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CHAPTER 1

INTRODUCTION

1. About this Standard

a. This standard contains the policies and procedures for architects, contractors, and telecommunications design professionals who are involved in Cornell University projects that include communications installation. The documentation should be used as a guide for projects providing communications cabling, to include Outside Plant Cable, Voice communications, Wireless Data Network, Network Systems, Video over IP, Converged IT services, Inter/Intra Building Life Safety Circuits, and Facility Circuits. Work may include new or renovated buildings and may consist of upgrading or adding cabling infrastructures, cable and network electronics equipment.

b. This standards document represents various methods for voice and converged data services. As robust, serviceable and secure network services are critical to Cornell at large, deviations must not be made without prudent review and dialog with the responsible stewards for campus-wide voice and data infrastructure oversight. If after review there remains fundamental disagreements about a given standard, vested parties should request a meeting with the Director of Network and Communication Services, the Director of Facilities Engineering, Director of Contract Colleges and the vested building owner(s.)

c. This standard applies to Endowed and Statutory facilities on the Ithaca campus

d. This guide will assist in planning for Non-Cornell owned buildings. Adhering to the below standards will allow the space planner to provision each area to meet the needs of any university affiliate.

2. Network and Communication Services “Responsibilities for Projects”

a. CIT/Infrastructure is responsible for Cornell University’s inside and outside communications system facilities, network connectivity, and the associated backbone equipment. These responsibilities include the review of all project plans that include communications.

1) When a new building or a building renovation is planned, project drawings shall be released for review by CIT/ Infrastructure Engineering.

2) CIT/Project Management shall be included in all capital projects for budget and scheduling coordination.

3) The network electronic equipment, to include design, engineering and configuration of the facility’s network system is accomplished by the CIT/Network Engineering Department.

b. Architects, contractors, and telecommunications design professionals must indicate on the design drawings and in the design specifications, the location and specification of the physical infrastructure required for a complete communications cabling pathway and distribution system:

1) The Horizontal Segment, Chapter 2, consists of the outlets, cabling to the ER or TR, and the associated pathways.

2) The Telecommunication Rooms, Chapter 3, describes the ER and TR, as well as the hardware for terminating the horizontal cable along with riser and campus cables.

3) The Riser Segment, Chapter 4, refers to the riser cable, and the sleeves, slots, and conduits that enable the cable to pass from floor to floor, ER to TR.
4) The Campus OSP Segment, Chapter 5, refers to the cabling and infrastructure that interconnect buildings or systems on a campus.

5) The Emergency, Inter/Intra Building Life Safety and Facility Circuits, Chapter 6, refers to the requirements for installation of special circuits.

6) The Wireless Network Systems, Chapter 7, refers to the requirements for installation of wireless devices.

c. Temporary installations are exempt from current infrastructure recommendations. Occupancy of approximately 2 years or less in duration is considered temporary. Temporary installations are never to be used for permanent service. Prior to beginning occupancy, vested parties should be made aware that voice and data service in temporary locations may not be equivalent service to that available in permanent installations.

d. CIT stocks select components for voice and data services that may be obtained through the CIT Department. This hardware is typically installed and maintained by the CIT field services staff.

e. Engineers/Designers shall consider LEED certification for all designs. The areas to include are materials and resources and innovation in design.

3. Regulations and Code Compliance

a. All work specified within this document shall comply with the applicable requirements of:

1) Americans with Disabilities Act.
2) ANSI/TIA/EIA-568-C.
3) ANSI/TIA/EIA-569-A.
4) ANSI/TIA/EIA-606-A.
5) TIA/EIA-J-STD-037.
6) TIA/EIA-758.
7) ANSI/NECA/BICSI 568.
8) ANSI/TIA/EIA-862 Building Automations Systems
9) Building Code of New York State.
12) Federal Communications Commission.
13) Federal Occupational Safety and Health Administration.
14) IEEE - Institute of Electrical and Electronics Engineers, Inc.
15) Insulated Cable Engineers Association.
18) NEC - National Electrical Code, NFPA 70.
19) New York State Department of Labor Rules and Regulations.
20) New York State Department of Health.
24) Underwriters Laboratory.

b. National Electrical Safety Code Board of Fire Underwriters inspection is required for all new electrical construction work. Specific Cornell Fire and Safety requirements must be met. In the event of conflict between or among such codes/requirements, the more stringent will apply.
4. Glossary

a. Acronyms and Abbreviations.

1) ADA  Americans with Disabilities Act
2) ASME American Society of Mechanical Engineers
3) ANSI American National Standards Institute
4) BICSI An Information Transport Systems Organization
5) CIT/Infrastructure  Cornell Information Technologies/Infrastructure
6) CSI Construction Specifications Institute
7) EIA  Electronics Industries Association
8) FCC Federal Communications Commission
9) IEEE Institute of Electrical and Electronics Engineers
10) NEC National Electrical Code
11) NEMA National Electrical Manufactures Association
12) NESC National Electrical Safety Code
13) NFPA National Fire Protection Association
14) OSHA Occupational Safety and Health Administration
15) TIA Telecommunications Industry Association
16) UL Underwriters Laboratories

5. Definitions of Terms

- **Aerial Cable** - Telecommunications cable installed on aerial supporting structures such as poles, sides of buildings, and other structures.

- **Active Equipment** – Energized equipment used for receiving or transmitting analog or digital signals.

- **American Wire Gauge (AWG)** - The standard gauge for measuring the diameter of copper, aluminum, and other conductors.

- **Approved Ground** - Grounds that meet National Electric Code (NEC) requirements such as building steel, ground rings, and other devices.

- **Armoring** - The additional protection between jacketing layers to provide protection against severe outdoor environments. It is usually made of plastic-coated steel and may be corrugated for flexibility.

- **Attenuation (Insertion Loss)** - The decrease in power magnitude of a signal in transmission between points.

- **Backboard** - A wooden material used for mounting electronic equipment and cross-connect hardware.

- **Backbone cabling** – Cable and connecting hardware that provides connections between telecommunication and equipment rooms.

- **Bend Radius** - Maximum radius a cable can bend to avoid physical or electrical damage or cause adverse transmission performance.

- **Bonding** - The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity, the capacity to conduct safely any current likely to be imposed, and the ability to limit dangerous potentials.

- **Buffer Tubes** - Loose fitting covers over optical fibers used for protection and isolation.

- **Building Entrance Terminal** – A device used to terminate cables entering a building that provides voltage and current modules protecting from lightening and foreign voltage.

- **Cable** - An assembly of one or more conductors or optical fibers within an enveloping sheath, constructed to permit use of the conductors singly or in groups.

- **Cable Tray** – A support mechanism used to route and support telecommunications cable.
• **Category 5e/6 cabling** – A structured cabling system following ANSI/TIA/EIA 568-C specifications capable of Gigabit Ethernet transmission.

• **Ceiling Distribution System** - A distribution system that uses the space between a suspended or false ceiling and the structural surface above the ceiling.

• **Channel** – Horizontal cabling and termination modules from the telecommunications room to the user outlet including patch cords.

• **Conduit** - A rigid or flexible metallic or non-metallic raceway of circular cross-section through which cables can be pulled or housed.

• **Connector** - A mechanical device used to provide a mechanical means for attaching and achieving continuity between conductors or optical fibers.

• **Core Area** - The area within a building that contains usable space for elevators, power cables, and telecommunications cables.

• **Cross-connection** - A connection scheme between cabling runs, subsystems, and equipment using patch cords or jumpers that attach to connecting hardware on each end.

• **Data Network** – An interconnected system of computers, peripherals and software over which commands, file and messages are sent and received.

• **Demarcation Point (DEMARC)** - A point at which two services may interface and identify the division of responsibility.

• **Dielectric** - A material that is non-metallic and non-conductive. A dielectric cable contains no metallic components.

• **Direct Buried Cable** - A cable installed under the surface of the ground in direct contact with the soil.

• **Distribution Frame** – A structure with terminations for the cabling of a facility in such a manner that interconnections or cross connections can be readily made.

• **Drop Ceiling** - A ceiling that creates an area or space between the ceiling material and the structure above the material.

• **Duct Bank** - An arrangement of enclosed pathways (typically conduit) for cables usually placed in soil or concrete.

• **Electromagnetic Interference (EMI)** - Any electrical or electromagnetic interference that causes undesirable signals in electronic equipment.

• **Emergency Power** - A stand-alone secondary electrical supply source that is activated when service from the primary electrical source is interrupted.

• **Entrance Facility (EF)** - An entrance to a building for both public and private network service cables (including antennae) including the entrance point at the building wall and the entrance room. **Equipment Room (ER)** – A centralized space for telecommunication equipment that serves the occupants of an entire building.

• **Faceplate** - See “Outlet”.

• **Fiber Optics**- A thin filament of glass. An optical wave-guide consisting of a core and a cladding that is capable of carrying information in the form of light.

• **Firestop** - A material, device, or assembly of parts installed in a cable system in a fire rated wall or floor to prevent passage of flame, smoke, or gases through the rated barrier.

• **Floor Slab** - The upper part of a reinforced concrete floor carried on beams below the slab. A concrete mat poured on sub-grade serving as a floor rather than as a structural member.

• **Fuse Cable (Fuse Link)** – A length of cable that is two gauges smaller that the cable being protected and intended to open on excess foreign power currents.

• **Gigabits Per Second (Gb/s)** – A transmission rate denoting one billion bits per second.

• **Ground** - A conducting connection, intentional or accidental, between a circuit or equipment and the earth (or to some conducting body that acts in place of the earth).
• **Grounding Conductor** - The conductor used to connect the electrical equipment to a grounding electrode.
• **Grounding Electrode** - A conductor (usually a rod, pipe, or plate) in direct contact with the earth providing an electrical connection to the earth.
• **Handhole** – An OSP structure similar to a maintenance hole but not large enough for full access.
• **Hertz** – A unit of frequency equal to one cycle per second.
• **Horizontal Cabling** – The cable and termination hardware from the ER/TR to the work area outlet.
• **IDC** – A type of wire termination connection in which the insulation jacket is cut by the connector where the wire is inserted.
• **ITS** – Information Transport Systems
• **Inner duct** - Additional plastic flexible conduit placed inside a larger diameter conduit.
• **Jack (Port)** - A position in an outlet that enables a physical connection via copper or fiber media.
• **Jumper** – A copper conductor typically consisting of one or two pairs used to connect two IDC connectors or an optic fiber cable with connectors on both ends.
• **Ladder Rack** - The vertical or horizontal open support that closely resembles as ladder. Typically located in ER/TR above the equipment and cabling racks for management and distribution.
• **Link** - Horizontal cabling and termination modules from the telecommunications room to the user outlet.
• **Local Area Network (LAN)** - A geographically limited communications network intended for the local transport of data, video, and voice.
• **Maintenance Hole (MH)** – A vault located in the ground used to house, access and maintain underground cable plant.
• **Main Telecommunications Grounding Backbone (MTGB)** - #6 AWG stranded green insulated conductor from the building ground electrode to the communications entrance facility.
• **Megabits Per Second (Mb/s)** – A transmission rate denoting one million bits per second.
• **Megahertz (MHz)** - A unit of frequency that is equal to one million hertz.
• **Micron (µm)** - A term for micrometer (one millionth of a meter).
• **Modular Jack** – A component used for copper terminations.
• **Multimeter** – Test equipment that can be set up to perform a variety of electrical property measurements including resistance, voltage and current.
• **Multimode Fiber** - An optical wave-guide in which light travels in multiple modes. Core size 62.5µm is the recommended size for campus facilities.
• **Outlet** - A mechanical cable termination point for horizontal cable in the work area (WA) that houses jacks and provides a cable designation location.
• **Patch Cord** - A short length of cable with connectors on each end used to join communication circuits.
• **Pathway** - A facility for the placement of telecommunications cable typically conduit or cable tray.
• **Pedestal** – A protective above ground enclosure use to house splices and terminals.
• **Plenum** – A designated area used for transport of environmental air. Cables installed in this space require a higher fire rating.
• **Port** - See “Jack”.
• **Power Pole/Utility Column** - A raceway placed between the ceiling and floor in conjunction with ceiling distribution systems.
• **Primary Protection** – An NEC required device that limits voltages between telecommunication conductors and ground. These are located in the EF or ER as close to the building entrance as practical.
- **Protector Unit** - A device to protect against either over-voltage or over-current or both. The unit may contain carbon electrodes, gas tubes, diodes, solid state devices, heat coils, fuses, or a combination of these components to address a particular application that screws or plugs into a protector, protected terminal, connecting block, central office connector.
- **PVC** - The abbreviation for polyvinyl chloride used in manufacturing a type of jacketing material.
- **Radio Frequency Interference (RFI)** - A disturbance in the reception of radio and other electromechanical signals due to conflict with undesired signals.
- **Relay Rack** – A vertical metallic frame consisting of threaded holes for equipment mounting.
- **Riser Cabling** - The backbone cabling that distributes between TR’s.
- **Single Mode Fiber Cable** - An optical fiber that supports one mode of light propagation in which the signal travels in a small core with a diameter of 8.3 µm. The light source is normally a laser.
- **Slab on Grade** - A concrete floor placed directly on soil without a basement or crawl space.
- **Sleeve** - A short piece of conduit with bushings that is placed through the wall, ceiling, or floor to allow the passage of cables and wires.
- **Solid State Protectors** - An over-voltage and transient current module used in primary protectors at building entrance facilities.
- **Splice Closure** - A container used to organize and protect splice trays and modules.
- **Splicing** - The joining of cable ends.
- **Support Strand** - A strong element used to carry the aerial of the telecommunications cable and wiring.
- **Telecommunications** - The transfer of information over some distance, including inter-building and intra-building distances by an approved media type.
- **Telecommunications Main Grounding Busbar (TMGB)** – A busbar placed in an accessible location bonded to the building power service ground.
- **Telecommunications Room (TR)** - An enclosed space for housing telecommunications equipment, cable terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and horizontal cabling and is floor or zone serving.
- **Termination** - A mechanical connection or device that is used to access the conductors of a cable.
- **Trench** - A narrow furrow dug into the earth for the direct installation of buried cable.
- **Underground Cable** - A telecommunications cable installed in an underground duct system.
- **Wiring Closet** - See “Telecommunications Room”.
- **Work Area** – A building space where the personnel interacts with voice and data applications.
CHAPTER 2

THE HORIZONTAL SEGMENT

1. General

   a. The horizontal segment consists of two elements:

      1) The horizontal cable and connecting hardware between the outlet in the work area and the Equipment Room (ER) or the Telecommunications Room (TR).
      2) The horizontal cabling pathways and supports that distribute the horizontal cable.

2. Common Design Considerations

   a. Cabling will be installed in a cost effective manner. This concept will utilize metallic and plastic raceways, cable trays and cable supports.
   b. All cabling will be installed according to applicable codes, EIA/TIA Standards, Bicsi methods and manufactures recommendations.
   c. Enclosed cable trays are the preferred structure to support the horizontal cabling in buildings due to their design and flexibility of accommodating future growth and installations for horizontal applications.
   d. Closed metallic pathways will be used in exposed visible areas of egress. Plastic raceways or open cabling devices should be avoided in these locations due to aesthetics and code related issues.
   e. Verify that the distance from each outlet to the patch panel does not exceed 295 ft. This distance must include the planned cable path as well as any vertical transitions.
   f. Whenever possible, outlets shall be flush mounted. In existing buildings when walls cannot be fished, surface outlets will be acceptable.
   g. Cable be loosely bundled and follow 2.5.c.d to minimize cross talk and power over Ethernet heat loads.
   h. CIT maintained cables shall not be installed in the same conduit or cable tray with other types of cabling such as fire alarms, signaling, speakers or audio video.
   i. When multiple outlets are to be placed on the same wall, the cabling should be consolidated into one single outlet to reduce installation costs.
   j. An outlet location will not serve as a feed for another outlet location.
   k. All pathways, pull boxes and junction boxes shall have an adequate access space provided to ensure the contractor or installer a safe means of entry.
   l. The accessible portion of abandoned communication cabling that is not terminated, labeled or intended for future use shall be removed as part of any renovation or upgrade per the NEC article 800.
   m. When specific manufacturer or hardware is identified, substitutions may be approved the CIT/Infrastructure Engineer.

3. The Type and Number of Outlets

   a. Outlets at Cornell University fall into five general configurations:
1) The **Duplex** design consist of two 4-pair UTP category 6 copper cables and supports administrative offices and residential locations.

2) The **Basic** design consists of one 4-pair UTP category 6 cable.

Examples of a Basic outlet:
- a) Wall phones
- b) Fire alarm panels (will be wired directly to device).
- c) Utility (chill water, card readers, time clocks, elevator and customer owned equipment)

3) The **Wi-Fi** design consists of one category 4-pair UTP 6A cable.

4) The **Laboratory/Classroom** design consists of an outlet supported by multiple 4-pair UTP category 6 cables. The number of cables will be determined in each individual instance.

5) The **Fiber Jack** design consists of 4 strands of multimode or singlemode fiber optic cable. These support complex systems that typically fall out of copper cabling distance limitations.

b. Number of outlets and locations

1) One administrative outlet will be supplied for each 150 to 200 square feet of a building. The actual outlet count will be determined by room use and end user requirements.

2) Outlets will be placed to minimize the use of surface raceways and support structures.

3) It is preferred to place outlets on perimeter wall or columns where possible.

4) The outlets shall be placed and configured to avoid obstruction by modular furniture.

5) Outlets shall be placed to meet ADA requirements.

4. **Cable and Connecting Hardware**

a. **Cable Types and Lengths**

1) Three types of cables for use in the horizontal segment: Category 6 UTP (unshielded twisted pair) cable, Category 6A UTP and fiber optic cable.

2) Category 6 UTP cable will be 4-pair, 24 AWG, solid conductor cabling that meets ANSI/TIA/EIA-568 cabling specifications for category 6 cable, to include any/all Amendments and Bulletins. CommScope-Systimax 1071E, Berk Tek Lanmark 1000, Panduit GenSPEED 6000 are the preferred and recommended manufactures.

3) Category 6A UTP cable will be 4-pair solid conductor cabling that meets ANSI/TIA/EIA-568 cabling specifications for category 6A cable, to include any/all Amendments and Bulletins. CommScope-Systimax 1091B is the preferred and recommended manufacture.

4) Fiber optic cable will be a minimum of 4-strands Singlemode 8.3/125μm or Multimode, 62.5/125μm graded index, tight-buffered, indoor cable that meet ANSI/TIA/EIA-568-C. cabling specifications. Corning Cable Systems MIC type cable is the preferred and recommended manufacture. ([http://www.corning.com/cablesystems](http://www.corning.com/cablesystems))

b. Horizontal UTP and fiber optic cables will not be spliced, nor will these cables contain manufactured splices.
c. Horizontal cables will not be connected directly to communications equipment. Suitable connecting hardware (i.e. patch panels and punch-down blocks) and factory-manufactured patch cords must be used to make the connection. Cross-connect jumper wire shall be used for voice and fire circuits only.

d. The maximum total length of horizontal cable from the telecommunication room to the outlets (link) is 295 ft (90 meters). Including patch cords (channel) and service loops, these circuits shall not exceed 328 ft (100 meters).

e. The minimum bend radius for 4-pair UTP cable is approx. 1 inch and 2 inch for 4-strand fiber.

f. Cable slack must be provided at both ends of cable runs to accommodate future cabling system changes.

g. Under-carpet flat cable is not used on campus.

h. Termination hardware required at the outlet:

   1) Each category 6 UTP cable will be terminated with an 8 position 8 wire T568A coded category 6 modular jack. Panduit is the preferred and recommended manufacturer. ([http://www.panduit.com/](http://www.panduit.com/)). Category 6 links will be terminated using the CJ688TG jack modules.

   2) Each category 6A UTP cable will be terminated with an 8 position 8 wire T568A coded category 6A modular jack. Panduit is the preferred and recommended manufacture. ([http://www.panduit.com/](http://www.panduit.com/)). Category 6 links will be terminated using the CJ6X88TG jack modules.

   3) Each fiber optic cable will be terminated using an SC or LC type connector. All strands shall be terminated at the outlet and ER or TR for testing and verification purposes. Corning Cable System is the recommended manufacturer.

   4) Outlets (faceplates and adapters) for the jack modules will be from the same manufacture Panduit. The preferred and recommended outlet is the mini-com executive series single gang electric ivory bezel (CBEEI).

i. Termination hardware required at the TR

   1) Termination hardware required to terminate the horizontal UTP copper and fiber optic cables at the ER and TR’s are covered in Chapter 3, The Telecommunication rooms.

j. Assigning Outlet Designations

   1) The outlet designations are used by CIT in the application of operational databases, for assignment of services to departments, and for other service related purposes. They are crucial to the implementation of service to the project.

   2) The Contractors/Installers shall obtain outlet number configuration for room layouts from the CIT/Infrastructure Engineer. Typically the outlet designations are assigned using the room number followed by letters A-Z in a clock-wise orientation from the left of the primary entrance of the room.

k. Cable Testing Procedures

   1) Horizontal Cable Testing:
a) Horizontal UTP and fiber optic cables will be tested for full compliance with ANSI/TIA/EIA 568-C and addenda.
b) The test results shall be provided on a MS-Windows formatted CD in a common delimited file.
c) Horizontal cabling will be permanent link tested with a level 3e tester for full category 6 compliance.
d) The dB loss for a horizontal segment must not exceed 2.0dB.
e) Field-testing instruments for multimode fiber optic cabling shall meet the requirements of ANSI/TIA/EIA-526-14-A. The light source shall meet the launch requirements of ANSI/TIA/EIA-455.

5. Pathways and Structures to Support the Horizontal Cabling

a. General:
   1) Communications cabling shall be self supported to the building structure.
   2) Communication cables shall be installed in a neat and workman like manner. Special attention must be provided when selecting and designing the type and layout of structures to support the horizontal cabling. The design must accommodate cabling changes with minimal disruptions to building occupants.
   3) As each building is unique, individual consideration will be given to provide the most cost effective solution for the life of the facility.
   4) The space above the ceiling grid be used, whenever possible, to route the support structure that will contain the horizontal cabling.
   5) Cable pathways will follow the corridors of the building.
   6) Where cable tray or conduit is not specified, a continuous pathway of independent cable supports shall be provided. The distance between supports shall not exceed 48” and shall be fastened to the building structure.
   7) Verify that the distance from each outlet to the patch panel does not exceed 295 ft. This distance must include the planned cable path as well as any vertical transitions.
   8) All metallic pathways will be bonded to complete continuity back to the building ground.
   9) Cable trays will be installed in accordance with NFPA 70 article 392.
  10) The cable tray dimensions will vary according to number and type of outlets it supports. Manufacturers fill ratios shall be used when determining cable tray sizing.
  11) When more than 30 cables are installed in a plenum environment, enclosed metallic pathways shall be used due to plenum cable cost. Refer to 2.5.c. D) for additional design criteria.
  12) Pathways designs shall consider POE heat loads and crosstalk issued related to cable bundling.
  13) NEMA load ratings will be followed based on maximum fill allowed by the manufacturer.
  14) Radius fittings shall be used when changing cable tray direction.
  15) Dual hanger or trapeze type are the preferred mounting methods for cable trays.
  16) Provide rollers and sheaves on threaded rods for cable installs.
17) Cable trays should not extend more than 12 inches inside of the TR.
18) Enclosed pathways will be provided with a pull string rated at 200 lbs.
19) Cable trays will be installed to allow the technician/installer adequate access and working clearances.
20) Access shall be provided to allow cable placement with minimum disruption to the buildings functions and occupants.
21) Maintain the following distances from EMI sources:
   a) Fluorescent Lights – 12 inches
   b) Power cables – 6 inches
   c) Transformers – 36 inches

b. Cable Tray:
   1) Enclosed Cable Tray:
   a) Closed cable tray designs will be constructed with a smooth solid bottom.
   b) The closed cable tray designs should have a smooth solid flanged cover that is composed of equal sections with a maximum length of 5 ft.
   c) The cable tray cover should not be screwed or hinged down.
   d) Conduits that attach to the closed cable tray design should enter from the side, located 2 inches from the bottom of the tray.
   e) Enclosed cable trays must be installed to allow technicians/installers adequate access space above and to the side of the structure.
      1. The minimum recommended height above the cable tray is 12 inches.
      2. The minimum recommended side clearance is 18 inches.
      3. Where full access is not available, conduits may be routed and group up to an accessible portion of the cable tray.

   2) Metallic Ladder Tray:
   a) ½ inch rod shall be used for ceiling hanger mounting.
   b) Individual sections will be secured with splice plates.
   c) Provide cable retaining post.
   d) The minimum recommended side clearance is 18 inches.

   3) Spine Tray:
   a) ½ inch rod shall be used for mounting and sleeved to protect cables.
   b) Sections will be mechanically secured to form a continuous structure.
   c) At support points the threaded rod shall be hung from concrete inserts or clamps that are secured to devices or beams that are securely fastened into slab, walls or structures.
   d) Stiffener bars shall be installed when try width exceeds 12” or threaded rod 3’.
e) The minimum recommended side clearance is 18 inches.

4) Wire Mesh Tray:
   a) ½ inch rod shall be used for mounting and sleeved to protect cables.
   b) Sections will be mechanically secured to form a continuous structure.
   c) At support points the threaded rod shall be hung from concrete inserts or clamps that are secured to devices or beams that are securely fastened into slab, walls or structures.

c. Cable Supports and Clamps
   1) 5 foot maximum spacing staggered between 4 and 5 feet.
   2) At support points the threaded rod shall be hung from concrete inserts or clamps that are secured to devices or beams that are securely fastened into slab, walls or structures.
   3) Cable clamps will be used for up to 4 cables per manufacturer’s guidelines.
   4) Cable support will be used as follows:
      a) 1 inch support for up to 15 cables.
      b) 2 inch support for up to 30 cables.

d. Conduits
   1) EMT conduit may be used from each outlet to the cable tray or telecommunications room.
   2) The ends of conduits will be reamed and bushed to eliminate sharp edges.
   3) Telecomm lb’s may be used to control bend radius around sharp corners.
   4) The minimum conduit size used for IT installations shall be 3/4 inch.
   5) The minimum bend radius for a conduit that is 2 inches or less in diameter should be 6 times the internal conduit diameter. If the conduit is larger than 2 inches the bend radius should be 10 times the internal diameter of the conduit.
   6) The use of flexible conduit shall be used when all other methods are not practical. Flexible conduits lengths shall be minimized and secured per the NEC.
   7) NMT or seal-tight conduit shall not be used.
   8) The following chart is used to determine the recommended conduit fill capacity.

e. Surface Raceways may be used for horizontal outlet locations.
   1) Raceways may be metal or plastic construction.
   2) Raceways shall be installed minimizing the use of couplings and fittings.
   3) Raceways shall be installed with entrance end fittings where the cable passes through a wall.
4) All raceways shall be sized with the equivalent cross sectional capacity as the specified conduit.

5) Additional conduits will be considered when the raceway routes around the perimeter of the room.

6) When the raceway is divided and shared, separate offset single gang device brackets shall be used.

7) Raceways shall be sized per manufacturer’s recommendations.

f. All raceways will be installed using mechanical fasteners. Adhesive tapes will not be the sole mounting device. Outlet Boxes

1) Plastic surface mount boxes may be used. Panduit CBX4EI-AY or equivalent.

2) Walls may be fished when possible and use a plastic surface mount box.

3) A 4 × 4 × 2.5 inch outlet box with a single gang plaster ring may be used at each work area outlet for a flush mount installation.

4) A 4 x 2 x 1.75 inch outlet box will be used for each wall phone and wireless access point. .75 inch EMT conduit shall connect the outlet box to the nearest cable tray, pullbox or ER/TR.

5) Utility locations shall terminate in a 4 × 4 × 1.75 inch outlet box with a blank cover. .75 inch EMT conduit shall connect the outlet box to the nearest cable tray, pullbox or ER/TR. A conduit shall also extend from the opposite side of the outlet box to the end device. See figure 2.3.

6) The communication outlet locations shall adhere to ADA requirements. For renovations some outlets may match existing electrical outlet heights.

g. Pull Boxes

1) A metal pull box shall be installed if any of these conditions exist:
   a) The length of the pathway is over 100 ft.
   b) Quantity of more than two 90-degree bends.
   c) There is a reverse bend in the run.

2) Pull boxes or junction boxes should be located in an area that is readily accessible.
CHAPTER 3

THE INFORMATION TECHNOLOGY ROOMS

1. General

a. On the Cornell University campus, Entrance Facilities (EF), Equipment Rooms (ER) and Telecommunication Rooms (TR) define the locations where IT equipment is located and serviced. These rooms house communications equipment to serve the voice, data, video, utility and life safety requirements for an entire building or specific area. IT rooms can vary in size depending upon termination space requirements, (i.e. equipment cabinets, equipment racks or backboard space).

b. An IT room provides a secure controlled environment in which CIT installs equipment racks, communications voice and data equipment, terminating hardware, splice closures, and protection apparatuses where applicable. This equipment may also include Private Branch Exchange (PBX) equipment, IP based video distribution equipment, network routers, wireless equipment. Uninterruptible power sources will be installed in all new IT room locations.

c. CIT is responsible for providing reliable service through physical security to the voice and data infrastructure as well as electronic security for the voice and data networks. As a result, these spaces are uniquely keyed. Rooms may be accessible to building occupants if an auditable electronic system is installed. Trades requiring access may sign out keys at PDC Customer Service. Access may also be granted by contacting CIT Operations Support.

d. Occupants or trades that desire to house network switches, life safety or building automation equipment in these locations should contact CIT/Infrastructure Engineering for space planning and allocation.

2. The Design Process

a. This section describes the policies and procedures for the following design activities:

1) Sizing the ER/TR
2) Determining the location of the ER/TR
3) Specific design requirements
4) Cable pathways Entering/Exiting the ER/TR

b. Common Design Considerations:

1) Telecommunication rooms shall be secured spaces. In new construction, the CIT rooms will be tied into the university Best Access BASIS Software System. All other CIT spaces are uniquely keyed with Medeco GM lock sets. In common or utility areas of a building, secure enclosures will be provided to house the IT equipment. Concerns about this requirement should be directed to Cornell Risk Management.

2) Equipment not related to the support of the communications facilities (e.g. sprinkler, steam, chilled water, supply and waste piping, ductwork, pneumatic tubing, shall not be installed in, pass through or enter the TR.
3) If the desire is to house Life Safety, Facilities monitoring, Card Access CATV or BMS or non-CIT maintained equipment in the TR, then the room needs to be enlarged accordingly to ensure that adequate space will be provided for safety and manageability of the equipment. The space shall have an auditable security system.

4) Horizontal pathways should terminate in the TR located on the same floor as the area being served. However in an effort to provide the most cost effective communications solution, a TR located on one floor and serving the floor above and below is acceptable practice. In this instance, the space must be sized accordingly.

5) Shallow riser rooms are used only as splice points for fiber or pass-through for category 6 copper cables from outlets and shall not house electronics.

6) The EF or ER shall be large enough to accommodate lightning protectors, cross-connects, wall and rack mounted data equipment, data equipment racks, and the main telecommunications grounding busbar (TMGB).

7) Considerations shall be given to evolving hardware on the market in regards to density and functionality

3. The Size of the ER/TR

a. The size and quantity of the TR’s will be influenced by the serving distance per floor and the number and type of outlets to be served from them. Also consideration for growth should be calculated into the dimensions.

1) The ER/TR must provide enough space for all planned cable terminations and electronic equipment, including any environmental control equipment, power distribution/conditioners, and uninterrupted power supply systems that will be installed to serve the telecommunications equipment.

2) The ER/TR must provide a 3 ft working clearance for safe access to the equipment for maintenance and administration purposes, and for equipment changes with minimal disruptions.

3) The minimum size of the ER/TR is based on providing exclusively communications service over a category 6 or fiber optic cable plant.

4) Multiple TR’s are required if the usable floor space to be served exceeds 20,000 square ft or the cable length between the outlet and the patch panel exceeds 295 cable/ft.

5) Recommended minimum IT Room sizes:
   a) EF - 6 ft. (w) x 4 ft. (d)
   b) ER - 10 ft. x 15 ft.
   c) Small TR - 6 ft. x 4 ft. This space will accommodate 192 cables.
   d) TR - 9 ft. x 8 ft. This space will accommodate 384 cables.
   e) TR – 9 ft. x 11 ft. This space will accommodate 768 cables.
   f) Shallow Room - 2 ft x 8.5 ft (only used for pass through applications).
6) There are a limited number of instances where a secure enclosure may be used. Generally, these are smaller facilities with limited growth expected. Examples include residential buildings and locations with shared occupancy. Working clearance shall be maintained around enclosures.

b. The minimum size of the TR can be determined as follows:

1) In a TR dedicated to communications infrastructure 19 inch x 84 inch rack(s) attached with side mounted vertical cable management should be installed adjacent to each other and parallel to the wall with the greatest length.

2) A clearance of 6 inches should be maintained from the first rack to the wall, and a minimum of 3 ft should be left at the anticipated end of the row of equipment racks. A 3 ft minimum clearance at the front and back of the equipment racks will allow space for wall mounted copper cable terminations.

3) In larger buildings requiring additional rows of equipment racks, the racks shall be lined up in rows with 5-ft separation row-to-row, and 3-ft row to wall. The number of equipment racks required will determine the dimension.

4) The CIT/Infrastructure Engineer will determine room applications in regards to the use and location of the TR. These details may be determined during informational and design meetings.

4. The Location of the ER/TR

a. Centrally located TR’s are preferred as they can cover the largest areas of a building.

b. In any multi-level structure, communications rooms should be designed so they are vertically aligned.

c. The ER/TR shall not be:

1) Located in any place that may be subject to water, steam, humidity, heat, and any other corrosive atmospheric or environmental substance.

2) Located near electrical power supply transformers, elevator or pump motors, generators, x-ray equipment, radio and radar transmitters, induction heating devices, and any other potential sources of electromagnetic interference (EMI).

3) Located near sources of mechanical vibration that could be conveyed to the room through the building structure.

4) Share space in or be located near electrical closets, boiler rooms, washrooms, janitorial closets, and storage rooms.

5) Located below water level unless preventive measures against water infiltration are implemented. The room shall be free of water or drain pipes not directly required in support of the equipment within the room.

d. The TR shall be located in an accessible area on each floor. Access to the ER/TR should be directly from hallways or service corridors; not through classrooms, offices, or spaces not accessible by maintenance level keys.
5. Design Requirements

a. The major factors that must be considered when designing the ER/TR are as follows:

1) Ceiling:
   a) The minimum ceiling height must be 9 ft.
   b) Ceiling protrusions must be placed to assure a minimum clear height of 8 ft, 6 inches to provide space over the equipment facilities for cables and suspended racks.
   c) For maximum flexibility, drop ceilings shall not be installed.

2) Entrance Doors:
   a) The door shall be a minimum of 36 inches wide and 80 inches high. Door shall be fire rated for a minimum of one hour, or more as required by local code requirements.
   b) Doors must open outward (code permitting).
   c) The keying of doors for all TR’s shall be keyed to the CIT/Infrastructure specifications. Refer to 3.2.b.1) for additional information.
   d) For security purposes, the room signage should be consistent with the Facility room numbering scheme.

3) Walls:
   a) Interior finishes shall be in a light color (linen) to enhance room lighting.
   b) TR’s shall be supplied with void free, ¾-inch AC-grade plywood 8 ft in length. Quantity and layout will be based on cable support structure and routing pathways required in the space.
   c) The plywood must be securely fastened to the wall-framing members.
   d) Plywood shall be fire retardant or painted with fire retardant paint.
   e) Plywood will be mounted vertically starting at 6 inches above the finished floor.

4) Floors:
   a) Floors must be sealed concrete to minimize dust and static electricity.
   b) If vinyl tiles are required, then anti-static vinyl tiles shall be used to avoid damage to the electronics located in the room.
   c) Floor loading capacity in the TR shall be designed for a minimum distributed load rating of 50 lbf/ft²
b. Environmental Controls

1) The current Hewlett Packard network electronic device generates about 4900 BTU/hr. This unit can accommodate 288 type 1 power over Ethernet devices. Cooling capacity should anticipate double that number in the event a second unit is required.

2) The recommended operating **temperature** should be set between 60°F to 80°F.

3) In situations where the daily temperature within a TR will exceed 80°F, or if ventilation is not possible within code, then an HVAC source must be considered. This may be accomplished by:
   a) Dedicated HVAC equipment.
   b) Access to the main HVAC delivery system.
   c) Wet cooling can be a fan coil unit with chilled water.
   d) Cooling may also be obtained with an AC unit and a remote condenser.

4) Where the daily temperature in the surrounding area does not exceed 80°F, building ventilation can be used to cool the room under the following conditions.
   a) The intake must be filtered.
   b) The exhaust cannot be vented in a manner that will violate code.
   c) Fire dampers will be installed to comply with code.
   d) Air within the room is exchanged at a rate which will keep the room temperature within limits from the finished floor to a height of 5-ft.
   e) Ventilation return and supply ducts should be terminated with a flushed mounted grid in the TR.

5) The recommended **humidity** level should fall **between 30% and 65%**. Humidity should be a concern if it is anticipated that normal level within the TR would fall outside these parameters.

6) The air handling system and environment controls for TR’s must be continuous and dedicated, and designed to provide positive airflow and cooling even during times when the main building systems are shut down. This may require separate air handlers and/or small stand-alone cooling systems that are thermostatically controlled in this space. If this room is to be used as a switch room, and or data node room the air handling system should be connected to the building’s backup power generation system. The room will house sensitive electronic components that will generate heat 24 hours a day, 365 days a year and must be cooled to maintain operating performance.

7) Heating, ventilation, and air-conditioning sensors and control equipment related to the environment within the TR must be located in the TR.

8) The TR shall be protected from contaminates and pollutants that could affect operation and material integrity of the installed equipment. When contaminates are present in concentrations greater than indicated in ANSI/TIA/EIA 569-A, Table 8.2-2, vapor barriers, positive room pressure or absolute filters shall be provided.
c. Lighting

1) Adequate lighting shall be provided in all TR’s.

2) Suspended light fixtures should be mounted at 8 ft, 6 inches above the finished floor. Position the light fixture(s) above an aisle area front and back only, and not directly over equipment racks or cabinets. Wall mounted fixtures are permissible if lighting standards are met. Wall mounts should be placed in such a manner that they will not interfere with infrastructure pathways, protective equipment, and cables.

3) Emergency lighting should ensure that the loss of power to normal lights will not hamper an emergency exits from the telecommunication spaces.

d. Electrical

1) TR’s shall contain electrical service fed by a dedicated 50 Amp sub-panel located within the TR and installed in accordance with NEC Article 110.26.

2) Electrical panels shall be located near the room entrance door to conserve wall space.

3) The TR must be equipped with a minimum of two dedicated 3-wire 120VAC nominal receptacle circuits for network electronics. These shall be 20A rated, non-switched, duplex electrical receptacles on separate branch circuits. These should reside in one 4-inch utility box.

4) Receptacles are not to be located on active equipment racks but may be installed on overhead ladder racking.

5) 120VAC 20A duplex convenience outlets shall be placed at 6 ft intervals around perimeter walls and will mount at the base of the plywood backboard.

6) Electrical service shall be connected to an emergency power source when available.

7) When emergency power is limited, one dedicated 120VAC 20A duplex EM outlet shall be installed on a pendant that will terminate next to the UPS.

8) Each ER/TR will be supplied with a Powerware 9125 2000VA UPS and a 48 EBM extended battery module. Any substitutes shall be SNMP capable and approved by CIT Network Engineering.

e. Grounding

1) Grounding shall conform to TIA/EIA-J-STD-037 - Commercial Building Grounding and Bonding Requirements for Telecommunications, NEC Article 250 and manufacturer's grounding requirements as minimum.

2) The TR must be provided with a Main Telecommunications Grounding Busbar (MTGB) (electrical ground) on a 4-inch or larger busbar. The ground wire shall consist of a green insulated #6 AWG copper-grounding conductor.

3) The busbar must be mounted on the plywood and placed so as not to interfere with the installation of the communications equipment or infrastructure pathways.

4) This grounding bar must be connected to a main building ground electrode.
5) Bonding conductors placed in ferrous metal conduit over 3-ft in length shall be bonded to the conduit on both ends.

6) Metallic pathways shall utilize star washers with bonding lugs on all surfaces.

7) All metallic pathways, racks, cabinets, patch panels, fiber housing units, and any other associated devices located in the TR must be bonded to the ground busbar (TGB).

8) In the event a TR is required, a #6 ground shall be installed as a communications grounding backbone interconnecting the TMGB “Telecommunications Main Grounding Busbar” in the ER to a TGB “Telecommunications Grounding Busbar” in the TR’s.

f. Fire Protection

1) If sprinklers are required within the TR, wall mounts above the plywood backboard are preferred. Should overhead sprinklers be required, the heads shall be provided with wire cages to prevent accidental operation.

2) When possible by code, arrange sprinkler system in TR’s to be on a separate zone from other spaces.

3) Pre-action sprinkler systems shall be used in TR’s to minimize inadvertent water discharge.

4) Fire extinguishers located in TR’s shall not contain materials that will damage network electronics or cable terminations. Amerex Water Mist or Halotron or suitable substitutes may be used.

5) Consideration should be given to the installation of alternate fire-suppression systems such as Dupont FM 200.

6. Cable Pathways Entering/Exiting the ER/TR

a. Cable pathways shall be terminated within 2-4 inches or room entry.

b. Conduits or sleeves in the room below should extend only far enough below the ceiling to permit installation of a bushing and a cap. All conduits or sleeves should be installed at a minimum of 2 inches and no more than 6 inches from the adjacent wall.

c. Sleeves and conduits must be positioned near a wall on which the cables can be supported.

d. Sleeves and conduits must be located where pulling and termination can be done so as not to interfere with other equipment within the room.

e. Sleeves and conduits must not be placed directly above or below the wall space that is used for termination fields.

f. Sleeves and conduits must extend a maximum of 3-inches above the finished floor level.

g. Refer to Chapter 5 - The Riser Segment for additional information.

7. Termination Hardware Requirements for the ER/TR

a. Patch Panels for Copper Horizontal Cabling:
1) UTP cables supporting data outlets will be terminated on T568A 48-jack patch panels which are mounted in a free standing equipment rack, or in an enclosed data cabinet. Panduit is the preferred and recommended patch panel.

2) Patch panels and active equipment in the ER and TR must be placed to allow interconnections via jumpers, patch cords, and equipment cables.

b. Cable Management Panel for Data Horizontal Copper Cabling:

1) Horizontal and vertical cable management panels shall be installed for data patch panels in all rack and cabinet installations. Two horizontal cable management panels are recommended for every data patch panel and will be configured so that one is above the patch panel and one is below it.

2) Angled horizontal cable managers may be used.

3) Vertical cable management will be located on both sides of the rack or cabinet.

c. Patch Panels for Fiber Optic Cabling:

1) Fiber optic cable for Outside Plant, Riser/Backbone and Horizontal cabling installations shall be terminated on Duplex SC or LC type connectors at the ER/TR.

2) All loose-tube Outside Plant fiber optic cables shall have a Buffer Tube Fan Out kit installed prior to the installation of fiber connectors.

3) Fiber optic termination enclosures/terminals shall be rack mounted in either equipment racks or enclosed data cabinets.

d. Patch Panels for Voice Connections:

1) Cabling for voice service shall be terminated on patch panels to 110 type termination blocks in the ER or TR. A 25 pair copper cable will be used to connect the two wiring devices. The patch panel will be positioned within the rack or cabinet and the 110 type termination block will be positioned on the wall below the building feed or riser termination points with a 188 backboard located between the two fields.

2) 25 pair cables will be routed from the 110 type hardware to the back of the patch panel.

3) The 25 pair will be terminated on the 110-style patch panel in a fashion that allows each pair to accommodate individual ports on the device. One pair should be terminated per position on the patch panel and terminate on the 110 type wall mount hardware via the color code.

4) Cross-connect fields, patch panels, and active equipment in the ER and TR must be placed to allow cross-connections and interconnections via jumpers, patch cords, and equipment cables.
8. **Structures to Support the Cabling in the ER/TR**

   a. Wire tray, ladder racking, equipment racks, plywood backboards, data equipment racks, and wire management brackets for the ER and TR equipment must be used to keep the cabling and equipment organized, and to allow the cable plant to be installed to TIA/EIA 569-A specifications. Wire tray or ladder racking must be used to route bulk communications cables within the TR.

      1) Wire tray must be at least 12 inches wide and be installed a minimum of 7 ft 6 in above the finished floor to allow adequate clearance at the top of the equipment racks and cabinets.

      2) Provide 12 inch minimum clearance between the top of the ladder rack and any obstacle that may be encountered.

      3) Free standing equipment racks must have equipment mounting holes 19 inches apart. The floor to top dimension should be 84 inches, with ANSI/EIA-310D spacing and 12-24 threads. Enclosed cabinets shall be ordered with the same spacing and threads to insure consistency.

      4) Adequate working clearance must be maintained in the front and behind each equipment rack and at one end of the equipment rack or multiple rack assemblies. The front and rear clearance must be measured from the outermost surface of the electronic equipment and connecting hardware rather than from the equipment rack itself since some of these devices may extend beyond the equipment rack.

   b. In limited applications, equipment and connecting hardware may be installed in enclosures or wall mounted using wood screws on rigid plywood backboard. This practice may be used when the outlet density is minimal and when limited expansion space is available. A floor mount rack design should be considered first.

      1) Wire management must be used to manage cables and jumpers.

      2) In very small buildings, of fewer than 24 outlets, fiber, voice patch panels, and UTP, can be located in the same equipment rack/cabinet.

**Equipment Wire Rack Layout**

Fiber housing is always located at the top of the equipment rack. Electronics shall be mounted 40-inches AFF. This will allow for future installation of equipment if necessary. Open wire management allow for a path across the rack without cluttering the jumpers housed in the closed management. Voice patch panels are installed as required for the area being served.

**Station Wire Rack**

Station wire racks should consist of open wire management, station wire or fiber patch panels, and closed wire management. These should be installed from the top down in quantities necessary to support the needs of the area being served.
CHAPTER 4

THE RISER SEGMENT

1. General
   a. The riser segment consists of the Copper and Fiber optic riser cable and the supporting infrastructure within a building. This pathway and cabling connects the Telecommunication Rooms vertically.

2. The Design Process
   a. This section describes the policies and procedures for the following design activities:
      1) The sizing, type, and termination of copper and fiber optic riser cables.
      2) Designing the structures to support a vertically aligned riser segment.
      3) Designing the structures to support a horizontally offset riser segment.

3. The Size, Type and Termination of Copper Riser Cable
   a. The size of the riser cable is a function of the number of administrative and higher density communication outlets supported by the TR.
      1) Building square footage and quantity of communication outlets.
      2) User requirements and technologies to be deployed. (Consult with Infrastructure engineering for specific riser pair counts.)
   b. The type of riser cable shall meet the following requirements:
      1) The type of riser cable will be ARMM, UL listed CMR rated.
      2) ARMM riser cables shall be grounded and bonded in accordance with TIA/EIA-J-STD-037 requirements, as applicable.
   c. The method of termination of the copper riser cable will conform to the requirements in Chapter 3.

4. The Size, Type, and Termination of Fiber Optic Riser Cable.
   a. The standard strand count of the riser fiber optic cable is 12 single-mode and 6 multi-mode.
   b. Riser fiber optic cables shall be terminated with SC or LC type terminations. All fiber strands shall be terminated and tested in accordance with this standard.
   c. The type of riser cable shall meet the following requirements:
      1) Conform to NEC Article 770, and comply with the State of New York fire codes.
      2) The type of riser cable will be UL listed OFNR rated.
3) All riser cable (fiber optic) should be of a tight buffer design.

4) The fiber optic components shall be manufactured by the same vendor to insure compatibility, performance and warranty. Corning Cable Systems is the preferred manufacturer.

5) The method of termination of the fiber optic riser cable will conform to the requirements in Chapter 3.

5. Testing Requirements for Copper and Fiber Optic Riser Cables
   a. Copper and fiber riser cables shall be meet the performance and test criteria in accordance with TIA/EIA 568-C.
   b. Fiber riser cables shall be tested in accordance with TIA-526.
   c. Copper cable binders will tested individually with a VOM for loop continuity.
   d. Fiber optic link segments shall be tested in one direction at 850 and 1300nm for multimode and 1310 and 1550 nm for single mode fibers.
   e. Test results shall be submitted to the manufacturer for cable warranties.

6. Structures to Support Vertically Aligned TR’s
   a. Riser conduit and/or sleeves between IT rooms shall consist of a minimum of two (2) 3 inch conduits or sleeves.
   b. TR’s that are vertically aligned must be connected with sleeves.
      1) Sleeves and conduits must be fitted with plastic bushings on both ends.
      2) All unused sleeves must be appropriately fire stopped in accordance with TIA/EIA 569-A, Annex A, and any/all local fire codes.
      3) The conduit, sleeves, and cable trays will be grounded on both ends.
   c. In a multi-story building, grip brackets must be specified to support the riser cable’s weight as it passes through the TR.

7. Structures to Support Horizontally Offset TR’s
   a. TR’s that are not vertically aligned must be connected with conduits and pull boxes.
   b. Conduit will be used to route the riser cables between the ER and the TR’s. Conduit paths must be coordinated with other trades during construction or remodeling.
      1) The conduit will be Electrical Metallic Tubing (EMT) 4 inches in diameter.
      2) The conduit will be bonded to the electrical ground at each end.
3) The conduit will be installed with a pull string and the ends will have plastic bushings to protect the cable.

4) Conduit will not turn down.

c. Pull Boxes

1) Pull boxes are required in sections of conduit that are 100 ft or more in length or that contain more than 180 degrees of bends.

2) Cables must feed straight through a pull box. Pull boxes must not be used in lieu of a bend.

3) The size of a pull box, junction box, or trough should be based on its intended use. Utilize industry standard sized boxes for installation purposes to minimize special order situations.
CHAPTER 5

THE OUTSIDE PLANT SEGMENT

1. General
   a. The campus segment consists of the Outside Plant (OSP) cables and structures needed to interconnect the Campus Buildings, and EF/ER for facilities associated with Cornell University.
   b. The supporting structure includes underground (in conduit) cables, direct buried cables, maintenance holes (MH), hand holes/pull boxes (HH/PB), aerial cables, pole lines, pedestals and outside terminals. The campus segment must be designed and installed to the NESC and ANSI/EIA/TIA-758 and 758-1 requirements and standards for outside plant construction. The HH/PB’s shall not be considered for splice points.
   c. Dual entrances shall be considered for new buildings.

2. The Design Process
   a. This section describes the policies and procedures for the following design activities:
      1) Identifying cable routes from the maintenance hole to a building or building-to-building.
      2) Selecting cable distribution methods.
      3) Determining the aerial, underground and direct buried cable requirements.
      4) Identifying the types of cable used in the campus segment.
      5) Determining maintenance hole, hand hole, and pull box requirements.
      6) Determining electrical protection and bonding/grounding requirements.

3. Cable Routes
   a. The following steps must be taken to identify the cable routes between new buildings and major building renovations.
      1) Provide an as-built of the campus utilities map for the specified area.
      2) Determine where the cable entrance point is for each building.
      3) Provide a drawing of the intended path for the cables from building entrance to the nearest serving facility.
      4) Note any obstacles, existing cable facilities, or other underground utilities on the campus map.
      5) Note if right-of-way permits or easements are required (off campus locations).
4. **Cable Distribution Methods**

a. All new communications cabling on Campus is to be installed in underground ducts encased in concrete. Direct burial or aerial cable may only be used if prior written approval is obtained.

b. An underground duct system consists of cables placed in buried conduits encased in concrete (duct bank) that is connected to maintenance holes (MH); hand holes/pull boxes (HH/PB) and serving building.

1) If new conduits (ducts) are required, a minimum of three (3) 5-inch ducts will be required. This arrangement will allow a spare duct for future technologies and vendors.

2) Minimum top cover for the encased duct bank is two ft. Conduit material will be schedule 40 PVC Carlon Type EB or equivalent.

3) Concrete for encapsulating duct-bank should be 3/8 inch aggregate with a nominal compressive strength of 4000 pounds per square inch. It should have just enough consistency to flow to the bottom of the formation but not as wet to cause the ducts to float.

4) Where practical, avoid locating duct banks adjacent to steam lines.

5) If telephone and electric duct-bank share a common trench, the following clearance requirements must be adhered to:

   a) When in concrete a minimum of 6 inches should be observed.
   
   b) When in masonry a minimum of 8 inches should be observed.
   
   c) When in well-tamped soil a minimum of 12 to 18 inches should be observed.

6) Where duct banks will be exposed (e.g., bridge crossings, etc.), a transition to rigid steel must be made. Expansion joints are required in conjunction with the steel conduit and the transition will be made no less than 10 ft from the point of exposure.

7) Where road crossings are needed, transition must be made to steel pipe or schedule 80 PVC Carlon Type EB if the cover will be less than four (4) ft.

8) A duct-bank that has a downhill grade prior to entry of a building, a maintenance hole should be installed to protect against flooding.

9) Metallic locating tape labeled "telephone cable" must be placed approximately 6 inches below grade and immediately above duct banks.

10) The following illustration depicts detail for an underground duct bank encased by concrete.

c. A direct buried cable system consists of cables and associated splices directly placed in the earth. The trench runs from the building entrance location to a pole, pedestal, MH or HH/PB.

1) All direct buried cables shall have a minimum ground cover of two ft; road crossings or ditches require a minimum ground cover of three ft. In addition, the road crossings shall utilize at least a four-inch sleeve that extends at least ten ft on either side of the road. Sand should be used to backfill around the sleeve.
2) Metallic locating tape labeled "telephone cable" must be installed approximately 6 inches below grade over buried cable.

3) Where direct buried cables enter a pedestal, the bottom 6 inches of the pedestal must contain crushed stone.

4) All direct buried feed cables must have route markers installed so as to safeguard against accidental service interruption.

5. Underground Cable Requirements
   
a. All underground conduit and OSP construction and installation at Cornell University must conform to Cornell Design and Construction Standard 16700.

b. Underground and OSP cable projects must be designed and approved by the CIT/Infrastructure Engineer. These drawings must include the following information:
   
   1) Details showing duct locations in regards to, clearances from final grade, backfill materials, depths, and cross sections of the duct configuration, including entries into the selected building and maintenance holes.

   2) Construction notes applicable to the work being performed.

   3) A scale drawing showing location ties to existing structures, cable, conduit, utility boxes, and any conflicting substructures and profile drawings of congested areas where vertical and horizontal separation from other utilities is critical during cutting and placing operations and any other areas as requested by Cornell University.

   4) A legend explaining symbols of all relevant structures and work operations.

   5) Cable types, counts, and directions of feed.

   6) Conduit types, dimensions, and wall-to-wall measurements when used with MH, HH/PB, and TR's.

   7) MH drawings showing cable-racking information, applicable cable counts, conduit assignments, splicing details, north point arrows, and street outlets. MH drawings must be consistent with CIT/Infrastructure Engineering standards.

      a) All maintenance holes and hand holes will be pre-cast or cast-in-place reinforced concrete designed for a minimum H-20 loading.

      b) Maintenance holes should be located so as to avoid unnecessary hazards and cause minimum interference with normal traffic flow. Communications maintenance holes should be located outside the traveled portion of the roadway or sidewalk whenever possible.

      c) Pulling irons are required in every manhole and vault. In general irons are to be placed in the wall opposite each duct entrance at a point from six to twelve inches below the ducts with which they are associated and in line with the center line of the duct.

      d) Service structures will be designed to meet the needs of each project.
e) Maintenance hole covers and frames will be cast iron and conform to Cornell Specifications. Covers will be labeled CU Communications.

f) All MH’s and HH/PB’s will be equipped with a storm drain located at the bottom with positive drainage. Sump pumps shall not be used as an alternate.

g) A ground lug will be provided in all manholes and connected to a grounding rod at length and size that is compliant with code (NEC).

h) Pulling irons will be located on the opposite wall, and one (1) foot below the horizontal projection of the lowest duct, for each duct bank entering the manhole.

i) A maintenance hole is the preferred service device to be installed for Campus communications needs. A HH/PB is limited to future accommodations to growth and configurations. Splices are not allowed in HH/PB’s.

c. All cables entering a building must conform to the bonding and grounding requirements listed in the NEC, Articles 250, 770 and 800.

d. Warning tape containing metallic tracings must be placed a minimum of 12 inches above the underground conduit/duct structure and direct buried cable to minimize any chance of an accidental dig-up. The American Public Works Association has adopted the color orange for identifying the telecommunication cables and structures.

e. The minimum depth of a trench must allow 24 inches of cover from the top of the conduit/cable to final grade. All underground utilities must be located and marked prior to any excavation or trenching.

f. All OSP conduits shall be strung with a mule line rated at a minimum of 1,250 lbs.

6. Aerial Cable Requirements

a. An aerial cable system consists of cables installed on aerial supporting structures such as poles, sides of buildings, and other above ground structures.

b. Aerial cable projects shall include the following information:

1) Pole owner and designations.

2) Pole data, including pole class, length, heights of attachments, cross arms and pole steps.

3) Cable support strand sizes, down guys, anchors and lead-height ratios.

4) Span lengths, including appropriate information for slack span constructions, crossover, pull-offs, or any other special proposals.

5) Grounding and bonding instructions.

6) Cable counts, types and directions of feed.

7) Terminal counts and splicing details.
c. Aerial entrances must be limited to small buildings requiring 100 cable pairs or less for service provider connections.

d. The following steps must be taken to design an aerial plant:

1) Select permanent locations for pole lines while considering:
   a) Future road widening expansion of other utilities special problems such as road, railway, and power line crossings.
   b) Safety and convenience of workers and the public.

2) Coordinate with other utilities with respect to possible joint use and to minimize inductive interference.

3) The most economical span length must be used:
   a) The span from the last pole to the building must not exceed 100 ft.
   b) Slack span construction must be used.
   c) The suspension strand and cable must be placed on the roadside of the pole line.
   d) For minimum clearances of wires and cables over streets, sidewalks, agricultural areas, railroads, etc., see ANSI/TIA/EIA 758.

4) Aerial cables must enter a building through a conduit with an approved service head.

7. Cable Types

a. Two types of cable are recognized for outside use in the campus OSP segment, copper cable and fiber optic cable.

1) Outside Plant Copper Cable:
   a) 24 AWG category 3 balanced twisted pair cables are available in 50, 100, 200, 400, 600 and 900 pair counts and shall be used.
   b) Filled core, (waterproofing compound) cable must be used for underground and direct buried cable installations.
   c) Direct buried cable may require an armored sheath to resist rodent and penetration type damage.
   d) Cables must be marked with cable length, cable code, date and manufacturer.

2) Outside Plant Fiber Optic cable:
   a) Loose Tube cable must be used for underground and direct buried fiber optic cable installations. Water blocking materials preserves the integrity of the cable by providing physical protection against moisture penetration and seepage.
   b) Corning Cable Systems shall manufacture all OSP fiber optic cable and components used for University facilities. Consult with CIT/Infrastructure engineering for alternate hardware proposals.
8. **Maintenance Holes (MH) and Hand Holes/Pull Boxes (HH/PB).**

   a. MH’s or HH/PB’s are required where maximum cable reel lengths are exceeded, at the intersection of main and branch conduit runs, and at other locations where access to the cable in a conduit system is required.

   1) Pre-cast MH/HH/PB’s must be used whenever possible. Site-cast MH/HH/PB’s may be used when the size required exceeds pre-cast sizes, obstructions prohibit placing pre-cast MH/HH/PB’s must be rebuilt, or a custom design is required.

   2) The maximum distance between MH’s shall be <500 ft.

   3) MH’s will be sized based on the quantity of ducts to be installed and be located to optimize the use of the associated conduit routes.

   4) All conduits must be sealed in a MH/HH/PB system to prevent water entry.

   5) The strength of concrete used for MH’s must be at least 3,500 psi.

   6) All hardware in maintenance holes will be galvanized. Maintenance holes must be equipped with:

      a) Bonding and grounding attachments and Uni-struts for racking.

      b) Pulling eyes at least 7/8 inches in diameter and, at a minimum, should be located opposite of each conduit entrance point.

      c) A positive drain of at least 8 inches in diameter.

   7) Conduit entry points:

      a) Should be located at opposite ends of the MH/HH/PB and the conduit formations shall enter the walls at a point approximately halfway between the floor and the ceiling.

      b) For wall racking considerations, design splayed duct bank entrances at the end walls rather than center placement to ease in the racking of the cables and splices.

      c) Lateral conduits entering the side of MH/HH/PB’s should be avoided.

      d) If the total number of conduits being placed is significantly less than the capacity of the termination MH or cable entrance, conduit should enter at the lower level. The upper space should be reserved for future additions.

      e) Conduits installed between MH/HH/PB’s and Buildings, and between other MH/HH/PB’s will be sloped at .125 inch per ft to insure proper drainage of water.

      f) All conduits in buildings and MH/HH/PB’s shall be plugged (Waterplug Quick-Setting Hydraulic Cement) to prevent the entrance of water and gases.

   8) Cores into existing MH’s can only be done via shop drawings clearly identifying the methods and procedures to be used in the coring process. Personnel from CIT/Infrastructure should be on-site during the boring to ensure a safe entry into the MH.
9) The maximum distance allowed between buildings and MH/HH/PB’s and between MH/HH/PB’s is 400 ft.

10) No more than two 90° sweeps or bends will be allowed between buildings, MH/HH/PB’s, and MH/HH/PB to MH/HH/PB’s. 45° conduit angles are preferred.

b. Hand holes/Pull Boxes (HH/PB) must be placed at strategic locations in a conduit system to allow installers to pull cable through the conduit with minimum difficulty and to protect the cable from excess tension.

1) Conduit entry points must be at opposite ends of the HH/PB.

2) HH/PB’s shall be sized at a minimum of 24 in(l) x 18 in(w) x 18 in (d).

3) All HH/PB covers must be 36 inches in diameter and marked for easy identification (CU Communications).

4) All HH/PB covers will be secured with a minimum of two lugs per cover.

5) All HH/PB covers will be rated for the area in which they are installed (i.e., sidewalks, traffic lanes, etc).

6) HH/PB’s will not be used as a splice points.

9. Security

a. All MH/HH on campus shall be secured from intrusion. CIT/Infrastructure has a contract with McGard Security Products. These proprietary products have the following features:

1) Triple-nickel chrome plated lock to resist corrosion.

2) Alloy steel heat treated to 150,000 psi tensile strength.

3) Controlled access using McGard patented keys.

4) Easily retro-fitted to existing covers.

5) Standard 5/8" sizes fit all foundry product lines.

6) Non-corrosive protective caps.

10. Splicing Methods and Splice Closures

a. Copper Cable Splices:

1) Copper telephone cables will be spliced using a 3M 4000-D/TR Super Mini Splice Connector for underground, direct buried, aerial and building terminal splices.

2) All splices will be accomplished using the conductor fold-back method to ease future splicing and maintenance efforts.

3) All splice closures shall be labeled, to include serving locations, size and designator.

4) All splice closures shall be properly racked and lashed to the MH/HH/PB racks.

5) All splice closures shall be properly grounded to the MH/HH/PB grounding and bonding system.
6) All OSP copper slice closures shall be encapsulated to protect from water damage.

b. Fiber Optic Cable Splices

1) Should a field splices be required, both multimode and single mode OSP fiber cables will be spliced using an approved fusion splicing machine only. Mechanical splices will not be allowed for permanent splices. Heat shrink type fusion protectors with a strength member shall be used for all fusion splices.

2) The splice trays shall contain 12 inches of slack for each strand of fiber that is spliced. A minimum of 24 inches of slack shall be allocated for each buffer tube and the correct bend radius must be maintained.

3) A minimum of 30 ft of slack fiber optic cable will be provided in the MH/HH/PB. This slack is required to allow splicing activities to take place outside of the MH/HH/PB and in a controlled environment (e.g. splicing trailer/van). This slack shall be properly stored and lashed to the MH/HH/PB racks, and will not interfere with existing cables and splice closures.

4) All splice closures shall be properly racked and lashed to the MH/HH/PB racks.

5) All splice closures shall be properly grounded to the MH/HH/PB grounding system, when applicable.

11. Building Entrance Facilities

a. Outside Plant copper cables entering the EF/ER shall be terminated on wall-mounted building entrance protector terminal(s) equipped with solid state protector modules.

b. If point of entrance for the building is not within the ER, a continuous metallic conduit must be provided.

c. Protector terminals shall be mounted in a location on the backboard that will allow sufficient space for future cable and cross-connect installations.

d. Copper cables up to and including 100 pairs shall be terminated on protected terminals.

e. Copper cables over 100 pairs shall be terminated on individual 100 pair protected terminals equipped with a factory installed, 26AWG swivel cable stub on the In-side (field side), and 110 type terminations on the Out-side (equipment side). Cable stubs shall be no shorter than 2 ft in length after installation.

f. Factory cable stubs shall be spliced with 3M 4000-D/TR Super Mini Splice Connectors to the Outside Plant copper cable, using the fold-back splice method. An indoor rated splice closure and 3M 4000-D/TR Super Mini Splice Connectors shall be installed and securely mounted to the plywood backboard or existing cable ladder. Indoor closures will not be encapsulated.

g. Where the entrance conduits penetrate the foundation, footings or outside walls, rigid metallic conduit will be used. At the point of exit, a minimum of 2' ground covers at 5% grade shall be maintained. The following illustration depicts detail of the duct entry into a building.
12. Electrical Protection and Bonding/Grounding Requirements
   a. Any system installed on the Cornell University campus must conform to the *NEC ARTICLE 800* for primary electrical protection and bonding/grounding requirements. Also, buildings shall meet TIA/EIA-J-STD-037 *Commercial Building Grounding and Bonding Requirements for Telecommunications*.
   b. All underground, direct buried and aerial cables (copper and fiber) shall be properly grounded and bonded at each end, in each MH/HH/PB and on poles, where applicable.

13. Testing Requirements for OSP Campus Cables
   a. Copper and fiber optic OSP backbone cables shall meet the performance criteria in accordance with TIA/EIA 568-C.
   b. Fiber optic OSP backbone cables shall be tested in accordance with TIA-526.
   c. Copper cable binders will be tested individually with a VOM for loop continuity.
   d. Fiber optic link segments shall be tested in one direction at 850/1300 nm for multimode and 1310/1550 nm for single mode fibers.
   e. Single mode fiber shall be tested with an OTDR to obtain a graphic signature of the fiber link.
CHAPTER 6
EMERGENCY, INTER/INTRA BUILDING LIFE SAFETY AND FACILITY CIRCUITS

1. General
   a. These circuits require special attention and go beyond the normal phone and Ethernet connections.
      
      1) Emergency and inter/intra building circuits consist of the following and should be maintained
         and operational at all times due to their nature:
         a) Fire alarms
         b) Blue light phones
         c) Emergency phones
         d) Elevator phones
         e) Chilled water circuits
         f) Radio circuits
         g) Time clocks
         h) Building card access
         i) Vending/Laundry machines
         j) Cameras

      2) Refer to Chapter 2, Section 9 (Structures to Support the Horizontal Cabling) for specific
         pathway requirements.

2. Fire Alarms
   a. Fire alarm circuits are point-to-point circuits that originate from the main panel and utilize the campus
      backbone to the remote sites. The remote panel voltage can range from 18 to 48 volts depending on
      the panel. These circuits are single pair circuits that are wired directly to the remote panel.

   b. When installing conduit to a new fire alarm panel, conduit shall be installed from the nearest CIT
      Telecommunication Room directly to the fire alarm panel enclosure.

   c. The circuits are directly wired from the 110 block in the TR to the main building Fire Alarm panel.

3. Blue Lights Phones
   a. Blue light phones are ring down phones that are located throughout campus in case of emergency
      situations. Blue light phones are located outside of campus buildings and are attached to a metal pole
      with a blue light located top. Some blue light phones are positioned on the exterior side of a building,
      with a corresponding blue light above.

   b. Each blue light has a conduit for a dedicated power circuit and a separate conduit for the voice circuit.
      Conduit for the voice cabling shall terminate in the nearest building. A #14 AWG (min) ground wire
      shall be available for primary protection bonding.

   c. The blue light phone enclosure is a yellow metal box type enclosure and shall be installed to meet
      ADA specifications. Each blue light phone is assigned a PX number for location referencing.

      1) Blue Light phone enclosure is a Ramtech 926D part# 912OSHA Yellow.
2) Blue light phone is Ramtech R733 telephone part # R733.

d. All blue light phone installations must adhere to ADA specifications. (See Chapter 2, Section 4 for detail drawings and clearances.)

4. Emergency Phones

a. Emergency phones are designed to perform the same function as a Blue Light phone, but are located inside buildings.

b. These phones ring directly to the University Police Department.

c. Emergency phones are required in main entryways, public areas, auditoriums, athletic facilities and laboratories.

d. When the building is larger than 7,000 square feet, minimally, one emergency phone will be required on each floor.

e. EM phones will also be placed in areas where cellular telephone coverage is currently, or expected to be problematic.

f. These instruments will be located to meet ADA requirements for height and clearance.

h. Surface mount emergency phones shall be yellow in color for higher visibility and do not have a keypad for dialing purposes. The Viking E-1600-45 will be used.

i. Flush mount emergency phones will be the Viking E-1600-30A.

j. Signage will be required per the CUPD.

k. If lights are installed above the phones, they will be blue in color.

l. Deviations shall be at the direction of Risk Management, EH&S, University Police Dept and CIT.

5. Elevator Phones

a. Elevator phones are ring down phones that are located in the elevator car to be used for an emergency situation. Each elevator phone has a PX number assigned for location referencing. A voice circuit is delivered to the elevator control room and is then carried to the elevator car via the vertical elevator umbilical cabling. This retractable cable will be provided and maintained by the elevator manufacturer.

b. When installing conduit for an elevator phone circuit, the conduit shall be run from the nearest ER, TR or suitable raceway. This will serve as the demarcation point. Another conduit will be installed from the opposite side of the outlet box into the elevator control unit. This pathway will house the drop cord that will be installed by the elevator maintenance contractor.
c. All telephone instruments located in cabs are connected to an emergency reporting system. All passenger elevators must have a 10"(h) x 7"(w) x 3.25"(d) compartment when a CIT supplied phone is required. The elevator phones used are the Viking E10 Elevator Phone part # E10EHF.

d. There are instances where the elevator vendor supplies the voice instrument in the car. All new elevator phones will be supplied by the elevator vendor. CIT will deliver analog dial tone to the demarcation point.

6. Chilled Water Circuits

a. Chilled water circuits have traditionally been point-to-point circuits originating at Chilled Water Plants and terminating at the remote panel site. These circuits can be 2-wire or 4-wire circuits that are connected via campus copper backbone to individual buildings. There are also instances where these devices may connect to the University’s IP network via an Ethernet connection.

b. When installing conduit for a chill water circuit, the conduit shall be run from the nearest ER, TR or suitable raceway to a double gang box outside of the control cabinet. This will serve as the demarcation point. Another conduit will be installed from the opposite side of the outlet box into the chill water control unit. This pathway will house the drop cord that will be installed by the EMCS maintenance staff.

7. Radio Circuits

a. Radio Circuits are a point-to-point circuit utilizing a single pair of copper through the campus backbone. These circuits are polarity sensitive and originate from one building and can be bridged to several other locations. Radio circuits contain a local transmitter that is self-powered at 70v DC.

8. Time Clocks

a. These devices operate via an Ethernet connection.

b. When installing conduit for a time clock, the conduit shall be run from the nearest ER, TR or suitable raceway, to a double gang box outside of the time clock controller. This will serve as the demarcation point. Another conduit will be installed from the opposite side of the outlet box into the control unit. This pathway will house the drop cord that will be installed by the time clock maintenance staff.


a. Building card access units are located in the entryway of student dorms or other secured areas. These units are connected to the central card access panel in the building that uses Ethernet to communicate back to the reporting systems.

b. When installing conduit for a card access circuit, the conduit shall be run from the nearest ER, TR or suitable raceway, to a double gang box outside of the card access controller. This will serve as the demarcation point. Another conduit will be installed from the opposite side of the outlet box into the control unit. This pathway will house the drop cord that will be installed by the card access maintenance staff.

c. Card access installation is the responsibility of the vendor. CIT will provide an Ethernet circuit for off site monitoring.
10. Vending/Laundry Circuits

a. Vending and Laundry card swipes are have traditionally been single pair point-to-point circuits. These circuits utilize the campus backbone cabling back to a controller. These controllers are owned and maintained by Campus life. There are also instances where these devices may connect to the University’s IP network via an Ethernet connection.

11. Cameras

a. Digital cameras may take advantage of the University’s IP network. These devices will operate over the standard twisted pair copper cable plant.

b. These devices are typically maintained by the occupying department.

c. When installing conduit for a camera, the conduit shall be run from the nearest ER, TR or suitable raceway, to a double gang box next to the camera. This will serve as the demarcation point. Another conduit will be installed from the opposite side of the outlet box into the unit.
CHAPTER 7

WIRELESS NETWORK SYSTEMS

1. General
   a. This chapter provides general requirements that apply to the design and acceptance for wireless network systems.
   b. These systems include:
      1) Wi-Fi access points for network connectivity.
      2) Distributed Antenna Systems for enhanced cellular coverage.

2. Wi-Fi Access Point Design Process
   a. Determine the coverage area:
      1) Generally, the desired areas will be where users tend to assemble and use laptops or other handheld-networked devices. Examples include libraries, lounges, classrooms and public study areas. Provide markings on the associated facility floor plan to indicate the areas to be covered.
      2) An RF site survey should be executed to ensure adequate IEEE 802.11a/b/g/n coverage.
      3) Wall Wi-Fi access point locations are to be installed per specification of RF site survey indicated on drawing; a 4"x4"x 2 1/2" back box with single gang plaster ring finished flush to wall. Locations should be set such that a line of site can be established without obstruction to the computing devices that will utilize the Wi-Fi network. The standard installation height should be 90 inches above the floor and 9-12 inches from the ceiling, cornices or molding and 24" away from light and other fixtures if possible. Unless otherwise noted, connect with 1" conduit to nearest cable tray provide the current CAT standard cable. Terminate the cable at box with 6" - 8" tail without face plate and terminate at BDF/IDF in patch field.
      4) Ceiling Wi-Fi access point locations are to be installed per specification of RF site survey indicated on drawing keeping at least 24" away from light fixtures with a 4"x4"x2 1/2" back box finish flush to ceiling with double gang plaster ring. Unless otherwise noted, connect with 1" conduit to nearest cable tray provide the current CAT standard cable. Terminate the cable at box with 6" - 8" tail without face plate and terminate at BDF/IDF in patch field.
      5) Avoid close proximity to other electronics that emit strong signals, i.e. microwaves, TVs, monitors, satellite dishes, etc., also avoid elevator shafts and large pipe chases and other similar building components that will have the tendency to block the RF signal of the access point.
      6) Indicate location of jack in prints and cable records, including height of jack.
      7) The pathway for the Wi-Fi media should adhere to the specifications and support structures found in Chapter 2, Section 8 - Structures to Support the Horizontal Cabling.
      8) Installation and configuration of the electronics will be completed by CIT/Network Engineering.
3. Distributed Antenna Systems
   
   a. Cellular coverage in many buildings does not extend into the lower levels of the facility. DAS pathways and cabling shall be included in capital project designs.

   b. Each segment will utilize a combination of fiber optics and co-axial cabling.

   c. Consult with CIT/Infrastructure for a review and site specific design for each building.
CHAPTER 8

DRAWINGS & DELIVERABLES FOR UNIVERSITY ARCHIVING

1. Standards
   a. Drawings shall be created utilizing ANSI and Architectural sized drawings:
      1) ANSI A size on 8 1/2 inch by 11 inch paper.
      2) ANSI B size on 11 inch by 17 inch paper.
      3) Architectural C size on 18 inch by 24 inch paper.
      4) Architectural D size on 24 inch by 36 inch paper.
      5) Architectural E1 size on 30 inch by 42 inch paper.
   b. Drawing plots (hard copies) may be produced in all colors with the exception of yellow or any other light color that will not reproduce easily.
   c. Electronic drawing files shall be in AutoCAD 2004 (.dwg) format or later.
   d. Electronic drawing files shall use the U.S. National CAD Standard for layer names, colors, and line types for technology related material.
   e. Electronic drawing files may contain no fonts or line types which are not included in with the standard installation of Autodesk AutoCAD 2004 or later versions, with a Microsoft Windows XP professional operating system, or a Microsoft Windows Vista operating system software.
   f. All electronic drawing files given to Cornell shall be fully editable line drawings using the (.dwg) file format with all associated files necessary for proper reproduction.
   g. Flat image files are not acceptable (jpeg,tif).

2. Deliverables for Commissioning and Service Activations.
   a. Contractors shall supply the following to CIT/Infrastructure and the building IT coordinator after the cabling completion and two weeks prior to occupancy:
      1) Record drawings with as-built notations showing telecomm rooms (TR), major pathways, pullboxes and outlet designations.
      2) A cable schedule in MSWord format identifying TR room number, racks, patch panels and IT outlet designations.
      3) A copy of the AutoCAD and MSWord files listed above delivered on CD.
      4) Cable manufacturer’s warranty naming CIT/Infrastructure Engineering as the owner.