UCONN
UNIVERSITY OF CONNECTICUT

Telecommunications Design Guidelines and Performance Standards

University Planning, Design and Construction and Information Technology Services

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1 Introduction

Information Technology Services (ITS) is the service provider for all voice, data, and TV at the University. The Designer shall adhere to all standards outlined, unless otherwise directed by the University Representative in conjunction with ITS. All telecommunication designs and installations for the University shall be a complete Structured Cabling System, tested for error free delivery of voice, data, wireless and TV services to the end user; consistent with the guidelines and performance standards as set forth in this document.

The Designer shall incorporate existing systems to ensure a seamless co-existence of newly installed and existing systems. Only certified personnel shall perform all such designs, required certifications are identified farther into this document.

These Standards are a living set of documents. As such, the criteria contained within are subject to updates due to technological advances within the telecommunications industry. The Designer is responsible for adhering to the most current University Design Standards including all appendixes.

2 General Requirements

2.1 Purpose

The purpose of this document is to provide the Designer general information necessary for the proper design and constructability of a Telecommunication's Structured Cabling System at the University. A properly designed and constructed Structured Cabling System, based on industry and University standards, will provide a flexible, efficient, long-lasting, and cost-effective transportation solution for our present and future communication needs.
The implementation of these Telecommunications Standards will ensure a flexible, uniform telecommunications environment that will allow for the growth of high speed, high bandwidth communication services required by the specialized applications used in a higher education environment.

2.2 Certification Requirements

It is required that the Designer have a sub-consultant who is fully trained and experienced in Telecommunications design and have full understanding of current trends and practices within the telecommunications industry. When the design involves Data Centers, Server Rooms or Outside Plant Cabling the Designer shall be trained and demonstrate an understanding of those specific systems. The designer shall also have a current BISCI RCDD, CT TLT, or CNet CNIDP Certification.

All telecommunications shall comply with all Connecticut building codes and follow the Telecommunication's Industry standards and best practices as defined and/or interpreted by the following agencies and organizations:

- The American National Standards Institute (ANSI)
- The Institute of Electrical and Electronic Engineers (IEEE)
- The Telecommunications Industry Association (TIA)
- Building Industry Consulting Services International (BICSI)
- Telcordia

All codes, industry standard practices, and the University specific requirements shall be adhered to. Should there be conflict between university requirements and code or industry standard, the higher quality and/or requirements that are more stringent shall take precedence.

The Designer shall include within the specifications, the below conditions the structured cable contractor must meet to be deemed qualified to install inside and outside plant cabling for the University:

- Evidence the structured cabling contractor has service facilities within fifty miles of the project.
- Evidence the structured cabling contractor has successfully completed a minimum, three structured cabling projects of similar size and scope within the past three years.
- Evidence the structured cabling contractor has under direct employment, installers (technicians and supervisors) who will be assigned to the project and who hold current certificates (minimum three) endorsed by an approved connectivity manufacturer and who have current certifications in specialized training from an independent/vendor neutral organization such as BICSI or CNET, on installation of structured cabling systems, both inside and outside plant cabling.
  Such connectivity manufacturer certification training shall be industry recognized and equal to:
    - Hubbell certified installer.
    - Belden certified installer.
    - Siemon certified installer.
    - Corning certified installer.
- Evidence the structured cabling contractor successfully received recent project registration documents from the selected connectivity manufacturer.
- Evidence all equipment intended to be used on the project has been consistently tested on its calibration and re-calculated if necessary. Such evidence will be reconfirmed prior to testing the cables.
- The above are all requirements to register the project under the extended warranty program.

2.3 Definitions

In addition to the definitions described within the University's Design Guidelines & Performance Standards, below are definitions specific to this document.

AOR – Area of Refuge
DATA - Equipment and services associated with connectivity to the local and wide area networks and the internet.
DUS - Division of University Safety
EF - Entrance Facility
Emergency Services - Fire or Security Alarms
ER - Equipment Room
FO – University's Facilities Operations
ITS-PIP - University's Information Technologies Services – Physical Infrastructure and Planning
MAC -Moves, Additions, and Changes post-construction cabling.
OEM - Original Equipment Manufacturer
OSP - Outside Plant Cabling

TELECOMMUNICATIONS – Term used to describe voice, data, and TV services and the infrastructure to deliver them.
TR – Telecommunications Rooms
MDF - Main Distribution Frame
IDF - Intermediate Distribution Frame
BDF – Building Distribution frame
TV - Equipment and services associated with the delivery of HUSKYvision broadband cable television solutions.
UPDC - University Planning Design and Construction
UTP - Unshielded Twisted Pair
VOICE - Equipment and services associated with the delivery of analog, digital, IP, or wireless telephony.
WAO - Work Area Outlet. The Telecommunication outlet located at the end user's work area or point of service utilization.
WAP - Wireless Access Point

3 Scope and Deliverables

Close and careful coordination between the Designer and ITS is required to assure the proper design of the Telecommunication pathways and spaces. Project size does not dictate compliance with this requirement. Comply with Appendix II Electronic Document Submission for design review submission for telecommunications and other standards.

The Designer shall provide a design for a complete and functional Telecommunication Structured Cabling System; include equipment, materials, labor, tools and installation services. System components include, but are not limited to:

- Outside Plant pathway infrastructure
- Raceways, boxes, cable tray, and cable supports
- Wall and floor penetrations and sleeves
- Fire-stopping
- Inside and outside plant cabling
- Line protection
- Splice enclosures
- Balanced twisted-pair cabling, terminations, and splicing
- Optical fiber cabling, terminations, and splicing
- Coaxial cabling, terminations, and splicing
- Work area communication outlets
- Consolidation points
- Cross-connect systems (wiring blocks, patch panels)
- Equipment racks, frames, and cabinets
- Wireless Access Point Enclosures
- Grounding and bonding
- Cable management
- Testing and labeling
- Pre-construction submittals

- As-built Record Documents – incorporate the Contractor's as-built documentation into the record documents a format outlined within these standards and provide them as a separate attachment document when turning over the record and as-built documentation. As-builts or record documents shall be in electronic format. See Appendix II – Electronic Document Plan Submission Requirements for details on record document submissions.
- Existing cabling that is being affected by the design, shall not be reused and shall be required to be removed in its entirety back to the IDF or MDF. Abandonment is not acceptable.

The University is its own Telecommunication Service Provider, ITS will provide the following:

- All design and installation of the transportation media (i.e. copper, fiber, wireless) necessary to deliver telecommunication services to a demarcation point established at the building's Entrance Facility (EF). However, the pathways for the media (i.e. underground conduits, manholes, pole lines, masts) shall be included in the project's scope, budget, and their designs as part of the Designer's scope of work.
- All telephone sets, equipment (i.e. NT1 cards, power supplies), and cross-connects to deliver voice services to the end user.
- All network equipment (i.e. routers, switches, wireless access points) to deliver network services to the end user.
- All fiber receivers, amplifiers, taps, splitters, and cross-connects to deliver TV services to the end user.
- The non-reoccurring installation and equipment costs associated with delivering these ITS services shall be borne by the project or requesting department. Coordinate information with ITS to estimate their values.

3.1 Project Management

Projects managed by ITS, Designer shall include in the specifications that the telecommunication's trade contractor provide a schedule of events in the form of a Gantt chart that graphically identifies task durations and dependencies and a Network Diagram that identifies the project's critical path. The trade contractor shall also be responsible for providing progress updates.

Projects managed under the Capital Projects Program under UPDC, schedule requirements are defined in Division One of the specifications.

The Designer shall include the following requirements in the specifications:

- 6 weeks prior to move-in ALL TR's including the MDF shall be fully assembled cleaned and dust free. This includes permanent power, permanent cooling, a permanent lockable door, racks/wire management all cable terminations and labeling. This time is required for equipment burn in, programing, testing and to bring building systems on to the UConn Network.
- 6 weeks prior to move-in the installer shall provide a cut sheet in excel format with the following cable information: Floor, Station Room Number, Jack Number, MAC Addresses, TR Number and Jack Description (Voice, Data, CAM, WAP, BMS, Meter,

Elevator, AOR/emergency phone). This is required so we can build our databases, assign phone numbers and create host reservations.

4 Design Requirements

All Design documents shall be in accordance with the contract requirements, University's Design Standards and the latest edition of the BICSI Telecommunications Distribution Methods Manual (TDMM).

4.1 Entrance Facility

For the purposes of this document, the Entrance Facility (EF) is the area within the ER where the service lateral conduits terminate. Refer to University Design Standards Volume 1 for details on Telecommunications Duct Banks.

Provide a minimum of two (2) trade size 4" conduits from the nearest University telecommunications vault to the building's main Equipment Room. Where the purpose of the building, either in whole or in part, is to serve the telecommunications needs of other buildings (i.e. SLC site, Network Distribution Layer Node, Wiring Center, etc.) provide a minimum of six (6) trade size 4" conduits. When the EF is below grade provide a drain in the telecom vault directly connected to the building.

For line-protection and splicing of copper cable(s), provide on the wall two 4' X 8' X ¾" fire-retardant plywood sheets adjacent to the Entrance Facility conduits.

For terminations and splicing of optical fiber cable(s), provide one two-post Equipment Rack.

4.2 Telecommunications Spaces

Telecommunication Spaces (ER, TR) shall be directly accessible from main corridors; technicians shall not have to pass through other spaces, such as offices or mechanical rooms, to access Telecommunication Spaces.

4.2.1 Function of the Space

The rooms shall be rectangular shape; all corners are at right angles and opposing walls parallel to each other. The doors shall have locks and keyed to ITS specified keys for Telecommunication Spaces. The rooms shall be clearly labeled as a Telecommunications Space on the exterior of the door. If the building has a card access system, all TR's shall have electronic access control.

No equipment shall be installed in a TR room other than IT equipment, access control equipment, or electrical panels that service the telecom room. Fire alarm panels, electrical sub-panels, lighting control, etc. shall not be permitted to be installed in any telecom room.

Provide enough space for all equipment located within the TRs and offer a safe working environment for technicians. Code and standards establish minimum working clearances, but considerations shall be given to the layout and additional space that allows a

technician with a tool belt to work safely around active equipment without having to step around or over cords, cables and equipment.

Designer shall include ¾" fire-retardant plywood backboard on all telecommunication space walls that do not have doors. 4' by 8' sheets should be specified with the long side vertical and mounted with the bottom of the sheet 6" from the floor.

4.2.2 Environmental Needs

The Designer shall include a solution for the room's environmental needs for conditioned air and heat to maintain temperatures and humidity levels within the recommended limits of the telecommunication equipment manufacturers, as well as the ventilation of any accumulated fumes and gases. Heating and cooling to the rooms shall be available 24x7x365. Monitoring of the environment within the space shall be included through the building automation system, reporting to FO.

As buildings become "smarter", more and more services are becoming dependent on the local area network for their communication needs. As a result, it has become a critical function of the University to keep the network running on a 24/7 basis. Power availability, quality and in some cases back-up power systems are significant components to make the network access operation reliable. The University has built the network core and fiber backbone for high availability.

With new construction or major renovations where TRs contain a significant volume of data equipment (i.e. Data Center, Server Farm, Network Distribution Layer Node, etc.) or service a large portion of the building needs, these rooms shall be designed to include a pre-action and/or clean agent fire suppression system.

4.2.3 Uninterrupted Power

Prior to designing for uninterrupted power, the design team shall consult with DUS, FO, ITS and the building management to determine what network / telecommunication services fall into the "EMERGENCY SERVICES" category. If it is determined the TRs will support "EMERGENCY
SERVICES", the Designer should include back-up power with an Uninterruptable Power Source (UPS) in the design. The UPS shall only be in place to bridge the gap of Emergency Power coming online. The design of the UPS shall include centralized monitoring compatible with existing University systems. Integration shall be included with system start-up. Provide branch circuits for telecommunications equipment as noted below. In addition, provide at least one 120VAC 20A outlet in each room from normal building power for maintenance operations.

4.2.4 Equipment Needs

Provide equipment racks in quantities and types as described. Racks shall be of a high strength extruded aluminum construction with a black powder-coat finish; standard TIA 19" design with #12-24 threaded holes spaced according to the EIA-310-D Universal Hole pattern on both the front and rear of the rails. The rails shall be labeled along the front to identify the Rack Mount Unit (RMU, 1.75") spaces. Racks shall be 7-foot tall providing 45-

RMU of mounting space. Provide cable management troughs with rounded "waterfall" edges at the top of each rack. The racks shall be securely fastened to the floor and to the ladder racking above. Mount racks side-by-side in continuous row with 10" wide vertical cable management in between each pairing of racks and 6" wide vertical cable management at the outside of the row. Vertical cable managers shall be double-sided, 7 foot tall with deep "T" shaped rigid cable guides spaced at 1-RMU increments. They shall have hinged covers that open to the left or right by a single control action (i.e. Chatsworth Products, Inc. EVOLUTIONTM series or approved equal). Provide double-sided vertical cable managers with two-post racks and single-sided with four-post racks.

4.3 Equipment Room (ER)

The purpose of the ER is to serve as the building distributor for Telecommunication services. It shall be located as close as practicable to the main electrical service. Located within the ER shall be the EF; the TMGB; terminations for all Telecommunication Backbones; Telecommunications Equipment that serve the building (i.e. ISDN NT1's, telephone power supplies, routers, switches, servers, broadband amplifiers, etc.). Where the size of the building is such that it only requires one Telecommunications space, the ER may also serve as the TR.

4.3.1 Equipment Needs

Provide overhead ladder racking around the perimeter of the ER and over each Equipment Rack. This ladder rack shall be sized to accommodate the orderly distribution of cable within the room but shall not be less than 12" wide. Install the ladder rack approximately 7'-6" AFF. Provide "waterfall" cable guides over each vertical cable manager and vertical cable route to protect the cables' bend radius.

Locate the UTP copper and P-III coaxial backbone terminations on a ¾" plywood backboard near the OSP line-protection.

4.3.2 For terminations and splicing of the building backbone optical fiber cable(s):

- Provide one (1), two-post Equipment Rack, location shall be adjacent to the EF rack.
- Provide two (2) 120VAC 20A branch circuits with two NEMA 5-20R duplex receptacles each from the Telecommunications power supply, one circuit at the plywood backboard and the other at the equipment rack.

4.4 Telecommunications Rooms (TR)

The purpose of the TR is to serve as an area or floor distributor for Telecommunication services; it shall be located near the center of the area/floor served. In a multi-story building, the TR's should be located as to stack one directly above the other. The area served by the TR and the location of the TR shall be such that no Permanent Link exceeds 90 m (295 ft.) in total length. Located within the TR shall be the termination fields for the Permanent Links and backbone cables, the TGB, active and passive equipment racks, and the Telecommunications equipment to serve the area.

In situations where a building has a smaller footprint that does not warrant a full telecommunications closet, a telco wall mounted cabinet with two – (2) L5-20 20A 120V twist lock outlets is sufficient. Acceptable mounted cabinet shall be Hubbell REBOX, RE4XB, 42.2" x 24.2" x 10".

4.4.1 Equipment Needs

Provide overhead ladder racking around the perimeter of the TR and over each Equipment Rack. This ladder rack shall be sized to accommodate the orderly distribution of cable within the room, but shall not be less than 12" wide. Install the ladder rack approximately 7'-6" AFF. Provide
"waterfall" cable radius bend protection over each vertical cable manager and vertical cable route to protect the cables' bend radius.

Provide a minimum of two (2) two-post equipment racks in each TR to house all cable terminations and Telecommunications equipment. The rack loading shall be designed so as not to exceed 80% (32-RMU) usage of the available space. Note: A typical TR should be provisioned with three (3) racks with space allocated for a future fourth rack.

Provide an intra-TR backbone in each TR. An intra-TR backbone is a category 3 UTP backbone from the plywood backboard, near the UTP backbone, to the equipment rack. This backbone should terminate to a 110-type wiring block mounted on the plywood backboard and to 48-port T568B patch panel(s) on the equipment rack. Equip the 110-type wiring block with 110-C4 connector blocks. This backbone shall be sized in 48 port increments to provide 1.1 patch panel ports (4-pairs per port) for each standard and wall-phone WAO served from the TR.

Provide one (1) 120VAC 20A branch circuit with two NEMA 5-20R duplex receptacles from Telecommunications power supply at the plywood backboard near the intra-TR backbone termination field in each TR. Provide two-(2) 208VAC 30A 3-phase wye branch circuits with NEMA L21-30R receptacles from Telecommunications power supply for each equipment rack with active electronic equipment. Install 2 owner provided vertical PDU's for each active equipment rack.

4.5 Grounding and Bonding

Include in the design for a low-impedance Telecommunications Grounding System. Each equipment rack, cable raceway, cable runway, cable tray, and line protector shall be bonded to the Telecommunication Grounding System. A Telecommunications Main Grounding Busbar (TMGB) shall be required and shall be located in the TR in close proximity to the entrance into the space; and bonded in accordance to NEC Art. 800.100. Size the TMGB to provide enough points of attachment for each bonding connection plus 20% growth. The minimum size for the TMGB is ¼" D X 4"H X 12"L. Provide a telecommunications grounding busbar (TGB) in each Telecommunication Room (TR). The TGB shall be located high on the wall just below the overhead ladder racking. Size the TGB to provide enough points of attachment for each bonding connection plus 20% growth. The minimum size for the TGB is ¼" D X 2"H X 12"L.

4.6 Testing and Labeling

Provide a schedule of each permanent link with the following fields: floor #, room #, jack #, TR #, patch panel port #, x-conn switch port and cable use (Voice, Data, CAM, WAP, BMS, Meter, Elevator, AOR/emergency phone, Fire). Include permanent link ID's (labeling) above each outlet location on the T drawings. Utilize ITS- PIP provided CAD drawing template and CAD blocks for planned work area outlet (WAO) modifications (Add, Remove, Existing to Remain). The Designer shall work with ITS-PIP representative to clarify T- Series CAD requirements. Baseline layers to be filled out may include:

- T-Anno-Path (Junction box locations)
- T-Comm-D (Existing WAOs being demolished)
- T-Comm-E (Existing end user WAOs that will be remaining)
- T-Comm-E-Security Cameras (Existing security camera that will be remaining) T-Comm-E-Wireless (Existing Wireless AP WAOs that will be remaining)
- T-Comm-N (New WAOs that will be installed)
- T-Comm-Path (The main pathway feeding into rooms)
- T-Comm-Penetrations (penetrations through fire-rated walls) T-Comm-TR (the location of the Telecommunications rooms)

The Designer shall include in the specifications the following requirements for testing out and labeling of devices:

- Identify and label each Equipment Room and Telecommunication Room with a unique identifier derived from the University's Design Document Standards. The labels shall be permanent and consistent with the labeling style established for the building. Along with the room number, the label shall include "TEL/DATA" as the use describer.

  Example: 110
TEL/DATA

- Identify and label each Equipment Rack with a unique identifier that includes the Telecommunication Space room number followed by a hyphen then a single numeric character. The labels shall be engraved plastic; the font shall be at least 1 inch high and contrasting the background in color. Securely attach the label to the front of the ladder rack, directly above the equipment rack.

  Example: 110-1

- Identify and label each Wall with a Plywood Backboard with a unique identifier that includes the Telecommunication Space room number followed by a hyphen then a single alpha character. The labels shall be engraved plastic; the font shall be at least 1 inch high and contrasting the background in color. Securely attach the label to the front of the ladder rack directly, above the plywood backboard.

  Example: 110-A

- Identify and label each Patch Panel with a single alpha character. The labels shall be durable, machine generated, self-adhering, at least 3/8" wide; the font shall be a minimum of 3/16" high and contrasting the background in color. Affix the labels to the front of the patch panel or wiring block so that they will remain clearly visible once cross-connects or patching is completed.

  Example: A (rack-mount patch panel 1)

- Identify and label each Wiring Block with a unique identifier that includes the Plywood
- Backboard identifier followed by a single alpha character. The labels shall be durable, machine generated, self-adhering, at least 3/8" wide; the font shall be a minimum of 3/16" high and contrasting the background in color. Affix the labels to the front of the patch panel or wiring block so that they will remain clearly visible once cross-connects or patching is completed.

  Example: 110-AA (wall-mount wiring block)

- Uniquely identify and label each Backbone Cable as to reference its source and destination termination patch panel or wiring block, the cable's type and size. The labels shall be durable, machine generated, self-adhering, at least 3/8" wide; the font shall be a minimum of 3/16" high and contrasting the background in color.

  Examples:
  001-AA/110-AA 100-3-UTP (UTP copper backbone)
  001-1A/110-0A 12-SMF (fiber backbone)
  001-AB/110-AB P3-500 (coaxial backbone)

- Uniquely identify and label each Permanent Link as to reference its source termination patch panel port or wiring block position. The identifier shall include the patch panel or wiring block identifier followed by a two-digit port or position number. The labels shall be durable, machine generated, self-adhering, at least 3/8" wide; the font shall be a minimum of 3/16" high and contrasting the background in color. Affix wrap around cable labels at the end of each cable within 12 inches of termination and to the front of the faceplate near the connector module.

  Examples:

  <u>Patch panel</u>

WAO room number:	first line	→**126-A01**←
Port:	second line	→ **BMS, CAM, or WAP**←

  <u>WAO</u>

Top Window:	→**A01, A02, A03**← (patch panel port)
Bottom window:	→ **TR-110**← (TR room number)

  <u>Wrap around labels:</u>
  Affix labels within 12 inches of each cable on both work area outlet and patch panel side. Include the TR room and Panel and port number on work area outlet side. Example: 110.A01, and on the patch panel side include WAO room number, then patch panel and port number. Example: **126.A01**

Include as part of the close-out documentation specifications to provide a table that shows the relationship of each permanent link, by its identifier, to the room number of the TR and the room number where the WAO is installed. All identifiers shall be clearly recorded on the as-built drawings.

4.7 Specific Materials

The University primarily utilizes products from the following manufacturers and has adapted language, practices, expectations, and a maintenance inventory based on their use. All telecommunication designs shall specify the features, quality, and performance of the products offered by these manufacturers. Substitutions are allowed; however, they shall meet or exceed these requirements and integrate seamlessly with any existing cable plant.

- Unshielded Twisted Pair (UTP) copper, horizontal and backbone cabling: Hubbell Premise Wiring and all cable manufacturers allied with their 25 year warranty program
- Optical fiber outside plant cabling: Corning Cable Systems only
- Inside fiber horizontal or backbone cabling: Corning Cable System or same as the selected
- connectivity manufacturer
- Open frame and enclosed equipment racks, cable management, and cable runway: Chatsworth Products, Inc.
- Surface Metal Raceways: Legrand/Wiremold

All materials, equipment, hardware, and components shall be new and free from defects in materials and composition. Materials and equipment shall be installed, placed, terminated, tested, handled and processed in a manner consistent with manufacturer's instructions.

4.7.1 Structured Cabling Requirements

Design the Structured Cabling System to meet the following minimum requirements:

- Unshielded Twisted Pair (UTP) Horizontal Permanent Links: Category 6A, low diameter, with a continuous noise barrier. Supports 10 gigabit ethernet to the maximum distance of 100 meters with transmission parameters characterized up to 500MHz as identified in the TIA-568.2-D standard.
- UTP Backbone Cabling: Category 3 compatible
- Optical Fiber Backbone Cabling and Permanent Links: ITU-T G.652.D compliant Full Spectrum Single-mode (OS2
- Coaxial Horizontal Permanent Links: Series 6 (RG6) Quad-shield; tested to 3GHz
- Coaxial Backbone Cabling: .500" Parameter III

4.7.1.1 <u>UTP Copper Backbone</u>

Provide a UTP copper backbone cable from each TR back to the ER. The cable shall be, at a minimum, category 3 compatible and UL listed to be installed in an environmental return-air plenum space (CMP).

Size the UTP copper backbone in 100 pair increments to provide at least 2.3 pairs for each standard and wall-phone WAO served.

Ensure in the specifications that the terminations are to wall-mount 300-pair 110-type wiring block(s) in the ER and TR. The 110-type wiring blocks shall be equipped with 110-C5 connector blocks. Provide cross-connect wire management above and below each 110 wiring block.

And include each cable pair shall be tested for point-to-point continuity. This includes testing to certify correct wire mapping and to insure there are no opens, shorts, crosses, or grounds.

4.7.1.2 Optical Fiber Backbone

Provide a single-mode optical fiber backbone from each TR back to the ER. The cable shall be of a tight-buffer construction with an aluminum interlocking armor jacket and UL listed to be installed in an environmental return-air plenum space (OFCP). The fiber shall be ITU-T G.652.D compliant Full Spectrum Single-mode (OS2).

Size the optical fiber backbone in 12-fiber increments to provide at least 8 fibers per application (ITS typically has one application per TR).

Ensure in the specifications that the terminations are by fusion-splicing pigtail cable assemblies to the cable ends. The pigtail cable assemblies shall be factory terminated with SC/APC connectors and contained within a cassette designed to protect the splice. SC/APC splice on connectors are also acceptable. Protect the fusion-splices with reinforced heat-shrink sleeves. Specify rack-mount patch panels with the ability to accept splice cassettes or SC-APC adapter panels. Mechanical splices or field-terminated connectors are never acceptable.

Specify optical fiber testing shall be performed in accordance with ANSI-TIA/EIA-568.1-D and .3-D Perform a Tier 1 (LS/PM) test on each optical fiber. Fibers that are spliced, with other than pigtail splicing, shall also undergo a Tier 2 (OTDR) test.

4.7.1.3 Coaxial Backbone

Provide a Coaxial Backbone from the plywood backboard in each TR back to the plywood backboard in the ER. The cable shall be a .500" Parameter III coax distribution cable and UL listed to be installed in an environmental return-air plenum space (CATVP). Ensure in the specifications the following:

- Terminations are for each cable end with F81 bulkhead connector. All connectors shall be terminated with OEM specified tools.
- Require parameters for testing of each cable: Continuity, length and insertion loss. Testing shall be done in accordance to OEM requirements for warranty.
- Require an additional 10 feet of cable be neatly stored at each location.

4.8 Pathways, Raceways and Spaces

Pathways and spaces identified for Telecommunication use shall be dedicated solely for that purpose. Concerns for network security, complexity of the systems, sensitivity to alien interferences (i.e. static electricity, RF or EMI), power quality, and special environmental requirements make it necessary that telecommunications equipment and cabling to be the sole occupant of these pathways and spaces.

4.8.1 Telecommunication Pathways

Information technology is constantly evolving. As such, the media infrastructure for new technologies must adapt and expand to keep pace and transport these services to the user.
Because of the dynamic nature of this industry, the telecommunications pathway

must be well designed and should provide ease of access for the installer, to minimize damage to the building and operational cost associated with post construction adoptions of new technologies. The Pathway should be of sufficient size to accommodate future cabling needs such as MAC cabling for staffing changes or wholesale media upgrades. With this in mind, include the following points in designing the Telecommunications Pathways.

- Cable supports shall be wide-based and close enough together to prevent distortion to the cables' geometry from the weight of other cables piled on top and excessive cable drooping.
- Telecommunications wiring shall not share the same pathway in J-hooks, cable trays, or conduit with other building wiring systems. For example: Fire alarm cabling, control wiring, security wiring, speaker and Audio-Visual cabling.
- Securing cables to supports, service looping, cable-bundling, and dressing, will be done with Velcro or hook and loop fastener equivalent. Ty-wraps shall not be used in any circumstance. The fastener will be at least half of an inch in thickness as a bare minimum. If the cabling is in a plenum environment, plenum rated hook and loop fasteners will be required.
- Provide oversized or additional sleeves through common pathway walls and floors or along the major cable paths.
- Provide additional conduits through non-accessible spaces like fixed or gypsum ceilings.
- In areas where horizontal cables aggregate into the TR, provide cable tray.
- Design the telecommunications Pathways to run parallel with and perpendicular to the lines of the building and other construction.
- All through-wall and through-floor penetrations for the Telecommunications Pathway shall be sleeved and properly fire-stopped. All Fire-stopping solutions shall be re- enterable.
- Provide pull-strings in empty conduits and cable tray for future cable installations.
- No exposed cabling allowed when passing through electrical and mechanical spaces.

4.8.1.1 <u>Backbone Pathways</u>

Backbone cabling pathways shall be clearly identified as such, designed to provide adequate space and protection for the backbone cables, and to allow room for future growth. Backbone Pathways shall be either cable tray or conduit. Where backbone cables pass vertically through stacked TR's, provide a ladder rack vertically mounted from floor to ceiling for cable support. Where possible, the pathway should extend to the roof to accommodate future cabling needs.

4.8.1.2 Horizontal Pathways

Cable pathways shall be accessible and should be mounted in the corridors of the building. Where cable tray or conduit is not specified, a continuous pathway of independent cable supports shall be provided.

4.8.1.3 Work Area Outlet Boxes

WAO boxes shall be a minimum of 4-11/16"H x 4-11/16"W x 2- 1/8"D with a single gang plaster ring. Each WAO box shall have a minimum trade Size 1 conduit stubbed to an accessible ceiling space or cable tray. Conduit openings shall be bushed to protect cables from damage.

4.8.1.4 Surface Mounted Raceway

Raceways shall be metallic and sized to accommodate the number of cables specified for installation. They shall maintain proper cable bend radius and provide room for additional cables. Provide split or dual channel raceway for installations that require both power and telecommunication services to share the raceway. Shall be a minimum size of 21/32" x ¾" 700 series (or equivalent) raceway.

4.8.1.5 Modular system furniture and paneling

System furniture and paneling shall accommodate the University's specific materials and does not require the use of proprietary cabling components. They shall have integral raceways that conceal telecommunication cables without distorting, damaging, or compromising cable bend radius requirements. System furniture raceways shall have metal barriers to separate telecommunications cables from power cables. Outlets shall be terminated in adapters designed to fit the factory cutouts of the furniture raceway. The Contractor is responsible for supplying and installing the proper furniture manufacturer's adapters to fit the data openings, not by others.

5 Horizontal Cabling (permanent links)

All horizontal cabling, including video cabling, shall be distributed in a star configuration running from the WAO back to the serving TR.

Include in the specifications acceptance is only those Permanent Links whose field-test results with a "pass". Permanent Links with a field-test result of "fail" or "*pass" will not be accepted. Results are to be stored by the Permanent Link identification as shown on the design documents.

Include as part of the close-out requirements documentation of the test results and the testing equipment's make, model, serial number, and most recent certification of calibration by the manufacturer. List the setting(s) used, as well as, cable identification, from/to locations of each cable, test date and the names of the testing technicians.

5.1 UTP Permanent Links

Cables shall be solid copper conductors, 23 AWG, 100 OHM balanced unshielded twisted- pair (UTP) low diameter category 6A cables, with four individually twisted-pairs, with a continuous noise barrier.

Supports 10 gigabit ethernet to the maximum distance of 100 meters, with transmission parameters characterized up to 500MHz, as identified in the TIA-568.2-D standard. The color of the cable's outer jacket shall be yellow. Data cables shall be UL listed for the application and environment for which they are installed, with the following modification: cables installed in residence buildings and places of public assembly shall be, at a minimum, UL listed to be installed in an environmental return-air plenum space (CMP). All cables in slab on grade conduit MUST be rated for wet locations and be suitable for the ceiling environments they may pass through. All telecom cables are to be low diameter CAT6A, regardless of the technology being supported.

Modular Connectors (Jacks) shall be category 6A; "Keystone" in design; wired T568B; and meet or exceed the mechanical and transmission performance specifications in ANSI/TIA- 568.2-D. The color of the jacks shall match the color of the mounting frame and the nearby electrical outlets.
Patch Panels shall be "jack type panels" with white category 6A jacks and yellow category 6A jacks (for wireless); wired T568B; 48 port; 2-RMU; designed to mount on a standard TIA 19" frame; and shall meet or exceed the mechanical and transmission performance specifications in ANSI/TIA-568.2-D; color BLACK. Each port shall be uniquely and permanently numbered from the manufacturer. Panels shall also have integrated label windows for in field labeling.

Patch and Work Area Outlet Cords shall be factory made, low diameter, 4-pair cables; terminated with an 8-position plug at each end. The patch / WAO cord brand shall be the same as the connectivity manufacturer to allow for a complete channel warranty. Patch / WAO cord shall be the same category as the permanent link. Provide one 5' blue patch cord for each cable terminated at the patch panel. Furnish one blue WAO cord for each cable terminated at the WAO (50% 7' and 50% 10'). Install the patch cords at the patch panels in the TR's at the owner's direction.

Specify that each Permanent Link be tested as a complete horizontal cabling system, with jacks and faceplates completely assembled and properly mounted in their final position. Perform permanent link field tests with a Level III field tester; in accordance to test unit manufacturer instructions. Field-test each category 6 permanent link in accordance with ANSI/TIA-568-C.0, ANSI/TIA-568.1-D and ANSI/TIA -568.2-D.

Store and identify test results by the permanent link identification as shown on the contract documents.

5.2 Optical Fiber Permanent Links

Specify that the cables shall be of a fan-out type construction with a minimum 2.0mm outer jack and high- strength reinforcing fibers protecting each fiber. And shall contain four Single mode (OS2) fibers, which meet or exceed the mechanical and transmission performance specifications in ANSI/TIA-568.3-D. The color of the cable's outer jacket shall be Yellow. Cables shall be UL listed for the application and environment for which they are installed with the following modification: cables installed in residence buildings and places of public assembly shall be, at a minimum, UL listed to be installed in an environmental return-air plenum space (OFNP).

The fibers shall be splice on small form factor LC connectors which meets or exceeds the mechanical and transmission performance specifications in ANSI/TIA-568.3-D. Adaptor modules shall be flush mount duplex LC and produced by the same manufacturer of the UTP modular connectors. The color of the modules shall be green. Mechanical splices or field-terminated connectors are never acceptable.

Require a test with each permanent link as a complete horizontal cabling system, with connectors, adaptors, and faceplates completely assembled and properly mounted. Perform permanent link field tests with a Level III field tester, in accordance to test unit manufacturer instructions. Field-test each fiber Permanent Link in accordance with ANSI/TIA

5.3 Coaxial Permanent Links

Cables shall be Series 6 (RG6) Quad-shield coaxial construction; 75Ω unbalanced video cable; 18 AWG copper-clad steel center conductor; Foam dielectric; Aluminum foil – 60% braid – foil – 40% braid shield; factory tested to 3GHz cables shall be UL listed for the application and environment for which they are installed with the following modification: cables installed in residence buildings and places of public assembly shall be, at a minimum, UL listed to be installed in an environmental return-air plenum space (CATVP, CMP).

Specify each end of the coaxial cable will be terminated with an F-type compression connector. Positive compression type connectors with minimal signal leakage characteristics shall be installed with OEM installation tool. Hex crimp connectors are not acceptable. At the TR, the cable shall be connected to an F-81 ground block orderly and securely mounted to the plywood backboard. At the WAO the cable shall be connected to an F-81 adapter module. . The color of the modules shall match the color of the mounting frame.

Test each Permanent Link as a complete horizontal cabling system, with connectors, adaptors, and faceplates completely assembled and properly mounted. Test the following parameters of each cable: Continuity, length and insertion loss. Testing shall be done in accordance to OEM requirements for warranty. As part of the closeout documentation, provide to the University Representative and UITS the test results of each coaxial cable along with the testing equipment's make, model, serial number, and most recent certification of calibration by the manufacturer. List the setting(s) used, as well as, cable identification, from/to locations of each cable, test date and the names of the testing technicians.

6 WAO Design Considerations

6.1 Mounting Frames and Faceplates

Connector modules and adapters shall be installed in a NEMA standard rectangular (Style-Line®, GFCI) shaped plastic mounting frame. The frame shall be the rear-loading type and shall be made by the same manufacturer as the connector and adaptor modules. The connector and adaptor modules shall mount flush with the frame's front surface. The color of the frames should match the color of the nearby electrical outlets. Each frame shall have no more than three ports. If more than three ports are required at a location, than consider using multiple-gang faceplates.

Faceplates shall accommodate the rectangular mounting frames and shall match the nearby electrical outlet faceplates in appearance. The faceplates shall have provisions to affix and display labeling for the connector or adaptor modules.

6.2 Commonly Used WAO's

- Standard WAO – Standard WAO shall have a two-port rectangular frame and faceplate with two UTP Permanent Links. The topmost/leftmost port is typically reserved for voice applications and the remaining port(s) for data.

- Wall-phone WAO – Wall-phone WAO shall have one UTP Permanent Link. The wall-phone faceplate shall be made of stainless steel with a brushed finish and shall have two mounting posts that accommodate a standard wall-phone. The faceplate shall be rear loading with a recessed port opening.
- TV WAO – TV WAO in residence halls shall consist of a one port rectangular frame and faceplate with one Coaxial Permanent Link.
- TV WAO – TV WAO in office, academic and common spaces shall consist of a three port rectangular frame and faceplate, one Coaxial and two UTP Permanent links.

6.3 Program Space WAO Requirements

The WAO layouts should be based on the planned location of furniture or specialty requirements. Location of all WAO's in residential buildings shall be coordinated with ITS and Residential Life during design development phase at the latest.

The following are minimal WAO requirements. Additional WAO may be required for ancillary devices (printers, fax machines, charging areas, etc.), specific needs of the occupant(s), and the size or intended use of the room. Each WAO should be located near an electrical power outlet.

6.3.1 Single Faculty/Staff Office: One Standard WAO next to the workstation.

6.3.2 Double Faculty/Staff Office: Two Standard WAO

6.3.3 Dean/Director Office: Two Standard WAO on opposing walls and one TV WAO.

6.3.4 Clerical Staff and Graduate Student Work Area: One Standard WAO for each desk or workspace.

6.3.5 Conference Room: Two Standard WAO on opposing walls with one positioned to service the AV cabinet and one TV WAO.

6.3.6 Lounge or Break Room: One Wall Phone and one TV WAO. Consideration should be given to mount the TV WAO high on the wall or in the ceiling for wall-mounted televisions.

6.3.7 Computer Lab: One Standard WAO for every two computers, one TV WAO, and one Wall- phone WAO located near the door.

6.3.8 Research / Laboratory: One Standard WAO for every two workstations and one Wall-phone WAO located near the door.

6.3.9 Classrooms: Two Standard WAO; one near the teaching station and one on an opposing wall; one TV WAO at the front of the room; and one Wall-phone WAO located near the door. Through the University Representative, additional consultation shall be sought with the University's AV Technology Services Division (Academic IT) for additional WAO and AV requirements.

6.3.10 Student Housing:

6.3.10.1 **Traditional dorm-style single room** – Provide one single cable WAO per room for University furnished, Contractor installed wall mounted hospitality access point and one TV WAO per space.

6.3.10.2 **Residential Assistant room** – Provide Standard WAO per room for University furnished, Contractor installed wall mounted hospitality access point and one TV WAO per space.

6.3.10.3 **Suite Style Residential Halls** - Provide one single cable WAO per bedroom for University furnished, Contractor installed wall mounted hospitality access point and one TV WAO per space.

6.3.10.4 **Common Area / Study Lounge** - Provide one single cable WAO per room for University furnished, Contractor installed wall mounted hospitality access point.

6.4 Electronic Room Schedule Signs

One MPTL UTP cable in a blank faceplate, mounted at 52" AFF outside of each conference room and classroom. See Appendix VIII for details on type and other requirements.

6.5 Electronic Surveillance and Security (ESS)

One UTP Permanent Link for each door access controller and CCTV camera. These cables shall be installed by the awarded cabling contractor (not the security or electrical contractor)

6.6 Building Automation Systems (BAS):

Requires dial-up or network connectivity and Permanent Links as noted:

- HVAC : One UTP Permanent Link (Per Controller)
- Power Metering: One UTP Permanent Link
- Steam Metering: One UTP Permanent Link
- Chilled Water: One UTP Permanent Link
- Reclaimed Water: One UTP Permanent Link
- Domestic Water: One UTP Permanent Link
- Lighting controls: One UTP Permanent Link (per Controller)
- Sewage Pumping Station: One UTP Permanent Link

6.7 Emergency Circuits

Requires dial-up or network connectivity and Permanent Links as noted:

- Elevator: Two UTP Permanent Links
- Fire Alarm Control Panel: Two UTP Permanent Links.
- Emergency Circuit Permanent Links shall terminate to a 66 block next to the voice wall field in the TR. This includes elevator, fire alarm and AOR. Fire Alarm, elevator, intrusion detection and alarm system installers are to coordinate dial plans with the University Representative.

6.8 Outdoor Devices

Outdoor network connectivity shall include provisions for physical connectivity of wireless access points and IP based cameras on the outside of buildings. Such a design shall integrate with the existing systems and include any impacts associated with existing equipment and centralized storage capacity. The exterior envelope of the building and/or surrounding area may be used for mounting of equipment or antennas that support the systems, the Designer is responsible to coordinate the location of the system devices with the location of the security and surveillance devices to ensure there is sufficient room for each and unobstructive view or access use. Consult and review design criteria with the University Representative in conjunction with ITS, the outdoor wireless design consultant and DUS as there currently is an outdoor campus technology master plan that must be integrated into the design.

6.9 Wireless Network Access (WLAN)

The University provides wireless network access (IEEE 802.11a/b/g/n) via a Cisco Unified Wireless Network solution consisting of WLAN controllers and lightweight access points. The Designer shall conduct an engineered study to establish the best location for each access point to provide optimum wireless coverage (predictive model for construction). The Designer must have a current Certified Wireless Network Professional CWDP or Cisco CCNA or above Wireless Certification and proof of training from the manufacture of the wireless design software utilized. The individual Designer shall also have practical experience for installation of Enterprise solutions such as high client density areas like classrooms, auditoriums, laboratories, or residential halls within academic environments. The objective of this wireless design is to integrate technical capabilities and operational support of the Wireless System in conjunction with the architectural design integrity of the building

The wireless design shall meet the minimum technical requirements for delivery of voice and video quality and large file transfers based on IEEE 802.11 services as defined by Cisco Systems:

- Radio shall be set on UNII2/3 frequencies at no more than 25mW power/14dBm (50% power level to allow the controllers to adjust power settings up/down)
- Optimal Cell Boundary of the wireless access point shall be -67db measured by the client adapter in the 5Ghz band
- 20% cell overlap based on the optimal cell boundary to ensure smooth client roaming
- Latency shall be no less than 20 milliseconds
- Packet loss shall be no more than zero within the design coverage
- Packet jitter shall be less than 20ms
- Confirm centralized infrastructure settings and WAP standards with the University
- Location placement shall be done with future operational support in mind (typical height 8-12', accessibility for servicing)

When specifying, include one (1) Category 6A UTP Permanent Link, terminated with channel compliant field termination flexible plug (MPTL) for each wireless access point (crimp on rj-45 plugs are not acceptable). The University will provide the wireless access point equipment, however, ensure that it is specified the contractor shall install the access points.

The Designer shall utilize the following criteria as part of their design strategy:

- Catalog of Equipment - The University's current catalog utilizes the Cisco 9000 series access points and antennae. The designer shall select the appropriate access points and antennae based on the variable for each location (i.e., building material, density, room usage). It is the responsibility of the Design Firm to confirm with the UConn IT representative for any changes in the catalog.
    - Access Points - C9136I-x, C9130AXI-x, C9130AXE-x, C9130AXE-STA-x, C9120AXI-x, C9120AXE-x, C9120AXP-x, C9115AXI-x, C9115AXE-x, C9105AXI-x, C9105AXW-x,C9124AXI-x, C9124AXD-x, C9124AXE-x
    - Antennae - C-ANT9101=, C-ANT9102=, C-ANT9103=, AIR-AP-BRACKET-9=, AIR- ANT2524DW-RS, AIR-ANT2535SDW-RS, AIR-ANT2524V4C-RS=, AIR-ANT2544V4M-RS=, AIR-ANT2566P4W-RS=, AIR-ANT2566D4M-RS=, AIR-ANT2513P4M-NS=, AIR- ANT2566P4W-DS=, AIR-ANT2566D4M-DS=

6.10 Design Review and As-Builts

6.10.1 Schematic Design (SD) 100%

The Designer shall provide the layout of the building which identifies size, height, façade material, skeleton material, building construction materials, building/rooms dimensions including ceiling heights, programmatic needs, space use, seating, and occupancy capacity for review of the initial wireless plan with the University representative in conjunction with ITS. Review comments shall be incorporated into the SD documents prior to progressing to DDs.

6.10.2 Design Development (DD) 50% and 100%

The Designer shall incorporate the wireless design into these documents for review by the University Representative in conjunction with ITS. This phase shall take into consideration any changes to the programmatic plan, building construction and finish materials that may impact coverage. These include permanent fixtures, large built-in equipment (such as freezers or lab equipment) within the spaces. The design shall also show initial location of wireless access points and infrastructure details for main distribution pathways and cabling. The Designer shall also provide a copy of their predictive analysis as part of the review process. Review comments shall be incorporated into the documents prior to progressing into CDs.

6.10.3 Construction Documents (CD) 50% and 90%

The Designer shall provide documents showing the final placement and the mounting details of the wireless access points, antennae and brackets that incorporates the functional Wireless System requirements with the overall architectural finishes and aesthetics plan. Review comments on the 50% CD and 90%CDs shall be incorporated into the CDs prior to stamping them for permits and bidding.

- In the specifications, include a quantity allowance for up to 30% of the total quantity of wireless access points identified within the conformed documents set for construction, for adjustments post occupancy. The quantity allowance shall include all labor, equipment, materials, oversight, programming,

commissioning, reporting, as-built documentation, and overhead/profit necessary to move the wireless access point and associated supporting infrastructure, up to 20 feet from original installation location. Unit price shall not be requested, nor shall a value be requested nor a condition to the bid requirements.

- Additionally include in the specifications a quantity allowance of 5% of the total quantity of wireless points identified in the conformed document set for construction, new/additional wireless access supporting infrastructure (all oversight, labor, materials, and equipment necessary) associated with and include installation of the Owner supplied wireless access device. Oversight, programming, commissioning, reporting, as- built documentation, and overhead/profit shall be included. Unit price shall not be requested, nor shall a value be requested nor a condition to the bid requirements.
- Post Implementation – the Designer shall perform a post-installation survey (as close as possible to actual move in conditions) to verify coverage and capacity connectivity. Dependent on the findings, the Designer shall issue a bulletin for relocation and/or additional of wireless access points, if it is determined that such change is required.

6.10.4 As-Built Documentation

The Designer shall require the Contractor to identify the exact final locations of each installed WAP and electronically document the locations on the appropriate T-Series drawings. Along with documenting locations, the as-built documentation shall also provide the following:

- The data-jacks unique identifier specific to each WAP that it supports
- The unique identifier of the UTP permanent link supporting each WAP
- The serial number and MAC address of each WAP in reference to its location

7 Closeout

7.1 Testing and Certification

As part of the close-out documentation require the Contractor document and certify the test results of each fiber/cable along with the testing equipment's make, model, serial number, and most recent certification of calibration by the manufacturer. List the setting(s) used, as well as, cable identification, from/to locations of each cable, test date and the names of the testing technicians.

7.2 Warranty / Guarantee

The Designer shall include in the specifications that the Contractor shall provide an unconditional warranty against all defects in materials and workmanship for a period of no less than one year from the date of substantial completion of the project. The Contractor shall also be required to submit from the connectivity component manufacturer(s) an extended warranty with a representation that all materials and cabling shall be free from defects and function as intended for a period of no less than twenty-five years. All materials, labor, and expenses to correct a breach of the warranty shall be included.

7.3 As-Built Documentation

The Contractor will perform a final as-built of the systems and provide the following documentation:

- Emergency Blue Phone - Routing conduit locations, electrical panel number and branch circuit information.
- Wireless access point installation schedule - See requirements for wireless under the As-built documentation
- A detailed report generated by Air Magnet (Netscout) or Ekahau of post-implementation survey.

END OF DESIGN STANDARD