/
[Accessed 14 January 2026].

Johansson, L., 2023. *Is It Better To Have Dhcp On Router Or Server.* [Online]
Available at: https://lostbyte.org/is-it-better-to-have-dhcp-on-router-or-server/
[Accessed 14 January 2026].

Rahim, I., 2024. *Network Design for Rahim Solutions,* Manchester: s.n.

Appendix

Screenshots of configuration and ping tests pasted below:

1. VLAN:

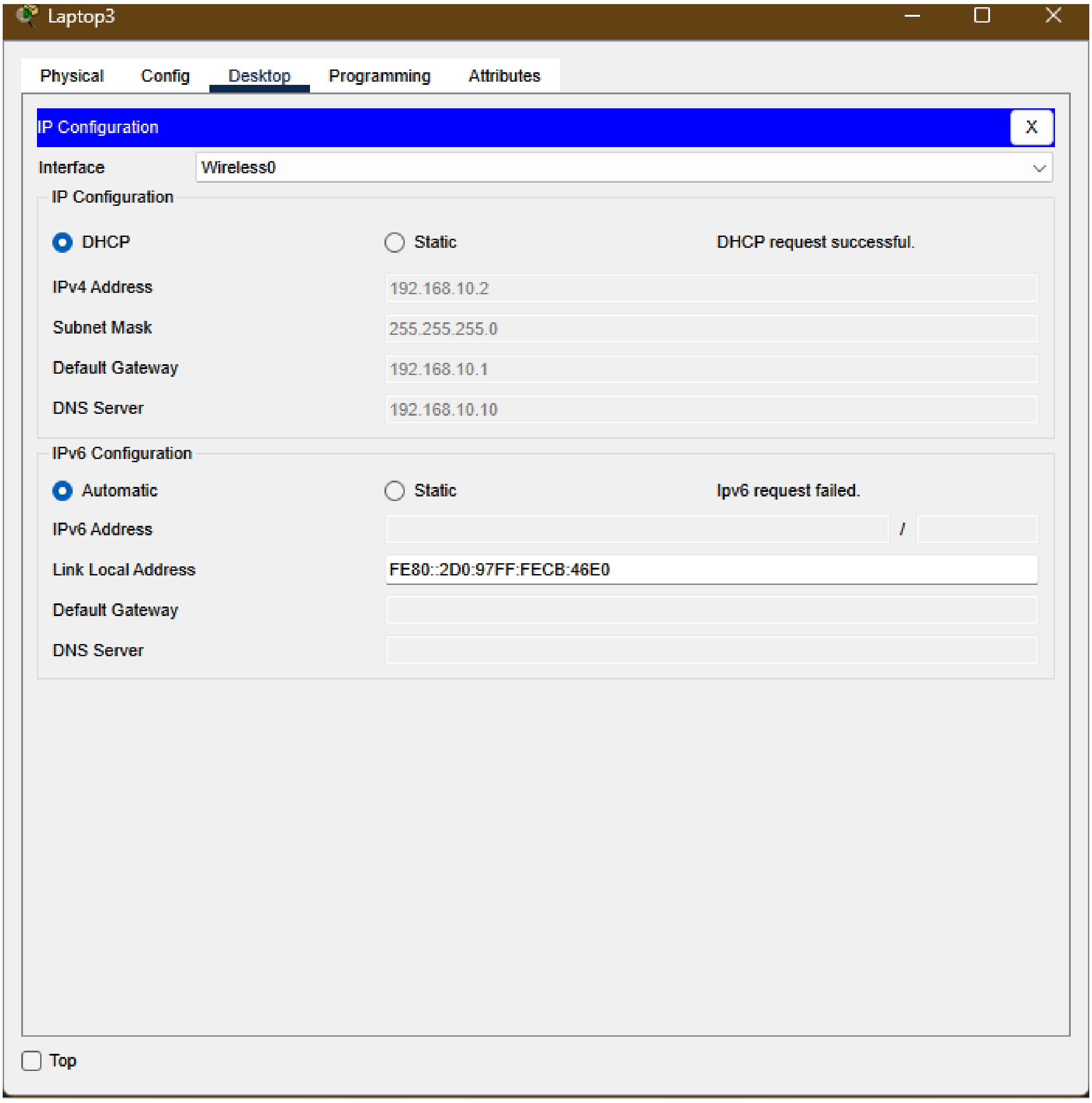
```
Switch# show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    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
10   VLANLondonOfficeA                active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                                Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                                Fa0/9, Fa0/10, Fa0/12, Fa0/13
1002 fddi-default                     active
1003 token-ring-default               active
1004 fddinet-default                  active
1005 trnet-default                    active
Switch#
```

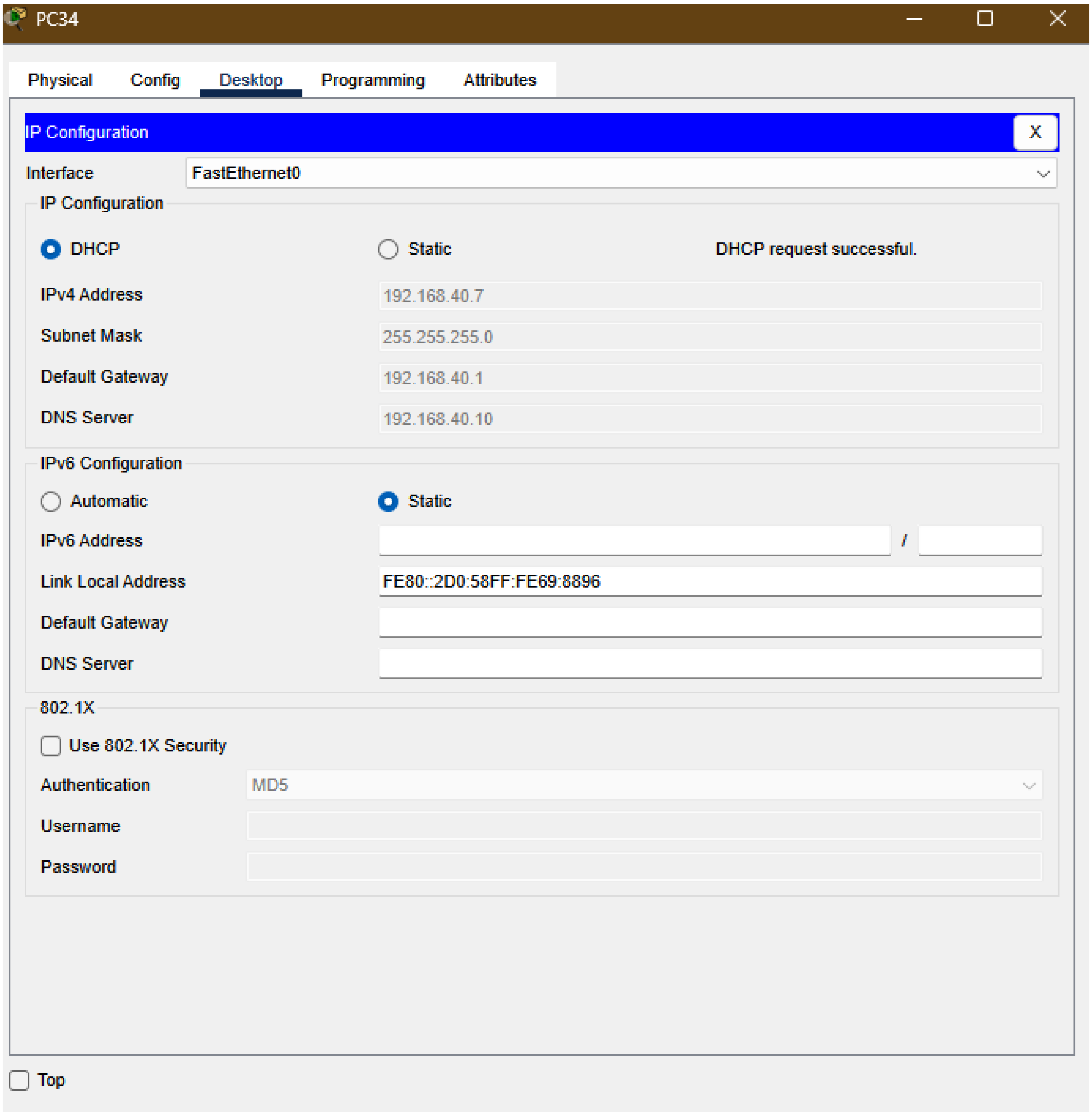
```
Switch#show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    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
20   VLANLondonOfficeB                active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                                Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                                Fa0/10, Fa0/11, Fa0/12
1002 fddi-default                     active
1003 token-ring-default               active
1004 fddinet-default                  active
1005 trnet-default                    active
Switch#
```

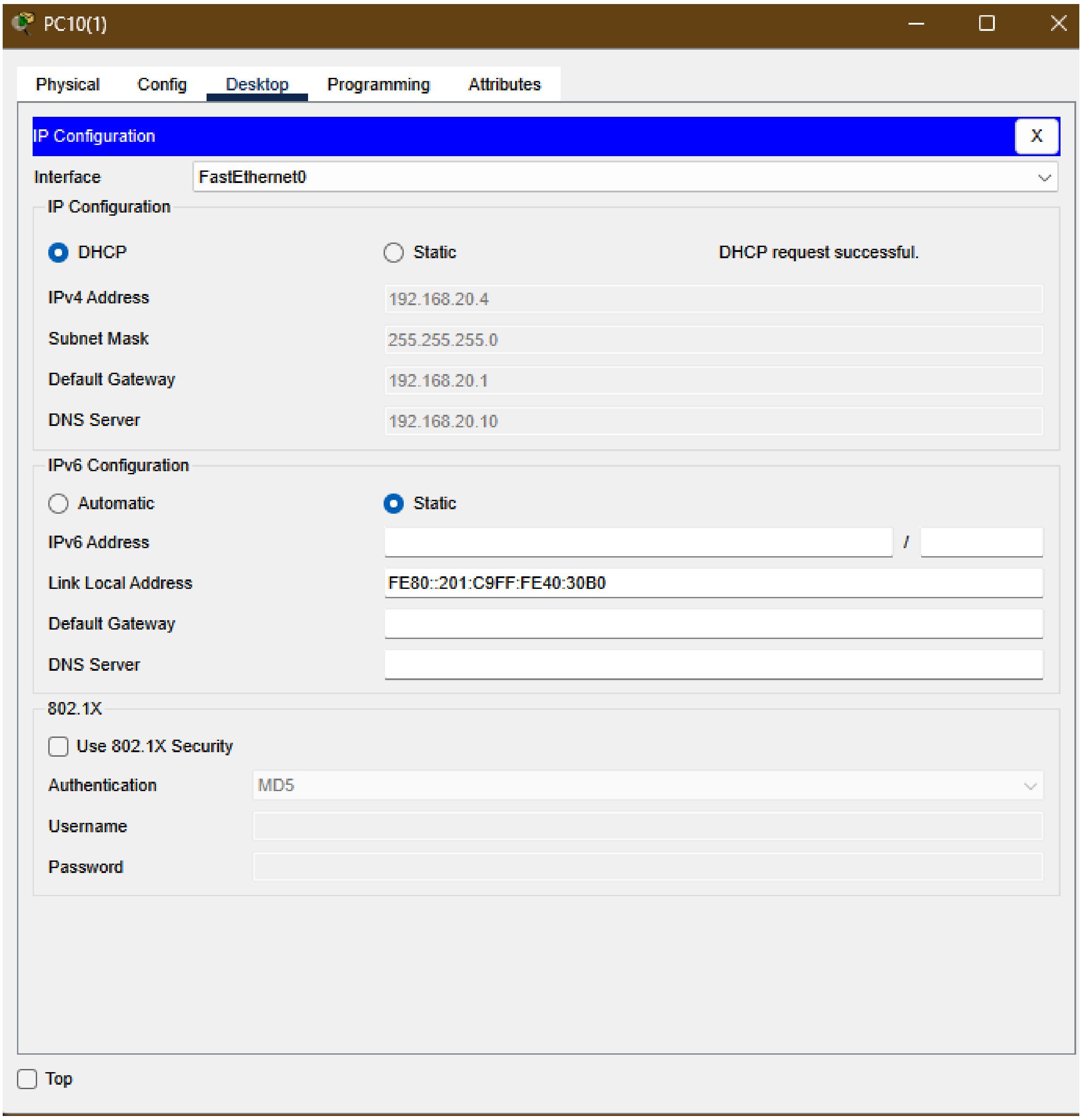
```
Switch#show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa0/15, Fa0/16, Fa0/17, Fa0/18
                                                Fa0/19, Fa0/20, Fa0/21, Fa0/22
                                                Fa0/23, Fa0/24, Gig0/1, Gig0/2
10   VLAN0010                         active
30   Manchester_Office_A              active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                                Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                                Fa0/10, Fa0/11, Fa0/12, Fa0/13
                                                Fa0/14
50   Workshop                         active
1002 fddi-default                     active
1003 token-ring-default               active
1004 fddinet-default                  active
1005 trnet-default                    active
Switch#
```

```
[OK]
Switch# show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    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
40   VLANManchesterOfficeB            active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                                Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                                Fa0/9, Fa0/10, Fa0/12
1002 fddi-default                     active
1003 token-ring-default               active
1004 fddinet-default                  active
1005 trnet-default                    active
Switch#
```

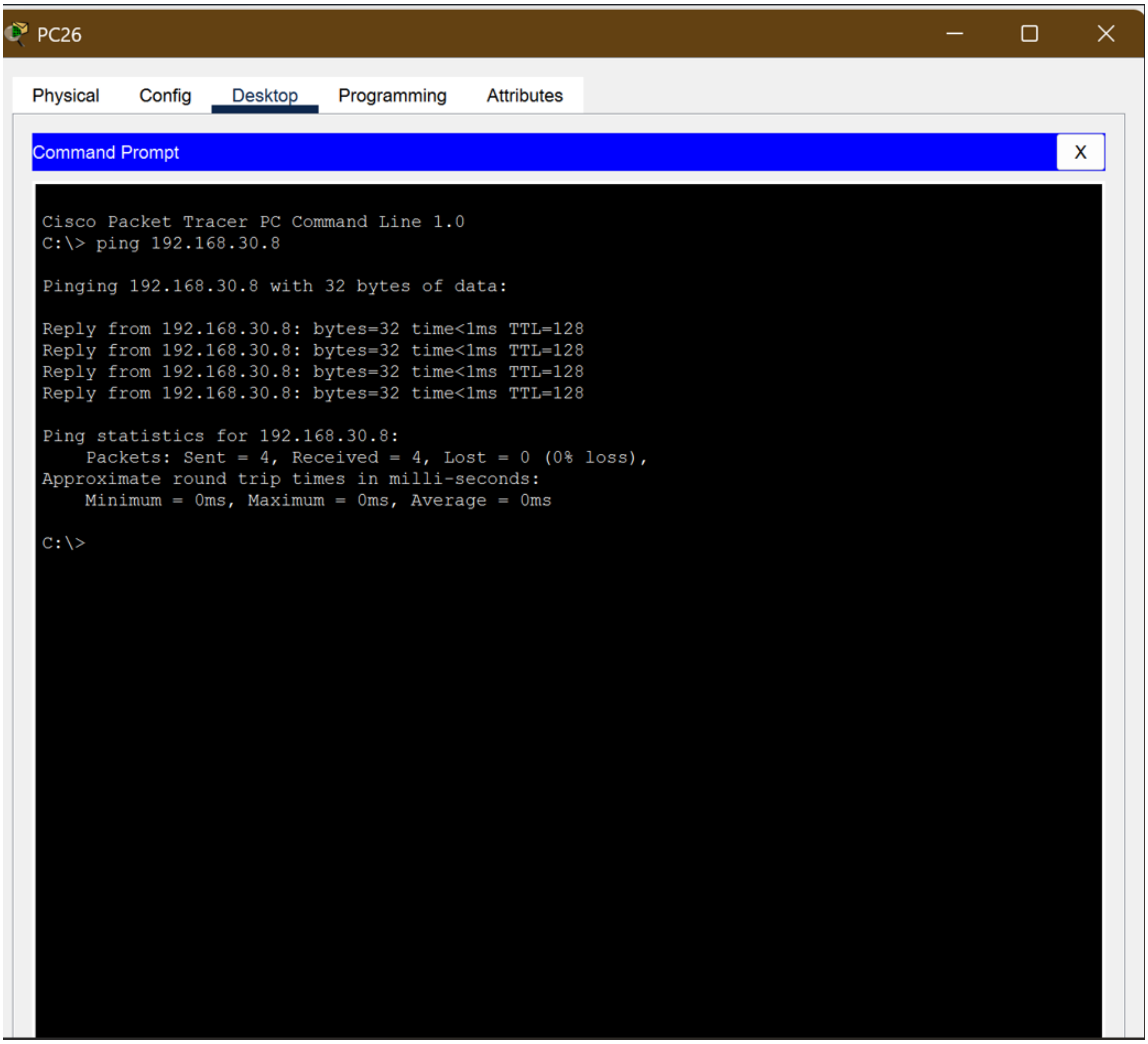
2. DHCP:

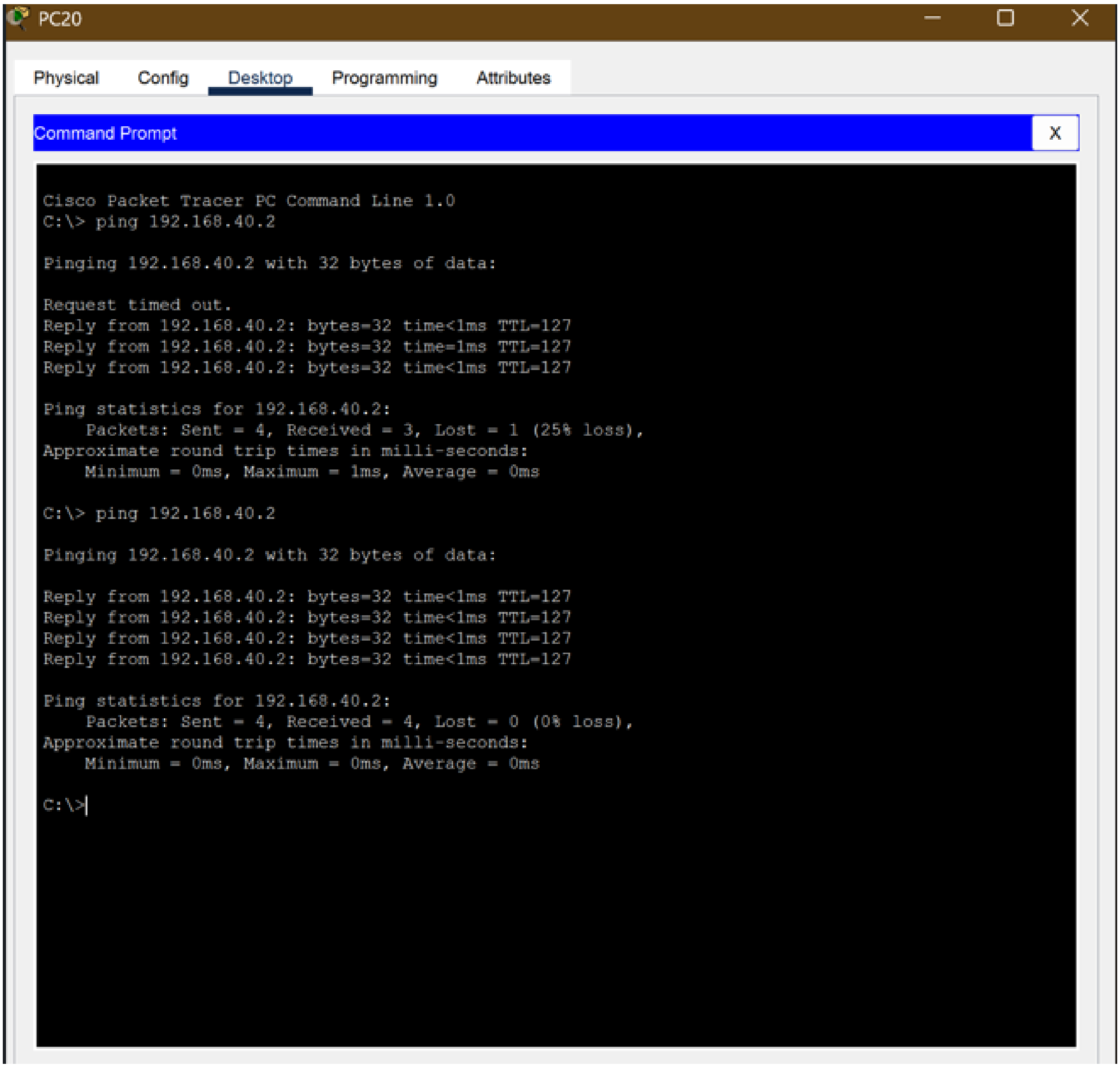



PC34
Physical
Config
Desktop
Programming
Attributes
IP Configuration
X
Interface
FastEthernet0
IP Configuration
DHCP
Static
DHCP request successful.
IPv4 Address
192.168.40.7
Subnet Mask
255.255.255.0
Default Gateway
192.168.40.1
DNS Server
192.168.40.10
IPv6 Configuration
Automatic
Static
IPv6 Address
/
Link Local Address
FE80::2D0:58FF:FE69:8896
Default Gateway
DNS Server
802.1X
Use 802.1X Security
Authentication
MD5
Username
Password
Top


PC10(1)
Physical
Config
Desktop
Programming
Attributes
IP Configuration
X
Interface
FastEthernet0
IP Configuration
DHCP
Static
DHCP request successful.
IPv4 Address
192.168.20.4
Subnet Mask
255.255.255.0
Default Gateway
192.168.20.1
DNS Server
192.168.20.10
IPv6 Configuration
Automatic
Static
IPv6 Address
/
Link Local Address
FE80::201:C9FF:FE40:30B0
Default Gateway
DNS Server
802.1X
Use 802.1X Security
Authentication
MD5
Username
Password
Top

3. Pinging across the same offices in London and Manchester as well as cross-city pinging:





4. RIP routing test:

```
RouterLon# traceroute 192.168.10.1
Type escape sequence to abort.
Tracing the route to 192.168.10.1

  1   192.168.10.1    1 msec    4 msec    2 msec
```

```
RouterMan# traceroute 192.168.30.1
Type escape sequence to abort.
Tracing the route to 192.168.30.1

  1   192.168.30.1    6 msec    8 msec    3 msec
```