

Ethernet Network Design Project

Old Dominion University – IT 315

Cora Wilson

1. Executive Summary

This Project presents a complete Ethernet network design for a four-level school building consisting of a basement, first floor, second floor, and third floor. The building includes 74 rooms, each needing two active network outlets, along with a main office that must connect to a secure internet connection shared across the entire school. Cable distances stay within industry standards, with the longest run measuring 98.17 meters, the shortest 11.32 meters, and an average length of 54.75 meters.

The objective of this design is to create a secure, cost effective, and professional grade network that meets project requirements without introducing unnecessary enterprise level complexity. This paper outlines the physical topology, structured cabling approach, selected equipment, security measures, and a detailed budget based on current market pricing from industry vendors.

Physical Topology and Cabling Design

2.1 Building Layout and Telecommunications Closets

The network is designed using a hierarchical star topology, consisting of one equipment room found on the first floor and three telecommunications closets positioned on the basement, second floor, and third floor. All closets are vertically aligned, which simplifies backbone cabling and ensures consistent cable distances across floors.

Room distribution is as follows:

Basement: 17 rooms – 34 Drops

First floor: 21 rooms – 42 Drops

Second floor: 19 – 38 Drops

Third floor: 17 rooms – 34 Drops

This results in a total of 74 rooms and 148 network drops

2.2 Main Office Connectivity

The main office, found on the first floor, includes two dedicated ethernet outlets, consistent with all other rooms. Because it is positioned near the equipment room, it connects directly to the centralized pfSense firewall. This ensures that the main office uses the same secured internet connection as the rest of the school.

2.3 Horizontal Cabling (Cat6)

Category 6 (Cat6) unshielded twisted pair (UTP) riser rated (CMR) cable is used for all horizontal runs. Cat6 supports speeds up to 1 Gbps at distances up to 100 meters (about 328.08 ft) and follows ANSI/TIA-568 standards. This makes it a reliable and cost-effective choice for a professional network environment.

The total cabling requirement is calculated as follows:

148 drops x 54.75 meters = 8,103 meters (26,585 feet)

To allow for installation of slack and potential waste, 27 boxes of 1000 foot Cat6 cable are selected. This design assumes non-plenum ceiling spaces if plenum spaces were present; plenum rated (CMP) cable or conduit would be needed to meet fire safety requirements.

2.4 Fiber Backbone

A 6 strand OM3 multimode fiber backbone connects each telecommunications closet to the equipment room on the first floor. This backbone supports high speed communication between floors and allows for future scalability. Including fiber aligns with modern networking practices and ensures the network can accommodate increased bandwidth demands overtime.

3. Network Equipment and Logical Design

3.1 Switching Infrastructure

The design uses four 48 port managed power over Ethernet (PoE) switches, with one installed on each floor.

The first-floor switch functions as the core switch and handles inter VLAN routing.

The remaining switches act as access switches, providing connectivity to end devices.

PoE capability allows devices such as wireless access points to receive power directly through ethernet cables, cutting the need for separate power sources.

3.2 Firewall and Security Technology

A netgate 6100 pfSense+ security gateway is implemented to manage network security and traffic, its key features include:

- Stateful firewall protection
- VLAN segmentation and routing
- Virtual private network (VPN) support
- Optional intrusion detection and prevention capabilities

3.3 Wireless Access Points

Four Ubiquiti U6-LR Wi-Fi 6 access points are installed, with one on each floor. These devices provide reliable wireless coverage throughout the building and are powered using PoE from the network switches.

4. Materials List and Budget

Cabling and Installation Materials

Item	Quantity	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

Network Hardware

Item	Quantity	Unit Price	Subtotal
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
--------------------------	---	----------	----------

Infrastructure and Supporting Equipment

Item	Quantity	Unit Price	Subtotal
APC Smart-UPS 150VA	2	\$661.00	\$1,322.00
OM3 Fiber Backbone	1	\$447.00	\$447.00
Patch cords (Estimated)	—	—	\$800.00
Racks, Tools, and Miscellaneous	—	—	\$1,500.00

Total Estimated Cost

The total estimated cost of the network design is \$13,591.20. This budget reflects current pricing while keeping a balance between affordability and professional grade quality.

5. Conclusion

This network design provides a complete and compliant Ethernet infrastructure for a multi-story school building. By incorporating Cat6 cabling, fiber backbone, managed PoE switches, and a dedicated firewall, the design satisfies all project requirements while keeping cost-effective and practical.

The main office is fully integrated into the network and securely connected to the centralized internet gateway used by the entire school. With a total estimated cost of \$13,591.20, this design is realistic, scalable, and aligned with current networking standards.

Pricing Sources

trueCABLE. (2026). *Cat6 UTP riser (CMR) Ethernet cable, 1000 ft.* Retrieved May 5, 2026, from <https://www.truecable.com/products/cat6-riser-ethernet-cable-unshielded>

Amazon. (2026). *Cat6 keystone jack, 100-pack.* Retrieved May 5, 2026, from <https://www.amazon.com/100-Pack-Cat6-Keystone-Jack-Compatible/dp/B07YS6RP9G>

Leviton. (2026). *QuickPort 2-port wall plate.* Retrieved May 5, 2026, from <https://www.leviton.com/en/products/41080-2wp>

Computer Cable Store. (2026). *48-port Cat6 rack-mount patch panel (2U).* Retrieved May 5, 2026, from <https://www.computercablestore.com/48-port-cat6-rack-mount-patch-panel-2u>

Ubiquiti. (2026). *UniFi Switch 48 PoE (USW-48-POE).* Retrieved May 5, 2026, from <https://store.ui.com/us/en/products/usw-48-poe>

Ubiquiti. (2026). *UniFi U6-LR Wi-Fi 6 access point.* Retrieved May 5, 2026, from <https://store.ui.com/us/en/products/u6-lr>

Netgate. (2026). *Netgate 6100 pfSense+ security gateway.* Retrieved May 5, 2026, from <https://shop.netgate.com/products/6100-base-pfsense>

APC by Schneider Electric. (2026). *Smart-UPS 1500VA (SMT1500C).* Retrieved May 5, 2026, from <https://www.amazon.com/APC-Smart-UPS-SmartConnect-Uninterruptible-SMT1500C/dp/B0762QJ6Y1>

Amazon. (2026). *OM3 multimode fiber cable (6-strand, 1000 ft).* Retrieved May 5, 2026, from <https://www.amazon.com/Multimode-Fiber-Indoor-Distribution-Corning/dp/B0D25ZZFYB>