Operating Systems and Networks

(5COM1055)

Project:

**Network Design and Administration for LC Solicitors**

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**Abstract :**

This report outlies the network design and implementation strategy to establish efficient connectivity between London and Manchester. The goal is to create a smooth network infrastructure that facilities file sharing, resource accessibility and communication among employees while maintain different subnets for each office and LAN network for Admin and Lawyer. Key components of network design include subnet allocation, VLAN configuration for LAN network, wireless access point deployment, router configurations and security measures to protect data.

This report also includes the documentation of installation of Linux distribution in virtual machine environment. It explores the creation of different users within the Linux system and into key concepts related to Linux networking providing an overview of essential networking elements.

**Network Project Objective :**

The objective is to design and implement VLAN configuration for the LAN network in both London and Manchester offices. This includes creating IP addressing scheme, configuring routers and PC’s, ensuring full connectivity between devices and incorporating wireless network.

**Network Design:**

A screenshot of a computer game

Description automatically generated

The network infrastructure that I have developed consists of two VLAN networks in AP Finance’s London and Manchester offices, facilitated by a WAN network. The network setup includes detailed components, costs and connectivity lines to ensure seamless communication and collaboration across both cities.

**Network Components and Cost:**

* **London Components:** 5 PC’s, 1 switch, 1 Access Point and 1 Router.
* **Cost :** £ 7505
* **Manchester Components:** 5 PC’s, 1 switch, 1 Access Point and 1 Router.
* **Cost :** £ 7505
* **Total Cost of Network :** £ 15010
* **Topology :** Star Topology implemented in both offices, with switches connecting all devices to the router.
* **Connectivity :** Copper Straight – Through wiring for internal connections, Serial DTE wire for interconnecting Routers.

**Components :**

**SWITCH**

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I have used the 2960 switch in my network as it offers unparalleled performance, reliability, and scalability, ensuring seamless data transfer and accommodating the evolving needs of our network infrastructure with its advanced features and robust design. In my network I have used switch to set up the VLAN connection in London and Manchester respectively.

**ACCESS POINT**

**A black router with two antennas

Description automatically generated**

I have used Access Point-PT in my network because it offers a dedicated platform for simulating and understanding wireless networking configurations, allowing me to focus specifically on wireless networking components such as access points, SSIDs, and security protocols.

**ROUTER**

**A black router with green lights

Description automatically generated**

I have used a 2911 Router in this network as it provides exceptional performance, versatility in connectivity options, advanced security features, modular design for scalability, and unmatched reliability, ensuring seamless and efficient network operations. I have added HWIC-1GE-SFP which is a single-wide HWIC with one Small Form-Factor Pluggable (SFP) slot. The SFP slot is populated with Cisco copper and optical Gigabit Ethernet SFPs which provides 1-port Gigabit Ethernet connectivity and also added HWIC-2T which is a Cisco 2-Port Serial High-Speed WAN Interface Card, providing 2 serial ports.

**WAN Technology:**

Wide Area Network(WAN) design plays a crucial role in ensuring seamless communication and data transfer between geographically dispersed locations. WAN design involves carefully planning and implementing the network architecture to meet specific business requirements. It encompasses factors such as bandwidth, scalability, security and redundancy. By understanding the foundations of WAN design organizations can lay a solid foundation for their network infrastructure. MPLS and VPN connections provide a balance between security, bandwidth and cost are ideal for most businesses.

The network infrastructure for AP Finance ‘s London and Manchester offices, a suitable bandwidth requirement for the WAN connection would depend on factors such as expected traffic volume, types of application used and desired level of performance. A minimum of bandwidth of 100 Mbps symmetrically (upload and download speeds) would be good for network supporting 5PC’s in each office, as there are frequent file transfers, VOIP calls and cloud – based applications (Conran, 2014).

Various WAN choices and their pros and cons (Terry, 2023) :

|  |  |  |
| --- | --- | --- |
| WAN CHOICES | pros | cons |
| Multiprotocol Label Switching  (MPLS) | * Provides reliable and predictable performance for prioritizing traffic. * Offers Low latency and supports traffic engineering. | * Are very costly for small networks. * Limited flexibility for adding new devices or changing configurations. |
| Leased Lines | * Dedicated and symmetric bandwidth ensuring consistent performance for critical applications. * Service Level Agreements(SLAs) guarantee uptime and performance metrics. | * Higher cost for higher bandwidth. * Installation lead delays and often physical line disruptions. |
| Broadband Connections | * Cost effective for small networks. * Available in various speeds, can be upgraded if needed. * Quick installation compared to leased lines. | * Asymmetric as it has faster download speed then upload speed. * Performance can be affected by network congestion. * SLAs may not guarantee performance levels. |

In conclusion, for LC Solicitors’ needs , considering the cost – effectiveness along with reliable and sufficient performance, MPLs with at least 100 Mbps symmetric bandwidth could be a suitable choice. It provides a balance between cost and performance, ensuring decent speeds for file transfers, VOIP class and other business applications.

**IP Address:**

Following is the IP Address table for the London and Manchester Offices respectively:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Device Name | Interface | IP address | Subnet Mask | Default Gateway | Network Address | Broadcast address |
| R-London | Se0/1/0 | 1.1.1.1 | /30 | - | 1.1.1.0 | 1.1.1.3 |
| G0/0 | G0/0/1.10  Admin | 10.0.0.1 | /26 | - | 10.0.0.0 | 10.0.0.63 |
| G0/0/1.20  Lawyer | 10.0.0.65 | /27 | - | 10.0.0.64 | 10.0.0.95 |
| G0/0/1.30  Guests | 10.0.0.97 | /28 | - | 10.0.0.96 | 10.0.0.111 |
| L - PC1  Fa0/1  L – PC2  Fa0/2 | VLAN 10 –  Admin | 10.0.0.2  10.0.0.3 | /26 | 10.0.0.1 | 10.0.0.0 | 10.0.0.63 |
| L – PC3  Fa0/3  L – PC4  Fa0/4 | VLAN 20 –  Lawyer | 10.0.0.66  10.0.0.67 | /27 | 10.0.0.65 | 10.0.0.64 | 10.0.0.95 |
| L – Wireless  Fa0/5 | VLAN 30 –  Guest | 10.0.0.98 | /28 | 10.0.0.97 | 10.0.0.96 | 10.0.0.111 |
| R-Manchester | Se0/1/0 | 1.1.1.2 | /30 |  | 1.1.1.0 | 1.1.1.3 |
| G0/0 | G0/0.10  Admin | 10.0.0.129 | /26 |  | 10.0.0.128 | 10.0.0.191 |
| G0/0.20  Lawyer | 10.0.0.193 | /27 |  | 10.0.0.192 | 10.0.0.223 |
| G0/0.30  Guests | 10.0.0.113 | /28 |  | 10.0.0.112 | 10.0.0.127 |
| M-PC1  Fa0/1  M-PC2  Fa0/2 | VLAN 10 –  Admin | 10.0.0.130  10.0.0.131 | /26 | 10.0.0.129 | 10.0.0.128 | 10.0.0.191 |
| M-PC3  Fa0/3  M-PC4  Fa0/4 | VLAN 20 –  Lawyer | 10.0.0.194  10.0.0.195 | /27 | 10.0.0.193 | 10.0.0.192 | 10.0.0.223 |
| M-Wireless  Fa0/5 | VLAN 30 –  Guest | 10.0.0.114 | /28 | 10.0.0.113 | 10.0.0.112 | 10.0.0.127 |

**Configurations:**

A computer screen shot of a computer code

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London Router VLAN configurations

A computer screen shot of numbers

Description automatically generated

Manchester Router VLAN configurations

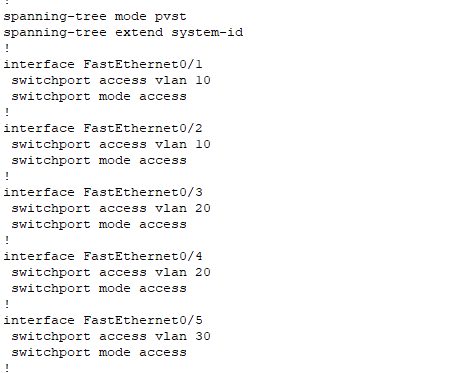
A screenshot of a computer

Description automatically generated

Ethernet VLAN connections for London Switch

A screenshot of a computer

Description automatically generatedEthernet VLAN connections for Manchester Switch

A screenshot of a computer

Description automatically generated

London Router VLAN configuration Manchester Router VLAN configuration

**Connectivity:**

A computer screen with white text

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VLAN connection between two PCs of London Admin

A computer screen with white text

Description automatically generated

VLAN connection between one PC of London and one PC of Manchester

**Security:**

Security reasons taken into consideration for the deployment of the network:

1. The Configure Privileged EXEC, unencrypted password – **cisco.**
2. The Configure Privileged EXEC, encrypted password – **class.**
3. Added a WEP key to both the Access Point – 1234567890.
4. Creation of VLANs enhance security via segmentation and isolation.

**Network Management:**

**Network Performance Monitoring Tools**

Network monitoring is the process of collecting, analysing and interpreting data from computer network to evaluate its performance and health. The goal of network monitoring is to detect and troubleshoot issues before they can cause any problem in network that can impact the user’s experience. Monitoring can be done by using different types of tools including software – based solutions that run on a network device, hardware-based monitoring appliances and cloud-based monitoring services. These tools provide network users with comprehensive view of network performance and help them to identify and address potential issues proactively. Identifying and exploring different hardware and software tools to measure network performance is crucial for maintaining a healthy and efficient network infrastructure (Club, n.d.).

Hardware tools play a critical role in network performance monitoring by providing real – time visibility into network traffic and performance metrics at the physical level. These tools are essential for network users to diagnose issues, improve performance and also ensure reliability of network operations.

1. Network Analysers: They are sophisticated hardware devices designed to capture, scrutinize and analyse network traffic.

* Network Tap is a pivotal tool which serves as a passive monitoring device placed within a network. They facilitate non-intrusive traffic monitoring without latency or impacting network performance. They achieve this by duplicating both incoming and outgoing traffic, sending mirrored copy to monitoring tools such as packet analysers or intrusion detection systems(IDS).
* Packet Sniffer is a standalone device or can be even integrated into the network system. They are involved in capturing network packets and offering detailed analysis of packet contents, encompassing protocol details, payload data and timing intricacies.

1. Network Performance Probes : They are hardware devices carefully deployed to monitor and evaluate critical performance metrics such as latency, bandwidth, utilization, packet loss and jitter. These devices establish interfaces with network devices such as routers, switches or access points to gather data on network traffic and performance parameters.

* Latency Probes : Used to measure the duration taken by data packets to travel from source to destination, identifying potential delays and network bottlenecks.
* Bandwidth Probes: Monitor the consumption of available bandwidth across network lines, enabling users to fine tune traffic management and allocate resources properly.
* Jitter Probes : Used for tracking instances of packet loss and variations in packet arrival times, both of which are paramount for ensuring the desired Quality of Service (QoS) for real – time applications such as VOIP and video conferencing.

Software tools play a critical role in network performance monitoring by offering advanced analytics, visualization and reporting capabilities. These software empower administrators to delve into network data, uncover trends and make data driven decisions to enhance network performance and reliability. This holistic approach to network monitoring enables organizations to address issues, optimize resource allocation and ensure seamless network operations that align with business objectives.

1. Wireshark : It is a preeminent network protocol analyser that delves deep into the intricacies of network traffic. Its ability to provide in-depth packet analysis supports its status as the finest choice for experts looking for a thorough understanding of network interactions.
2. Tcpdump: Is a well-established network diagnostic tool that facilitates packet capturing and analysis directly from the command line. It is best for those who want direct and efficient packet capture without the use of a graphical interface.
3. Ettercap: Is a toolkit designed for network protocol analysis and security auditing. Especially adept at facilitating man- in – the - middle attacks. It also has the ability to intercept and modify network traffic on-the-fly.
4. Kismet: Geared for detecting, sniffing and analysing wireless network traffic. With its expertise in identifying networks across a wide array of protocols , it stands as an indispensable asset for professionals striving for excellent wireless network detection and surveillance.

**Network Metrics**

Network Metrics are quantitative measurements used to evaluate and monitor the performance and reliability of computer network. These metrics provide valuable insights into various aspects of network behaviour such as speed, bandwidth usage, latency, packet loss and other network key performance indicators (Lamberti, 2022).

1. Latency : Measure of time it takes for data to reach its destination across a network. When measuring latency, consistent delays are signs of major performance issue that can happen, therefore go unnoticed but can have a huge impact when using VoIP or unified communication systems such as Zoom , Skype , Microsoft and Teams.
2. Jitter : Disruption that occurs while data packets travel across the network. Jitter can be caused when network devices are unable to send the equivalent amount of traffic they receive so their packet buffer fills up and they start dropping packets. If you are talking to someone on a video call and their voice speed changes which means there is jitter problem.
3. Bandwidth : Maximum amount of data a network connection can transmit within a specific time frame. If several devices use the network concurrently the available bandwidth will be shared among the devices resulting in slower network speeds.

**Monitoring Network Performance for LC Solicitors**

* Monitoring Network Performance helps detect issues such as network congestion, equipment failures and even configuration errors before they impact users or critical applications.
* IT teams can identify areas of improvement, optimize bandwidth utilisation and prioritize traffic based in business needs by analysing performance metrics.
* Regular assessments help identify potential bottlenecks or issues early allowing proactive maintenance and minimizing downtime.
* Monitoring helps meet SLA commitments by tacking and maintain network performance within defined threshold, ensuring reliable services for clients and internal users.
* Regular performance evaluations provide data for benchmarking, trend analysis and implementing optimization strategies leading to continuous improvement in network performance and reliability.

**Dual – Stack Implementation:**

A dual network is a networking environment that supports the simultaneous use of both IPv4 and IPv6 addresses. This configuration enables devices to run IPv4 and IPv6 concurrently, resulting in smoother transition from the older IPv4 to more modern IPv6. When communicating with another device, the system will choose the appropriate IP version based on the destination address or the preferred protocol. If a device on an IPv6 network wishes to communicate with an IPv4 device, it will use IPv4 address and vice versa  (nordvpn.com, n.d.).

**Advantages of Dual – Stack network**

* Allows smooth transition from IPv4 to IPv6 without service interruptions.
* Supports communication with devices that are still on IPv4.
* Networks can adept and function effectively in future even as technology evolves.

**Disadvantages of Dual – Stack network**

* Requires complex managing and configuring two separate IP addresses for each device.
* Consumes more memory and processing power on networking devices.
* Maintaining two protocols can introduce additional security, if not managed correctly.

**IPv4 vs IPv6: What is the difference?**

IPv4 is the current protocol for creating, assigning and using IP addresses. This internet protocol uses 32- bit numerical addresses, which means it can have 4.3 billion(approx..) unique IP addresses. IPv4 still routes most of today’s internet traffic.

The new generation protocol IPv6 increases the address space to accommodate limitless devices with unique addresses. IPv6 provides nearly 3,4x10 ^ 38 unique addresses. IPv6 is built with security in mind. It provides confidently, authentication and data integrity.

**IP Address for IPv6:**

|  |  |  |  |
| --- | --- | --- | --- |
| Device Name | Interface | IP address | Default Gateway |
| R-London | Se0/1/0 | 2001:db8:1::1/64 | - |
| G0/0 | G0/0/1.10  Admin | 2001:db8:10::1/64 | - |
| G0/0/1.20  Lawyer | 2001:db8:20::1/64 | - |
| G0/0/1.30  Guests | 2001:db8:30::1/64 | - |
| L - PC1  Fa0/1  L – PC2  Fa0/2 | VLAN 10 –  Admin | 2001:db8:10::2/64  2001:db8:10::3/64 | 2001:db8:10::1/64 |
| L – PC3  Fa0/3  L – PC4  Fa0/4 | VLAN 20 –  Lawyer | 2001:db8:20::2/64  2001:db8:20::3/64 | 2001:db8:20::1/64 |
| L – Wireless  Fa0/5 | VLAN 30 –  Guest | 2001:db8:30::2/64 | 2001:db8:30::1/64 |
| R-Manchester | Se0/1/0 | 2001:db8:1::2/64 |  |
| G0/0 | G0/0.10  Admin | 2001:db8:10::10/64 |  |
| G0/0.20  Lawyer | 2001:db8:20::10/64 |  |
| G0/0.30  Guests | 2001:db8:30::10/64 |  |
| M-PC1  Fa0/1  M-PC2  Fa0/2 | VLAN 10 –  Admin | 2001:db8:10::11/64  2001:db8:10::12/64 | 2001:db8:10::10/64 |
| M-PC3  Fa0/3  M-PC4  Fa0/4 | VLAN 20 –  Lawyer | 2001:db8:20::11/64  2001:db8:20::12/64 | 2001:db8:20::10/64 |
| M-Wireless  Fa0/5 | VLAN 30 –  Guest | 2001:db8:30::1/64 | 2001:db8:30::10/64 |

**Linux Objective :**

The objective is to install Linux Distribution in virtual machine(VM) , capturing screenshots of different stages of installations, creating different users and explaining key concepts about Linux networking.

**Linux Installation Process**

I have chosen to download Ubuntu on Virtual Machine for LC Solicitors’ :

* Ubuntu is user-friendly interface and straightforward installation process. Users who have no prior experience with Linux systems, making it easier for them to adapt and work efficiently.
* Ubuntu has large number of users and developers. There are numerous online forums, guides and resources available to help troubleshoot and find solutions quickly.
* Ubuntu has large number of repositories available , making it easy to download and manage the application relevant to business applications.
* Ubuntu provides regular updates and patches to keep system secure. This is crucial for protecting sensitive data and ensuring compliance with data protection regulations.

Installing Ubuntu on virtual machine with VMware creates sandbox environment for testing and development that does not affect the main system. It also enables quick backup and restoration of the virtual computer. Overall, Ubuntu is appropriate solution for legal businesses like LC Solicitors because of its usability, support, security and stability.

A screenshot of a computer

Description automatically generatedinstallation process of Ubuntu

A screenshot of a computer

Description automatically generated

Ubuntu Configuration for my PC.

**User Configuration**

To create different user account on the Linux system, representing various role like admin, lawyer, and client.

First open the terminal in ubuntu. Ctrl + Alt + T or searching for “Terminal” in the Ubuntu application menu.

Type ‘**sudo adduser admin**’ and press enter. Then enter a password and other optional information. Or skip the optional information by pressing Enter. In this way we can create lawyer user and client user, but the administrative privileges is only to the admin user. For security I have even added passwords.

A screenshot of a computer program

Description automatically generated

Creation of groups

I have created directory for admin, lawyers and guest. However not all directories have same permission . 700 allows only the owner of the group to modify the directory whereas 770 allows all users of the group to modify directory.

A screenshot of a computer program

Description automatically generated

Creation of directory

**Networking in Linux**

To display the network configuration information, execute the ifconfig command.

A computer screen shot of a program

Description automatically generated

Ifconfig command

A screenshot of a route

Description automatically generatedTo view the table of routing information , use the route command.

route command

I have used 127.0.0.1 which is the loopback internet protocol address. The address is used to establish an IP connection to the same machine used by the end use. I used the command grep 127.0.0.1 /etc/hosts.



grep command

**End User and Server OS**

End User and Server Operating Systems are sorts of operating systems designed to serve exclusive purposes inside computer network surroundings. Understanding the difference between End User and Server OS is vital for effectively dealing and deploying Computer systems in various network environments (GeeksforGeeks, 2020) .

Server OS : It is more sophisticated OS version with more effective features and capacities for offering various services to other linked devices. They can control and modify linked client devices. The majority of processes are started by operating system commands.

Types of Servers OS: Windows Server, Linux Server, Unix MacOS Server

Characteristics of Server OS:

* It uses CUI and GUI to reach the server.
* Manages operating systems and user PC.
* Web and business apps are installed and used by it.
* Majority of processes can be carried out using OS commands.

End User : It is an operating system that operates within the desktop environment. It is used to obtain services from server. It is designed to run on user devices including desktop computers, laptops and smartphones. It is optimized for supplying user friendly interface and assisting and extensive range of programs and responsibilities normally carried out by individual customers.

Types of End User : Chrome OS, IOS , Android, BSD

Characteristics of End User:

* Assist for various variety of packages and software program equipment utilized by give up-users for productivity, conversation, amusement and personal duties.
* Designed to work with wide range of hardware devices and peripherals often used by end users, including printers, scanners, cameras and input devices.
* Consists of GUI that lets the user to interact with the running system including home windows, icons , menus and buttons.

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