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Columbia University
Information Technology

Technical Design Requirements v09.30.18

COLUMBIA UNIVERSITY
Information Technology

Network Infrastructure
Technical Design Requirements

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Overview

This document is intended for use by those involved in maintaining, designing and installing Telecommunications Infrastructure for Columbia University. The purpose of this document is to ensure that Columbia University Information Technology (CUIT) Network Infrastructure design and installation standards are conformed to throughout the course of a construction or renovation project. New design considerations are outlined in this document to provide increased resiliency, redundancy and scalability for the University's network infrastructure. CATV, Electronic Classroom, Smart Conference Room, Building Management and Public Safety infrastructure requirements are also addressed.

Columbia University Network Protection Policy

Please note that Columbia University's published Network Protection Policy requires that all network, communications and telecommunications-related equipment and devices be installed and maintained by Columbia University Information Technology (CUIT).

Additionally, all devices connected to the University Network (other than devices connected to the CUMC Network) must use:

(a) the DHCP to configure Network IP addresses and
(b) the DNS protocol for Server information.
The entire policy can be found here:

http://policylibrary.columbia.edu/network-protection-policy

Columbia University Computing and Technology Policy Library

Can be found here:

http://policylibrary.columbia.edu/category/computingtechnology

Section 1.0 Definitions

Telecommunications Room (TR)

This facility is a room that serves a floor area of a building with communications services. The TR is the connection point between a building's backbone and horizontal distribution pathways. The TR provides an environmentally suitable and secure area for installing cables, rack/wall-mounted hardware and technology equipment.

Equipment Room (ER)

This facility differs from a TR in that it is meant to serve as the connection point between inter-building and intra-building distribution systems. The ER is meant to serve the entire building rather than a floor or specific location. The ER is the recognized termination point of all backbone cabling within a building. The ER also houses technology equipment specific to the backbone cabling of a building and provides an environmentally suitable and secure area for this equipment. Note that an ER can serve as both an ER and a TR if necessary. Buildings shall typically be outfitted with dual ER's for redundancy.

Entrance Facility (EF)

This room is designated for use by outside service providers to terminate their infrastructure upon entering the building, in lieu of collocating in any CUIT ER or TR. Collocating outside service providers in CUIT ERs or TRs is prohibited.

Horizontal Cable

Unshielded Twisted Pair (UTP) and coaxial CATV cable that is run from the TR to the workstation (or network outlet) are the two most common types of horizontal cabling. See Section 3.0.

WLAN

Wireless Local Area Network

Network Jack

Female connector terminated on the end of the horizontal cable.

Network Outlet

Faceplate in which the network jacks are mounted.

Inter-building Backbone Cable

This is cable that is used to link buildings together. Multi-strand fiber optic cable and multi-pair copper cables are the most common examples here. See Section 5.0.

Intra-building Backbone Cable

This cable is used to connect the Equipment Rooms to the Telecommunications Rooms within a building. Multi-strand fiber optic cable and multi-pair copper cables are the most common examples here. See Section 5.0.

Section 2.0 Project Roles and Responsibilities

CUIT Network Engineering provides design guidance, interpretation of CUIT design requirements and commissioning oversight. CUIT Network Engineering can provide installation services for CUIT cable infrastructure and perform relevant commissioning tasks but may also provide direction to have the General Contractor bid out the cabling infrastructure component of any project. This will be determined on a per project basis. In all cases, CUIT Network Engineering will specify and procure all active network electronic components.

CU Facilities Project Management performs new construction and renovation projects incorporating all CUIT system needs in the planning, design and construction phases including build-out of Telecommunications Rooms and their related infrastructure needs, distribution and riser pathways and systems furniture coordination.

It is the responsibility of CU Facilities Project Management and CU Facilities Operations to notify the CUIT Network Operations Center (NOC) of any planned electrical or cooling system outages that may impact CUIT ERs or TRs. The CUIT NOC can be notified via email at noc@columbia.edu.

Section 3.0 Horizontal Cable

CUIT will determine the category and manufacturer of horizontal cable to be installed on a per-project basis.

3.1 Category 6A UTP

- Conform to ANSI/TIA/EIA-568-B (CSA T520-95) - Commercial Building Telecommunications Cabling Standard
    - T568B pin/pair assignment for UTP cabling
- All vendors and subcontractors working with Cat 6A horizontal cabling shall be Systimax and/or Belden Certified
- Maximum 90 meter run
- Supports up to 10,000 Mbps Ethernet

Systimax X10D Structured Cabling Solution:

Systimax Part #	Description
2091E	X10D Category 6A UTP Cable
760109744 M4800A-1U-GS* M4800A	1U Angled 48-port patch panel
MGS600BH-262	Electrical White Information Jacks
760056069	Cap with Strain Relief for MGS jack
M60B – 123	Icons Voice-over-IP PoE (yellow)
M60B – 003	Icons Traditional Voice (black)
M60B – 112	Icons Data Only (orange)
360GS 10E	Gigaspeed X10D modular patch cable

Belden 10GX Structured Cabling Solution:

Belden Part #	Description
10GXS13	CAT6A (625MHz), 4-Pair, U/UTP-Unshielded, Plenum-CMP,
AX104601	KeyConnect Angled Patch Panel, 48-port, 2U, Black (Empty)
AX104600	KeyConnect Angled Patch Panel, 48-port, 1U, Black (Empty)
AX103249	KeyConnect AngleFlex Patch Panel, 48-port, 2U, Black (Empty)
AX103248	KeyConnect AngleFlex Patch Panel, 24-port, 1U, Black (Empty)
AX102282	10GX Modular Jack, Category 6A, RJ45, KeyConnect White (TIA 606)
AX102283	10GX Modular Jack, Category 6A, RJ45, KeyConnect Black (TIA 606)
CA2110XXXX	10GX Modular Cords

- Category 6A certification results shall be provided to CUIT in electronic format upon completion *(see Appendix A for sample report).*
- Test results must comply with TIA/EIA specifications.
- Test results MUST include calibration date of the test equipment. *Test results with equipment calibration dates of more than 1 year from the test date will not be accepted.*
- Please note: only pre-terminated, factory-tested and warrantied Ethernet patch cables are to be installed. *Field-terminated Ethernet patch cables are not permissible*.
- A Patch Schedule shall be submitted to CUIT and must include all information reflected in the sample Patch Schedule provided *(see Appendix C).*

3.2 Coaxial/CATV

- RG6 horizontal runs shall not exceed 150 feet.
- RG11 is to be installed on any horizontal runs that exceed 150 feet.

Systimax Part #	Description
Commscope part# 2275V	CATV RG6 Horizontal Cabling
Commscope part# 2287V	CATV RG11 Horizontal Cabling
Systimax M81C	Coupler Information Outlet

Section 4.0 Cable Pathways and Placement for Network Outlets

- Conform to ANSI/TIA/EIA-569-A (CSA T530) - Commercial Building Standard for Telecommunications Pathways and Spaces.
- **All pathways shall be sized to accommodate Belden 10GXS Cat6A cable.**
- Cable pathways shall be designed in a manner to avoid sources of electromagnetic interference (EMI). Minimum physical separation distances between UTP cable and sources of EMI shall conform with the guideline established in ANSI/TIA 569-C Telecommunication Pathway and Spaces, Annex B:

Condition	<2KVA	2-5KVA	>5KVA
Unshielded power lines in proximity to open/PVC cable pathways	5 in	12 in	24 in
Unshielded power lines in proximity to grounded metallic cable pathways	2.5 in	6 in	12 in
Power lines enclosed in metal grounded pathways in proximity to grounded metallic cable pathways	<1 in	3 in	6in

- Minimum 1 outlet box/faceplate per workstation (5”x 5” back box with single gang reducer and 1-1/4” stub-up to nearest accessible ceiling).
- Minimum 1 outlet box/faceplate per 100 sq. feet (5”x 5” back box with single gang reducer and 1-1/4” stub-up to nearest accessible ceiling).
- 3 UTP cables run to each outlet box/faceplate at a typical administrative work station (design must include one discrete port for every IP Phone location).
- Any floor boxes or other raceways shall accommodate Systimax MGS400/MGS600 or Belden KeyConnect jacks.
- Multiple outlet boxes are not to share a single conduit pathway (i.e., no “daisy-chaining”).
- All conduit raceways shall be provided with drag lines installed.

4.1 Ceiling Pathways

- The design of ceiling pathways shall provide a suitable means for supporting cables from the telecommunications closet to the network outlets (Manufacturer – Erico fastening products CAT21AFAB3-32-CAT6 or CAT32AFAB3-50-CAT6 or similar).
- Cable shall not be laid directly on the ceiling tile or grid. A minimum of 75 mm (3 in) clear vertical space shall be available above accessible ceilings for horizontal cabling and pathway.
- Inaccessible ceilings require access panels at intervals adequate for future changes and additions.
- A minimum of 5" physical separation is to be maintained between UTP cable and fluorescent, neon, mercury-vapor, HID, etc. lighting

4.2 Cable Trays and Raceways

- Cable trays and wireways (two side rail systems) are prefabricated rigid structures for housing and protecting cables or conductors that are pulled or laid in place after the pathway has been installed as a complete system. These pathways shall be installed in accordance with the applicable electrical code.
- The overall fill ratio of the tray or wireway shall not exceed 40%. This practice applies to both header and distribution trays as applicable. Care shall be exercised not to exceed the specified bend radii of the cables or the weight loading of the tray or wireway. Cable trays and wireways for new construction and for renovated spaces shall be sized as per manufacturers specification for Belden 10GXS Cat6A cable.

4.3 Furniture Raceway Systems

- Furniture raceway systems shall be reviewed with the CUIT Network Engineer to ensure:
    - compliance with sizing requirements.
    - interoperability with other wiring components found in section 3.0.
    - appropriate cable ingress hardware is provided.
- Reviews shall take place at the Schematic Design phase and at 90% Construction Documents, and shall include detailed information on the cable ingress to the furniture system.
- Furniture cable raceways shall be sized to accommodate Belden 10GXS Cat6A cable.
- Factory pre-wired systems furniture (including lab benches) are not permitted. All cabling in furniture systems are to be field-installed home runs back to the nearest CUIT TR, tested and certified as per CUIT specifications.

4.4 Conduit

- The use of EMT conduit as a distribution raceway system for telecommunications cabling shall be provided when:
  - it is required by code.
  - outlet locations are inaccessible by any other means.
  - the distribution path transits a mechanical space.
- Conduit runs shall be no longer than 30 m (100 ft.) between pull points.
- Conduit runs shall contain no more than two 90-degree bends, or equivalent, between pull points (e.g., outlet boxes, telecommunications closets, or pull boxes).
- Pull boxes shall be installed at all reverse (U-shaped) bends.
- The inside radius of a bend in conduit shall be at least 6 times the internal diameter. Bends in the conduit shall not contain any kinks or other discontinuities that may have a detrimental effect on the cable sheath during cable pulling operations.
- The use of conduit bodies (LB, LR, etc.) is subject to prior approval by CUIT. Such approval will be based on the use of a telecommunications-style conduit body that is specifically designed to meet minimum cable bend radius requirements.
- Installation of flexible conduit shall be avoided.
- All conduits and sleeves shall be sized to allow for the possible migration to Category 6 Augmented UTP Cabling.
- The fill ratio of conduit shall not exceed 40%.
- Any riser or backbone conduit system utilizing conduits of 3” or greater diameter shall be fully pre-populated with 1-1/4” innerduct with drag lines.

Section 5.0 Backbone Cabling and Infrastructure

5.1 Cable Types

5.1.1 Corning Optical Fiber product line – plenum-rated

Corning Part #	Description
012T88-33190-29	50-micron OM4 multimode cable, 12-strand minimum
012E88-33131-29	Single-mode OS2 cable, 12-strand minimum (ITU-T G.652.D-compliant)
012T88-33190-D3	12str 50um MM PLENUM MIC DX OM4 dielectric armored
012E88-33131-D3	12str SM PLENUM MIC DX OS2 dielectric armored
95-200-42	Uni-Cam connectors – SC Single-mode
95-050-41-X	Uni-Cam connectors – SC Multi-mode
CCH-04U	"Closet Connector Housing" patch panels
CCH-CP12-59	"Closet Connector Housing" Cassettes – Single-mode
CCH-CP12-E7	"Closet Connector Housing" Cassettes – Multi-mode
024TC8-14190-A3	50-micron OM4 multimode armored ribbon cable, 24-strand indoor
012EC8-14101-A3	Single-mode OS2 armored ribbon cable, 12-strand indoor
CCH-CS12-A9-P00RJ	12-F SPLICE CASSETTE PANEL LOADED OS2 RIBBON PIGTAIL-LC
CCH-CS12-E4-P00QJ	12-F SPLICE CASSETTE PANEL LOADED LOMMF RIBBON PIGTAIL-LC

- Conform to ANSI/TIA/EIA-568-B (CSA T520-95) - Commercial Building Telecommunications Cabling Standard
- Where 24 strands (or more) of a single type of fiber are required between two points, multiple cables of 12, 24, 48, etc. strands shall be used to provide the necessary strand count.
- Any riser or backbone conduit system utilizing conduits of 3" or greater diameter shall be fully pre-populated with 1-1/4" innerduct with drag lines.
- Armored fiber should be considered in certain riser applications. Metallic-armored jackets must be grounded in accordance with industry standards and local electrical codes. With CUIT approval, the use of equivalent OS2 or OM4 armored fiber may negate the need for innerduct.
- Ribbonized fiber may be required by CUIT to accommodate 40Gb and 100Gb connectivity. Contact CUIT for direction.
- The use of LC connectors may be considered with CUIT approval.

5.1.2 Multi-Pair Copper Backbone Cable

- Provide Category 5e UTP backbone riser cables from the ER to each TR.
- Terminate all UTP Category 5e riser cables in the ER onto wall mounted 110-type termination blocks.
- Provide Cat5e tie lines between the 110-type wall field and a RJ45 telco patch panel in the ER (RJ45 pins 4,5).
- Terminate all UTP Category 5e riser cables in each TR onto RJ-45 telco patch panels (RJ45 pins 4,5).
- Pair counts shall be determined by CUIT.

5.1.3 CATV Backbone/Riser Cabling

- Riser - Commscope part# 2312V
- Single mode fiber as per Section 5.1.1 is used for inter-building CATV backbone cabling.
- Angled polished connectors (APC) shall be used along entire path of fiber used for CATV.
- If a project requires an inter-building CATV backbone cable, additional design consideration shall be taken to accommodate the CATV strands. CUIT shall provide direction on a per-project basis.

5.1.4 CATV

- CUIT provides an unencrypted cable signal.
- If tuner-less LCD monitors are installed, a CATV tuner must be provided by the AV integrator.

5.2 Fiber Testing

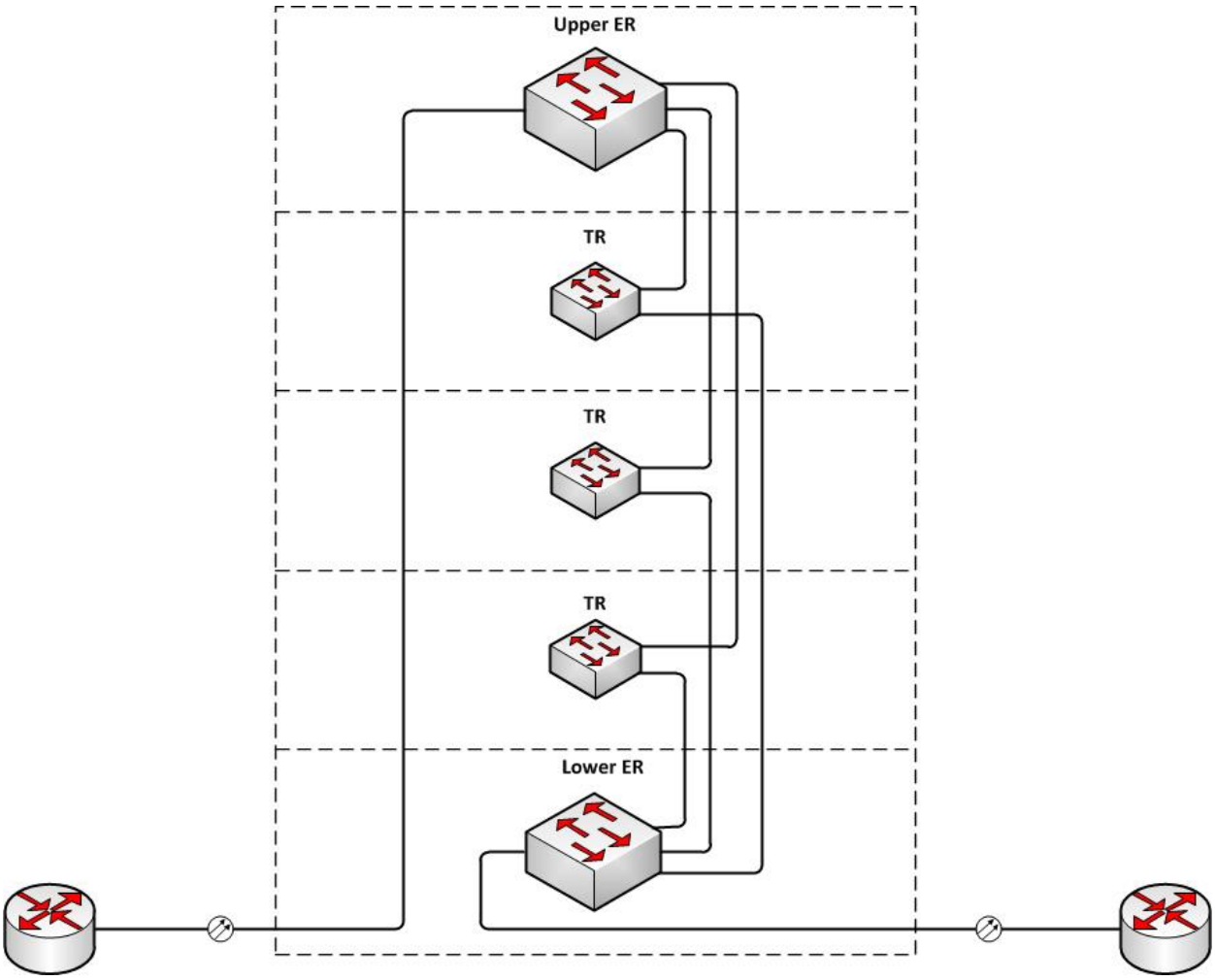
- Fiber optic strands must be individually tested at the relevant wavelengths using a power meter and source.
- 850/1300nm – multimode cabling
- 1310/1550nm – single mode cabling
- Test results shall be documented in Excel format for submission to CUIT upon completion *(see Appendix B for sample report).*
- Attenuation loss shall not exceed the manufacturer's acceptable loss parameters found on the data sheet of the relevant cable.
- .5dB loss is allowed per connector pair.
- Test results MUST include calibration date of the test equipment. *Test results with equipment calibration dates of more than 1 year from the test date will not be accepted.*

5.3 Design Guidelines

Infrastructure Scenario 1

Dual Equipment Rooms exist (or are being designed within the project scope)

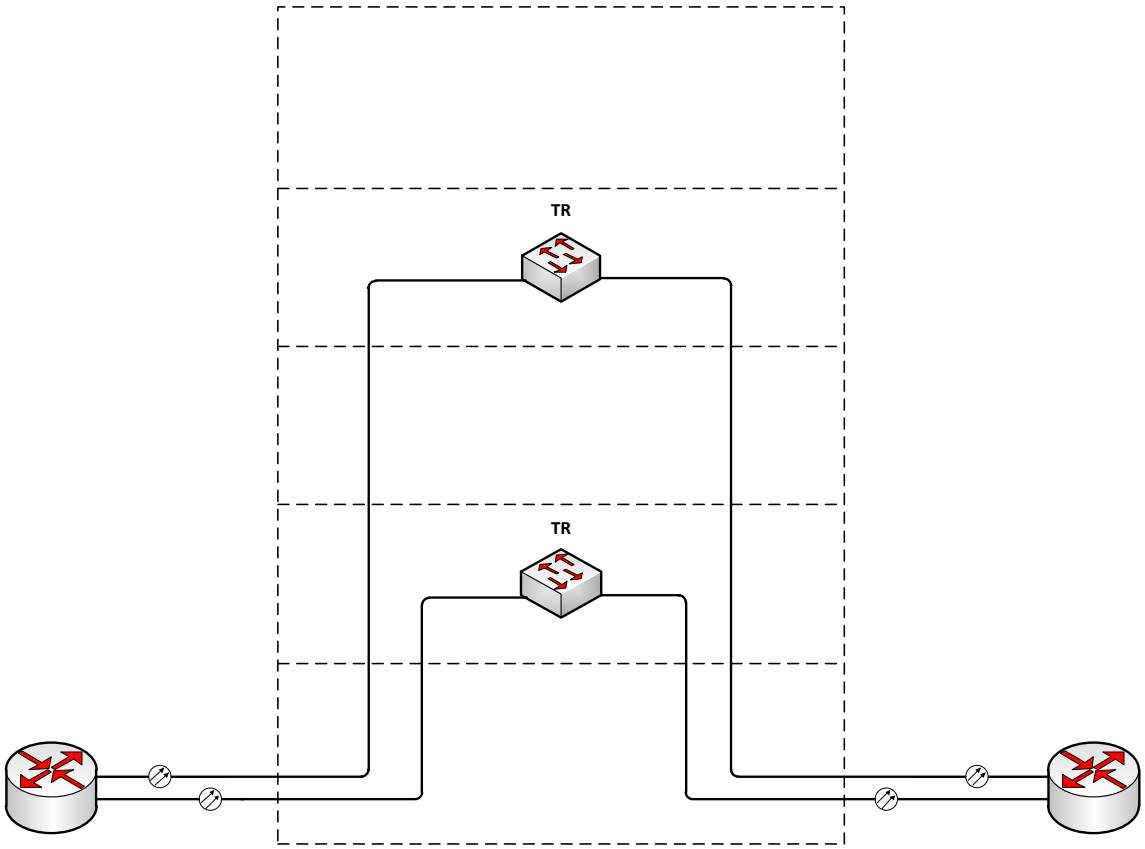
- Each TR shall be linked with two physically diverse pathways to each ER via a minimum of one 12-strand multimode cable and one 12-strand single-mode cable (two separate cables). Refer to fiber specifications in section 5.1.1.



Infrastructure Scenario 2

Equipment Rooms do not exist (will not exist – outside of project scope)

- Each Telecom Room shall be linked to the nearest two CUIT Equipment Rooms with a minimum 12-strand single-mode cable via physically diverse pathways.
    - Multimode cable may be required in addition to the single-mode cable where applicable.
    - In this scenario, the Equipment Rooms are not in the same building as the Telecom Rooms.



5.4 Physical Redundancy Requirements

- Dual Equipment Rooms are required for new construction and gut renovation projects.
    - Equipment Rooms are to be located in the vicinity of Interbuilding Backbone Cable points-of-entry, most likely on a basement level (refer to drawing in section 5.3).

  OR
    - If Equipment Rooms are not located on the same level as the point-of-entry, then physically diverse pathways must be designed to connect the points-of-entry to the Equipment Rooms (refer to drawing in section 5.3).
    - Equipment Rooms can "double" as Telecommunications Rooms.
- Each Telecom Room shall be connected via fiber optic cable (Section 5.1.1) to BOTH Equipment Rooms via physically diverse pathways (see Figure 5.3).
- Physical Redundancy between ER and TR rooms creates resiliency in the event of a cable cut, equipment failure, or power failure preventing voice and data network downtime.
- Where 24 strands (or more) of a single type of fiber are required between two points, multiple cables of 12, 24, 48, etc. strands shall be used to provide the necessary strand count.
- Separate cables shall be used when running multimode and single-mode cables along the same path, i.e. no "hybrid" cables.

5.5 Wide Area Networking Considerations

Some projects will require special network design and equipment because of their unique nature.

- Examples include, but are not limited to:
    - CU occupation of a portion of a non-CU property, e.g. Chrysler Building.
    - CU property that is remotely located relative to the Morningside campus (e.g. Nevis, Lamont-Doherty, CUMC).
- Special needs include, but are not limited to:
    - Leased circuits from local carriers such as Verizon.
    - Trenching of NYC streets (includes petitioning NYC DOT for Revocable Consent, payment of annual Revocable Consent franchise fees and renewal of Revocable Consent agreements).
    - Leasing underground pathways from local companies such as Empire City Subway.
    - Rooftop point-to-point wireless solutions.

Section 6.0 Telecommunications/Equipment Room Design Requirements

Conform to ANSI/TIA/EIA-569-A (CSA T530) - Commercial Building Standard for Telecommunications Pathways and Spaces.

CUIT shall participate in and approve design decisions regarding the number and location of required TR rooms based on current and future needs. As a general guideline for average CU floorplates, TRs are needed, at a minimum, every third floor. High densities of cabling in an area may dictate more than one TR per 3 floors.

- TR cooling and equipment power shall be wired to emergency generator power if available.
- 4 copies of keys are to be provided to CUIT Network Operations Center (NOC).
- TRs shall be accessible by CUIT on a 24x365 basis. TRs shall be located on a public corridor or other public space (access via private office or classroom space is not acceptable). Access via mechanical spaces only with CUIT and CU Facilities Operations approval.
- Please note: CUIT must be notified in advance of any scheduled building power or chilled water shutdown (or local shutdown impacting any CUIT spaces) via email to the CUIT Network Operations Center (noc@columbia.edu).

6.1 Room requirements:

- Interior fire retardant 3/4" plywood on one wall.
- 5' wide x 5' high wall space reserved for CATV equipment.
- Raised concrete pad in basements and flood-prone areas.
- Floor-mounted leak-detection.
- Static-dissipative floor tiles.
- Ground busbar connected to building steel or nearest building ground electrode (EIA/TIA-607).
- Locating air conditioning equipment or piping directly over IT racks is to be avoided. This presents a risk of water leakage due to condensate overflow and may also restrict servicing of the unit. In all cases, installation of a full external condensate pan under the unit (including units with integrated drip pans) with water leak detection in the external pan as well as in the AC unit's internal condensate pan is required. Both alarms shall be tied to a local alarm panel (i.e. visual and audible alarms) and generate remote alarm signals via the network at

CUIT and the BMS. Moreover, a continuous water pan with leak detection under all water piping situated over IT racks shall be installed.

- Cooling system to maintain 24x365 operating temp of 50-80 degrees F (77 degrees nominal) with 20,000 BTUh heat dissipation. CUIT will provide anticipated heat load figures during design phase.
- No other utilities shall be placed in any TR other than those specifically servicing the TR (e.g. electrical panels, plumbing, Verizon, etc.).
- Placement of CUIT security hardware and fire alarm panels in a TR shall be considered by CUIT on a case-by-case basis.
- Open relay racks are the most widely used in CUIT Telecom Rooms – Chatsworth Part# 55053-503.
- Vertical wire managers are also utilized between relay racks for cable management – Chatsworth Part# 12096-503 or 11729-503 depending on cabling density.
- TRs and ERs must be sized to provide 3 feet of clearance in front and behind of the network equipment racks (4 feet preferred). Some network equipment may require additional clearance.
- TRs and ERs must be sized to provide sufficient clearance for CUF Ops personnel to perform routine maintenance and/or replacement of any HVAC equipment located within the TR or ER without requiring any network equipment to be relocated or removed.
- Door locking hardware to be coordinated with the CU Lock Shop through the CUIT Network Operations Center and follow the existing CUIT keying system.

6.2 Electrical Details

- Fluorescent or LED lighting sufficient to illuminate the front and back of equipment racks and all wall fields, controlled by a wall switch.
- Two (2) NEMA L14-30R outlets.
- Two (2) dedicated 20 amp circuits with a NEMA 5-20R quad outlet.
- One (1) 15-amp convenience duplex outlet.
- All electrical circuits are to have dedicated neutrals and dedicated grounds.
- Electrical circuits that are dedicated to equipment within the same Telecom Room shall be on different phases to reduce the probability of a complete electrical failure.
- Electrical circuits shall be labeled inside the panels to denote “Telecom Room” and the respective floor.
- Electrical outlets shall be labeled with breaker panel and circuit ID.

- Electrical circuits shall be commissioned by the installer in the presence of CUIT Network Engineering staff to ensure conformity with this document.
- When emergency power is available, CUIT requires that ER and TR electrical circuits shall be tied into the building emergency generator. A red receptacle shall distinguish these circuits.

6.3 "Room-ready" requirements:

- The TR/ER will be deemed ready for turnover to CUIT for network equipment installation and network testing when:
  - the room is secure (lockable).
  - all painting, flooring and ceiling finishes are complete.
  - all electrical, lighting and grounding components are installed and tested.
  - cooling and ventilation equipment is installed and tested.
  - all copper and fiber cabling is completely installed, terminated and tested.
- The room shall be clean and secure and all other trades must have completed their scope of work within the room.

6.4 Cable ID info

- Typical network outlet faceplate label: 10-001-A
  - "10" indicates floor # of faceplate location.
  - "001" indicates faceplate number on the floor.
  - "A" indicates jack (cable) in the faceplate.
  - Wireless access point locations shall have an 'AP' suffix added.
  - Wall Phone locations shall have a 'WP' added.
  - Security Camera locations shall have a 'SC' added.
  - Examples:
    - 06-010-B AP indicates wireless access point cable 'B' on faceplate 010 on the 6th floor.
    - 06-099-A SC indicates security camera cable 'A' on faceplate 099 on the 6th floor.
  - Labels may need to be customized to a further extent in instances when more than one TR is supporting a floor (i.e., a TR designation will need to be incorporated into the labeling scheme).

Section 7.0 Data/Voice/Video/CATV Equipment

- Data and voice equipment shall be specified, designed, and installed by CUIT Network Engineering.
- CUIT Network Engineering shall provide voice and data equipment specifications on a per-project basis.
- Equipment ordering must take place at least 6 months prior to Telecom Infrastructure installation commencement date.
- CUIT must receive approval and an account number before ordering.
- Project schedule shall accommodate the installation of data/voice/video/CATV equipment by CUIT (non-union) staff members.
- CUIT provides an unencrypted CATV feed.
- Specifications for any hardware interfacing with CUIT-provided CATV shall be submitted to CUIT for review.

Section 8.0 Obsolete Infrastructure Removal

- The scope of work for any renovation project shall include removal of all existing obsolete low voltage telecommunication cabling infrastructure back to the source.
- Costs associated with this removal shall be included in the capital project budget.
- CUIT will assist in identifying existing telecommunications cabling and will determine if it can/should be removed.
    - It is possible that all low voltage communication cabling may not be identified and/or may not be the responsibility of CUIT to identify (i.e., security cabling, BMS cabling, outside service provider cabling, etc.)
    - Any cabling that cannot be identified will not be removed by CUIT.
- For telecommunications cabling that has been identified, CUIT will:
    - Mark or label active cabling that must remain in place and be protected during demolition and construction.
    - Mark or label cabling that shall be removed by the general contractor.
    - Pull back and stage cabling for re-use.
    - Include the cost of removal in the overall IT estimate in instances where CUIT will be responsible for physical removal.

Section 9.0 Wireless Networking

Wireless networking infrastructure is a requirement of all renovation and new construction projects.

9.1 Horizontal cabling for WLAN

- CUIT Network Engineering shall specify network outlet placement for wireless networking after floor plans have been submitted.
- WLAN outlets for wireless access points are usually located above drop ceilings or integrated with drop ceilings via special WLAN hardware mounting provisions.
- See “Ceiling Pathways” section 4.1 for cable pathway considerations.
- CUIT may require the project to install mounting provisions for WLAN hardware where appropriate.
- Two Cat6A UTP cables shall be run to each WLAN outlet.

9.2 Design for 5GHz ubiquitous coverage

- Ubiquitous wireless coverage indicates that all spaces within a defined area have coverage in the 5GHz spectrum. This includes mechanical spaces, hallways, lounges, lobbies, kitchens, etc. If a space does not require ubiquitous coverage, excluded spaces shall be explicitly documented.
- Wireless access point locations shall be determined by CUIT Network Engineering.
    - For estimating purposes only, assume that one access point per 750 sq. ft. will be required to provide ubiquitous 5GHz coverage.
- All wireless coverage shall be designed to provide 802.11ac service.
- CUIT deploys only Aruba 802.11ac wireless access points. Hardware cut sheets will be provided upon request.
- All access points shall be mounted exposed, below the lowest ceiling.
    - Minimum height 96”.
    - Maximum height 120”.
    - Minimum distance from ceiling 12”.
    - Access points shall be a minimum of 10 feet apart.
- WLAN electronics shall be specified and installed by CUIT Network Engineering.

9.2.1 WLAN Coverage Requirements

- High-density spaces such as lecture halls, auditoriums and classrooms exceeding a capacity of 50 students have very specific radio frequency design criteria and shall be designed only with the close cooperation of CUIT Network Engineering.
- Low-density spaces (those which are not considered high-density) shall be designed using the following design criteria:
    - All wireless networks shall be designed for both coverage *and* capacity.
    - Wireless coverage shall be designed as "voice quality":
        - It shall be expected that the WLAN will be used for Wi-Fi calling as well as Voice over IP over WLAN.
    - It shall be expected that each occupant will be using a minimum of 2 wireless devices.
    - Wireless coverage shall be designed such that the EIRP of the 5GHz transmitters is no greater than 18dBm and the difference between 5GHz and 2.4GHz EIRP shall be a minimum of 6dBm.
    - Wireless signal strength (RSSI) in all covered areas shall be no less than -65dBm.
    - Signal-to-Noise Ratio (SNR) shall be no lower than 25dB.
    - Each location at which an occupant will be seated or standing shall be serviced by a minimum of two 5Ghz transmitters with a signal strength of no less than -65dBm and a separation between adjacent AP channels of -85 dBm.
    - Minimum throughput expected in all coverage areas shall be 11Mbs.
    - Each wireless access point shall be expected to support no more than 20 devices per radio.
    - Channel widths shall not be expected to exceed 20Mhz.
    - CUIT Network Engineering uses Dynamic Frequency Selection (DFS) channels.

9.3 Outdoor Wireless

- Infrastructure for outdoor wireless access points shall be incorporated into any project to refresh existing or develop new outdoor seating or congregation areas.
- Outdoor access point placement shall be determined by CUIT Network Engineering in cooperation with CUF Operations and CUF Exteriors and Historic Preservation.
    - Any proposed changes to the CUIT design require CUIT Network Engineering approval.
- Outdoor AP mounting poles shall have a minimum of one 5" x 5" flat mounting surface and one 4" x 6" hand hole at the base.

  - Outdoor wireless access points shall be mounted between 9' and 12' above the ground.
  - If a Public Safety security camera is to be mounted on the same pole as an outdoor wireless access point, the camera shall be a minimum of 12” to the nearest point on the access point body or the access point mount, whichever is closer.
- A minimum of two 1" solid conduits shall be provided from the indoor building lockbox to the mounting pole base.
  - Conduit installation shall follow appropriate guidelines regarding bend radius, lack of conduit bodies, etc. as outlined elsewhere in this document.
- An indoor building lockbox (Hoffman A6N64) shall be provided near the building envelope and will act as the point of transition from outdoor-grade cable to indoor-grade cable and house an in-line Ethernet lightning arrestor.
- Earth grounds with a minimum #10 AWG green wire shall be provided to the building lockbox, to the access point mounting location and to the DIN rail mounted in the nearest CUIT TR.
- Hardware Specifications:
  - Terrawave TW-SP-1GBPS-10-1T Single Port 10KA 1GB Ethernet Surge Suppressor for 802.3at
  - DEHN M CAT6 RJ45S 48 (929 100) Surge Arrestors
  - DEHN MS DPA (929 199) DIN rail
- Outdoor: Belden 2148A Multi-Conductor - Category 6A Indoor/Outdoor CMR/CMX Cable
- Indoor: Belden 10GXS13 Multi-Conductor - Category 6A Nonbonded-Pair Cable

9.4 Potential RF conflicts to be considered

The CUIT WLAN is increasingly becoming the primary means of network connectivity for Columbia University students, faculty and staff. Devices that impact the RF environment and may affect the wireless local area network (WLAN) must be reviewed and approved by CUIT Network Engineering prior to installation or deployment.

Certain occupancy sensors will cause interference with/degrade the performance of 802.11 Wi-Fi networks. If wireless occupancy sensors are to be installed, CUIT requires that infrared or ultrasonic sensors be specified in lieu of the 5.8Ghz microwave sensors.

Only DECT 6.0 (Digital Enhanced Cordless Telecommunications) cordless telephone handsets are permitted for use on the Columbia University campus where CUIT Wi-Fi is operating.

- DECT 6.0 standard devices operate at 1.9 GHz (1920 – 1930 MHz) which causes little interference with the CUIT 802.11 Wi-Fi network.
- Look for the DECT 6.0 Interference Free Communication logo when purchasing cordless devices.
- Avoid cordless handsets using 5.8 GHz or 2.4 GHz technology.
- Cordless handsets that use Bluetooth for "Connect to Cell" type features should also be avoided.

All wireless devices that operate in the following frequency ranges are prohibited:

- 2.40 - 2.485 GHz
- 5.18 - 5.835 GHz

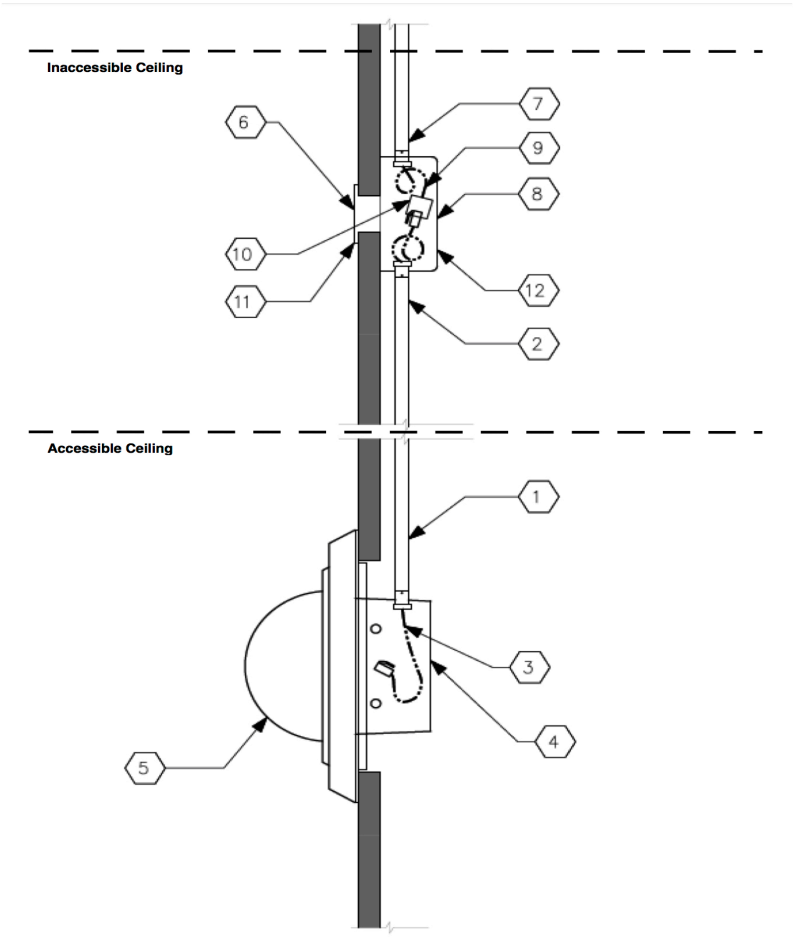
9.5 Wireless Access Point Mounting Options

All wireless access point mounting hardware options and mounting methods are subject to review and approval by CUIT Network Engineering.

Section 10.0 Building Systems, Public Safety

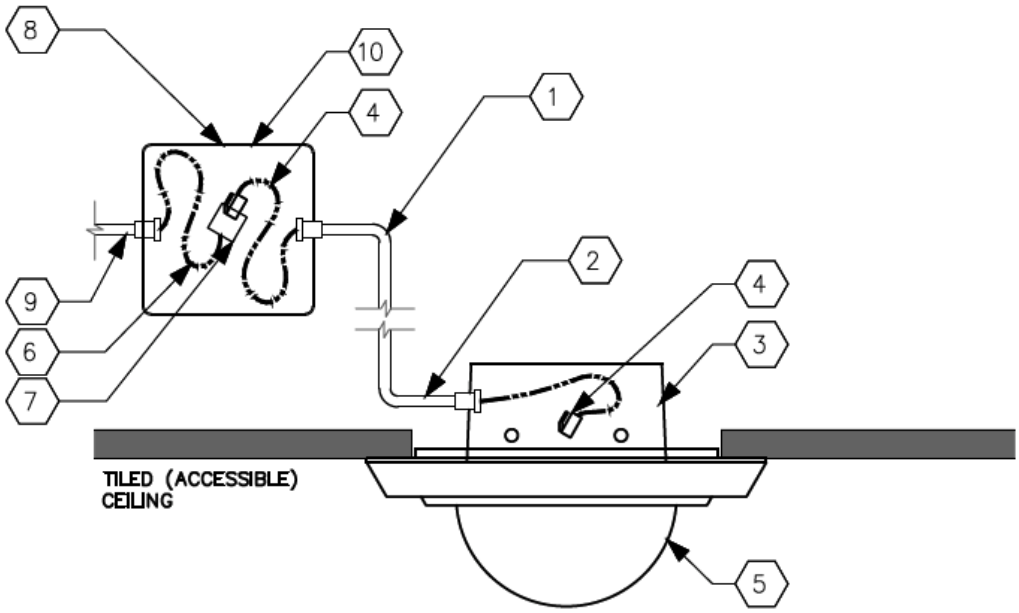
- Systems such as Fire and Environmental controls require access to the CU data network. CUIT Network Engineering in conjunction with Columbia University Facilities IT shall provide direction as to the technical infrastructure needs of these systems on a per-project basis.
- All low voltage system infrastructure that interfaces with the CUIT data network must adhere to the specifications detailed in this document (e.g. BMS, Lighting Control, Security, AV, etc.).
- Public Safety surveillance hardware requires access to the CU data network. CUIT Network Engineering in conjunction with Columbia University Department of Public Safety shall provide direction as to the technical infrastructure needs of these systems on a per-project basis.
- Refer to diagrams 10.1, 10.2 and 10.3 for typical box and conduit requirements for Department of Public Safety IP camera installations.

10.1 Typical Wall-Mount Camera Conduit Design



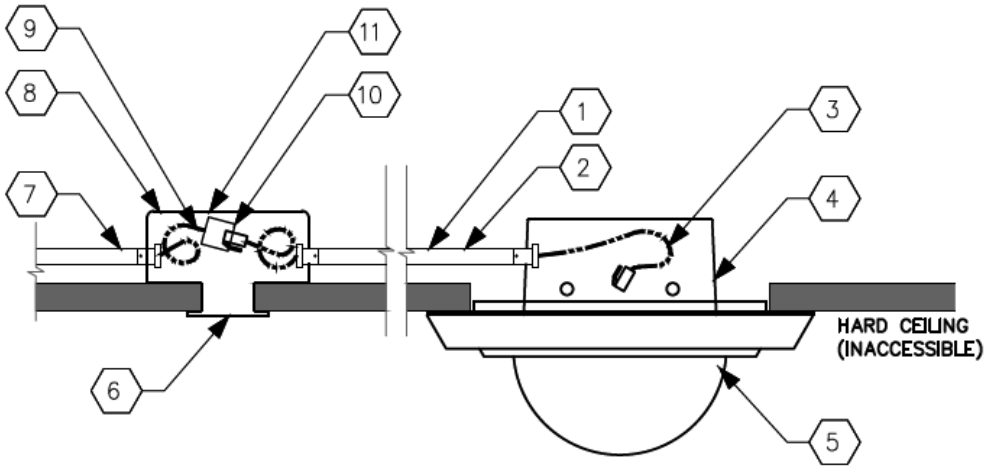
1. 3/4" PLENUM RATED FLEXIBLE CONDUIT (LENGTH NOT TO EXCEED 3 FT.) TO BE SECURED EVERY 18" USING CLIPS OR PLENUM RATED TY-WRAPS.
2. SECURITY CONTRACTOR TO USE 3/4" FLEXIBLE CONDUIT TO ROUTE CAT-6 PATCH CORD FROM INFORMATION OUTLET TO CAMERA PORT
3. CAT-6 PATCH CORD FURNISHED BY CCTV CONTRACTOR (SAME MANUFACTURER AS STRUCTURED CABLING SYSTEM)
4. CAMERA FIXTURE BACK BOX
5. CCTV CAMERA MOUNTED AND SECURED PER NEC AND IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.
6. SINGLE GANG BLANK FACEPLATE
7. 3/4" FIXED CONDUIT (EMT) TO NEAREST ACCESSIBLE LACATION OR CABLE TRAY FLUSH TO CEILING.
8. 5"X5" INFORMATION OUTLET BACKBOX WITH MUD RING REDUCER AND SINGLE GANG BLANK FACEPLATE
9. CAT-6 STATION CABLE COILED, LABELED AND TERMINATED WITH STRAIN RELIEFED, 8-POSITIONS CAT-6, RJ-45 TYPE FEMALE (JACK) CONNECTOR
10. FREE FLOATING INFORMATION OUTLET WITH STRAIN RELIEF
11. CU-IT TEST POINT
12. INFORMATION OUTLET CAN BE MOUNTED ABOVE OR TO LEFT OR RIGHT OF CAMERA LOCATION.

10.2 Typical Ceiling-Mount Camera Conduit Design (Accessible)



1. 3/4" PLENUM RATED FLEXIBLE CONDUIT (LENGTH NOT TO EXCEED 36") TO BE SECURED EVERY 18" USING CLIPS OR PLENUM RATED TY-WRAPS
2. SECURITY CONTRACTOR TO USE 3/4" FLEXIBLE CONDUIT TO ROUTE CAT-6 PATCH CORD FROM INFORMATION OUTLET TO CAMERA PORT.
3. CAMERA FIXTURE BACKBOX
4. CAT-6 PATCH CORD FURNISHED BY CCTV CONTRACTOR (SAME MANUFACTURE AS STRUCTURED CABLING SYSTEM)
5. CCTV CAMERA MOUNTED PER NEC AND MANUFACTURER'S RECOMMENDATIONS AND INSTRUCTIONS
6. CAT-6 STATION CABLE COILED, LABELED AND TERMINATED WITH STRAIN RELIEFED 8-POSITION, CAT-6 RJ-45 TYP. CONNECTOR.
7. FREE FLOATING INFORMATION OUTLET WITH STRAIN RELIEF
8. 5"X5" INFORMATION OUTLET BACK BOX WITH BLANK COVER SECURED ABOVE SUSPENDED ACCESSIBLE CEILING. BACKBOX INDEPENDENTLY SUPPORT (NO BLACK IRON OR CEILING GRID TO BE USED)
9. CONDUIT TO NEAREST ACCESSIBLE LOCATION OR CABLE TRAY
10. CU-IT TEST POINT

10.3 Typical Ceiling-Mount Camera Conduit Design (Inaccessible)



1. 3/4" PLENUM RATED FLEXIBLE CONDUIT (LENGTH NOT TO EXCEED 3 FT.) TO BE SECURED EVERY 18" USING CLIPS OR PLENUM RATED TY-WRAPS.
2. SECURITY CONTRACTOR TO USE 3/4" FLEXIBLE CONDUIT TO ROUTE CAT-6 PATCH CORD FROM INFORMATION OUTLET TO CAMERA PORT
3. CAT-6 PATCH CORD FURNISHED BY CCTV CONTRACTOR (SAME MANUFACTURER AS STRUCTURED CABLING SYSTEM)
4. CAMERA FIXTURE BACK BOX
5. CCTV CAMERA MOUNTED AND SECURED PER NEC AND IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.
6. SINGLE GANG BLANK FACEPLATE
7. 3/4" FIXED CONDUIT (EMT) TO NEAREST ACCESSIBLE LACATION OR CABLE TRAY FLUSH TO CEILING.
8. 5"X5" INFORMATION OUTLET BACKBOX WITH MUD RING REDUCER AND SINGLE GANG BLANK FACEPLATE
9. CAT-6 STATION CABLE COILED, LABELED AND TERMINATED WITH STRAIN RELIEFED, 8-POSITIONS CAT-6, RJ-45 TYPE FEMALE (JACK) CONNECTOR
10. FREE FLOATING INFORMATION OUTLET WITH STRAIN RELIEF
11. CU-IT TEST POINT

Section 11.0 Electronic Classrooms & Smart Conference Rooms

11.1 E-Room Definition

A classroom designed with AV/IT components integrated into the teaching space.

Electronic Classroom Standard AV/IT Components

- Smart Podium
  - Windows or Apple Desktop Computer
  - Crestron AV/IT Control System
  - Auxiliary AV/IT Connections (Laptop, Doc Cam, etc.)
  - Wired and Wireless Microphone
- Audio Reinforcement (Speech and Program)
- Projection (Projector and Automated Screen)

Electronic Classroom Optional AV/IT Components

- Digital Annotation
- Lecture Capture
- Web Conferencing
- Video Conferencing
- Webcasting
- Wireless Presentation
- Assisted Listening

E-Room Ready

A classroom that is designed with provisions for AV/IT components but without the components installed. At a minimum, all newly-constructed or renovated Columbia University Registrar classrooms must be configured as “E-Room Ready” classrooms. A classroom is deemed “E-Room Ready” when it has the power outlets, data network outlets and empty conduits in place for future AV/IT hardware components including podium, control system, podium computer, projector and cabling to support AV/IT system installation. Further consultation with CUIT will be required when upgrading “E-Room Ready” classrooms to fully-equipped electronic classrooms.

Smart Podium Location
Either in the floor under the proposed podium location (preferred, usually in new construction or renovation projects) or on the wall adjacent to the podium (existing classroom upgrade):

(1) 20A quad receptacle
(1) box and 1-1/4" conduit stubbed to nearest accessible ceiling with 6-port voice/data outlet
(1) box with two empty 1" conduits to speaker locations on each side of projection screen and one empty 1-1/2" conduit to ceiling projector location

Assistive Listening
An ODS approved Assistive Listening Device is an ADA compliant system to assist audience members overcome hearing loss. Provisions for the system's integration with the classroom's AV/IT system are a pre-requisite. System specifications are space and system dependent and will be reviewed and approved by CUIT on a per project basis.

Audio Reinforcement
Speaker locations on both sides of the proposed projector screen location (exact dimensions and spacing TBD by CUIT based on room design and installation needs).

(2) boxes with empty 1" conduits back to podium.

Projector Location
Ceiling projector location (exact location TBD by CUIT for each installation)

(1) 20A duplex receptacle installed above ceiling (requiring a 12" x 12" access panel in gyp. board ceilings).

(1) box and empty 1-1/2" conduit back to podium installed above ceiling (requiring a 12" x 12" access panel in gyp. board ceilings).

Optional A/V Components
Additional technologies and options including wireless display, lecture capture or web conferencing require additional cabling, conduit pathways and components.

11.2 Conference Room AV/IT System

A conference room designed with integrated AV/IT components to support advanced presentation and conferencing functionality.

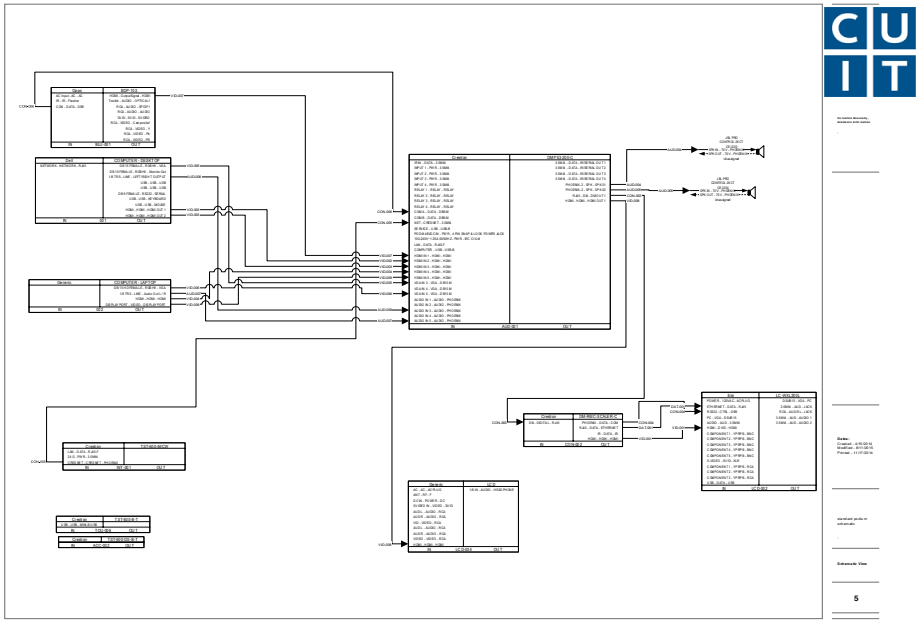
Smart Conference Room Standard AV/IT Components

- Conference Table
  - Crestron AV/IT Control System
  - Auxiliary AV/IT Connections (Laptop)
  - Windows or Apple Desktop Computer
- LED Display
- VoIP Telephone Conferencing Phone

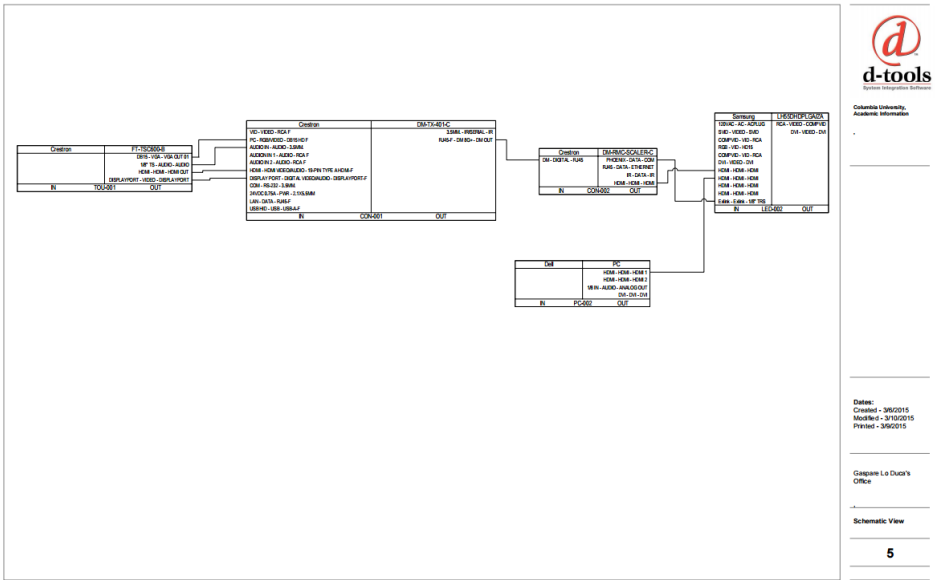
Conference Room AV/IT System Optional Components

- Web Conferencing
- Wireless Presentation
- Video Conferencing
- Webcasting
- Digital Recording (Voice and Video)

11.3 Typical Electronic Classroom Design



11.4 Typical Conference Room AV/IT System Design



Section 12.0 CUIT Support of Construction Management Offices

- Data and voice services in external (non-CU-staffed) Construction Management offices and trailers are not provided or supported by CUIT.
- External Construction Management entities working on campus shall provide their own ISP and voice services.
- Exceptions may be made for small offices occupying spaces within CU-owned buildings with existing CUIT network infrastructure in place.
- All exceptions are subject to approval by CUIT Network Engineering.

Section 13.0 CUIT Support of Retail Spaces

- Data and voice services in (non-CU-staffed) Retail Spaces within CU-owned buildings are not provided or supported by CUIT. Retail tenants are to engage commercial service providers directly and work with their CU building reps to coordinate the installation.

Section 14.0 CUIT Project Management

- Only CUIT Network Engineering shall issue final written approval of any data and voice infrastructure designs or design changes. CUF Capital Project managers shall forward all information regarding data and voice connectivity to CUIT Network Engineering via netproject@columbia.edu.
- CUIT Network Engineering must approve any changes to the IT project scope that might occur throughout the course of the project.
- CUIT Network Engineering shall review any changes to the construction documents that might occur throughout the course of the construction.
- CUIT shall provide an order of magnitude estimate at the schematic design phase.
- Please reference the CU Network Communications and Equipment Policy on page 4 of this document.

Appendix A

LINKWARE
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 10-001A
Date / Time: 09/25/2013 07:58:26 AM
Headroom 5.4 dB (NEXT 12-36)
Test Limit: TIA Cat 6 Perm. Link
Cable Type: Cat 6 UTP
Calibration Date: 08/29/2013

Operator: STANLEY
Software Version: 2.7400
Limits Version: 1.9300
NVP: 69.0%

Test Summary: PASS
Model: DTX-1800
Main S/N: 8749007
Remote S/N: 8749008
Main Adapter: DTX-PLA002
Remote Adapter: DTX-PLA002

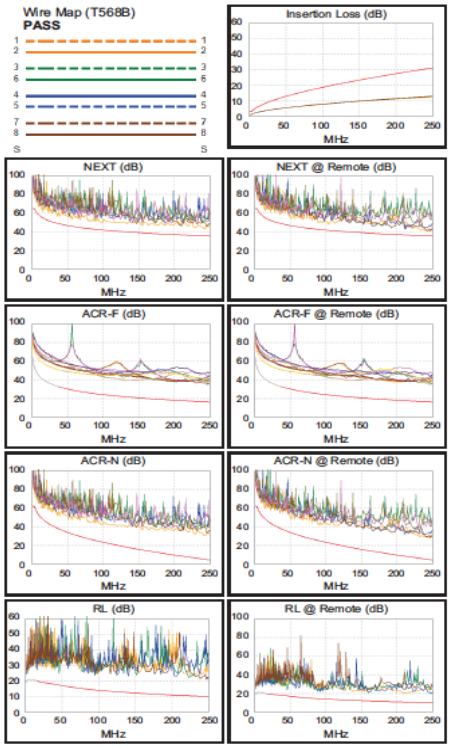
Length (ft), Limit 295	[Pair 45]	126
Prop. Delay (ns), Limit 498	[Pair 12]	195
Delay Skew (ns), Limit 44	[Pair 12]	10
Resistance (ohms)	[Pair 12]	5.8
Insertion Loss Margin (dB)	[Pair 36]	18.3
Frequency (MHz)	[Pair 36]	250.0
Limit (dB)	[Pair 36]	31.1

126 ft

Wire Map (T568B)
PASS

	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	12-36	12-36	12-36	12-36
NEXT (dB)	6.8	5.4	7.4	5.4
Freq. (MHz)	104.5	245.0	242.0	245.0
Limit (dB)	41.5	35.5	35.6	35.5
Worst Pair	12	36	36	36
PS NEXT (dB)	8.3	5.2	8.4	5.2
Freq. (MHz)	51.3	241.5	244.5	241.5
Limit (dB)	44.1	33.0	32.9	33.0
PASS	MAIN	SR	MAIN	SR
Worst Pair	12-78	78-12	45-78	78-45
ACR-F (dB)	17.5	17.5	18.7	18.7
Freq. (MHz)	6.8	6.8	245.5	245.5
Limit (dB)	47.6	47.6	16.4	16.4
Worst Pair	12	12	78	45
PS ACR-F (dB)	18.0	17.9	19.8	18.8
Freq. (MHz)	1.0	1.0	246.5	246.5
Limit (dB)	61.2	61.2	13.4	13.4
N/A	MAIN	SR	MAIN	SR
Worst Pair	12-36	12-36	12-36	12-36
ACR-N (dB)	11.4	11.6	25.5	23.5
Freq. (MHz)	14.3	14.3	242.0	245.0
Limit (dB)	48.8	48.8	5.0	4.7
Worst Pair	36	36	36	36
PS ACR-N (dB)	12.7	12.7	26.4	23.2
Freq. (MHz)	14.3	14.3	244.5	241.5
Limit (dB)	46.4	46.4	2.2	2.5
PASS	MAIN	SR	MAIN	SR
Worst Pair	36	36	78	45
RL (dB)	8.0	6.7	11.0	10.1
Freq. (MHz)	46.0	46.0	247.0	248.5
Limit (dB)	17.4	17.4	10.1	10.0

Compliant Network Standards:
10BASE-T, 100BASE-TX, 100BASE-T4, 1000BASE-T, ATM-25, ATM-51, ATM-155, 100VG-AnyLan, TR-4, TR-16 Active, TR-16 Passive



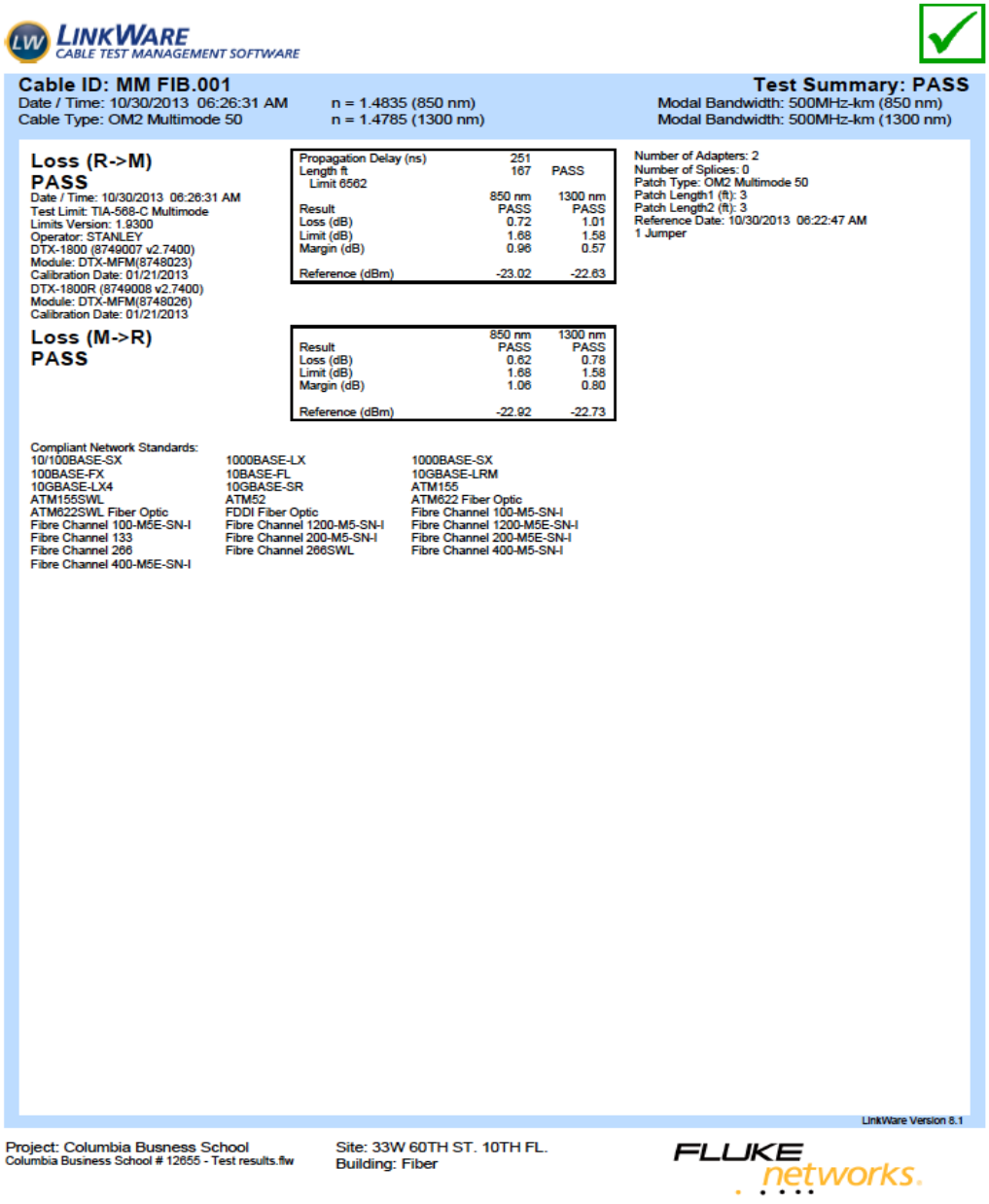
LinkWare Version 8.1

Project: Columbia Busness School
Columbia Business School # 12655 - Test results.flw

Site: 33W 60TH ST. 10TH FL.
Building: Copper

FLUKE networks

Appendix B



LINKWARE
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: MM FIB.001
Date / Time: 10/30/2013 06:26:31 AM
Cable Type: OM2 Multimode 50

n = 1.4835 (850 nm)
n = 1.4785 (1300 nm)

Test Summary: PASS
Modal Bandwidth: 500MHz-km (850 nm)
Modal Bandwidth: 500MHz-km (1300 nm)

Loss (R->M)
PASS
Date / Time: 10/30/2013 06:26:31 AM
Test Limit: TIA-568-C Multimode
Limits Version: 1.9300
Operator: STANLEY
DTX-1800 (8749007 v2.7400)
Module: DTX-MFM(8748023)
Calibration Date: 01/21/2013
DTX-1800R (8749008 v2.7400)
Module: DTX-MFM(8748026)
Calibration Date: 01/21/2013

Propagation Delay (ns)	251	
Length ft	167	PASS
Limit 6562		
	850 nm	1300 nm
Result	PASS	PASS
Loss (dB)	0.72	1.01
Limit (dB)	1.68	1.58
Margin (dB)	0.96	0.57
Reference (dBm)	-23.02	-22.63

Number of Adapters: 2
Number of Splices: 0
Patch Type: OM2 Multimode 50
Patch Length1 (ft): 3
Patch Length2 (ft): 3
Reference Date: 10/30/2013 06:22:47 AM
1 Jumper

Loss (M->R)
PASS

	850 nm	1300 nm
Result	PASS	PASS
Loss (dB)	0.62	0.78
Limit (dB)	1.68	1.58
Margin (dB)	1.06	0.80
Reference (dBm)	-22.92	-22.73

Compliant Network Standards:

10/100BASE-SX	1000BASE-LX	1000BASE-SX
100BASE-FX	10BASE-FL	10GBASE-LRM
10GBASE-LX4	10GBASE-SR	ATM155
ATM155SWL	ATM52	ATM622 Fiber Optic
ATM622SWL Fiber Optic	FDDI Fiber Optic	Fibre Channel 100-M5-SN-I
Fibre Channel 100-M5E-SN-I	Fibre Channel 1200-M5-SN-I	Fibre Channel 1200-M5E-SN-I
Fibre Channel 133	Fibre Channel 200-M5-SN-I	Fibre Channel 200-M5E-SN-I
Fibre Channel 266	Fibre Channel 266SWL	Fibre Channel 400-M5-SN-I
Fibre Channel 400-M5E-SN-I		

LinkWare Version 8.1

Project: Columbia Business School
Columbia Business School # 12655 - Test results.flw

Site: 33W 60TH ST. 10TH FL.
Building: Fiber

FLUKE networks

Appendix C

PATCH SCHEDULE												
FROM			CABLE			TO						
TR CLOSET	RACK	PORT	CABLE ID	QTY	TYPE	DESCRIPTION	Room Number	OUTLET LABEL	PORT	SWITCH	BLADE	COMMENTS
L3-086	R1	01	03N-001-A	1	4-PAIR CATEGORY 6A	2-PORT OUTLET	L3-015	03N-001	A	1	2	ON COLUMN
L3-086	R1	02	03N-001-B	1	4-PAIR CATEGORY 6A	2-PORT OUTLET	L3-015	03N-001	B	1	2	
L3-086	R1	03	03N-002-A	1	4-PAIR CATEGORY 6A	3-PORT OUTLET	L3-016	03N-002	A	1	2	FLOOR BOX
L3-086	R1	04	03N-002-B	1	4-PAIR CATEGORY 6A	3-PORT OUTLET	L3-016	03N-002	B	1	2	
L3-086	R1	05	03N-002-C	1	4-PAIR CATEGORY 6A	3-PORT OUTLET	L3-016	03N-002	C	1	2	
L3-086	R1	06	03N-003-A-SC	1	4-PAIR CATEGORY 6A	1-PORT OUTLET	wall near L3-017	03N-003	A	1	2	SECURITY CAMERA
L3-086	R1	07	03N-004-A	1	4-PAIR CATEGORY 6A	3-PORT OUTLET	L3-018	03N-004	A	1	2	FLOOR BOX
L3-086	R1	08	03N-004-B	1	4-PAIR CATEGORY 6A	3-PORT OUTLET	L3-018	03N-004	B	1	2	
L3-086	R1	09	03N-004-C	1	4-PAIR CATEGORY 6A	3-PORT OUTLET	L3-018	03N-004	C	1	2	
L3-086	R1	10	03N-005-A-AP	1	4-PAIR CATEGORY 6A	2-PORT OUTLET	ceiling near L3-018	03N-005	A	1	2	WAP
L3-086	R1	11	03N-005-B-AP	1	4-PAIR CATEGORY 6A	2-PORT OUTLET	ceiling near L3-018	03N-005	B	1	2	
L3-086	R1	12	03N-006-A	1	4-PAIR CATEGORY 6A	2-PORT OUTLET	L3-086	03N-006	A	1	2	Lenel Panel
L3-086	R1	13	03N-006-B	1	4-PAIR CATEGORY 6A	2-PORT OUTLET	L3-086	03N-006	B	1	2	