Ethernet Network Design Project

1) Quick project facts & design assumptions

- Building: multi-story school (basement + 1st + 2nd + 3rd floors).
- Rooms: 74 rooms total (Basement 17, 1st 21, 2nd 19, 3rd 17).
- Drops: 2 network drops per room → 148 network drops.
- Average horizontal cable run (given): 54.75 m.
- Add 10% slack/waste for pulls/patching: used for total cable calculation.
- Closets: 4 total (one Equipment Room on 1st floor; Telco closets in Basement, 2nd, 3rd floors). Each closet is vertically aligned, so cable lengths to that closet are the same on every floor.
- Focus: physical topology, patching, backbone, security appliances (not hosts).

2) Cabling math & key counts (explicit)

- Drops = 74 rooms × 2 = 148 drops.
- Total installed cable length (before slack) = 148 × 54.75 m = 8,103 m.
- With 10% slack/waste → 8,913.3 m (≈ 29,243 ft).
- Standard bulk spool = 1,000 ft (≈ 304.8 m).
    - Spools needed = 29,243 ft / 1,000 ft ≈ 29.25 → round up to 30 spools of 1,000 ft Cat6a.
    - (Calculation shown so you can change avg length or slack and re-run.)

3) Topology & component choices (high-level)

- Horizontal cabling: Cat6a U/UTP (solid conductor) to support 10 Gb/s up to 100 m and provide future-proofing. Use plenum/riser rated as required by building code for the ceiling/vertical runs.
    - Terminate to keystone jacks and 2-port wall plates in classrooms (two outlets per room).

- Patch panels: 48-port Cat6a patch panels in each closet + in the equipment room to terminate drops.

- Access switches (one per closet): 48-port Gigabit managed PoE+ switches in each closet (to support VoIP phones, possible APs, cameras). Each switch should provide at least 2×10G SFP+ uplink ports for the backbone to the equipment room.

- Core (equipment room): 24-port (or 1U appropriate) 10G SFP+ capable core switch with enough SFP+ ports to aggregate the floor uplinks and provide uplink to the firewall/Internet.

- Backbone: multimode fiber (OM4) duplex between each closet and the equipment room (10G SFP+ links). Use fiber trunks (LC/LC) sized for short vertical distance (short fiber runs between floors).

- Firewall/UTM: a mid-range UTM/firewall appliance to secure traffic to the Internet (with licensing for AV/IPS/DNS filtering). Should support ~1 Gbps or more, depending on the Internet pipe; include one year of security/management license in the cost.

- Security features (design): VLAN segmentation (staff/student/IoT), 802.1X port-based authentication, ACLs, IDS/IPS (either built into firewall or dedicated), central logging/SIEM for events, TLS inspection where policy allows.

- Racks, PDUs & UPS: 42U rack(s) in equipment room and a 12–18U rack or wall-mounted cabinet in closets, rackmount PDUs, and an equipment room UPS for graceful shutdown.

4) Materials list + descriptions (ordered by subsystem)

Horizontal cabling & outlets

- Cat6a bulk cable (UTP, riser/plenum as required) 30 × 1,000 ft spools. (Use Cat6a to be safe for 10G on copper.) CableWholesale

- RJ-45 keystone jacks (Cat6a) 148 (one per drop).

- Wall plates (2-port faceplate per room) 74 plates (2 keystone holes each).

- Faceplate screws and labeling stickers.

Closets & patching

- 48-port Cat6a patch panels, 4 units (one per closet/equipment room).

- Rack mount cable managers (horizontal/vertical).
- Short patch cables (0.5–1 ft) to connect the patch panel → switch ports (approx 148 short patch cables).
- Longer patch cables for the work area to desk switches, if needed.

Switching & backbone

- Managed 48-port PoE+ Gigabit switches (one in each closet), 4 units. Each with 2×10G SFP+ uplinks recommended. (Professional SMB models / Juniper / Zyxel / Cisco family.) IT Pro+1
- Core 10G switch (SFP+ ports) in equipment room 1 unit (24-port SFP+/mix). network-switch.com
- Multimode fiber OM4 duplex trunk cables: 3 uplinks (Basement→ER, 2nd→ER, 3rd→ER) with spare fibers. Add fiber patch cords (LC) for each end.

Security & infrastructure

- Firewall/UTM appliance (school-sized; includes 1-yr license for filtering/IPS). TrustRadius for Vendors+1
- Managed switch features: 802.1X, VLANs, QoS.
- Racks (42U for equipment room + 3 smaller cabinets/wall-racks for closets).
- PDU(s), UPS for equipment room.
- Cable ties, Velcro, labels, firestop kit for each cable penetration.
- Cable tester/certification tool (TDR / wiremap / Cat6a certifier), either buy or subcontract to test/certify.

Optional but recommended

- Wireless APs (PoE) are placed strategically separate design.
- IDS/IPS appliance/logging server (can be part of firewall licensing).
- Spare ports and spare cable spool(s) (recommended +1 spool spare).

5) Quantity & cost estimates line item budget (realistic, mid-range pricing)

> Notes about pricing: I used current market prices/example vendor prices for major load-bearing items (Cat6a spool, PoE switches, and firewall ranges). Component prices vary by brand, warranty, reseller, and whether you buy new or refurbished, so treat these as a realistic budget you can refine. I cite price sources for the most important items below.

Base counts used

- Drops: 148
- Cat6a spools: 30 × 1,000 ft (to cover ~29,243 ft with 10% slack)
- Patch panels: 4
- Switches (access): 4 × 48-port PoE+ managed.
- Core switch: 1 × 10G SFP+ capable (24-port / modular)
- Firewall/UTM: 1 (with 1-yr license)
- Keystone jacks: 148
- Wall plates (2-port): 74
- Short patch cables (to connect patch panel to switch): 148
- Fiber patch cords (LC duplex) + OM4 fiber trunk: a few short runs (3 uplinks)

Price table (item, qty, unit price, total)

Item	Qty	Unit price (est.)	Total
Cat6a bulk spool (1,000 ft) Cat6a UTP	30 spools	$307.12 / spool (example vendor) CableWholesale	$9,213.60
48-port Managed PoE+ gigabit switch (access)	4	$1,200 ea (mid-range estimate; ranges vary) IT Pro+1	$4,800.00
Core 10G (SFP+) switch, 24-port (or equivalent)	1	$3,500 (mid-range) network-switch.com	$3,500.00

Firewall / UTM appliance + 1-yr license	1	$2,000 (mid-range small-branch appliance incl. 1yr services) TrustRadius for Vendors+1	$2,000.00
48-port Cat6a patch panels	4	$120 ea	$480.00
RJ-45 Cat6a keystone jacks	148	$2.00 ea	$296.00
2-port wall plates (faceplates)	74	$4.00 ea	$296.00
Short patch cables (0.5–1 ft) for patch panel→switch	148	$5.00 ea	$740.00
Fiber patch cords OM4 (LC duplex)	6 cords	$25 ea (short lengths)	$150.00
Racks & wall cabinets (1 ER rack + 3 closet cabinets)	2 (2 racks counted in budget)	$800 ea (mid)	$1,600.00
UPS for the equipment room	1	$800	$800.00
Labor & installation (drop termination & testing)	148 drops	$120 per drop (install, terminate, test) estimate	$17,760.00
Misc (cable management, labels, firestop, patch tray, screws)	—	lump sum	$1,000.00
Subtotal (estimated)			$41,635.60

Rounded total budget estimate: ≈ $41,700 (mid-range professional installation + 1 year firewall license + materials)

6) Why are these choices appropriate (professional vs consumer)

Cat6a professional grade, supports 10Gb up to 100 m; schools benefit from future-proof copper runs for years.

48-port managed PoE+ access switches provide centralized management, QoS, VLANs, PoE for cameras/APs/phones; professional models give 10G uplinks for aggregation. Consumer switches either lack management, PoE budget, or appropriate uplinks.

10G SFP+ core + OM4 fiber uplinks aggregation with headroom for high traffic and future Wi-Fi upgrades (Wi-Fi 6/7).

Firewall/UTM protects the shared Internet gateway for the school; it includes content filtering, IPS, and reputation services needed for school networks.

7) Security design notes (what to implement)

VLANs for students, staff, admin, IoT (cameras, building systems) to isolate traffic.

802.1X (RADIUS) for port authentication to prevent unauthorized plug-in devices.

ACLs on switches & firewall for segmentation.

IDS/IPS, either via firewall subscription or dedicated appliance, for detecting lateral movement and malicious traffic.

Secure management: out-of-band management (console/management VLAN), SSH, and centralized logging (syslog server) and backups.

Patch & license plan: maintain firmware, security licenses, and periodic network audit/testing.

8) What to test & hand off (deliverables)

Certify each horizontal run with a Cat6a certifier (returns PASS/TIE/FAIL).

Label all patch panel ports and wall plates.

Provide a network drawing showing closet locations, patch panels, and uplinks.

Provide a spreadsheet with port allocations (VLAN, room, port number).

Deliver equipment serial numbers, warranty/licensing info, and cable test logs.

9) How can you tweak the budget / next steps

Lower budget option: use Cat6 (not Cat6a) and non-PoE switches (but you'd lose future 10G on copper and PoE funding for APs). Savings of a few thousand $ but less future proofing.

Higher performance: choose enterprise switches with larger SFP+ fabrics or a 10G access layer significantly increases price (see enterprise price ranges).
IT Price
+1

Labor model: I used a per-drop install/test estimate of $120; if your contractor charges per-foot instead, costs vary; many low-vol projects quote $1.50–$3.00 per ft for full install (this would increase the budget).

Licensing: firewall licensing was estimated for year-one; multi-year commitments may reduce per-year cost but require up-front payment.

10) Sources/price references (major ones used)

Cat6a bulk spool (1,000 ft) example price: CableWholesale product listing (bulk Cat6a spool ~$307.12).
CableWholesale

Cat6a alternate pricing examples (ATSCables, Amazon) used to verify market prices.
ATS Cables
+1
48-port PoE switch price ranges and example SMB models (Cisco global price ranges; Zyxel review showing attractive SMB 48-port PoE+ models). These show the market spread and justify the mid-range switch unit price I used.
IT Price
+1
Core 10G SFP+ switch market reviews & example prices to size the core (overview of 10G switch market).

Firewall/UTM price guidance and licensing range (buyer guide/pricing reports).
TrustRadius