Ethernet Network Design Project

Old Dominion University — IT 315
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1. Executive Summary

This project outlines a complete Ethernet network design for a four-level school building consisting of a Basement, First Floor, Second Floor, and Third Floor. The building contains 74 rooms, each requiring two live network outlets, and a Main Office that must connect to a secured internet connection shared by the entire school. Cable distances fall within industry standards, with the longest horizontal run measuring 98.17 meters, the shortest 11.32 meters, and an average run length of 54.75 meters.

The goal is to design a professional-grade, cost-efficient, and secure network that meets project requirements (i.e., middle-of-the-pack leaning towards better performance) without introducing unnecessary enterprise-grade complexity. This paper describes the school's physical topology, structured cabling, equipment selection, security considerations, and a detailed materials budget using updated Amazon pricing and other third-party industry vendors' websites and warehouse inventory.

2. Physical Topology and Cabling Design

2.1. Building Layout and Telecommunications Closets

The school uses a hierarchical star topology, with one Equipment Room (ER) on the First Floor and three Telecommunications Closets (TCs) located on the Basement, Second Floor, and Third Floor. All closets are vertically aligned, which ensures consistent cable distances between floors and general building infrastructure.

Room distribution:

- Basement: 17 rooms → 34 drops
- First Floor: 21 rooms → 42 drops
- Second Floor: 19 rooms → 38 drops
- Third Floor: 17 rooms → 34 drops
- Total: 74 rooms × 2 = 148 drops

2.2. Inclusion of the Main Office

The Main Office, located on the First Floor, has two dedicated Ethernet outlets like all other rooms. Because it is located on the same floor as the Equipment Room, it connects directly to the school's centralized pfSense firewall, ensuring that the Main Office uses the secured internet connection shared by the entire building.

2.3. Horizontal Cabling (Cat6)

Cat6 UTP riser-rated (CMR) cable is used for all horizontal runs. Cat6 supports 1 Gbps up to 100 meters, meets ANSI/TIA-568 requirements, and provides excellent performance without exceeding "professional-grade" expectations.

Cable requirement:

148 drops × 54.75 m average ≈ 8,103 meters (~26,585 ft)

To meet this requirement with ample slack, 27 boxes of 1000 ft Cat6 cable are selected. This design assumes non-plenum ceiling spaces for horizontal cabling; in a true plenum environment, code would require plenum-rated (CMP) cable or conduit, but this level of detail is beyond the project scope.

2.4. Fiber Backbone

A 6-strand OM3 multimode fiber backbone connects each TC to the First-Floor Equipment Room, supporting high-speed uplinks and future bandwidth expansion. A fiber backbone is included between wiring closets to support future bandwidth expansion and long-term scalability, consistent with modern networking best practices.

3. Network Equipment and Logical Design

3.1. Switching Infrastructure

The design uses four 48-port managed PoE switches, with one per floor:

- The First Floor switch serves as the core switch, performing inter-VLAN routing.
- The Basement, Second Floor, and Third Floor switches serve as access switches.
- PoE capability allows support for wireless access points or other powered devices.

3.2. Firewall and Security Technology

A Netgate 6100 pfSense+ Security Gateway provides:

- Stateful firewall protection
- VLAN routing and segmentation
- VPN capability
- Optional IDS/IPS modules

3.3. Wireless Access Points

Four Ubiquiti UniFi U6-LR Wi-Fi 6 access points (one per floor) offer modern wireless coverage and operate using PoE from the switches.

4. Materials List and Budget

Item	Qty	Unit Price	Subtotal
Cat6 Cable (trueCABLE, 1000 ft)	27	$190.00	$5,130.00
Keystone Jacks (100-pack)	2	$75.00	$150.00
Wall Plates (10-pack)	8	$5.15	$41.20
Patch Panels (48-port)	4	$70.00	$280.00
UniFi Switch 48 PoE	4	$589.00	$2,356.00
UniFi U6-LR Access Points	4	$179.00	$716.00
Netgate 6100 Firewall	1	$849.00	$849.00
APC Smart-UPS 1500VA	2	$661.00	$1,322.00
OM3 Fiber Backbone	1	$447.00	$447.00
Patch Cords*	—	—	$800.00
Racks, labels, tools, misc.*	—	—	$1,500.00
Total Estimated Cost:			**$13,591.20**

**** Patch cords and miscellaneous tool costs are shown as lump sums because they include multiple low-cost components whose individual pricing varies. Total values are based on current market averages.***

All selected equipment—Cat6 cabling, OM3 fiber, UniFi PoE switches, and the Netgate firewall—meets the requirement for professional-grade hardware while avoiding unnecessary enterprise-level cost or complexity. This design also incorporates emerging best practices such as VLAN segmentation, Wi-Fi 6 wireless access points, and a fiber backbone to ensure modern, scalable network performance. Additional components such as rack-mounted PDUs, enterprise NAC systems, or advanced monitoring appliances were intentionally excluded, as they exceed the scope of this assignment and are not required for a functional, professional-grade school network.

5. Pricing Sources

- **trueCABLE Cat6 UTP Riser (CMR), 1000 ft:** https://www.truecable.com/products/cat6-riser-ethernet-cable-unshielded
- **Cat6 Keystone Jack, 100-pack:** https://www.amazon.com/100-Pack-Cat6-Keystone-Jack-Compatible/dp/B07YS6RP9G
- **2-Port Keystone Wall Plates (10-pack):** https://infinity-cable-products.com/products/white-wall-plate-2-port
- **48-Port Cat6 Patch Panel (2U):** https://www.computercablestore.com/48-port-cat6-rack-mount-patch-panel-2u
- **UniFi Switch 48 PoE (USW-48-POE):** https://store.ui.com/us/en/products/usw-48-poe
- **UniFi U6-LR Wi-Fi 6 AP:** https://store.ui.com/us/en/products/u6-lr
- **Netgate 6100 pfSense+ Gateway:** https://shop.netgate.com/products/6100-base-pfsense
- **APC Smart-UPS 1500VA:** https://www.amazon.com/APC-Smart-UPS-SmartConnect-Uninterruptible-SMT1500C/dp/B0762QJ6Y1
- **6-Strand OM3 Indoor Riser, 1000 ft spool:** https://www.amazon.com/Multimode-Fiber-Indoor-Distribution-Corning/dp/B0D25ZZFYB
- **Patch Cords, Copper & Fiber Patch Cords**: N/A
- **Racks & Tools:** N/A

6. Conclusion

This network design provides a complete, standards-compliant Ethernet infrastructure for a multi-story school building. By using Cat6 cabling, a fiber backbone, managed PoE switches, and a dedicated firewall, the design meets all instructional requirements while avoiding unnecessary enterprise-class cost and complexity.

The Main Office has its required dedicated outlets and connections through the same secured firewall-protected internet gateway used by the entire school, formally satisfying the project requirement.

At approximately ***$13,591.20***, this design is realistic, professional, cost-effective, and aligned with assignment expectations. It supports modern networking practices while remaining scalable for future upgrades.