INFORMATION TECHNOLOGY TECHNICAL DESIGN REQUIREMENTS 2024

COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

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Overview

This document contains the Columbia University Information Technology (CUIT) Network Infrastructure design and installation standards, and is intended for use by Consultants and Contractors who maintain, design and install Telecommunications Infrastructure for Columbia University.

The IT systems design shall adhere to Industry Standards, applicable building codes, and specific user requirements for the building. A partial listing of relevant codes and standards to be followed:

- *ANSI/TIA-568-E Commercial Building Telecommunications Cabling Standard*
- *TIA-569-E, Telecommunications Pathways and Spaces*
- *TIA-607-D, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises*
- *BICSI Telecommunications Distribution Methods Manual (TDMM), 14th Edition*

For a complete list of IT standards, refer to the BICSI TDMM 14th Edition Appendix A: Codes, Standards, Regulations, and Organizations.

The Columbia University Network Protection Policy requires that all network, communications and telecommunications-related equipment and devices be installed and maintained by CUIT.

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

- the DHCP to configure Network IP addresses and
- the DNS protocol for Server information.

The complete policies can be found here:

Columbia University Network Protection Policy
https://universitypolicies.columbia.edu/content/network-protection-policy

Information Technology (CUIT) Policies
https://universitypolicies.columbia.edu/content/information-technology-cuit-policies

01
Section 1.0 Definitions

Building Entrance Terminal (BET)
Cable termination equipment used to terminate outside plant (OSP) cables at or near the point of building entry. Fused BETs take copper (OSP) voice/data lines that are exposed to the possibility of surges of unexpected voltage and direct the surge to ground (surge protection/lightning protection).

Building Management System (BMS)
A Building Management System (BMS) is a computer-based system installed in buildings to control and monitor mechanical and electrical plants, including HVAC (heating, ventilation, air conditioning), lighting, shade controllers, power systems, fire systems, security systems, etc.

Cable Tray / Raceway
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.

Entrance Facility (EF)
A room specifically designated for use by outside service providers to terminate their infrastructure upon entering the building. Collocating outside service providers in CUIT ERs or TRs is prohibited.

Equipment Room (ER)
A room that serves as the connection point between inter-building and intra-building distribution systems. The ER serves the entire building (rather than a floor or specific location) and is the recognized termination point of all backbone cabling within a building. The ER houses technology equipment specific to backbone cabling and requires environmental control and security. With prior approval by CUIT, an ER may serve as both an ER and a TR if necessary. Buildings shall typically be outfitted with dual ERs for redundancy.

Horizontal Cable
Unshielded Twisted Pair (UTP) that is run from the TR to the workstation (or network outlet). See Section 3.0.

Inter-building Backbone Cable (also known as OSP - Outside Plant)
This cable is used to link buildings together. Multi-strand fiber optic cable and multi-pair copper cable are the most common examples. 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 cable are the most common examples. See Section 5.0.

Network Jack

A female connector terminated on the end of the horizontal cable.

Network Outlet

The faceplate in which the network jacks are mounted.

Telecommunications Room (TR)

A room that serves a floor or portion of a building. 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 and contains rack/wall-mounted hardware and technology equipment.

WLAN

A wireless Local Area Network.

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Section 2.0 Project Roles and Responsibilities

CUIT Network Engineering provides design phase guidance and interpretation of CUIT design requirements, as well as commissioning oversight. Depending on project scope, CUIT Network Engineering may provide installation and commissioning (Cx) services or may direct the General Contractor or Construction Manager to bid the work. The approach will be determined on a per-project basis. The GC or CM is responsible for debris removal generated by low-voltage infrastructure contractors whether in contract with the GC/CM or under a separate contract with the owner. In all cases, CUIT Network Engineering will specify and procure all active network electronic components.

CU Capital Project Management (CPM) and CU Manhattanville Development Group (MDG) manage new construction and renovation projects, incorporating all CUIT system needs in the planning, design and construction phases including build-out of Telecommunications Rooms and related infrastructure needs, distribution and riser pathways and systems furniture coordination.

CPM and MDG Project Representatives are responsible for notifying the CUIT Network Operations Center (NOC) of any planned electrical or cooling system outages that may impact CUIT ERs or TRs. The CUIT NOC shall be notified via email at noc@columbia.edu.

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Section 3.0 Horizontal Cable

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

Vendors engaged to perform the installation of horizontal cabling MUST be manufacturer-certified on the products to be installed (i.e., Belden-certified.) Proof of certification must be presented to CUIT prior to the commencement of work.

3.1 Category 6A UTP

- Conform to TIA-568-E - Commercial Building Telecommunications Cabling Standard
  - T568B pin/pair assignment for UTP cabling
- All vendors and subcontractors working with Cat 6A horizontal cabling shall be Belden Certified Installers
- Maximum 90 meter run from patch panel to network outlet
- Supports up to 10,000 Mbps Ethernet

Belden 10GX Structured Cabling Solution:

Belden Part #	Description
10GXS13	CAT6A (625MHz), 4-Pair, U/UTP-Unshielded, Plenum-CMP
2148A	CAT6A Indoor/Outdoor CMR/CMX Cable
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
CAD1106XXX	CAT 6A 28AWG Small Diameter Patch Cord Blue

3.2 Installation Requirements:

- Only pre-terminated, factory-tested and warrantied Ethernet patch cables are to be installed. The use of *field-terminated Ethernet patch cables is strictly prohibited*.
- Horizontal cabling that supports components (WiFi access points, IP cameras, etc.) that are installed outside of the building envelope (on building facades, building rooftops or on exterior poles) shall be terminated with in-line lightning arrestors. *(See Section 9.3 for additional guidance.)*
- A Pull/Patch Schedule shall be submitted to CUIT for review and approval prior to the commencement of cable terminations and must include all information reflected in the sample Pull/Patch Schedule provided *(see Appendix C). Please refer to Sections*

6.4 and 6.5 for additional guidance. The final/approved Pull/Patch Schedule is to be submitted in both a .pdf and .xlsx (or .csv) format.

3.3 Test Requirements:

- Category 6A certification results shall be provided to CUIT in electronic format upon completion *(see Appendix A for sample report).*
- Test results shall comply with TIA/EIA specifications.
- Test results shall include the 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.*

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Section 4.0 Cable Pathways and Placement for Network Outlets

Conform to TIA-569-E - 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 device cover 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 device cover and 1-1/4" stub-up to nearest accessible ceiling).
- Minimum 2 UTP cables run to each outlet box/faceplate at a typical administrative workstation (design must include one discrete port for every IP Phone location).
- Any floor boxes or other raceways shall accommodate 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 draglines and bushings 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 – nVent/Caddy/Erico fastening products CAT64HPBA or equivalent).
- Cable shall not be laid directly on the ceiling tile or grid.
- Inaccessible ceilings require access panels at intervals adequate for future changes and additions.
- A minimum of 5" physical separation shall be maintained between UTP cable and fluorescent, neon, mercury-vapor, HID, etc. lighting

4.2 Cable Trays and Raceways

- These pathways shall be installed in accordance with the applicable electrical code.
- The overall fill ratio of the tray or raceway shall not exceed 40% for both header and distribution trays. Do not exceed the specified bend radii of the cables or the weight loading of the tray or raceway. Cable trays and raceways for new construction and for renovated spaces shall be sized as per the manufacturer's specification for Belden 10GXS Cat6A cable.

4.3 Furniture Raceway Systems

- Furniture raceway system designs are to be reviewed with the CUIT Network Engineer at Schematic Design and 90% Construction Documents. Ensure:
  - sizing requirements are met.
  - interoperability with other wiring components found in section 3.0.
  - appropriate cable ingress hardware is provided.
- Detailed information on the cable ingress to the furniture system shall be provided.
- Furniture cable raceways shall be sized to accommodate Belden 10GXS Cat6A cable.
- Factory pre-wired systems furniture (including lab benches) is not permitted. All cables to be maintained by CUIT within 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:
  - 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).
- All conduits shall be installed with drag lines.
- Appropriate bushings shall be installed to prevent cable abrasion during the cable installation process.
- The use of set-screw conduit fittings (couplers, connectors, etc.) is prohibited. Use compression-style fittings only.
- 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 prohibited.
- Installation of flexible conduit shall be avoided and permitted only with the approval of CUIT Network Engineering.
- All conduits and sleeves shall be sized for the installation of Belden 10GXS Cat6A 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.

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Section 5.0 Backbone Cabling and Infrastructure

CUIT will determine the type and strand counts of fiber optic cable to be installed on a per-project basis.

Vendors engaged to perform the installation of fiber optic cabling MUST be Corning-certified on the products to be installed. Proof of certification must be provided to CUIT prior to the commencement of work.

5.1.1 Cable Types

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
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
95-200-99	Uni-Cam connectors – LC Single-mode (OS2)
95-050-99-X	Uni-Cam connectors – LC Multi-mode (OM3/OM4)
CCH-04U	"Closet Connector Housing" patch panels
CCH-CP12-A9	"Closet Connector Housing" Cassettes – LC Single-mode
CCH-CP12-AD	"Closet Connector Housing" Cassettes – LC Multi-mode
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-E (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.
- Metallic-armored and /or dielectric-armored fiber should be used when vulnerability is an issue. Metallic-armored jackets must be grounded in accordance with industry standards and local electrical codes. With CUIT approval, the use of OS2 or OM4 armored fiber may negate the need for innerduct.

- Any fiber installed outside of the building envelope (exposed or in conduit) must be outdoor or indoor/outdoor rated. Any exceptions must be approved by CUIT Network Engineering.
- Ribbon fiber is typically required by CUIT to accommodate 40/100/400Gb connectivity. Contact CUIT Network Engineering for direction.

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.
- Cable installed outside of the building envelope must be outdoor or indoor/outdoor rated. Any exceptions must be approved by CUIT Network Engineering.
- Metallic armored multi-pair backbone cable installed outside of the building envelope must be terminated on fused building entrance terminals (BETs)

5.2 Fiber Testing

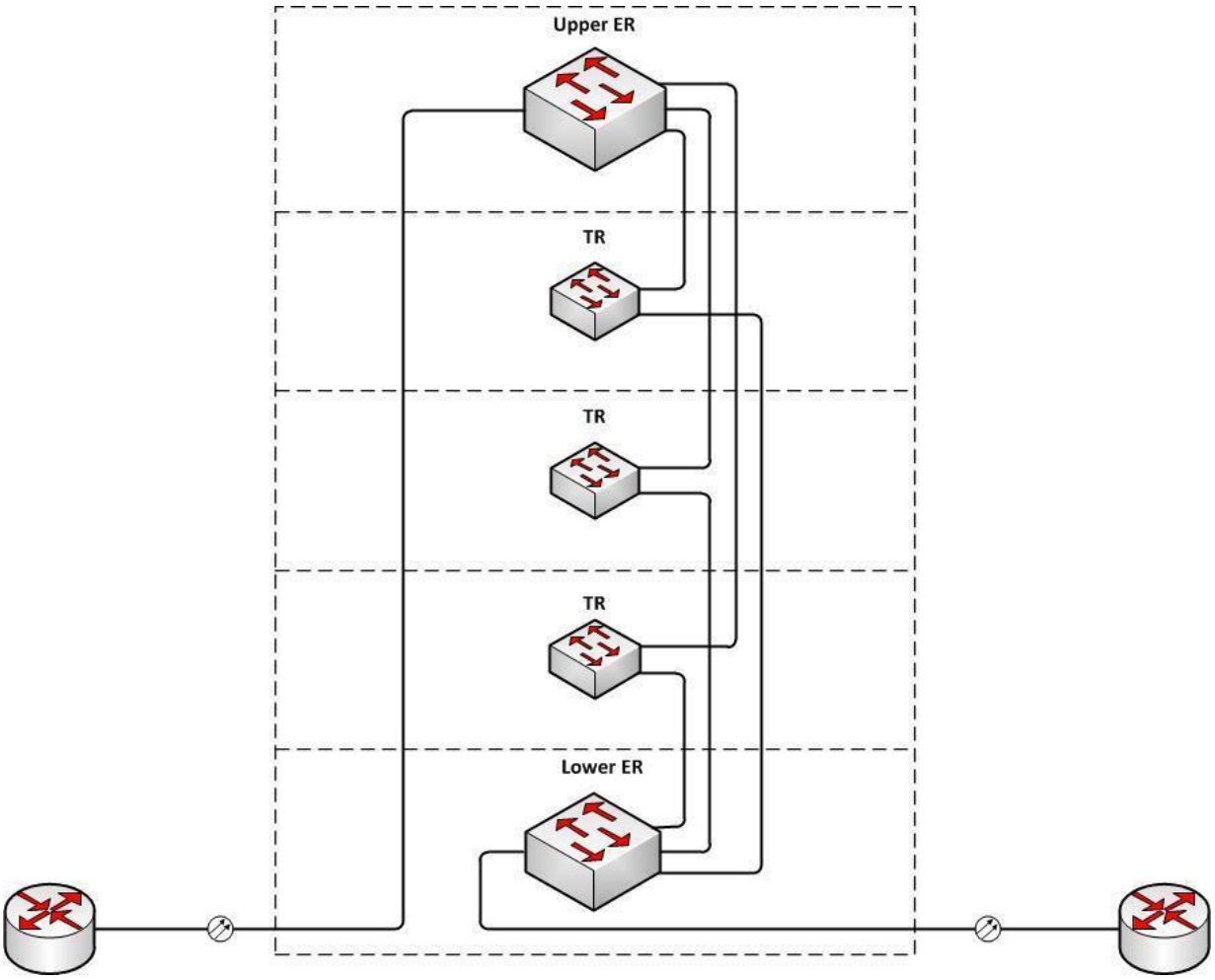
- Fiber optic strands must be individually tested at the relevant wavelengths using a power meter and source.
- 850/1300nm – multimode cabling
- 1310/1550nm – single mode cabling
- Test results shall be documented in .pdf format for submission to CUIT upon completion *(see Appendix B for sample report).*
- Attenuation loss shall not exceed the manufacturer's acceptable loss parameters found on the datasheet of the relevant cable.
- .5dB loss is allowed per connector pair.
- Test results MUST include the 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 Backbone Cable and Infrastructure Design Guidelines

Infrastructure Scenario 1

Dual Equipment Rooms exist (or are being provided in the project scope)

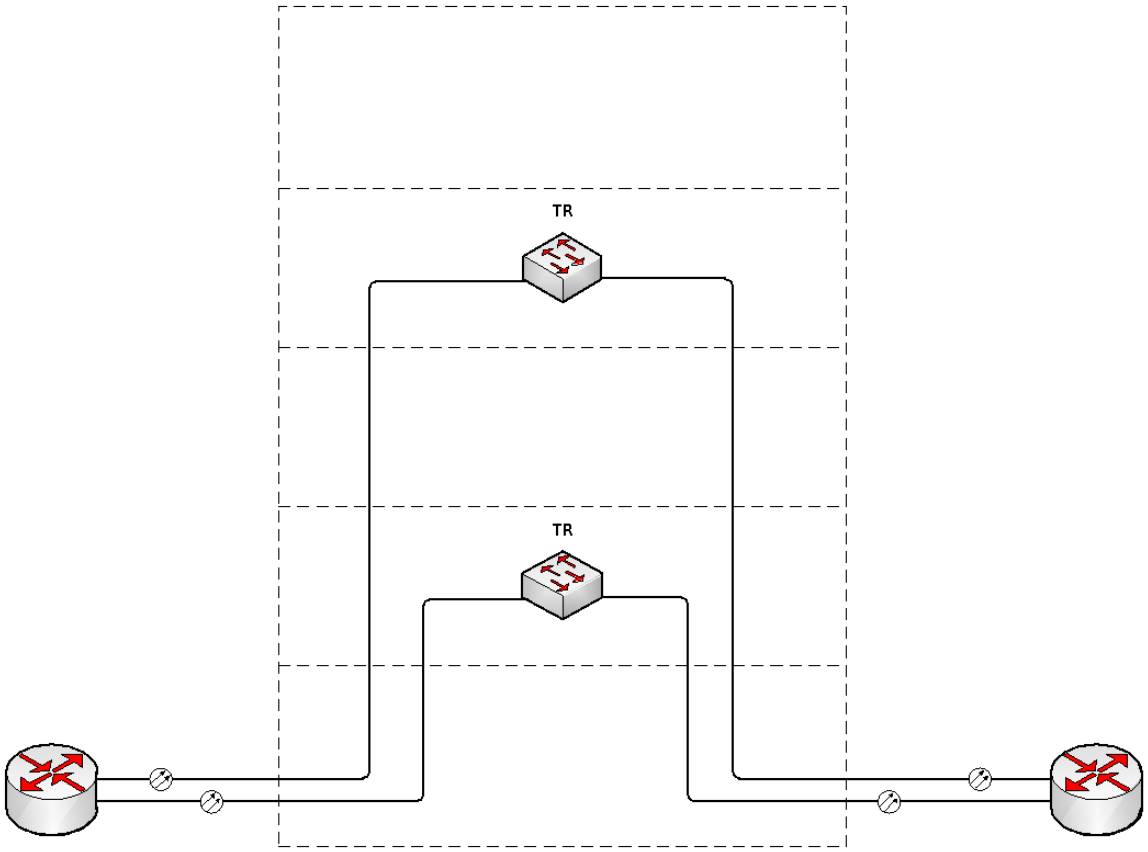
- Each TR shall be linked via two physically diverse pathways to each ER using a minimum of one 12-strand multimode cable and one 12-strand single-mode cable (two separate cables). Refer to fiber specifications in section 5.1.1.



Infrastructure Scenario 2

Equipment Rooms do not exist and will not be provided as part of project scope.
(Equipment Rooms may be located in a nearby building)

- 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.



5.4 Physical Redundancy Requirements

- Dual Equipment Rooms are required for new construction and large renovation projects. Physical redundancy between ER and TR rooms provides resilience in the event of a cable cut, equipment failure, or power failure preventing voice and data network downtime.

    - 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).
    - Two physically diverse Interbuilding Backbone Cable points-of-entry must be provided.

    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).
    - Two physically diverse Interbuilding Backbone Cable points-of-entry must be provided.
    - 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).
- 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 installed 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 require special network design and equipment because of their unique nature.

- Examples:
    - CU occupation of a portion of a non-CU property (e.g. The Interchurch Center).
    - CU property that is remotely located relative to the Morningside campus (e.g. Nevis, Lamont-Doherty, CUIMC).
- Special circumstances examples:
    - Leased circuits from local carriers (e.g., Verizon, Crown Castle).
    - 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 (ECS).

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Section 6.0 Telecommunications/Equipment Room Design Requirements

Conform to TIA-569-E - Commercial Building Standard for Telecommunications Pathways and Spaces.

During the Design Phase, CUIT shall approve the proposed quantity, size 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) on every third floor. High densities of cabling in an area may dictate that more than one TR per 3 floors will be required.

- 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 located on a public corridor or other public space accessible by CUIT on a 24x365 basis. Access via a private office or classroom space is not acceptable. Access to a TR via mechanical spaces MAY be acceptable with both CUIT and CU Facilities Operations approval.
- 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:

- TRs and ERs size, location and layout
  - provide 3 feet of clearance in the front and behind the network equipment (4 feet preferred). Some network equipment may require additional clearance.
  - Provide sufficient clearance for CUF Ops and CU DPS personnel to perform routine maintenance and/or replacement of any HVAC equipment or security hardware located within the TR or ER without requiring any network equipment to be relocated or removed.
  - The TR location selected may offer expansion into a larger room. Locations that are restricted by building components limiting future expansion shall be avoided (e.g., elevators, building structural elements, kitchens, outside walls, or other fixed building walls, etc.)
  - There shall be no obstructions in the room such as columns or building structure.
- Door locking hardware shall follow the existing CUIT keying system. Coordinate with the CU Lock Shop through the CUIT Network Operations Center.
- TRs are to be located in a dry area not subject to flooding. The room shall be free of water or drain lines not directly required in support of the equipment within the room. A raised concrete pad and a floor drain shall be provided within the room if the risk of water ingress exists.

- Plumbing, piping, and fixtures are not permitted within a TR, except for a code-required wet sprinkler line/head. The room shall not be located beneath toilets, showers, laboratories, kitchens, sinks, roof drain leaders, or other areas where water/liquid services are provided. No fire protection mains shall be routed through the room.
- Air conditioning equipment or piping shall not be installed directly over IT racks. A full external drip pan in addition to the unit's internal pan is required.
- Leak detection is required in all areas of vulnerability – floor, internal and external AC drip pans, and any water piping situated over IT racks. Alarms shall be tied to a local alarm panel with visual and audible alarms, and generate remote alarm signals via the network at CUIT and the BMS.
- The cooling system is to maintain 24x365 operating temp of 50-80 degrees F (77 degrees nominal) with 20,000 BTU/h heat dissipation. CUIT will provide project-specific anticipated heat load figures during the design phase.
- No other utilities shall be placed in any TR other than those specifically supporting the TR equipment (electrical panels, plumbing, service provider [e.g., Verizon], BMS equipment, etc.)
- Placement of CU DPS security hardware in a TR is permitted only with the approval by CUIT Network Engineering.
- Open relay racks are to be installed in CUIT Telecom Rooms – Chatsworth Part# 55053-703.
- Utilize vertical wire managers between relay racks for cable management – Chatsworth Part# 12096-703, 11729-703 or 3557X-703 (Evolution-series) depending on cabling density.
- Any vertical wire manager installed between two racks must be a minimum of 10" in width to accommodate higher cable densities.
- The TR shall be located away from transformers, switchgear, motors, x-ray equipment, induction heaters, arc welders, radio and radar systems, or other sources of electromagnetic interference.
- Mechanical lines (e.g., ductwork, pneumatic tubing, electrical conduits), not related to the support of the TR, shall not be routed through any TR. In addition, the corridor plenum areas adjacent to the TR shall remain accessible and clear for cable pathways exiting the room.
- Wall-mounted equipment: Install one 4' x8' sheet of ¾" interior fire-retardant plywood on one wall.
- Install static-dissipative floor tiles (Armstrong Excelon SDT or equivalent).
- Install a Telecommunications Ground Busbar (TGB). Connect ground busbar to building steel or nearest building ground electrode (EIA/TIA-607). All equipment racks and metallic raceways within the ER or TR are to be grounded to the TGB.

6.2 Electrical Details

- Lighting shall be designed to provide adequate light levels (min. 50 footcandles) AFTER all network racks, equipment and cabling have been installed in the room.
- Provide two (2) NEMA L14-30 receptacles.
    - NOTE: An alarm condition will be generated by the UPS if the input power phase rotation does not match the CLOCKWISE PHASE ROTATION on the output of the UPS. It is important to ensure that these L14-30 receptacles are wired to PROVIDE CLOCKWISE PHASE ROTATION.
- Provide two (2) dedicated 20-amp circuits with a NEMA 5-20 quad receptacle.
- Provide one (1) 15-amp convenience duplex receptacle.
- All electrical circuits must have dedicated neutral and dedicated ground conductors.
- Electrical circuits that are dedicated to equipment within the same TR 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 receptacles 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 to 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. A final *technical* cleaning by a qualified vendor is to be performed prior to room turnover.
    - Flooring is deep cleaned (and waxed if applicable)
    - Equipment racks, components, and trays are free of dust
    - Packaging, supplies, debris, and wire clippings are removed from the TR interior and exterior vicinity
    - Ductwork and vents serving the Telecom Room are clean

  Sequencing note: CUIT ERs and TRs are the sole source for network services required for building commissioning and inspection activities. Consequently, CUIT ERs and TRs and associated infrastructure must be substantially completed well in advance of occupancy in order to provide these essential services.

6.4 Cable Identification

- Typical network outlet faceplate label: 09A.10-001-A
  - "09A" indicates the TR in which the cable is terminated.
  - "10" indicates floor # of faceplate location.
  - "001" indicates the faceplate number on the floor.
  - No two locations on the same floor AND terminated in the same TR are to have identical faceplate designation numbers, regardless of the suffix identifier used (see suffix identifiers, below)
  - "A" indicates jack (cable) in the faceplate.
  - Wireless access point locations shall have an 'AP' suffix identifier added.
  - Wall Phone locations shall have a 'WP' suffix identifier added.
  - Security Camera locations shall have an 'SC' suffix identifier added.
    - Examples:
      - 07A.06-010-B AP indicates wireless access point cable 'B' on faceplate 010 on the 6th floor, terminated in the 7th floor TR
      - 07A.06-099-A SC indicates security camera cable 'A' on faceplate 099 on the 6th floor, terminated in the 7th floor TR
  - All faceplate and cable labels MUST include the TR designation.
  - The TR designation is NOT required on the patch panel labels in the TR.

6.5 Patch Panel Layout and Organization

- Every patch panel shall be labeled with one large floor # label (in addition to the individual cable labels with floor designation).
- Cables from different floors shall never be terminated on the same patch panel.
- All cables on every patch panel shall be terminated in sequential numerical order.
- Every floor shall start with the "001" faceplate designation and increment from there.
- All patch panels with cabling terminated from the same floor shall be grouped together in the rack.
- One RU of blank space is to be maintained between every patch panel.
- When cabling from multiple floors is terminated in the same TR, a minimum of 4 RU must be left between patch panels for floor A and floor B to maintain order for future expansion.

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Section 7.0 Data/Voice/Video Equipment

- Data and voice equipment shall be specified by CUIT Network Engineering and procured and installed by CUIT Network Field Services.
    - Exceptions to the procurement and installation responsibilities must be confirmed on every project by CUIT Network Engineering.
- Equipment procurement must commence at least 6 months prior to the Telecom Infrastructure installation date.
- CUIT must receive approval and an account number (or an approved Unifier PO) before procurement commences.
- The project schedule shall accommodate the physical installation of data/voice/video equipment by CUIT (non-union) staff members.

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Section 8.0 Demolition, Temporary Protection and Obsolete Infrastructure Removal

- Existing Telecom Rooms and infrastructure affected by project demolition and renovation shall remain in operation until successful cutover to replacement Telecom Rooms and infrastructure, or until temporary service is established.
- Prior to the demolition of existing Telecom Room walls, ceilings or flooring, temporary barriers must fully enclose the existing room equipment. The barriers shall provide physical protection from demolition debris and environmentally seal off the equipment to prevent ingress from dust and contaminants.
- Temporary cooling must be provided within the barrier spaces to maintain a temperature range between 50-80 degrees Fahrenheit. Provide positive pressure within the barrier for dust control.
- The GC/CM shall be held responsible for the replacement of CUIT equipment damaged or for voiding equipment warranties during construction per the general conditions of the contract.
- The scope of work for any renovation project shall include the 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 reuse, if possible.
    - Include the cost of obsolete cable removal in the overall IT infrastructure estimate in instances where CUIT will be responsible for physical removal.

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Section 9.0 Wireless Networking

Wireless networking infrastructure is required for all renovation and new construction projects.

9.1 Horizontal cabling for WLAN

- CUIT Network Engineering shall specify network outlet placement for wireless networking based on floor plans provided by the design team.
- 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 will 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/6GHz ubiquitous coverage

- All spaces within a defined area shall have ubiquitous coverage in the 5/6GHz 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 specified and/or approved by CUIT Network Engineering.
- For estimating purposes only, assume that one access point per 750 sq. ft. will be required to provide ubiquitous 5/6GHz coverage.
- All wireless coverage shall be designed to provide 802.11ax service.
- CUIT supports only Aruba 802.11ax wireless access points. Wireless access point hardware cut sheets will be provided upon request for architectural coordination.
- All access points shall be mounted exposed, below the lowest ceiling.
    - Minimum height 96".
    - Maximum height 120".
    - Minimum distance from ceiling 12" (when wall-mounted).
    - Access points shall be a minimum of 10 feet apart.
- All WLAN electronics shall be specified 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 collaboration 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 5/6Ghz 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 whose scope includes the refresh of existing or development of new outdoor seating or congregation areas.
- Outdoor access point placement shall be specified and/or approved by CUIT Network Engineering in cooperation with CUF Operations and CUF Exteriors and Historic Preservation.
- Any proposed change to the CUIT design requires 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, prohibition of the use of conduit bodies, etc. as outlined elsewhere in this document.
- IP68 rated enclosures for outdoor network outlets shall be incorporated into the design.
- Outdoor: Belden 2148A Multi-Conductor - Category 6A Indoor/Outdoor CMR/CMX Cable
- Indoor: Belden 10GXS13 Multi-Conductor - Category 6A Nonbonded-Pair Cable

9.5 Lightning arrestor requirements for outdoor infrastructure

- 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 #8 AWG green wire shall be provided to the building lockbox, to the access point mounting location and to the lightning arrestor hardware mounted in the nearest CUIT TR.
- Hardware Specifications:
    - Terrawave TW-SP-10GB-10-BTSingle Port, 10KA, 10 GB Ethernet Surge Suppressor for 802.3at, 802.3af, and 802.3bt Networks
    - DITEK DTK-RM24NETS 24-channel, 1U rack mount surge protector
    - DEHN M CAT6 RJ45S 48 (929 100) Surge Arrestors
    - DEHN MS DPA (929 199) DIN rail
- The design of the arrestor deployment is subject to review and approval by CUIT Network Engineering.

9.5 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.

Some occupancy sensors will cause interference with or 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 5.8 GHz 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 (unless specifically designed for WiFi interoperability (i.e., Zigbee):

- 2.40 - 2.485 GHz
- 5.18 - 5.835 GHz
- 5.925 GHz - 7.125 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.

Design documents must include drawings detailing the mounting means and methods for all models of wireless access points and all mounting conditions that may be applicable to a particular project (i.e., different ceiling or wall types).

10
Section 10.0 Building Management Systems (BMS)

- 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.).
- Any Building Management System that is being proposed for installation on the CU campus must be evaluated and approved prior to procurement and vendor contract execution. The following information for any proposed system must be gathered and presented to CUIT Network Engineering, CUFO-IT and CUF Commissioning for evaluation and approval:

- Basic functionality:
    - What systems will be monitored/controlled?
    - Post-installation, which department will assume responsibility for this system (who is the owner)?
        - A responsible party (owner) MUST be identified and documented.
    - Does the system require internet access?
        - Do the on-premise system components communicate with off-premise or cloud-based servers?
        - Do the on-premise system components always initiate communication with these off-prem/cloud servers or must the on-prem components accept connections initiated from off-campus?
            - Provide the DNS name and IP address of the off-prem servers with which the on-prem components must communicate.
            - Provide a list of TCP/UDP port numbers on which the devices will communicate.
            - If internet access is not a requirement, which (if any) on-prem servers will this system need to communicate with?
- Network Security (a minimum of one of these capabilities is REQUIRED and for which documentation must be provided):
    - What are the system's network security capabilities?
        - Host-based IP tables?
        - Host-based firewall?
            - The owner will be responsible for maintaining any host-based firewalls or IP tables.
        - Can the system be configured to use a web proxy server?

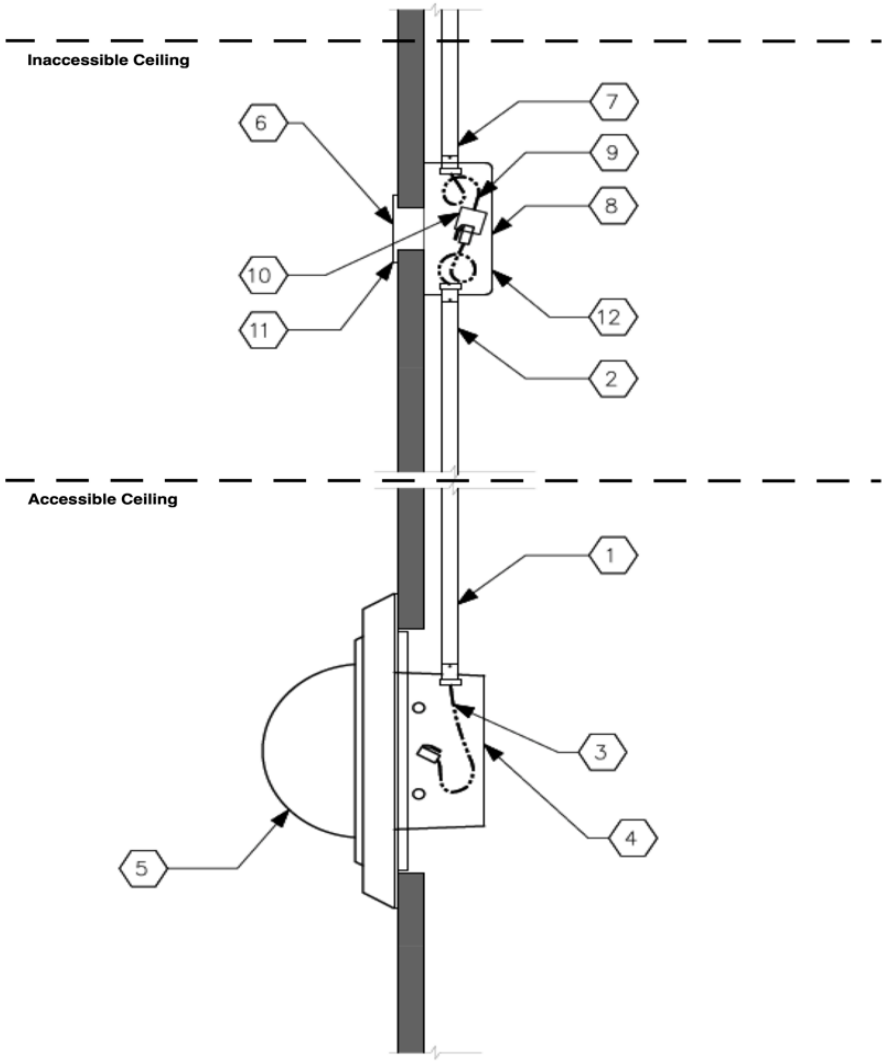
- What Operating System (OS) is used?
    - The vendor must confirm that the latest version of OS with the latest security patches will be installed prior to deployment.
    - The owner will be responsible for updating the OS and applying any relevant security patches as they become available.

- Any system accessible via web interface must be secured with an SSL certificate.
    - The owner is responsible for the renewal of this certificate.
- As per CU Network Protection Policy, all devices connected to the CUIT network (including BMS) must be configured to run Dynamic Host Configuration Protocol (DHCP).
    - No devices are to be "hard-coded" with an IP address and default gateway. The device must request and discover its registered IP addresses and network information via the DHCP process.
    - On-premise devices connected to the campus network must be registered with a static IP address.
        - Registration of these devices will be facilitated by CUFO-IT for any systems for which a CUFO-IT-supported team is the owner of the system
            - CUFO-IT registration requests are to be submitted via email to helpdesk@cuf.columbia.edu
        - Registration of these devices will be facilitated by CUIT for all other systems.

11
Section 11.0 Public Safety

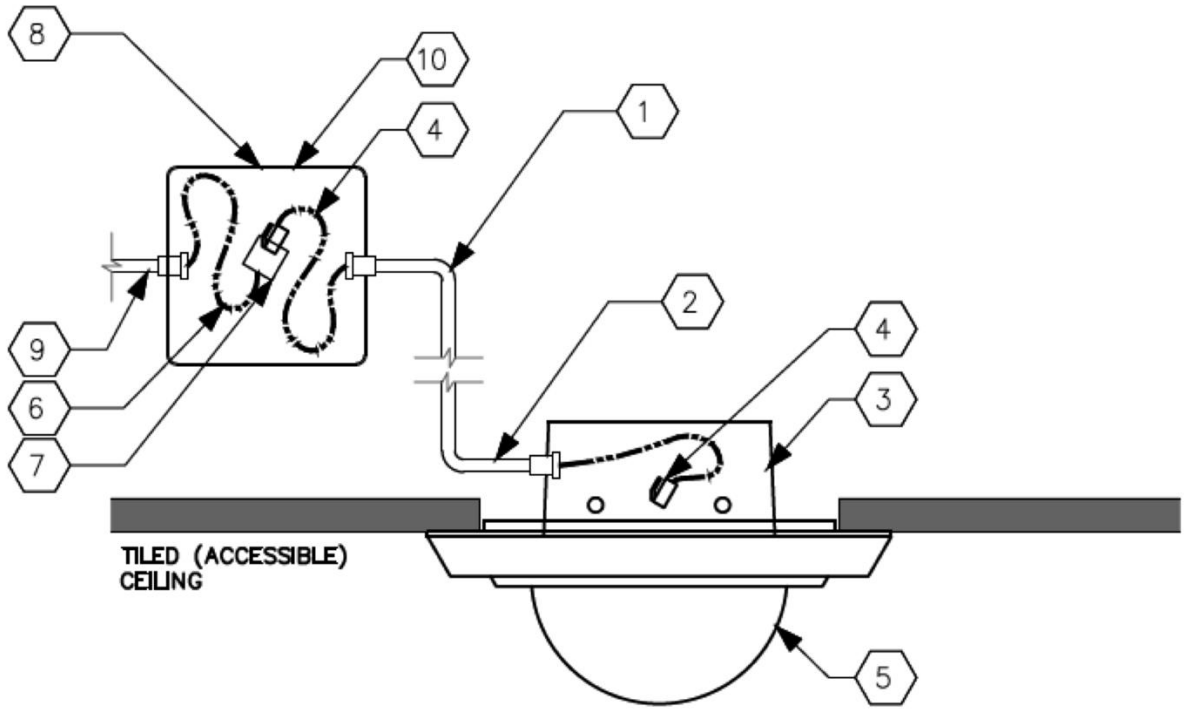
- Public Safety surveillance hardware requires access to the CU data network. CUIT Network Engineering in conjunction with the Columbia University Department of Public Safety shall provide direction as to the technical infrastructure needs of these systems on a per-project basis.
- Refer to diagrams 11.1, 11.2 and 11.3 for typical box and conduit requirements for Department of Public Safety IP camera installations.

11.1 Typical Wall-Mount Camera Conduit Design



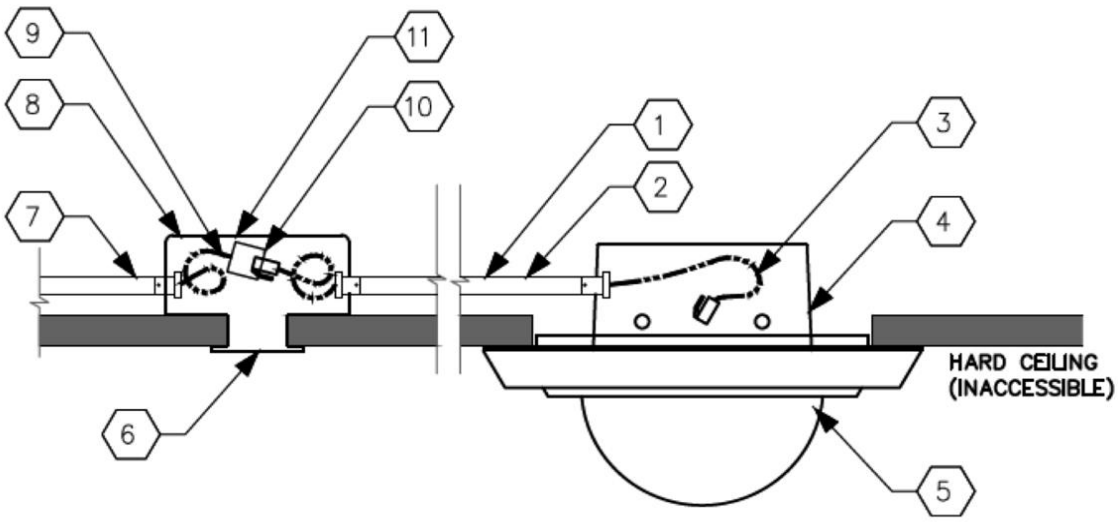
1. 3/4" PLENUM RATED FLEXIBLE CONDUIT (LENGTH NOT TO EXCEED 3 FT.) TO BE SECURED EVERY 18" USING CLIPS OR PLENUM RATED TY-WRAPS.
2. SECURITY CONTRACTOR TO USE 3/4" FLEXIBLE CONDUIT TO ROUTE CAT-6 PATCH CORD FROM INFORMATION OUTLET TO CAMERA PORT
3. CAT-6 PATCH CORD FURNISHED BY CCTV CONTRACTOR (SAME 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. 1-1/4" FIXED CONDUIT (EMT) TO NEAREST ACCESSIBLE LOCATION 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.

11.2 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. 1-1/4" CONDUIT TO NEAREST ACCESSIBLE LOCATION OR CABLE TRAY
10. CU-IT TEST POINT

11.3 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. 1-1/4" FIXED CONDUIT TO NEAREST ACCESSIBLE LOCATION 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
Section 12.0 Electronic Classrooms & Smart Conference Rooms

12.1 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 a 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 the 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 the 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.

12.2 Conference Room AV/IT System

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

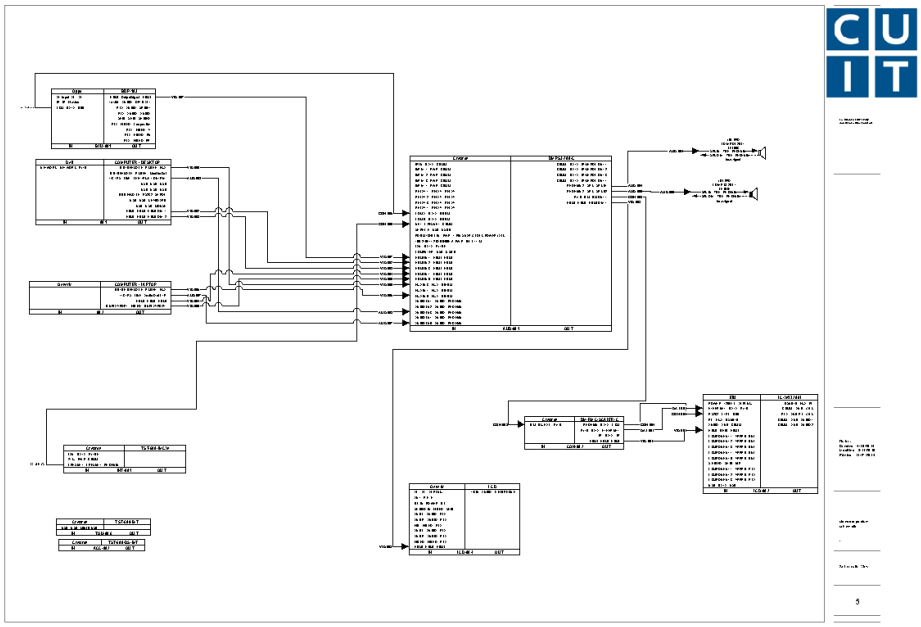
Smart Conference Room Standard AV/IT Components

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

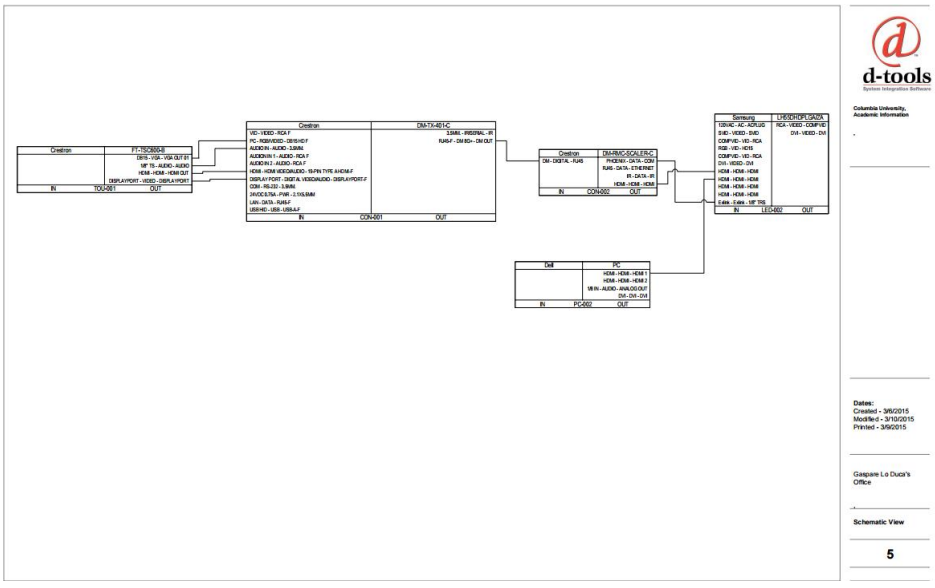
Conference Room AV/IT System Optional Components

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

12.3 Typical Electronic Classroom Design



12.4 Typical Conference Room AV/IT System Design



13
Section 13.0 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.

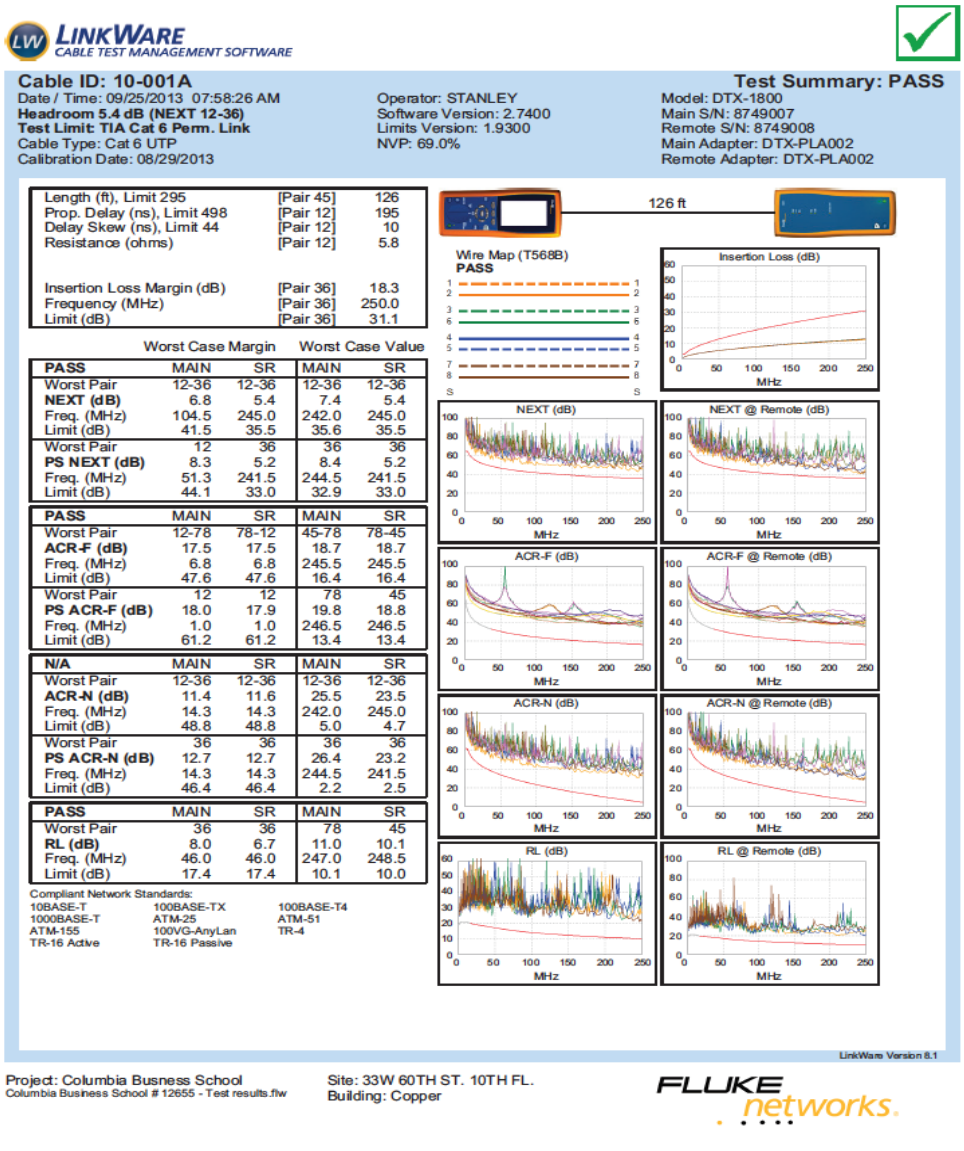
14
Section 14.0 CUIT Support of Retail Spaces

- 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.

15
Section 15.0 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 email to 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 cost estimate at the schematic design phase.
- Please reference the Columbia University Network Protection 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

Insertion Loss (dB)
NEXT (dB)
NEXT @ Remote (dB)
ACR-F (dB)
ACR-F @ Remote (dB)
ACR-N (dB)
ACR-N @ Remote (dB)
RL (dB)
RL @ Remote (dB)
MHz

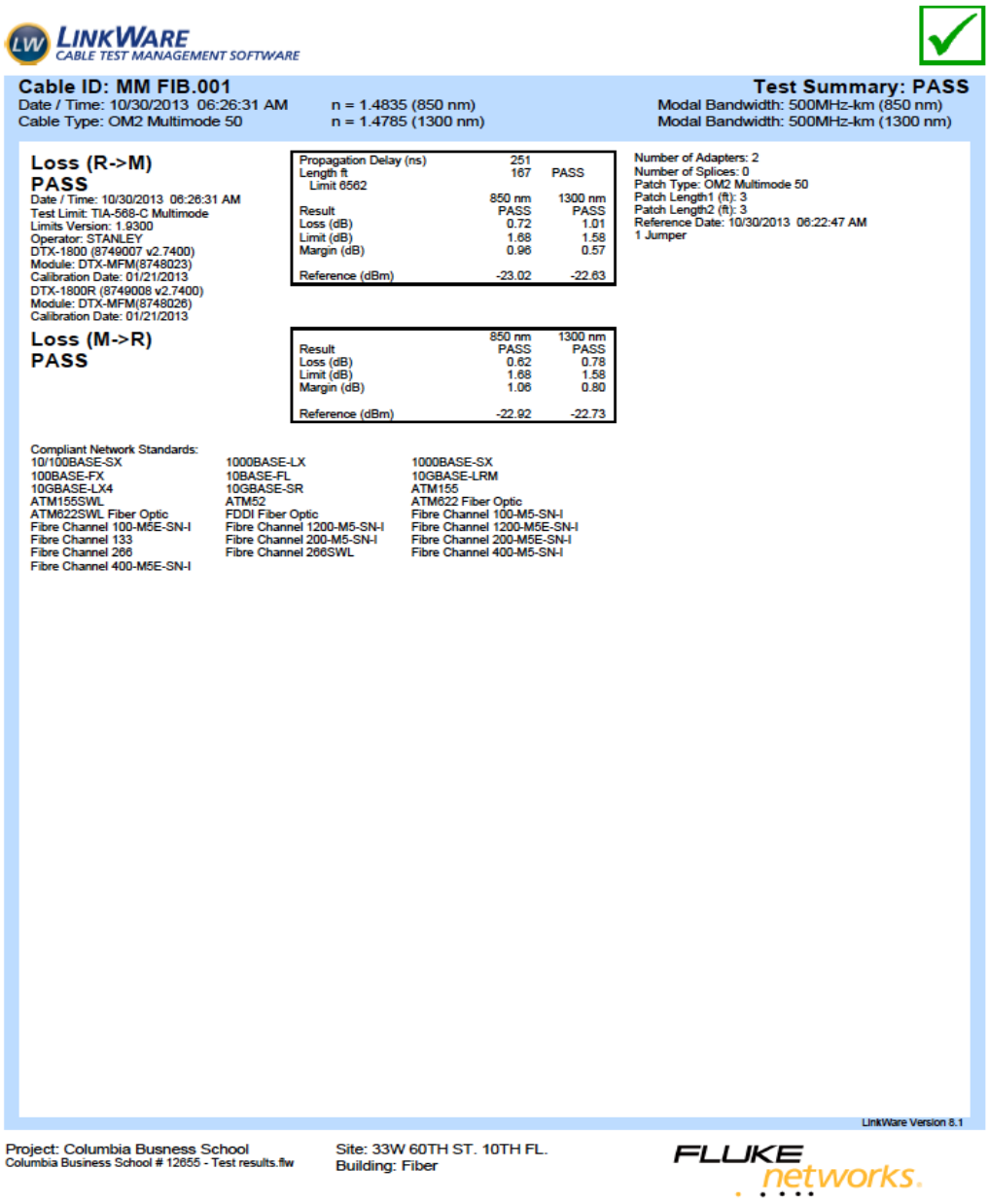
LinkWare Version 8.1

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

LinkWare Version 8.1

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

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

FLUKE networks

Appendix C

TR ID	Rack	Patch Panel #	Patch Panel Port #	Patch Panel Port Label	Switch Rack #	Switch ID #	Switch Slot #	Switch Port #	Cable Type	Cable Lable	Faceplate Lable	Floor	Room #	Location Description	Device Type
TR03															
TR03	R2	A	1	03-001-A					CAT6A	TR03-03-001-A	TR03-03-001-A	3	303	ELECTRICAL ROOM	DATA
TR03	R2	A	2	03-001-B					CAT6A	TR03-03-001-B	TR03-03-001-B	3	303	ELECTRICAL ROOM	DATA
TR03	R2	A	3	03-001-C					CAT6A	TR03-03-001-C	TR03-03-001-C	3	303	ELECTRICAL ROOM	DATA
TR03	R2	A	4	03-001-D					CAT6A	TR03-03-001-D	TR03-03-001-D	3	303	ELECTRICAL ROOM	DATA
TR03	R2	A	5	03-002-A					CAT6A	TR03-03-002-A	TR03-03-002-A	3	302	MECHANICAL	DATA
TR03	R2	A	6	03-002-B					CAT6A	TR03-03-002-B	TR03-03-002-B	3	302	MECHANICAL	DATA
TR03	R2	A	7	03-003-A					CAT6A	TR03-03-003-A	TR03-03-003-A	3	302	MECHANICAL	DATA
TR03	R2	A	8	03-003-B					CAT6A	TR03-03-003-B	TR03-03-003-B	3	302	MECHANICAL	DATA
TR03	R2	A	9	03-004-A					CAT6A	TR03-03-004-A	TR03-03-004-A	3	306	ELEVATOR CONTROL CLOSET	DATA
TR03	R2	A	10	03-004-B					CAT6A	TR03-03-004-B	TR03-03-004-B	3	306	ELEVATOR CONTROL CLOSET	DATA
TR03	R2	A	11	03-004-C					CAT6A	TR03-03-004-C	TR03-03-004-C	3	306	ELEVATOR CONTROL CLOSET	DATA
TR03	R2	A	12	03-004-D					CAT6A	TR03-03-004-D	TR03-03-004-D	3	306	ELEVATOR CONTROL CLOSET	DATA
TR03	R2	A	13	03-004-E					CAT6A	TR03-03-004-E	TR03-03-004-E	3	306	ELEVATOR CONTROL CLOSET	DATA
TR03	R2	A	14	03-004-F					CAT6A	TR03-03-004-F	TR03-03-004-F	3	306	ELEVATOR CONTROL CLOSET	DATA
TR03	R2	A	15	03-005-A					CAT6A	TR03-03-005-A	TR03-03-005-A	3	305	IT/AV ROOM	DATA
TR03	R2	A	16	03-005-B					CAT6A	TR03-03-005-B	TR03-03-005-B	3	305	IT/AV ROOM	DATA
TR03	R2	A	17	03-006-A					CAT6A	TR03-03-006-A	TR03-03-006-A	3	305	IT/AV ROOM	DATA
TR03	R2	A	18	03-006-B					CAT6A	TR03-03-006-B	TR03-03-006-B	3	305	IT/AV ROOM	DATA
TR03	R2	A	19	03-007-A-AP					CAT6A	TR03-03-007-A-AP	TR03-03-007-A-AP	3	305	IT/AV ROOM	DATA-AP
TR03	R2	A	20	03-007-B-AP					CAT6A	TR03-03-007-B-AP	TR03-03-007-B-AP	3	305	IT/AV ROOM	DATA-AP
TR03	R2	A	21	03-008-A-AP					CAT6A	TR03-03-008-A-AP	TR03-03-008-A-AP	3	303	ELECTRICAL ROOM	DATA-AP
TR03	R2	A	22	03-008-B-AP					CAT6A	TR03-03-008-B-AP	TR03-03-008-B-AP	3	303	ELECTRICAL ROOM	DATA-AP
TR03	R2	A	23	03-009-A-AP					CAT6A	TR03-03-009-A-AP	TR03-03-009-A-AP	3	302	MECHANICAL	DATA-AP
TR03	R2	A	24	03-009-B-AP					CAT6A	TR03-03-009-B-AP	TR03-03-009-B-AP	3	302	MECHANICAL	DATA-AP
TR03	R2	A	25	03-010-A-SC					CAT6A	TR03-03-010-A-SC	TR03-03-010-A-SC	3	301	CORRIDOR 301	SEC. CAMERA
TR03	R2	A	26	03-011-A-SC					CAT6A	TR03-03-011-A-SC	TR03-03-011-A-SC	3	306	ELEVATOR CONTROL CLOSET	SEC. CAMERA
TR03	R2	A	27	03-012-A-SC					CAT6A	TR03-03-012-A-SC	TR03-03-012-A-SC	3	S301	STAIR 01	SEC. CAMERA
TR03	R2	A	28	03-013-A-SC					CAT6A	TR03-03-013-A-SC	TR03-03-013-A-SC	3	S106	SOUTH WEST STAIRWELL	SEC. CAMERA
TR03	R2	A	29	03-014-A-BMS					CAT6A	TR03-03-014-A-BMS	TR03-03-014-A-BMS	3	303	ELECTRICAL ROOM	DATA-BMS
TR03	R2	A	30	03-014-B-BMS					CAT6A	TR03-03-014-B-BMS	TR03-03-014-B-BMS	3	303	ELECTRICAL ROOM	DATA-BMS
TR03	R2	A	31	03-015-A-BMS					CAT6A	TR03-03-015-A-BMS	TR03-03-015-A-BMS	3	307	MECHANICAL	DATA-BMS
TR03	R2	A	32	03-015-B-BMS					CAT6A	TR03-03-015-B-BMS	TR03-03-015-B-BMS	3	308	MECHANICAL	DATA-BMS