**Campus Network Design**

**Physical Network Design**

The proposed campus network for Holmview Primary School adopts a hierarchical star topology to balance performance, scalability, and security. At the centre of the network is a Main Distribution Frame (MDF) located in the administration block. The MDF houses the core switch, firewall, and router. Fibre optic cabling extends from the MDF to Intermediate Distribution Frames (IDFs) located in other buildings such as classrooms, staff blocks, and the library. Each IDF hosts an access layer switch that connects end-user devices via Cat6/cat6a ethernet cabling.

This star topology allows for high-speed connectivity between buildings and facilitates fault isolation. The core swich uses 10Gbps uplinks to distribution switch and access switches use 1Gbs ports to end-user devices

**Logical Network Structure**

The logical network is divided into Virtual LANs (VLANs) to isolate traffic by role and function. Each VLAN is allocated from the 10.10.0.0/16 private address space, with subnetting tailored to the scale of each group

* VLAN 10: Admin/Management - 10.10.10.0/24
* VLAN 20: Teaching Staff - 10.10.20.0/24
* VLAN 30: Students WiFi - 10.10.30.0/21 (over 2,046 usable addresses for students and BYOD devices)
* VLAN 40: Guest WiFi - 10.10.40.0/24
* VLAN 50: IoT Devices (e.g., CCTV) - 10.10.50.0/24
* VLAN 60: Servers/Infrastructure - 10.10.60.0/24

This subnetting model prevents broadcast domain bloat, optimises address usage, and simplifies troubleshooting. Inter-VLAN routing is handled at the core switch, with the gateway providing north-south routing, internet access, and firewall enforcement. To support resilience and scalability, the MDF and IDFs will run OSPF (Open Shortest Path First) as a dynamic routing protocol, ensuring automatic route advertisement of VLAN subnets and rapid convergence in case of link or device failures.

**IP Addressing**

The campus uses the private address range 10.10.0.0/16. Each VLAN is assigned a dedicated subnet to ensure logical separation and ease of management. The student VLAN uses a /22 subnet (10.10.30.0/22) to accommodate over 1000 users. DHCP is configured to automatically assign IPs within each VLAN range.

**IP Addressing Scheme**

The network design for Holmview Primary School adopts the private IP address space 10.10.0.0/16 to allow for scalability and efficient allocation of IP addresses across the various departments and functions within the school. To support logical separation and improved network performance, the network is segmented into VLANs by user type and service category. Each VLAN is assigned its own subnet, with address ranges tailored to anticipated device counts and future growth.

The student VLAN, which serves the highest number of users, is allocated a /21 subnet (10.10.30.0/21). This subnet provides 2,046 usable IP addresses, which is sufficient to support 2000+ students and their devices, with room for BYOD polices and growth over time.

The table below outlines the proposed IP addressing scheme:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **VLAN ID** | **Purpose** | **Subnet (CIDR)** | Subnet Mask | **Usable IPs** | **IP Range** | **Default Gateway** |
| 10 | Admin/ Management | 10.10.10.0/24 | 255.255.255.0 | 254 | 10.10.10.1 - 10.1010.254 | 10.10.10.1 |
| 20 | Staff | 10.10.20.0/24 | 255.255.255.0 | 254 | 10.10.20.1 - 10.10.20.254 | 10.10.20.1 |
| 30 | Students | 10.10.30.0/21 | 255.255.248.0 | 2046 | 10.10.30.1 - 10.10.37.254 | 10.10.30.1 |
| 40 | Guest WiFi | 10.10.40.0/24 | 255.255.255.0 | 254 | 10.10.40.1 - 10.10.40.254 | 10.10.40.1 |
| 50 | IoT Devices (CCTV, etc.) | 10.10.50.0/24 | 255.255.255.0 | 254 | 10.10.50.1 - 10.10.50.254 | 10.10.50.1 |
| 60 | Servers/ Infrastructure | 10.10.60.0/24 | 255.255.255.0 | 254 | 10.10.60.1 - 10.10.60.254 | 10.10.60.1 |

**Each subnet is routed through a Layer 3 switch or router, with firewall rules and access controls applied at the VLAN boundary to ensure data privacy and network security. This structed IP addressing approach ensures the network is easy to manage, scalable, and aligned with industry standards.**

**Switch and Cabling Standards**

* Core Switch: Layer 3 managed switch with 10G SFP+ ports
* Access Switches: Managed Layer 2 switches with PoE for wireless access points and IoT devices
* Backbone Cabling: Fibre
* Horizontal Cabling: Cat6 of Cat6a structured cabling to wall ports

**Redundancy and Scalability**

The design Includes:

* Dual fibre links between MDF and IDFs for redundancy
* Redundant power supply and UPS for core networking gear
* Space for additional switch ports to accommodate future growth
* Modular cabinet systems to expand rack capacity

**Network Star Topology Diagram**

Below is the star topology diagram illustrating the logical connections between the MDF (Core Switch) and all other blocks (Admin, Staff, Student, IoT/Library, and Server Room), with VLAN IDs and IP ranges clearly labelled:

**Network Equipment**

The Holmview Primary School network design will use Ubiquiti UniFi products for a consistent, centrally managed infrastructure.

* Core Layer
  + 1 x UniFi Dream Machine Pro Max - provides routing, VPN, and firewall services
* Aggregation (10G Backbone)
  + 1 x Enterprise Campus Aggregation – 48 x 25G SFP+ for spine/aggregation
  + Optics/Cabling: 10G SFP+ SR modules with OM4 MMF or SFP+ DAC for short runs.
* Core Switching
  + 1 x UniFI Enterprise Campus 48 PoE – Layer-3 features for inter VLAN routing.
  + Dual 10G SFP+ uplinks aggregated to Enterprise Aggregation (LACP).
* Distribution/Access (per IDF)
  + UniFi Enterprise Switch – VLANs, PoE for APs/IoT. Each with dual 10G SFP+ uplinks (LACP) back to Enterprise Aggregation.
* Wireless
  + UniFi U7 Pro Max - VLAN tagging for Staff/Student/Guest SSIDs.
* Servers / Video / Mgmt
  + UniFi Protect NVR
  + File/Backup Server
* Cabling & Power
  + OM4 Fiber between MDF-IDFs; Cat6a for horizontal runs
  + UPS in MDF/IDFs; consider redundant PSU models (e.g., Aggregation)

Sustainability and Future Proofing

The design reflects sustainable networking principles. All access switches support Power over Ethernet (PoE+), reducing the need for external power bricks and simplifying cabling for access points and IoT devices. Energy-efficient switches and UniFi’s central controller allow scheduled shutdown of noncritical devices outside school hours, reducing power consumption. Virtualised servers and cloud-based backup reduce hardware sprawl, while dual-stack IPv4/IPv6 support ensures the network will remain viable in the long term. The use of modular aggregation and high-capacity fibre backbone ensures that the school can expand its enrolment or add new facilities without a major redesign.

* **Dream Machine SE $499**

**Enterprise Campus 48 PoE Switch**

**U7 Pro XG AP**

**Security WiFi radius server**