Namal University, Mianwali

Department of Electrical Engineering

EE-342 (L) – Computer Communication Networks (Lab)

Design Project

Hospital Network Design Project

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Contents

Course Learning Outcomes

CLO-1 Follow instructions to implement local networks and analyze their performance on the simulator.

CLO-2 Explain and analyze the network with effective and timely submitted reports.

CLO-3 Construct and design networks to demonstrate various networking scenarios comprised of protocols & and applications.

Abstract

This report presents the design and implementation of a secure and efficient network for Melbourne Health Services. The hierarchical design ensures reliability, scalability, and adherence to the principles of Confidentiality, Integrity, and Availability (CIA). The proposed network leverages VLANs, DHCP, OSPF, and robust security measures to address the unique needs of a hospital environment.

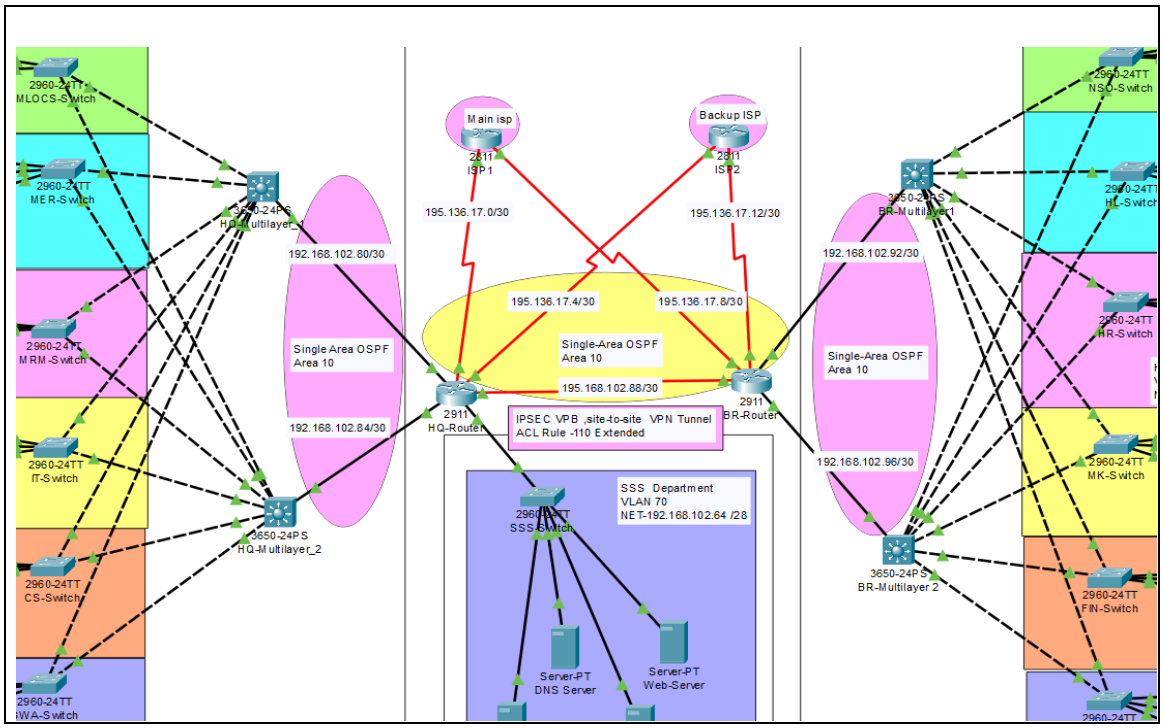
1. Introduction

Melbourne Health Services operates across two locations—a headquarters (HQ) and a branch hospital—with diverse departments providing healthcare services. The existing reliance on third-party IT services prompted the initiative to develop an independent network infrastructure. This project focuses on creating a hierarchical network model integrating Local Area Networks (LANs), a Wide Area Network (WAN), and a server-side site.

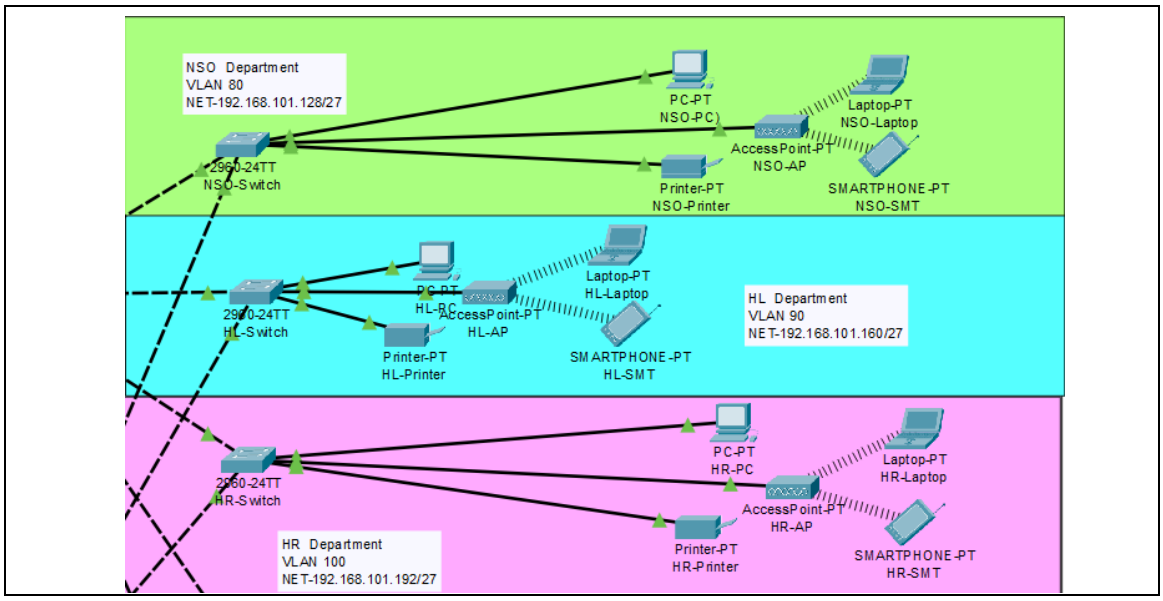
2. Network Requirements and Specifications

- **General Requirements:**

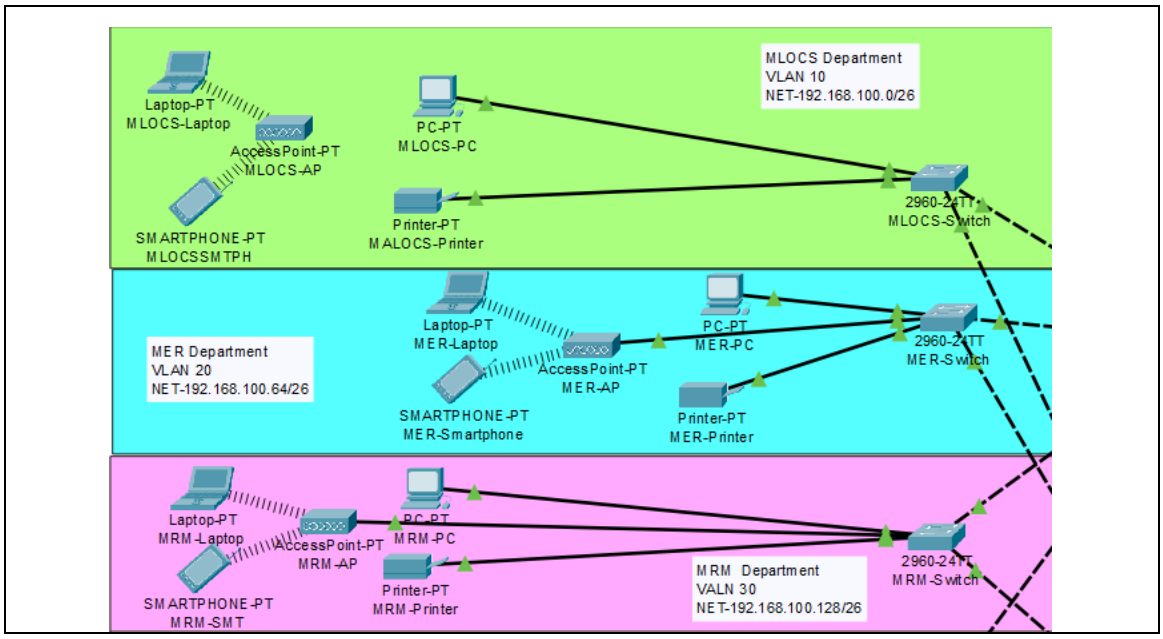
- A secure and reliable network infrastructure connecting HQ and branch hospital.



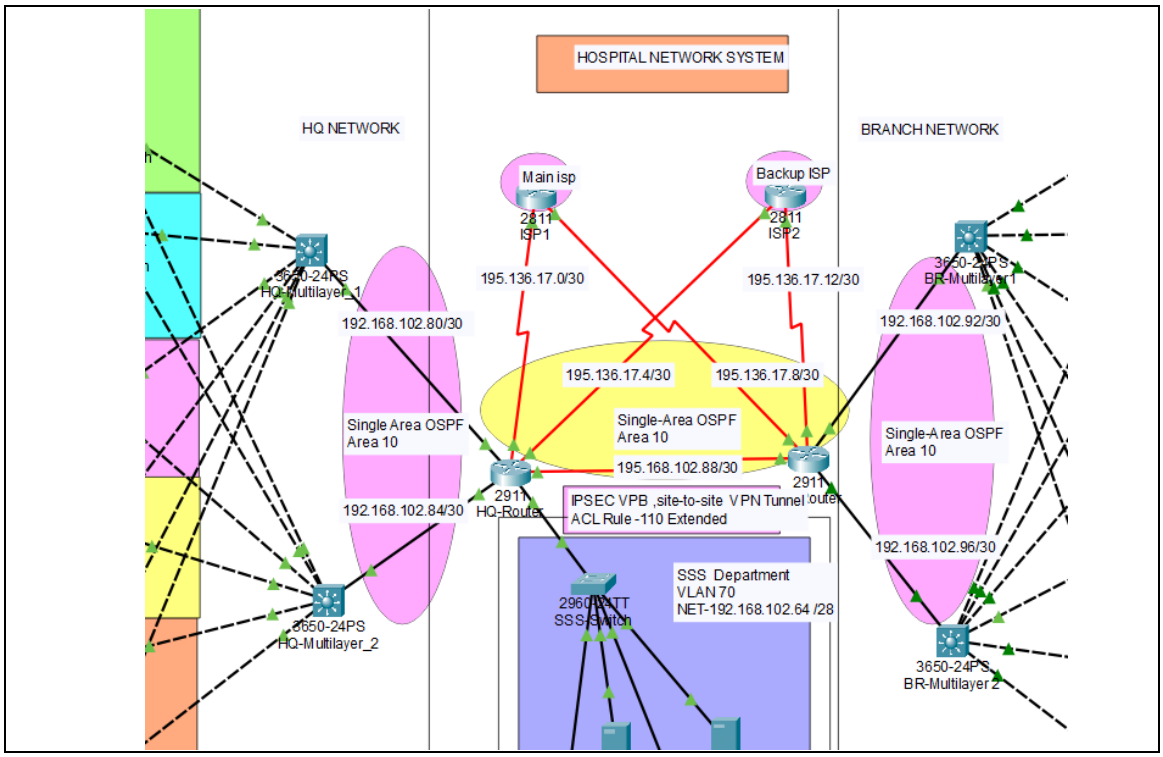
- VLAN segmentation for each department.



- Wireless networks in all departments.



- Hierarchical model with core routers, multilayer switches, and access switches.



- Integration of DHCP for dynamic IP allocation.
- Static public IPs for internet connectivity.

3. Specific Departmental Details:

- **HQ Departments**: Medical Lead Operation & Consultancy Services (MLOCS), Medical Emergency and Reporting (MER), Medical Records Management (MRM), Information Technology (IT), Customer Service (CS), and Guest Waiting Area (GWA).
- **Branch Departments**: Nurses & Surgery Operations (NSO), Hospital Labs (HL), Human Resource (HR), Marketing (MK), Finance (FIN), and Guest Waiting Area (GWA).
- Each HQ department supports ~60 users, and each branch department supports ~30 users.

4. Network Design Methodology

- **Hierarchical Network Design**: Core routers, multilayer switches, and access switches.
- **VLAN Segmentation**: Department-specific VLANs for isolation and traffic control.
- **IP Addressing**: Subnet allocation from a base network (192.168.100.0/24).
- **Routing Protocol**: OSPF for dynamic routing.
- **Security Measures**: ACLs, VPN, port-security, and SSH.

5. IP Addressing and Subnetting Plan

- **Headquarters:**

Department	Subnet Address	Subnet Mask	Host Address Range	Broadcast Address
MLOCS	192.168.100.0	255.255.255.192/26	192.168.100.1-192.168.100.62	192.168.100.63
MER	192.168.100.64	255.255.255.192/26	192.168.100.65-192.168.100.126	192.168.100.127
MRM	192.168.100.128	255.255.255.192/26	192.168.100.129-192.168.100.190	192.168.100.191

IT	192.168.100.192	255.255.255.192/26	192.168.100.193-192.168.100.254	192.168.100.255
CS	192.168.101.0	255.255.255.192/26	192.168.101.1-192.168.101.62	192.168.101.63
GWA	192.168.101.64	255.255.255.192/26	192.168.101.65-192.168.101.126	192.168.101.127

- **Branch Hospital:**

Department	**Subnet Address**	**Subnet Mask**	**Host Address Range**	**Broadcast Address**
NSO	192.168.101.128	255.255.255.224/27	192.168.101.129-192.168.101.158	192.168.101.159
HL	192.168.101.160	255.255.255.224/27	192.168.101.161-192.168.101.190	192.168.101.191
HR	192.168.101.192	255.255.255.224/27	192.168.101.193-192.168.101.222	192.168.101.223
MK	192.168.101.224	255.255.255.224/27	192.168.101.225-192.168.101.254	192.168.101.255
FIN	192.168.102.0	255.255.255.224/27	192.168.102.1-192.168.102.30	192.168.102.31

GWA	192.168.102.32	255.255.255.224/27	192.168.102.33-192.168.102.62	192.168.102.63

6. Security Measures

- **Access Control Lists (ACLs)**: Restrict access between departments.
- **Virtual Private Network (VPN)**: Secure communication between HQ and branch.
- **Port-Security**: Allow only authorized devices to connect.
- **SSH**: Secure remote access for managing devices.
- **NAT/PAT**: Efficient use of public IPs for internet access.

7. Network Topology

Network topology employs a hierarchical design to ensure scalability and reliability.

- **Core Routers**: Located at both HQ and branch, these routers are connected via a serial link and ensure robust communication between sites. Each router is also connected to two ISPs for redundancy.
- **Multilayer Switches**: Deployed at both HQ and branch to perform inter-VLAN routing and Layer 3 switching. These switches handle traffic within VLANs and enable efficient communication between departments.
- **Access Switches**: Located in each department, these switches connect end-user devices and enable departmental segmentation.
- **Redundancy**: Redundancy is implemented at the core and switch layers using dual uplinks and failover configurations to prevent single points of failure.
- **Server Placement**: A dedicated server room at HQ hosts DHCP, DNS, web, and email servers, ensuring centralized management and streamlined services for the entire network.
- **Wireless Access Points**: Integrated into all departments to provide seamless wireless connectivity, enhancing mobility for staff and guests.

8. Implementation Plan

1. Configure basic device settings (hostnames, passwords, banners).

- Switch>en

- Switch#config t
- hostname SSS
- enable password cisco
- no ip domain lookup
- banner motd #No Unauthorized Access!!!#
- line console 0
- password cisco
- login
- exit
- service password-encryption

2. Set up VLANs and inter-VLAN routing.

- vlan 70
- name SSS
- int range fa0/3-24
- switchport mode access
- switchport access vlan 70
- exit

3. Configure OSPF on routers and multilayer switches.

- ip routing
- router ospf 10
- network 192.168.100.0 0.0.0.255 area 0
- network 192.168.101.0 0.0.0.255 area 0

4. Implement DHCP servers for dynamic IP allocation.

- int vlan 10
- ip address 192.168.100.1 255.255.255.192
- ip helper-address 192.168.102.67
- int vlan 20
- ip address 192.168.100.65 255.255.255.192
- ip helper-address 192.168.102.67

5. Configure security measures (ACLs, VPN, port-security).

- crypto isakmp policy 10
- encryption aes 256

- authentication pre-share
- group 5
- crypto isakmp key vpnpa55 address 192.168.102.89
- crypto ipse transform-set VPN-SET esp-aes esp-sha-hmac
- crypto map VPN-MAP 10 ipsec-isakmp
- interface Serial0/3/0
- crypto map VPN-MAP

6. Test and validate the network.

- do sh ip route
- do sh start
- do sh port-security
- do show vlan brief
- do show interface trunk
- do sh ip int br
- do sh crypto ipse sa

9. Expected Outcomes

1. Enhanced security and data protection.
2. Reduced operational costs by eliminating third-party IT services.
3. Efficient communication across departments.
4. Scalability and reliability through hierarchical design.
5. Improved network performance through reduced latency, optimized bandwidth utilization, and enhanced speed of data transfer, ensuring seamless departmental collaboration and service delivery.

10. Conclusion

This project demonstrates a secure network design tailored to the needs of Melbourne Health Services. The use of a hierarchical topology, VLAN segmentation, and advanced security protocols ensures that the network is not only reliable but also scalable for future expansions. By reducing dependency on external IT services, the design supports cost savings while improving data security and communication efficiency across departments. Overall, this network plan highlights an effective approach to modernizing healthcare IT infrastructure while keeping it flexible for growth and technological advancements.

CCN Design Project Rubrics

Assessment tool/ weightage/ (CLO, PLO)	Excellent 10	Good 9-7	Satisfactory 6-1	Unsatisfactory 3-1	Poor 0	Marks Obtained
Viva (8%)	Excellent understanding of the project; flawless implementation	Good understanding with minor errors in implementation	Fair understanding, significant errors in implementation	Partial understanding, implementation incomplete or incorrect	No understanding or incorrect implementation	
Report (5%)	Comprehensive, well-organized, clear explanation with no errors	Good explanation, minor grammatical errors, wellstructured	Some clarity issues or errors in the explanation, moderate formatting issues	Lack of clarity, many grammatical or formatting errors	Report not submitted or irrelevant	
Simulation (7%)	All tasks are correctly implemented, fully functional network design	Most tasks are correctly implemented with minor errors	Some tasks were implemented correctly with significant issues	Most tasks are incomplete or incorrect, major network design flaws	No implementation or incorrect design	
Total						