Enterprise Campus Network Design for a New Technical College

Case Study Overview and Requirements Analysis

The selected case study involves designing a complete, modern enterprise network for a newly established technical college campus consisting of four main buildings:

1. Administration Building
2. Engineering Building
3. Computer Science Building
4. Library Building

The campus will serve approximately 1,200 students and over 140 faculty and administrative staff members. The network must support administrative functions, high-density computer laboratories, smart classrooms, wireless access for mobile devices, IP surveillance systems, IoT devices, and a centralized server farm.

Total estimated endpoints: approximately 530 wired and wireless devices (excluding infrastructure equipment).

Detailed Building and User Breakdown

Administration Building

- 30 administrative offices
- 10 HR and finance offices
- 3 conference rooms
- 1 central data center/server farm (DNS, DHCP, Active Directory, LMS, file storage, email, management servers)
- Total endpoints: 90 devices

Engineering Building

- 3 computer labs × 25 PCs = 75 PCs
- 20 faculty offices
- 10 smart classrooms

- 1 robotics/embedded systems workshop (requires isolation)
- Total endpoints: 150 devices

Computer Science Building

- 5 advanced labs × 30 PCs = 150 PCs
- 15 faculty offices
- 5 smart classrooms
- 1 dedicated AI/ML laboratory (high bandwidth + security requirements)
- Total endpoints: 200 devices

Library Building

- 40 public student workstations
- 10 staff workstations
- 20 wireless study tables
- IP surveillance cameras and access control systems
- Self-service kiosks and digital signage
- Total endpoints: 90 devices

Grand Total: ~530 endpoints

Network Design Objectives

- Hierarchical design: Core – Distribution – Access layers
- High-speed 10 Gbps fiber backbone between buildings
- Full VLAN segmentation by department and user type
- Scalable IP addressing scheme with room for future growth
- Dynamic routing using OSPF multi-area for fast convergence and redundancy
- Comprehensive security using ACLs, firewall, and zone segmentation
- High-availability design (redundant core switches, dual uplinks, HA firewall)
- Robust wireless coverage using Cisco 9120AX access points
- Centralized authentication and management
- Stateful firewall and NAT at the Internet edge

Physical Topology and Per-Building Equipment

Administration Building (Core + Data Center)

- 2 × Cisco Catalyst 9600 (Core Switches) – StackWise Virtual, redundant
- 2 × Cisco Firepower 2140 (Firewall HA pair – Active/Standby)
- 1 × Cisco ASR 1001-X (Border Router to ISP)
- 2 × Catalyst 9400 (Local Distribution Switches)
- 4 × Catalyst 9200L 48-port PoE+ (Access layer for offices)
- 12 × Cisco 9120AX Wireless Access Points
- Server Farm (all campus servers located here)

Engineering Building

- 2 × Catalyst 9300-48U (Distribution Switches – stacked)
- 8 × Catalyst 9200L 48-port PoE+ Access Switches
- 18 × Cisco 9120AX Wireless Access Points
- 8 × IP cameras
- Uplinks to Core: 2 × 10 Gbps fiber (L3 EtherChannel)

Computer Science Building

- 2 × Catalyst 9300-48U (Distribution Switches – stacked)
- 12 × Catalyst 9200L 48-port PoE+ Access Switches
- 22 × Cisco 9120AX Wireless Access Points
- 10 × IP cameras
- Uplinks to Core: 2 × 10 Gbps fiber (L3 EtherChannel)

Library Building

- 2 × Catalyst 9300-48U (Distribution Switches – stacked)
- 6 × Catalyst 9200L 48-port PoE+ Access Switches
- 16 × Cisco 9120AX Wireless Access Points
- 12 × IP cameras
- Uplinks to Core: 2 × 10 Gbps fiber (L3 EtherChannel)

VLAN Design

VLAN ID	VLAN Name	Purpose	Buildings Used In
10	Admin_Staff	Administrative staff	Administration
20	Faculty	All faculty offices	All buildings
30	Students_Wired	Student lab PCs	Engineering, CS, Library
40	Students_Wireless	Student Wi-Fi	All buildings
50	Guest_WiFi	Guest wireless network	All buildings
60	IoT_Surveillance	IP cameras & access control	All buildings
70	Robotics_Lab	Isolated robotics workshop	Engineering
80	AI_Lab	AI/ML lab (high security)	Computer Science
99	Management	In-band management	All switches/routers
100	Servers	Server farm subnet	Administration only
999	Native	Native VLAN (unused)	-

IP Addressing Plan (Using 172.16.0.0/16 Private Range)

Subnet Name	Network Address	Subnet Mask	Usable Range	VLAN	Assigned To	Hosts Needed	Hosts Available
Admin_Staff	172.16.10.0	255.255.255.0	172.16.10.1 – 172.16.10.254	10	Admin offices	90	254
Faculty	172.16.20.0	255.255.255.0	172.16.20.1 – 172.16.20.254	20	All faculty	70	254
Students_Wired	172.16.30.0	255.255.254.0	172.16.30.1 – 172.16.31.254	30	Lab PCs	375	510

Students_Wireless	172.16.32.0	255.255.252.0	172.16.32.1 – 172.16.35.254	40	Student Wi-Fi	600	1022
Guest_WiFi	172.16.36.0	255.255.255.0	172.16.36.1 – 172.16.36.254	50	Guests	200	254
IoT_Surveillance	172.16.37.0	255.255.255.0	172.16.37.1 – 172.16.37.254	60	Cameras & IoT	50	254
Robotics_Lab	172.16.38.0	255.255.255.0	172.16.38.1 – 172.16.38.254	70	Robotics workshop	30	254
AI_Lab	172.16.39.0	255.255.255.0	172.16.39.1 – 172.16.39.254	80	AI/ML lab	40	254
Management	172.16.99.0	255.255.255.0	172.16.99.1 – 172.16.99.254	99	Switch/router management	100	254
Servers	172.16.100.0	255.255.255.0	172.16.100.1 – 172.16.100.254	100	All servers	20	254
Core_Interconnect	172.16.200.0	255.255.255.248	172.16.200.1 – 172.16.200.6	-	Point-to-point links	-	6

Routing Protocol Selection

Chosen Protocol: OSPF Multi-Area Design

- Area 0: Core and inter-building links
- Area 1: Engineering Building
- Area 2: Computer Science Building
- Area 3: Library Building
- Area 100: Administration internal

Justification:

- Open standard (works with multi-vendor in future)
- Fast convergence (sub-second with BFD)
- Excellent scalability (multi-area reduces LSA flooding)
- Supports VLSM and summarization
- Preferred over EIGRP (Cisco proprietary) for educational environments

Access Control List (ACL) Security Plan

ACL Name	Applied On	Direction	Purpose
ACL_LAB_ISOLATE	Distribution routers	In	Deny lab subnets from accessing server subnet directly (force via firewall)
ACL_GUEST	Wireless Controller	In	Allow only HTTP/HTTPS/DNS, deny all internal access
ACL_IOT	Distribution	In	Allow IoT only to surveillance server, block everything else
ACL_ROBOTICS	Engineering Dist	In	Block robotics lab from accessing student wired subnet
ACL_INTERNET	Firewall outside	In	Block inbound traffic except established and VPN

Estimated Equipment Cost (2025 Pricing – Cisco GPL)

Item	Quantity	Unit Price (USD)	Total (USD)
Catalyst 9600 Core (Sup + 8×10G)	2	28,000	56,000
Catalyst 9300-48U Distribution	6	7,500	45,000
Catalyst 9200L-48P Access	30	3,800	114,000
Firepower 2140 HA Pair	2	35,000	70,000
ASR 1001-X Border Router	1	18,000	18,000
Cisco 9120AX Access Points	68	900	61,200
Servers & Licenses	Lot	-	45,000
Fiber Cabling + Patch Panels	Lot	-	25,000
Grand Total			**434,200 USD**

Conclusion

This design delivers a professional-grade, secure, scalable, and highly available campus network that exceeds typical educational requirements. The hierarchical structure, multi-area OSPF routing, comprehensive VLAN and ACL segmentation, redundant core, and centralized server architecture ensure long-term manageability and performance.