TechLearn Academy

Campus Local Area Network (LAN) Design for Smart Learning

IEB21703 – Computer Network: A Business Users Approach

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This document is a curated academic project excerpt prepared for professional portfolio demonstration purposes. Certain implementation-level details have been simplified.

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1. Project Scope

This project involves the design and implementation of a Local Area Network (LAN) for TechLearn Academy's three-storey campus to support smart learning activities such as video conferencing, real-time collaboration, and controlled access to academic resources. The proposed network aims to provide secure, reliable, and high-performance connectivity for faculty, students, and administrative staff. The design considers scalability, efficient Internet Protocol (IP) addressing, and logical traffic segmentation using Virtual Local Area Networks (VLANs). This report presents the network requirements, hardware selection, logical and physical topology design, IP addressing scheme, device configurations, and security strategies.

2. Project Proposal

2.1 Network Requirements Analysis

TechLearn Academy operates in a three-storey building with multiple functional areas, including reception, faculty offices, shared workspaces, computer laboratories, seminar rooms, and a resource center. All faculty members and students require network access at their desks, while mobile users require wireless connectivity in selected areas.

The network must:

- Support approximately 79 wired end devices
- Provide wireless access for mobile users
- Ensure secure separation between departments
- Allow future expansion without major redesign

2.2 IP Addressing Scheme and Subnetting

The private Class C network 192.168.10.0/24 is selected. Variable Length Subnet Masking (VLSM) is applied to allocate IP addresses efficiently according to departmental size.

Table 2-2-1: IP Addressing Scheme and Subnetting

VLAN	Department	Network Address	Subnet Mask	Usable Hosts
10	Administration	192.168.10.0	255.255.255.224 (/27)	30
20	Faculty	192.168.10.64	255.255.255.192 (/26)	62
30	Students	192.168.10.128	255.255.255.192 (/26)	62
40	Computer Labs	192.168.10.160	255.255.255.224 (/27)	30
50	Wireless Users	192.168.10.192	255.255.255.224 (/27)	30
99	Network Management	192.168.10.224	255.255.255.240 (/28)	14

This addressing scheme minimizes IP wastage while providing scalability and clear departmental separation.

2.3 Estimated Network Devices

- 1 Core Router
- 3 Access Switches (one per floor), with the design allowing additional access switches to be added per floor for future expansion.
- Wireless Access Points (AP): 10 units (planned deployment)
- 1 Central Server
- Approximately 79 wired end devices and multiple wireless client devices

3. Project Hardware Requirements

3.1 Networking Devices

Table 3-1-1: Networking Devices (Hardware)

Device	Manufacturer	Series	Model	Ports
Router	Cisco	ISR	2911	3 x GigabitEthernet
Switch	Cisco	Catalyst	2960	24 x FastEthernet, 2 x GigabitEthernet
Wireless AP	Cisco	N/A	AccessPoint-PT	1 x Ethernet
Server	N/A	N/A	Generic Server	1 x Ethernet

3.2 Cable Types

- Category 6 Unshielded Twisted Pair (UTP) – horizontal cabling
- Multimode fiber optic cable – inter-floor backbone
- RJ-45 connectors

3.3 End Devices and Server Specifications

Table 3-3-1: End Devices and Server Specifications

Device	Specification
Personal Computer (PC)	• Operating System: Windows 11 • Processor: Intel Core i5 • Memory (RAM): 8 GB • Storage: 512 GB SSD
Server	• Operating System: Windows Server 2022 • Memory (RAM): 32 GB • Storage: 2 TB SSD • Role: Centralized network services (e.g., DNS, web services)
Laptop (Wireless Client)	• Operating System: Windows 11 / macOS • Wireless Interface: Wi-Fi 6 enabled

4. Network Diagram

4.1 Logical Topology

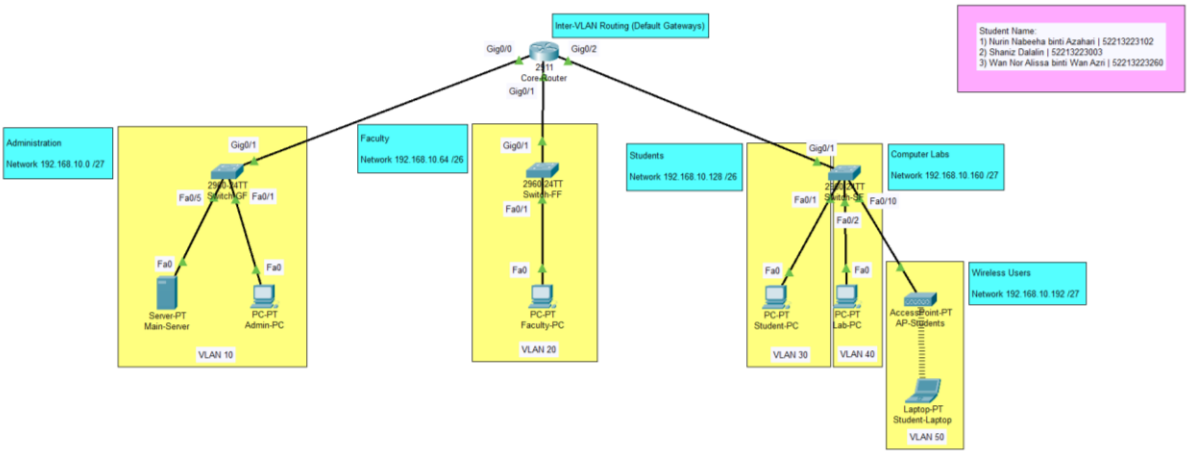

Figure 4.1.1: Logical Topology of TechLearn Academy Campus LAN

The logical topology of the TechLearn Academy campus network is designed using a VLAN-based segmentation approach to logically separate departments while sharing the same physical infrastructure. VLAN-based logical segmentation is widely adopted in campus Local Area Network (LAN) designs to improve traffic management, security, and scalability by isolating broadcast domains [1], [2].

Each functional area within the three-storey campus is assigned to a dedicated Virtual Local Area Network (VLAN) and corresponding IP subnet. The Administration, Faculty, Students, Computer Laboratories, and Wireless Users are logically separated into VLANs 10, 20, 30, 40, and 50 respectively. This logical separation reduces unnecessary broadcast traffic and prevents unauthorized access between sensitive network segments, which is considered a best practice in enterprise and educational network environments [3].

Inter-VLAN communication is provided by a central core router that performs routing between the different VLAN subnets using dedicated physical interfaces. This design approach simplifies network configuration while maintaining reliable communication between departments and supporting real-time smart learning applications such as video conferencing and online collaboration [2].

A centralized server is logically placed within the Administration VLAN to provide controlled access to network services and academic resources. Wireless access points are logically associated with the Wireless VLAN to support mobile users in seminar rooms and the

resource center. For simulation purposes, a representative access point is shown in the topology diagram. However, the logical design supports the deployment of multiple access points as required by the campus. [1].

Overall, the logical topology reflects a secure, scalable, and well-structured campus LAN design that aligns with established networking principles and supports the operational requirements of a smart learning environment. This logical design is implemented physically using a structured cabling system and hierarchical device placement, as described in Section 4.2.

4.2 Physical Topology

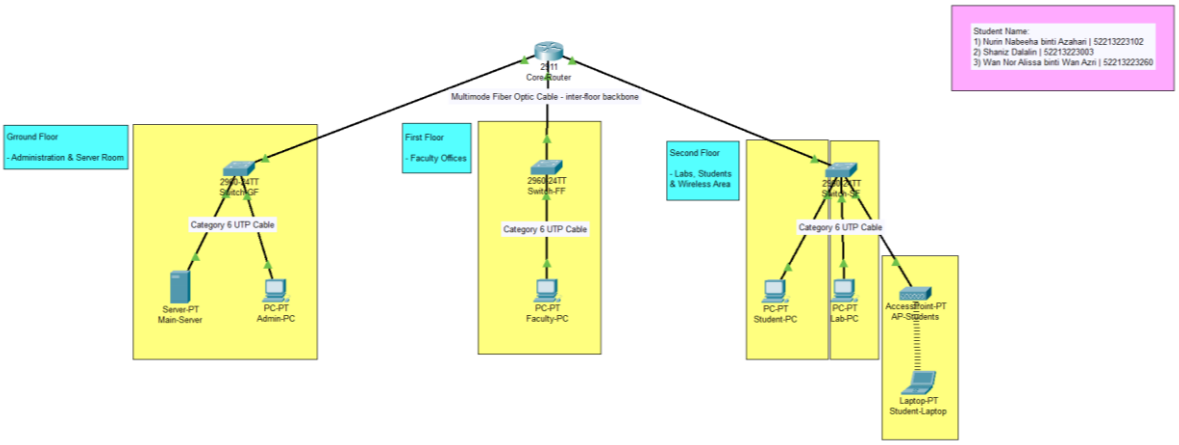

Figure 4.2.1: Physical Topology of TechLearn Academy Campus LAN

The physical topology of the TechLearn Academy campus network represents the actual placement of networking devices and the physical cabling infrastructure deployed across the three-storey building. The network follows a hierarchical star-based physical topology, which is commonly adopted in campus environments due to its simplicity, reliability, and ease of management [2], [3]. In this design, a central core router functions as the main distribution point and connects to access switches located on each floor.

On the ground floor, which accommodates the Administration Office and Server Room, an access switch is deployed to connect administrative workstations and the central server. These devices are connected using Category 6 Unshielded Twisted Pair (UTP) cables, which are suitable for horizontal cabling and support high data transmission rates with reduced interference [4]. Locating the server infrastructure on the ground floor allows for better physical security and simplified maintenance.

The first floor, dedicated to Faculty Offices, contains an access switch that connects faculty workstations using Category 6 UTP cabling. Deploying a dedicated access switch on each floor reduces cable length, improves fault isolation, and aligns with structured cabling practices recommended for enterprise and educational networks [3], [4].

The second floor hosts student learning spaces, computer laboratories, and wireless services. An access switch on this floor connects student PCs, laboratory PCs, and a wireless access point using Category 6 UTP cables. The wireless access point is physically positioned to provide network connectivity for student laptops and mobile devices in seminar rooms and shared learning areas, supporting flexible and mobile learning requirements [1], [2].

Inter-floor connectivity between the core router and all access switches is implemented using a high-speed backbone connection, forming the core of the campus network. Such centralized backbone connectivity is a standard practice in campus LAN design as it ensures reliable communication between floors and supports bandwidth-intensive applications such as video conferencing and real-time collaboration [2], [3].

Overall, the physical topology emphasizes structured cabling, clear device placement, and centralized routing. This design improves network reliability, simplifies troubleshooting, and allows the campus LAN to scale efficiently as the institution expands, while remaining consistent with established campus network design principles [2], [4].

5. Network Design Justification

A hierarchical LAN design is selected to simplify management and enhance performance. VLAN implementation reduces broadcast traffic and isolates departments for security purposes. Using physical router interfaces for inter-VLAN routing avoids complexity while maintaining reliable communication. Fiber optic backbone connections ensure high bandwidth and low latency between floors. This design supports real-time smart learning applications and allows future network expansion with minimal disruption.

6. Security Implementation

Security controls implemented:

- VLAN segmentation for traffic isolation
- Extended ACL to restrict student access to administration VLAN
- Separate wireless VLAN
- Controlled gateway routing
- Network management VLAN for monitoring

This design reduces unauthorized access risk, improves traffic isolation, and aligns with enterprise campus network design best practices.