XYZ University Network

MLB_WD_CSNE_01.01_11
IE1020 – NETWORK FUNDAMENTALS

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Introduction

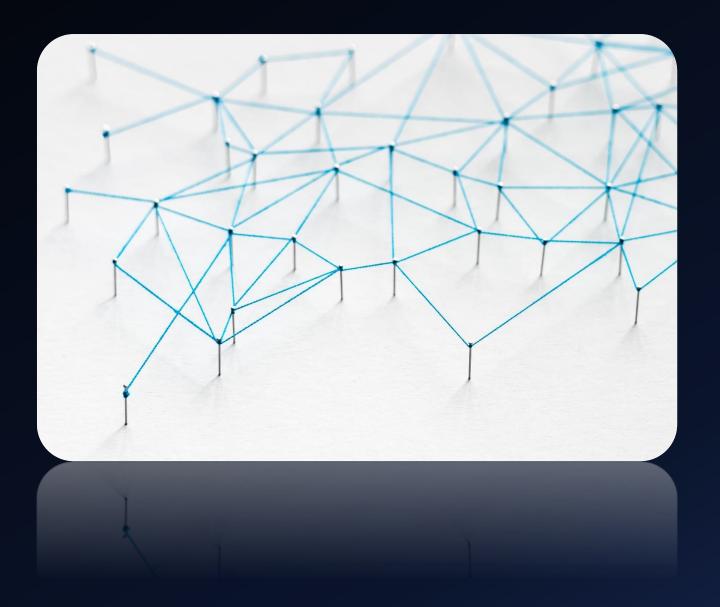This is a network designed for XYZ University with 7 branches located throughout the country.

The Main Branch is situated in the city of Colombo.

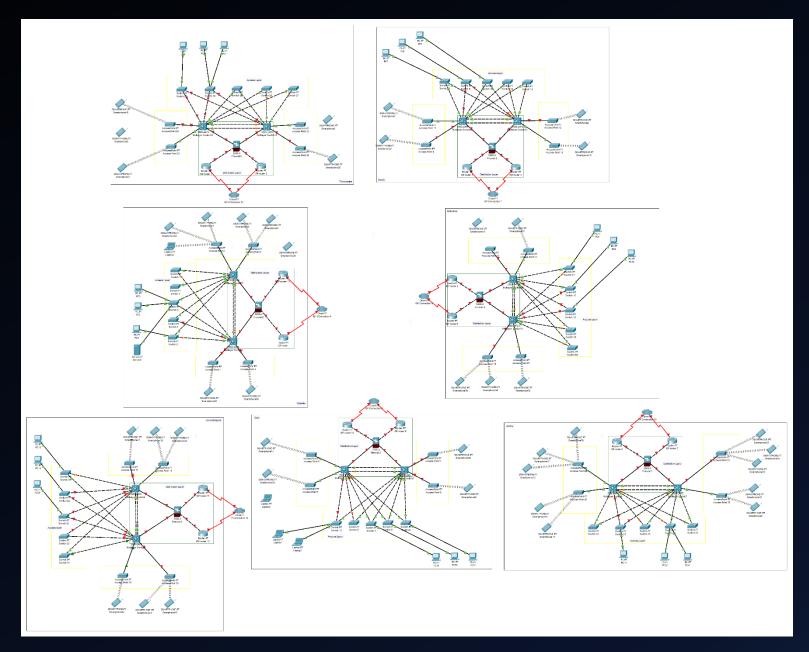This network is designed to accommodate 50,000 hosts.

University's IT Department is responsible for maintaining the network infrastructure for all the branches of the campus.

Colombo Branch holds the IT Department, which maintains the whole campus network.
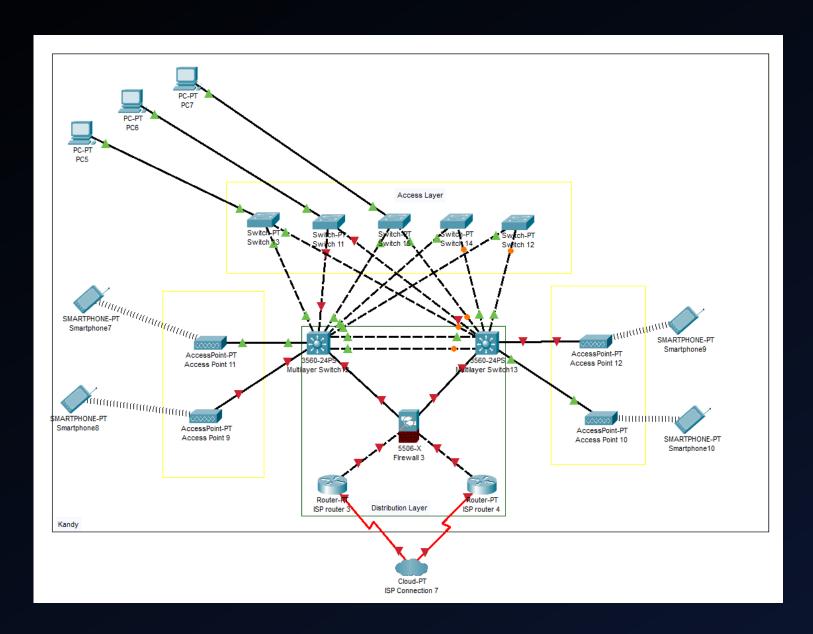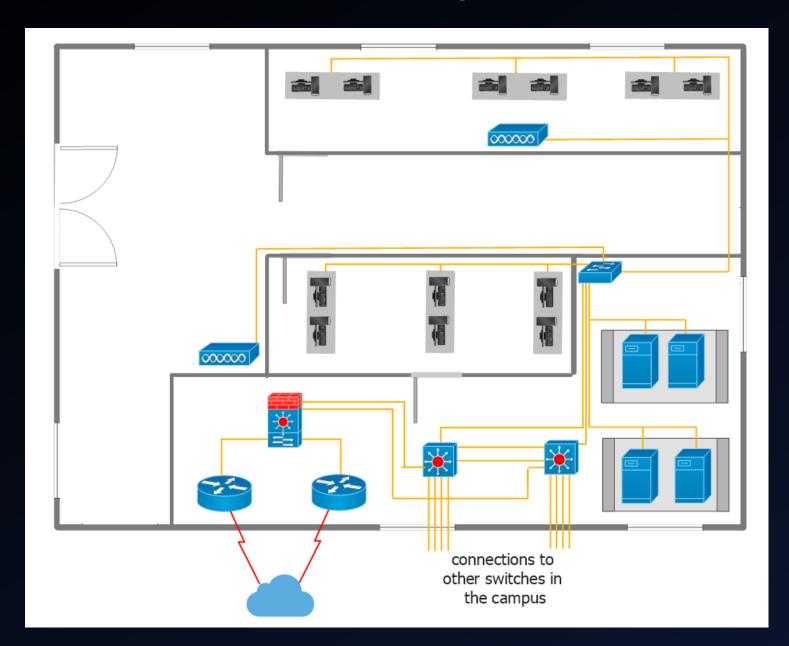
TOPOLOGY DIAGRAMS

Logical Topology Diagram

Logical Topology Diagram – Single Branch

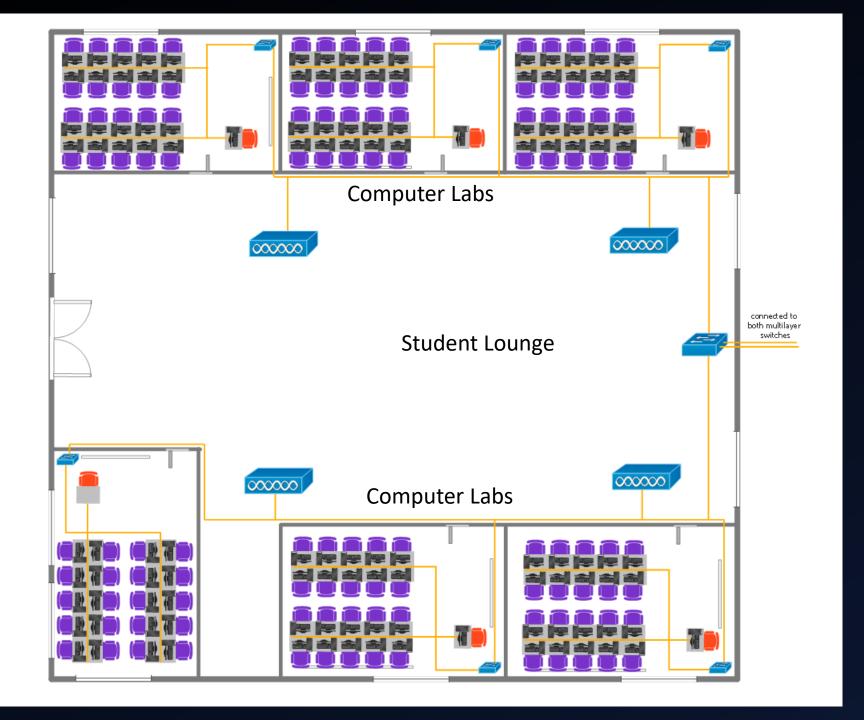

- Access Points located across the campus provides Wi-Fi connectivity to authenticated devices.

- Included for clarity

Physical Topology Diagram

Floor plan of IT Department

connections to other switches in the campus

Computer Labs

Student Lounge

connected to both multilayer switches

Computer Labs

Floor plan of a building

REAL WORLD NETWORK DEVICES

Multilayer Switch – Juniper EX4400-24X

- Provides high scalability and low latency.
- Provides faster data transfer speeds.
- Improve efficiency and security.
- Redundant power supplies to maintain uninterrupted operations. [1]

Router – Cisco Catalyst 8300 Series

- Use to facilitate 5G SD-WAN.
- Dual power supplies for fault tolerance.
- High-performance multicore processors support high-speed WAN connections. [2]

➤ Switch – Aruba 2930M 40G R0M67A

- Modular, flexible 10 Gbps Ethernet connectivity.
- Increases the scalability of an Ethernet network by providing a hierarchical structure.
- Traffic prioritization (IEEE 802.1p) for real-time classification into eight priority levels mapped to eight queues. [3]

➤ Access Points – Aruba 503 series

- Supports a wide variety of IEEE 802.11 up to 802.11ax standard devices.

- Wi-Fi 6 coverage with 1.49 Gbps maximum real-world speed.

- Two Ethernet wired network ports helps to connect to different switches which would allow for increasing fault tolerance. [4]

➢ Firewall – Cisco Adaptive Security Appliance Firewall (ASA)

- Helps organizations increase capacity and improve performance.
- Meets the unique needs of both the network and the data center.
- Offers integrated IPS, VPN, and Unified Communications capabilities.
- Adds security to the network. [5]

➢ Server – Supermicro SuperServer 2014TP - HTR

- Optimized balance of compute, memory, I/O, and storage resources.
- Providing up to 64 cores, 4TB of memory, and 128 lanes of PCIe 4.0 connectivity.
- Clip-in slide rails, pre-configured RAID, and pre-installed OS offer easy installation. [6]

➢ **Backup Service - Backblaze Business Backup**

- Provides customers with a broad variety of options for restoring data.
- Unlimited storage included.
- Convenient hard-drive-by-mail recovery option.
- Low-impact backup app runs in the background.
- Easy integration with Backblaze B2 cloud storage. [7] [27]

IP ADDRESS RANGE & VLSM

Private IP Address Range

➢ **Class B Private IP address range**

172.16.0.0 – 172.31.255.255

- Class A address range is too large.

- It will waste a large amount of IP addresses.

- Class C is too small.

- It is not sufficient to accommodate the required amount of IP addresses.

IP Addressing Schema (with VLSM)

Branch	Number of Hosts	Network Address	Usable Address IP Range	Broadcast Address
Colombo (Main)	30100	172.16.0.0/17	172.16.0.1/17 - 172.16.127.254/17	172.16.127.255/17
Kandy	8500	172.16.128.0/18	172.16.128.1/18 - 172.16.191.254/18	172.16.191.255/18
Galle	8000	172.16.192.0/19	172.16.192.1/19 - 172.16.223.254/19	172.16.223.255/19
Jaffna	1400	172.16.224.0/21	172.16.224.1/21 - 172.16.231.254/21	172.16.231.255/21
Anuradhapura	950	172.16.232.0/22	172.16.232.1/22 - 172.16.235.254/22	172.16.235.255/22
Trincomalee	800	172.16.236.0/22	172.16.236.1/22 - 172.16.239.254/22	172.16.239.255/22
Batticaloa	250	172.17.240.0/24	172.16.240.1/24 - 172.16.240.254/24	172.16.240.255/24

Protocols

- **Application Layer**

  SMTP – To send and receive e-mails over internet. [8]

  FTP – To send files through the network. [8]

  DNS – To translate domain names into IP addresses. [8]

  DHCP – To configure network devices to communicate on an IP network. [8]

- **Presentation Layer**

  SSL – Ensures the data that is transferred between client & server remains private. [9]

  NCP – used to access file, print, directory, clock synchronization, messaging, remote command execution and other network service functions [9]

- **Session Layer**

  RTCP – To monitor data delivery on multicasting. [10]

  SCP – Allows the server and client to have multiple connections over a single TCP connection. [11]

  PAP – Password-based authentication. [10]

- **Transport layer**

  TCP – Enables applications and devices to exchange messages over a network. [12]

  UDP – To prioritize time sensitive transmissions. (E.g. : DNS lookup) [13]

- **Network Layer**

  IP – Allows data packets to travel through the network to arrive at correct destination. [14]

  ICMP – Network diagnostic and error reporting is done by this protocol. [15]

  ARP – Used to discover MAC addresses associated with IP addresses. [15]

- **Data Link Layer**

    PPP – To connect one computer system to another. [16]

    STP – Used to prevent looping within a network topology. [17]

    IEEE 802.1X (NAC) – To ensuring that only authorized devices can connect to the network. [18]

- **Physical layer**

    IEEE 802.3 (Ethernet) – To create local area networks. [19]

    DSL – To transmit digital data over telephone lines. [20]

    IEEE 802.11 (Wi-Fi) – Refers to the set of standards that define communication for wireless LANs. [21]

Media Types

Wired Media

➢ **Cat6 Ethernet Cables**

- Perform up to 250 MHz which is more than twice that of CAT5e cables.

- Offer speeds up to 10-Gigabit Ethernet.

- Provide significantly lower interference (Near-End Crosstalk).

- Improves Equal-Level Far-End Crosstalk (ELFEXT), Return Loss (RL), and Insertion Loss. (IL)

- The result is less system noise, fewer errors and higher data transmission rates. [22] [23]

➤ Cat7 Ethernet Cables

- Designed to support 10 Gbps Ethernet.

- Cabling runs must be able to support frequencies (bandwidth) of up to 600 MHz over 100m of copper wire.

- Widely used across several industries demanding high performance networking and data transfer infrastructure.

- They can also to withstand a broad range of environmental and mechanical hazards.

LAN & WAN Technologies

WAN Technology

➢ **Software Defined Wide Area Network (SLT Mobitel)**

- Cost efficient.

- Increased bandwidth efficiency.

- Enhances network performance.

- Maintained by SLT Mobitel, which also makes the network futureproof. [24] [25]

LAN Technologies

➤ **Gigabit Ethernet**

- Speeds up to 10 Gbps.

- Reduced latency from 5 – 20 milliseconds.

- Supports high – speed internet and multiple devices. [26]

➤ **EtherChannel**

- A port link aggregation technology in which multiple physical port links are grouped into one logical link.

- It is used to provide high-speed links and redundancy.

- It is also known as Link Aggregation Control Protocol (LACP). [29]

- In this scenario, it is used to connect the separate floors of budlings via a backbone connection.

Physical Security
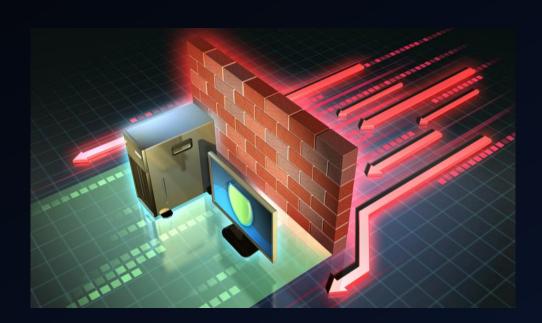
- The campus branches have security guards and check posts at every entrance.

- Only the students and authorized personnel are allowed to enter the campus premises.

- The IT Department is only accessible by providing the registered fingerprints and students are not allowed to enter.

- All the switch closets, server rooms, and racks are locked, and they are only accessible for authorized personnel.

Network Security

- The campus network is protected by Cisco ASA Software Firewalls.

- It allows collaboration with any type of device and allows dynamic routing. [5]

- The whole network is backed up using Backblaze B2 Backup Service.

- This service allows many forms of restoration methods and has unlimited storage, which is well suited for a large campus. [27]

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Q & A

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