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<th>Title</th>
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- Appendix A – Network Switch Protocol Specifications
- Appendix B – Communication Room Layout
- Appendix C – Wall Mounted Wireless
- Appendix D – Suspended Ceiling Mounted Wireless
- Appendix E – Open Ceiling Mounted Wireless
- Appendix F – Outdoor Mounted Wireless
- Appendix G – Hard Lid Ceiling Mounted Wireless
- Appendix H – Main Building Ground
- Appendix I - Typical grounding and bounding scheme for a multistory building
- Appendix J: Touch screen design samples
1 Introduction

1.1 General intent
This document provides design specifications for voice, video and data communications infrastructure at Colorado State University (CSU), otherwise referred to as the University. The offices of Academic Computing and Networking Services (ACNS) along with the office of Telecommunications oversee data/voice/video infrastructure design, construction, installation, operation, maintenance, upgrades and monitoring for CSU sites.

While various construction challenges may dictate modifications to these specifications, any modifications require written approval by ACNS/Telecom.

Changes to these specifications, with or without written approval, may incur time and materials charges for any subsequent support of the facility and its installed data/voice/video infrastructure.

1.2 Teams Involved in Design Process
Several teams are responsible for the communications infrastructure and should be involved in the design process. These include 1) Telecommunications for the physical infrastructure, 2) Academic Computing and Networking Services (ACNS) for the network equipment and video and 3) Classroom Support Services for classrooms. Contacts for these teams are given below.

Table 1. Contacts

<table>
<thead>
<tr>
<th>Team</th>
<th>Name</th>
<th>Role</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ACNS/Telecommunications</strong></td>
<td>Jason Huitt</td>
<td>Interim Assoc. Dir.</td>
<td>(970) 491-2511</td>
</tr>
<tr>
<td><strong>Telecommunications Projects</strong></td>
<td>William Tremelling</td>
<td>Team Lead</td>
<td>(970) 491-3839</td>
</tr>
<tr>
<td><strong>Classroom Support Services</strong></td>
<td>Jamie McCue</td>
<td>Interim Team Lead</td>
<td>(970) 491-4147</td>
</tr>
<tr>
<td></td>
<td>Allen Sneesby</td>
<td>Classroom support</td>
<td>(970) 491-6038</td>
</tr>
</tbody>
</table>

The Telecommunications Projects Team Lead is to be involved in all phases of design and construction along with any time questions arise during the project.
1.3 Applicable Standards

This document provides interpretation of the standards referenced in the previous paragraph and provides additional detail, in some cases superseding those standards. Where Systimax guidelines differ from ANSI/TIA standards, the Systimax guidelines supersede the ANSI/TIA standard. Should the contractor require additional interpretation of these design guidelines, the contractor shall contact the designated University representative (Table 1).

Telecommunications physical infrastructure as defined by the American National Standards Institute/Telecommunications Industry Association, or ANSI/TIA, consists of six elements: 1. Horizontal Infrastructure; 2. building main telecommunications room or Main Distribution Frame (MDF); 3. backbone cabling; 4. Intermediate Distribution Frames (IDFs); 5. Entrance facility (EF); 6. Outside plant; 7. Networking equipment required to provide data/voice service for the building. Also included are basic specifications for the delivery of broadband television services via a hybrid single-mode fiber optic and coaxial cable system.

In general, the following standards at a minimum shall be observed for telecommunications infrastructure and are incorporated herein by reference:

- ANSI/TIA 568-2017 Commercial Building Telecommunications Cabling Standard
- ANSI/TIA 758-B-2012
- ANSI/TIA 569-2012 Commercial Building Standard for Telecommunications Pathways and Spaces
- ANSI/TIA 607-A-2014 Commercial Building Grounding and Bonding Requirements for Telecommunications
- NEC-2017
- BICSI DD 120-Grounding Fundamentals for TELCO Facilities Chapter 4 Telecommunications Systems Grounding (as reference)
- IEEE 802.3-2006
- Systimax Structured Cabling System (SCS) standards
This document provides interpretation of the standards referenced in the previous paragraph and provides additional detail, in some cases superseding those standards. Where Systimax guidelines differ from ANSI/TIA standards, the Systimax guidelines supersede the ANSI/TIA standard. Should the contractor require additional interpretation of these design guidelines, the contractor shall contact the designated University representative (Table 1).

Table 2. Standards Hierarchy

<table>
<thead>
<tr>
<th>System</th>
<th>Purpose</th>
<th>Substitutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSI/TIA/NEC/BICSI</td>
<td>Grounding, Bonding, and Fire-stopping</td>
<td>None</td>
</tr>
<tr>
<td>Corning</td>
<td>Fiber Optics Glass</td>
<td>None</td>
</tr>
<tr>
<td>Systimax Structured System (SCS)</td>
<td>Category 5e, 6a Copper Cabling</td>
<td>None</td>
</tr>
<tr>
<td>ANSI/TIA</td>
<td>Data</td>
<td>None</td>
</tr>
<tr>
<td>ANSI/TIA</td>
<td>Voice</td>
<td>Must be pre-approved in writing</td>
</tr>
</tbody>
</table>

1.4 General Guidelines

Integral to the telecommunications infrastructure in buildings are the secure communications rooms, consisting of the MDF and, generally, one or more IDFs. These rooms must be secure, environmentally conditioned and clean before Telecommunications can work in them, especially as fiber must be terminated in these rooms. Expensive and delicate networking devices, requiring environmental conditioning, also are housed in these rooms. The MDF and IDFs shall be completed including environmental conditioning early in the project timetable. All penetrations shall be completed and sealed (e.g., capped) before Telecommunications work can continue in these environments.

1.5 Equipment and Materials Specifications

Check with Telecommunications Contact, Table 1, to ensure use of the latest materials list.

Note that there are some materials for which no substitutions are allowed. Where substitutions are allowed, these must be pre-approved in writing in an addendum prior to the final design bid. Questions about substitutions of these materials should be referred to the University designated representative (Table 1 Contacts).
1.6 Contractor Certifications

CSU requires contractors to be a Systimax Solutions Premier or Select Installation Partner and listed on commscope.com. Approval of certification must be submitted to ACNS/Telecommunications. In addition, ACNS/Telecommunications requires that contractor provide Technicians and Installers certified by the Building Industry Consulting Service International, Inc. (BICSI) permanently assigned for the duration of the CSU project. ACNS/Telecommunications requires a minimum of one (1) BICSI certified technician and a ratio of one (1) BICSI certified installer to three (3) installation workers.

Please refer to Table 1 Contacts for the ACNS/Telecommunications contact person for questions regarding this section.

1.7 Exceptions

Any exceptions to these standards are to have documented approval by ACNS/Telecommunications or may incur additional charges to address any labor or material necessary to address the changes.
2 Horizontal Infrastructure

2.1 General Provisions
Systimax Structured Cabling System (SCS) Category 6a cable, connectors, and fixtures shall be used for horizontal data cabling. Data cable runs shall be strictly limited to 90 meters in total length, according to standards. IDFs are to be located as to maintain less than a total 90-meter cable run. All cabling is to run to same floor communication room.

Per Systimax cabling warranties no cabling is permitted to be painted, it is a violation to do so and subject to be replaced at contractor or project’s expense.

2.2 Cable Colors
The following is the color standard for all horizontal cable on campus. Cat 6A cabling is the standard in all new construction. Remodels use of Cat6A will be evaluated on a case-by-case basis. Exceptions to this as granted only by the Vice President of Information Technology.

<table>
<thead>
<tr>
<th>Category</th>
<th>Color 1</th>
<th>Color 2</th>
<th>Color 3</th>
<th>Color 4</th>
<th>Color 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat. 5e</td>
<td>Orange</td>
<td>Gray</td>
<td>White</td>
<td>Yellow</td>
<td>White</td>
</tr>
<tr>
<td>Cat. 5e</td>
<td>Orange</td>
<td>Orange</td>
<td>Red</td>
<td>Red</td>
<td>Blue</td>
</tr>
<tr>
<td>Cat. 6</td>
<td>Orange</td>
<td>Orange</td>
<td>Red</td>
<td>Red</td>
<td>Blue</td>
</tr>
<tr>
<td>Cat. 6a</td>
<td>Orange</td>
<td>Orange</td>
<td>Red</td>
<td>Red</td>
<td>Blue</td>
</tr>
</tbody>
</table>
| Cat. 3 (no longer being installed) data jacks are Ivory

2.3 Plenum Spaces
Plenum cabling or conduit shall be used in plenum spaces, this includes under floor space. Contractor shall determine prior to work being started, in consultation with CSU Telecommunications and CSU Facilities, whether the space is a plenum space.
2.4 Underground Cable
All cable placed in raceways installed underground shall be rated for wet locations.

2.5 Patch Cords
The following is the standard color code for patch cords
- Data - Red/Gray
- VoIP - White
- Security Cameras, Card Key, Meters, EMS, Facilities - Green
- Wireless - Yellow
- A/V - Violet
- Switch to Switch Link - Orange
- Department Specific - Light Blue
Patch cords must be of proper length to eliminate “Jump Rope” and “Banjo” style of patching.

2.6 Asbestos
Buildings to be wired shall be inspected by CSU Environmental Health Services for Asbestos Containing Material (ACM). Where ACM exists, the University will decide whether to abate the asbestos or circumvent the asbestos by, for example, installing telecommunications infrastructure under the ceiling tiles.
2.7 Conduit


All conduit shall be in a minimum of 1" EMT unless noted otherwise by ACNS/Telecommunications.

Conduit capacity shall be as follows: For a 1" conduit a maximum quantity of 3 Cat6a cables with a single-gang "p" ring. Quantities greater than this will require a double-gang "p" ring and an additional 1" or upsizing to 1.25" conduit stubbed to cable tray with a maximum of 6 cables per location.

All conduits are to be routed continuously to nearest cable tray or MDF/IDF if no cable tray is present.

When utilizing multiple 2" conduit runs, no more than 5 (five) 1" conduits shall be run to a common 18”x18” j-box. More than 5 (five) 1" conduits will require an additional 2" conduit “homerun” feed.

<table>
<thead>
<tr>
<th>Number of Cables</th>
<th>Percentage Fill</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>53%</td>
</tr>
<tr>
<td>2</td>
<td>31%</td>
</tr>
<tr>
<td>&gt;2</td>
<td>40%</td>
</tr>
</tbody>
</table>
2.8 Installation of Cable Trays

Install cable trays with space to permit access for installing the cables. Clear space shall be provided above the top rail equal to the loading depth but not less than 12 inches. Provide lateral clearance of 24 inches on at least 1 side of the trapeze hung tray. CSU prefers aluminum ladder type cable tray with 9” spacing on rungs. All cable trays must be trapeze hung. The use of wire baskets is discouraged. If wire baskets are to be used, please contact the ACNS/Telecommunications Contact, Table 1, to discuss installation requirements.

In the event of an unforeseen obstacle requiring the cable tray to be transitioned from tray to conduit, the conduit shall be equal to or greater than the square inches of tray being replaced.

Every effort should be made to minimize changes in elevation or direction in the cable tray. If it becomes necessary to do so, those changes shall be accomplished by using factory manufactured and approved “UL” listed connections for bonding purposes.

All components within the cable tray system shall meet grounding and bonding requirements.

Cables shall be pulled with no more than a 25-pound pull force applied at any time during installation.

Cable trays are to be installed early enough in the process to minimize disruption to the trays during subsequent construction.

2.9 Testing and Reporting of Test Results

All cable installed shall be tested using a calibrated Fluke Series DSX-5000 Tester or higher version in accordance with the latest EIA/TIA 568 standards, and the results recorded on a separate USB stick for each building and provided to ACNS/Telecommunications.

The ACNS/Telecommunications contact from Table 1 shall be notified prior to any testing so that the representative or designate may be present during the testing. If the circuit testing is conducted in the absence of the University representative or designate, then the University may request a retest with the University representative present at the tester’s expense.
2.10 Systimax Certification
CSU requires that upon completion and testing of each building/project, Systimax certification be obtained. The Telecommunications contact person is responsible for coordinating the Systimax certification and facilitating any remedies. Please refer to Table 1 – Contacts for the name of the ACNS/Telecommunications contact.

2.11 As-Builds
Upon completion of termination and testing, as-build drawings of all drops shall be provided within four weeks for each major phase of work; such as 1) floors, 2) wings, or 3) entire buildings. The as-build drawings shall be provided in AutoCAD version 2013 or higher format. These files are to be on a separate USB stick for each building.

2.12 Drop (Circuit) Labeling
Each drop installed shall be labeled per CSU labeling scheme. Each drop shall be labeled on the front of the jack faceplate, on the patch panel in the IDF or MDF, and on both ends of the cable.

2.13 Labels
Four labels per fiber cable, two for the cable and two for the fiber patch panel, shall be prepared for all fiber cables. The University may elect to install the labels.

2.14 Invasive Work
Invasive work (e.g., core drilling, hammer drilling or work that is noisy, dusty, etc.) shall be conducted during off-business hours. Other work shall be coordinated with the University designated representative (e.g., to pull cables during off-hours), and these arrangements shall be determined by mutual agreement.
2.15 Scheduling for the Pulling of Cable
ACNS/Telecommunications crews will pull low voltage cable inside the building, terminate it at the specified wall jacks, test and certify the cable. To do this work, the contractor will need to coordinate with ACNS/Telecommunications (see Table 1 "Contacts") to ensure cable work is scheduled and complete prior to the installation of the ceiling grid. This will allow easy access to the cable trays and ensure that ACNS/Telecommunications crews do not damage the ceiling grid. If the ceiling grid is installed prior to cabling work, ACNS/Telecommunications will not be responsible for any damage to the grid and will begin using contingency funds to pay for the extra labor expense.
3 Communication Rooms

3.1 General Provisions

ACNS/Telecommunications room space, MDF and IDFs shall be dedicated to the telecommunications function and related support facilities. Equipment not related to the support of the ACNS/Telecommunications functions shall not be installed, passed through, or entered in the telecommunications rooms without review by ACNS/Telecommunications and consideration in the sizing of the space, environmental requirements, etc. Such equipment should be installed in the EF.

In rare cases where the project manager and ACNS/Telecommunications agree to host equipment from a non-CSU entity and that entity desires unsupervised access to the communication room, the project must provide for: 1) Cardkey access on the communication room door; 2) locking cabinets for CSU equipment; 3) Any other security arrangement deemed necessary by ACNS/Telecom.

ACNS/Telecommunications CANNOT install equipment in communications rooms prior to the completion of the following items; (a) permanent dedicated power, (b) proper grounding and lighting, and (c) secure permanent door and two keys provided to the Telecommunications Contact. ACNS/Telecommunications REQUIRES a minimum of three (3) weeks from the completion of the aforementioned items until the service data for the following services; (a) elevator telephones, (b) fire alarm(s), (c) door security, (d) environmental controls, and (e) voice, data and/or video services.

ACNS/Telecommunications strongly recommend that early in the design phase all parties desiring to install equipment in the MDF and/or IDFs be collectively engaged to discuss placement of equipment and determine size requirements for the communications rooms including any servers or equipment to be mounted in the rooms. Signatures and permission must be obtained in advance for any non ACNS/Telecommunications/Facilities operated equipment to be mounted in the communication rooms ("ACNS/Telecommunications Communications Room Installation Agreement"). Forms are available via ACNS/Telecommunications contact listed in Table 1.
3.2 **Main Distribution Frame (MDF)**

ACNS/Telecommunications shall provide customized communication room designs based on the requirements of each project. Please contact the Telecommunications Contact Table 1 page 3.

*The following are general guidelines in the absence of a custom communications room design.*

Buildings shall have an MDF where voice, video and data enter the building. The MDF also serves as the distribution point for voice, video and data and shall be secure to protect the integrity of these systems, particularly E911 services.

Grounding and bonding shall be provided in the MDF that includes bonding to equipment racks, cable trays and telecommunications conduits in strict accordance with the ANSI/TIA 607 standard, the most current edition NEC, and as a reference BICSI DD 120-Grounding Fundamentals for TELCO Facilities, Chapter 4 Telecommunications System Grounding and extended to all IDF as described therein. All penetrations of the MDF envelope shall be fire-stopped.

In buildings of size 5,000 square feet or greater, a secure room dedicated to telecommunications, shall be provided for the MDF. In smaller buildings, a secure wall-mounted Hoffman box may be an option in lieu of a separate, dedicated room.

ANSI/TIA 569 shall be strictly observed for the MDF, especially as to location (away from electromagnetic interference), perimeters (no false ceilings), limited access (i.e., security), HVAC, lighting and electrical.

**MDF Power Requirements:**

MDF shall be provided with four dedicated and one general use circuits.
Two 20 amp, 120 volts NEMA 5-20 terminated on double duplex outlets, and two 30 amp, 208 volts NEMA L6-30 outlet on the wall adjacent to the telecommunications racks. The general use outlet shall be near the door for ease of access – these locations shall be determined in consultation with ACNS/Telecommunications.

Provisioning of power and receptacles for non-ACNS/Telecommunications equipment requiring power installed in the MDF or IDF's is the responsibility and at the expense of the entity responsible for the equipment. No extension cords are acceptable whether they be loose on the floor or tied to the infrastructure.

No piping (sewer, water or other fluid), ductwork, mechanical equipment, or power cabling or similar shall be allowed to pass through a MDF that is not associated with the communications services in that specific MDF. Switched lighting of 50-foot candles shall not be sourced from the same circuit as the telecommunications equipment.

MDFs (entrance facilities) shall be environmentally conditioned to accommodate network equipment loads up to 10,000 BTU/hr. Temperature in MDFs (entrance facilities) shall not exceed 80°F.

The MDF shall have 3/4" A/C fire treated plywood backboards to be installed on all walls, 8' high starting 3.5" from floor and painted with matte white paint. All fire-rated labels must be masked off prior to painting and left clearly visible.

The MDF serves as the fiber distribution point for the building and houses the network switches.

In a multi-story building, there should a phone room on each floor, centrally located. CSU requires that the MDF be located on the ground floor. All data cable runs are to be limited to 90 meters in length.
The MDF shall be large enough to accommodate at least two 7’x19” relay racks and 3 - 12” vertical organizers; one rack for the building fiber and copper distribution and the other for the building data switches and associated UPS. The MDF shall also accommodate the voice and video distribution systems which may be wall or rack mounted.

All raceways into the MDF envelope shall be a fire barrier pathway.

Table 5. MDF Sizes

<table>
<thead>
<tr>
<th>Building Size (ASF)</th>
<th>MDF Size (Length x width - ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5,000</td>
<td>Hoffman Box</td>
</tr>
<tr>
<td>5,000 to 10,000</td>
<td>10x8</td>
</tr>
<tr>
<td>10,000 to 50,000</td>
<td>10x12</td>
</tr>
<tr>
<td>50,000 to 100,000</td>
<td>12x12</td>
</tr>
<tr>
<td>100,000 to 150,000</td>
<td>14x14</td>
</tr>
<tr>
<td>150,000 to 200,000</td>
<td>14x16</td>
</tr>
</tbody>
</table>

Doors shall open outward and adhere to all fire codes. It may be necessary to install double opening doors for this purpose. Self-closing locksets shall be used to ensure doors are secure upon their closure.
3.3 Intermediate Distribution Frame (IDF)

ACNS/Telecommunications shall provide customized communication room designs based on the requirements of each project. Please contact the ACNS/Telecommunications Contact Table 1.

*The following are general guidelines in the absence of a custom communications room design.*

Grounding and bonding shall be provided in the IDF that includes bonding to equipment racks, cable trays and telecommunications conduits in strict accordance with ANSI/TIA J-STD-607-A-2002 standard, the most current edition NEC, and as a reference BICSI DD 120-Grounding Fundamentals for TELCO Facilities, Chapter 4 Telecommunications System Grounding and extended to all IDF as described therein. All penetrations of the IDF envelope shall be fire-stopped.

ANSI/TIA 569 shall be strictly observed for the IDF, especially as to location (away from electromagnetic interference), perimeters (no false ceilings), limited access (i.e., security), HVAC, lighting and electrical.

IDF Power Requirements:

IDF shall be provided with four dedicated and one general use circuits.

![5-20R](image)

Two 20 amp, 120 volts NEMA 5-20 terminated on double duplex outlets

![L6-30R](image)

and two 30 amp, 208 volts NEMA L6-30 outlet on the wall adjacent to the telecommunications racks. The general use outlet shall be near the door for ease of access – these locations shall be determined in consultation with CSU ACNS/Telecommunications.
Provisioning of power and receptacles for non-Telecommunications/ACNS equipment requiring power installed in the MDF or IDFs is the responsibility and at the expense of the entity responsible for the equipment. No extension cords are acceptable either “loose” on the floor or tied to the infrastructure.

No piping, ductwork, mechanical equipment, or power cabling or similar shall be allowed to pass through an IDF that is not associated with the communications services in that specific IDF. IDFs shall be supplied with 50 foot-candle of switched lighting, which shall not be sourced from the same circuit as the telecommunications equipment.

Each floor shall have a dedicated IDF. IDFs shall be environmentally conditioned to accommodate network equipment loads up to 7,000 BTU/hr. Temperature in IDFs shall not exceed 80°F.

The IDF shall have 3/4" A/C fire treated plywood backboards to be installed on all walls in the IDF, 8' high starting 3.5" from floor and painted with matte white paint. All fire-rated labels must be masked off prior to painting and left clearly visible.

IDFs shall be located at points that minimize the runs of the data network to the end user, typically in the center of wings of buildings. Data cable runs are to be limited to 90 meters, and this may affect placement of the IDF or require additional IDFs (telecommunications rooms) to be added.

IDFs shall be sized such that there is ample room to install racks to house the equipment. The IDF shall be sized to accommodate a minimum of two vertical 7"x19" relay racks and 3 - 12" vertical organizers: one for the fiber, an IDF switch, and UPS; and another for edge network switches. Ideally, there shall be 48" of space on each side of the rack lineup. Preferably, the MDF and IDFs shall be vertically stacked within the building.

IDFs shall be sized to accommodate all connections that may potentially be used from that room. In a typical scenario, an IDF would serve an area of approximately 10,000-15,000 Assignable Square Feet (ASF), depending on density of connections deployed from the IDF.
Table 6. IDF Specifications

<table>
<thead>
<tr>
<th>Serving Area</th>
<th>Number of Jacks</th>
<th>Room Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,000 sq. ft.</td>
<td>361-480</td>
<td>10x12</td>
</tr>
<tr>
<td>8000 sq. ft.</td>
<td>241-360</td>
<td>10x10</td>
</tr>
<tr>
<td>5000 sq. ft.</td>
<td>0-240</td>
<td>10x8</td>
</tr>
</tbody>
</table>

ANSI/TIA 569-B 7.11.5.1.1

Additional rooms, one for each area up to 10,000 square feet or the horizontal distance to the work area exceeds 250 feet, shall be required.

Doors shall open outward, adhere to all fire codes, and secured with self-locking locksets. It may be necessary to install double opening doors for this purpose.

The communications rooms shall not be located below water level unless preventive measures against water infiltration are employed. The communications rooms shall be free of water or drain pipes not directly required in support of the equipment within the communications rooms. A floor drain shall be provided within the room if risk of water ingress exists.

3.4 Offices

Except for minimum numbers of jacks, the following are suggested configurations. In all cases, the final numbers of jacks should be determined in consultation with CSU Telecommunications and the building occupants.

In every office, there shall be a minimum of two data locations, located on opposite walls, each location will have at least two data jacks.

Where conduit is used, 1” conduit with a 4 11/16” square box 2 1/8” deep shall be placed to each communications outlet.
3.5 Grounding and Bonding

In general, all grounding and bonding to adhere to current BiCSI Telecommunications Distribution Methods Manual.

The telecommunications bonding backbone (TBB) shall be a copper conductor. The minimum TBB conductor size shall be a No. 6 AWG. The TBB should be sized at 2 kcmil per linear foot of conductor length up to a maximum size of 3/0 AWG. The TBB may be insulated. If the TBB is insulated, the insulation shall meet the fire ratings of its pathway. The sizing of the TBB is not intended to account for the reduction or control of electromagnetic interface. (See appendices H and I.)

Table 7. TBB Sizing

<table>
<thead>
<tr>
<th>TBB length linear ft.</th>
<th>TBB Size (AWG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less 13</td>
<td>6</td>
</tr>
<tr>
<td>14 – 20</td>
<td>4</td>
</tr>
<tr>
<td>21 – 26</td>
<td>3</td>
</tr>
<tr>
<td>27 – 33</td>
<td>2</td>
</tr>
<tr>
<td>34 – 41</td>
<td>1</td>
</tr>
<tr>
<td>42 – 52</td>
<td>1/0</td>
</tr>
<tr>
<td>53 – 66</td>
<td>2/0</td>
</tr>
<tr>
<td>&gt; 66</td>
<td>3/0</td>
</tr>
</tbody>
</table>

ANSI/TIA J-STD-607-A 5.4.4.1

All equipment shall be bonded to each rack's supplied bus bar in addition to not utilizing the power cord as the specified ground.

Lightning/Surge protection is required for all OSP cabling entering CSU facilities.
4 Riser/Building Backbone Infrastructure

The building backbone consists of fiber optic cable to support data, voice and video applications as well as copper cabling to facilitate any required analog services.

The infrastructure for the building backbone cabling shall consist of conduit between the MDF and each IDF where the run is vertical, or ladder racks (not hooks or rings) where the run is horizontal. Where conduits are run, separate conduits shall be used for copper cables and fiber cables. However, where runs are horizontal and ladder racks are used, both types of cables shall be run in a ladder rack.

EIA/TIA 569 shall be observed for the building backbone pathways. Conduits shall be sized to be no more than 40% full by volume. Long-radius metal sweeps shall be used instead of 90° fittings. No more than 180 degrees of bends between pull points shall exist in conduits without inclusion of a readily accessible and adequately sized pull box, the location of which shall be clearly marked on drawings. In situations where cable tray, conduit, or sleeves extend outside the MDF/IDF into occupied portions of the building, they shall be fire-stopped.

Both single-mode and 50-micron OM4 multimode fiber cable shall be run between the MDF and each IDF in a star configuration. At minimum, there shall be no less than 12 single-mode and 12 multimode fibers installed. A higher fiber optic pair count shall be permissible in consultation with ACNS/Telecommunications. Fiber cables shall be run in conduit or in innerduct if cable tray distribution method is selected. The fiber count depends on the number of data jacks in each IDF. One pair of multimode fibers is required for every 48 active data jacks with a 30% allowance for growth. Each number shall be rounded up to the next integer. Table 8 below illustrates fiber counts for a variety of situations:

<table>
<thead>
<tr>
<th>Number of active data jacks</th>
<th>Base fiber count</th>
<th>30% allowance</th>
<th>Total fiber count</th>
</tr>
</thead>
<tbody>
<tr>
<td>96</td>
<td>2 pair</td>
<td>1 pair</td>
<td>3 pair</td>
</tr>
<tr>
<td>144</td>
<td>3 pair</td>
<td>1 pair</td>
<td>4 pair</td>
</tr>
<tr>
<td>240</td>
<td>5 pair</td>
<td>2 pair</td>
<td>7 pair</td>
</tr>
<tr>
<td>336</td>
<td>7 pair</td>
<td>3 pair</td>
<td>10 pair</td>
</tr>
</tbody>
</table>
Note that fiber bundles are available only in certain numbers of pairs. As an example, consider the example where bundles with 12 fibers (6 pairs) are used. For the second example above, 144 active jacks, one 12-count (6-pair) cable would be required. For the last example above, 336 active jacks, two 12-count cables would be required. On a typical installation of a composite 12 single mode and 12 OM4 multi-mode fibers installed between the MDF and IDF a minimum of two single mode fibers shall have factory terminated Angle Polished Connectors (APC) to accommodate video transfer.

Single-mode fiber shall be pre-tested with an Optical Time Domain Reflectometer (OTDR) at 1310 nm & 1550 nm, upon cable delivery.

Multimode fiber shall be tested post installation at 850 nm and 1300 nm.

A bidirectional end-to-end test shall be conducted at dual wavelength for each fiber installed.

Prior to acceptance by the University, the OTDR and end-to-end test shall be randomly sampled and retested by the University.

Test results shall be electronically documented and submitted to the ACNS/Telecommunications contact from Table 1 on a USB stick.

Cable ladder racks shall be hung in a manner that ensures a minimum of 12" vertical clearance and 18" horizontal clearance on at least one side to allow for access to the ladder rack for cable installation and maintenance. Mount cable ladder racks 7’ 6” AFF (above the finished floor) to be accessible by cable handlers using standard 6-foot ladders. Transitions where changes in height are unavoidable shall be gradually sloping. The cable ladder rack shall be routed so as not to interfere with installation of other systems or access to those systems for maintenance. Coordination with other systems shall be maintained so that where these systems traverse above or below the ladder rack, access shall not be blocked or interfered with. Cable ladder racks shall not pass through firewalls. Instead, the ladder rack shall stop on either side of the firewall and be interconnected via multiple fire barrier pathways passing through the firewall. The bottom of these pass-through devices shall be aligned with the top of the cable ladder to ensure proper cable support and unrestricted passage. These pass-through conduits shall be no more than 40% full.
5 Building Entrance Infrastructure

5.1 General Provisions

At the University, telecommunications typically enter the building into the Main Distribution Frame or MDF. Thus, generally at the University, the Building Entrance and the MDF are one and the same. In certain venues, ACNS/Telecommunications may require the addition of an Entrance Facility to accommodate an interface between non-CSU service providers.

Buildings are required to have physically diverse paths to the campus fiber infrastructure from the MDF.

EIA/TIA 569 shall be observed for the building entrance. Underground conduits entering a building shall be dedicated for the exclusive use of ACNS/Telecommunications and no more than 25% full by volume.

ANSI/TIA 758-B section 4.3 shall be observed in providing diverse entrance points and routes.

ACNS/Telecommunications may request removal of unauthorized cable(s) within ACNS'/Telecommunication's entrance conduits. Copper and fiber cables shall be brought into the building in separate conduit systems. There shall be no more than a total of 180 degrees of bends between pull points, using only large radius PVC coated GRC or fiberglass sweeps, shall be used in conduit runs between pulling points.

5.2 University Policy Governing Entrance Infrastructure

ACNS/Telecommunications must be contacted, refer to Table 1 – Contacts, during the early planning stages for new constructions or remodels that will require new or modification of entrance infrastructure.
6 Outside Plant Infrastructure

6.1 Introduction and Project Conditions

The following specifications govern services contracted by Colorado State University (CSU). Contractors shall fully adhere to these specifications, unless the University designated representative authorizes a waiver or modification in writing.

The contractor shall be responsible for conducting all potholing and/or locates of all utilities along the prescribed route. The contractor is responsible for contacting UNCC at 811. In addition, it is the contractor’s responsibility to ensure that all utilities are located including CSU’s utilities. Facilities Management telephone number is 970-491-0077.

Locate and protect existing utilities and other underground work in a manner that will insure that no damage or service interruption will result from excavating and backfilling.

When applicable, the contractor shall be responsible for acquiring all relevant permits for street, alleys, easements, utility corridors, etc. from the City of Fort Collins.

When utilities are damaged, the contractor shall immediately contact CSU Telecommunications (970-491-5881) and CSU Facilities Management (970-491-0077).

The contractor agrees to remedy all defects identified by CSU during the final inspection of the contractor’s work. The scheduling of the remedies shall be approved by CSU. The contractor shall be responsible for obtaining a final work acceptance signature, from the University designated representative, on a mutually agreed upon “punch list” to indicate acceptance of the contractor’s work by CSU.

The contractor is responsible for adhering to all applicable industry and personal safety standards, including, but not limited to OSHA standards.

The contractor shall be responsible for providing an as-build drawing. Please refer to As-Builds section in Chapter 2 for details. However, for outside plant infrastructure projects, the contractor in addition shall illustrate route(s), depth and benchmark measurements from existing landmarks and fixtures.
The contractor shall report on the progress of the work to the ACNS/Telecommunications contact from Table 1 on a mutually agreed-upon schedule.

6.2 Landscaping, Irrigation Systems, Site Protection and Excavation
Contact CSU Facilities Management at 970-491-0077 for all requirements.

6.3 Directional Boring Specifications
Materials - Installed two-inch (2") inner duct, quantity to be determined. The inner duct shall have a No. 12 UF type tracer wire installed outside the duct along the entire path of the duct. The ACNS/Telecommunications contact from Table 1 shall approve any deviation.

Conduit shall only have new 1800 lb. Sequential Mule Tape, supplied and installed by the contractor, in each duct without knots and splices. The mule tape shall be exposed at least six feet (6’) for aiding in tying on to cable. Polyrope shall not be accepted within the duct.

Installation - The inner duct shall be installed a minimum of forty-eight inches (48") in depth. The inner duct shall have a gradual 2" sweep into the J-box or a location marked by CSU prior to start of work (e.g., manhole). The inner ducts shall have duct plugs installed and secured around cable to prevent any debris from entering the conduit. All vacant inner ducts shall have a duct plug installed and secured.

Building Entrance Only: Inner ducts exposed on the exterior of a building shall have installed GRC fittings to National Electrical Code (NEC) specifications attached for building entry conduit and approved by CSU. Plenum and non-plenum areas may require additional consideration.

Splices, where applicable, shall be dug to the depth of the bore and be in a straight line with the two (2) adjoining bores.

Manholes - shall be pumped and cleaned before and after work is completed. The manhole shall have sufficient racking drilled and mounted for cable attachment and service coil support. CSU shall be consulted for determination of service coil length and racking requirements. Inner duct entering through the manhole or concrete foundations shall be core drilled and have link seals installed.

Traffic Control - The contractor shall be responsible for providing traffic control commensurate with the requirements of the work it is conducting, and adheres to all municipal, State, and Federal guidelines and standards.
6.4 Trenching

**Materials** - The contractor shall coordinate with the ACNS/Telecommunications contact from Table 1 and they shall specify and approve the vault(s) for each project.

The contractor shall install a four-inch (4") Yellow Caution Tape labeled “Caution” twelve inches (12") from the bottom of the trench.

Conduit duct shall have a No. 12 UF type tracer wire installed outside the conduit. The ACNS/Telecommunications contact shall approve any deviation.

Conduit shall have only new 1800 lb. Sequential Mule Tape, supplied and installed by the contractor, in each duct without knots and splices. The mule tape shall be exposed at least six feet (6’) for aiding in tying on to cable. Polyrope shall not be accepted within the duct.

**Installation of Conduit and Vault** - All conduits shall be installed a minimum of 48” in depth. When PVC conduit is placed in a trench, PVC coated GRC or fiberglass large radius sweeps shall be used.

Contractor shall ensure that the integrity of the vault is retained throughout its installation. To the extent necessary, the contractor shall internally brace the vault to ensure its integrity throughout installation and soil compaction.

Each newly installed or reinstalled vault shall be excavated 2’ deeper in order to accommodate for 2’ 1” minimum aggregate of rock to bring the vault to grade and maintain adequate drainage.

Each newly installed or reinstalled vault shall have a 3M 1401 – XR 4” Ball Marker installed inside the vault.

Vaults shall NOT be drilled or penetrated without prior approval.

Vaults shall be sized to neatly accommodate copper and/or fiber optic cables and service coils.

Conduits shall gradually sweep in below the bottom of the fiberglass vaults.

Ducts shall have duct plugs installed and secured around cable to prevent any debris from entering the conduit.

6.5 Steam Tunnel Cable Installation

Contact CSU Facilities Management at 970-491-0077 prior to commencing any work in the University steam tunnels.
7  Network Switches

7.1  General Provisions
Buildings shall be supplied with a building data switch and sufficient edge switches to provide network access to current users. ACNS/Telecommunications shall be responsible for specifying the specific brand and model for network equipment. Using this standard equipment will ensure that the network equipment is compatible with campus backbone network equipment. This is the only way to ensure that performance, advanced features such as Quality of Service (QoS), multicast, security, and manageability, will exist and interoperate with campus networking infrastructure. All switches and related network equipment must adhere to CSU’s Network Operations Policy http://policylibrary.colostate.edu/policy.aspx?id=718

7.2  General Switch Standards:
• If more than two 1U switches are required to provide sufficient connectivity, a chassis-based switch shall be used in place of 3 or more 1U switches.
• All switches are to provide 10G uplinks capability.
• All switches are to provide 1G connections on all edge ports.
• All switches are always to provide PoE+ on all ports.
• In general, a 70% activation rate is to be assumed, that is a 30% allowance shall be made for ports that are not initially activated.
• Switches shall meet all operational standards as listed in Appendix A.
• Switches housed in outdoor locations shall be enclosed in a Hoffman box with environmental controls of heating and cooling.
• Temperatures are not to exceed 80 degrees F nor go below 32 degrees F.
• All switches to be mounted in MDF/IDFs or secured Hoffman type boxes. Switches are not to be installed on desktops, in rooms, labs or other non-communication rooms. Switches installed outside of formal communication rooms are supported on a time and materials basis.
• Network devices not spec’d, configured, installed and monitored by ACNS/Telecom and connected to the campus network must be approved in writing and are supported on a time and materials basis.
7.3 MDF Switches Additional Standards:

- The primary MDF switch is to connect to the campus core with two 10G connections on disparate routes out of the building.
- The primary MDF switch is to have redundant power supplies.
- MDF switches with multiple power supplies are to be able to provide power on all ports at PoE+ levels even if one power supply fails.
- Primary MDF chassis-based switches are to have the first two modules reserved for central services and uplinks. User data jacks are not to be terminated out of these ports.
8 Wireless Access Points and Devices

8.1 General Provisions

- "Wireless access points" are defined as any device adhering to the IEEE 802.11 WiFi specifications for network access.
- "Wireless devices" are all other devices operating in the same spectrums as the IEEE 802.11 WiFi specifications, i.e.: 2.4Ghz, 5GHz
- All new construction and remodels should receive input from ACNS/Telecommunications regarding how the project will affect current wireless signals.
- All new construction and remodels should receive input from ACNS/Telecommunications regarding any necessary adds/moves/deletes from existing wireless infrastructure.
- Two cat6a cables shall be provided to every access point location.
- PoE+ will be provided over each of the cat6a cables to wireless access points.
- ACNS/Telecommunications will specify the type, count and location of all access points.
- No additional access points or devices acting as an access point can be connected to the campus network per campus IT Security Policy.
- ACNS/Telecommunications must approve the use of any wireless device that will connect into the data network. This is to ensure proper balance of devices within the available spectrums.
- ACNS/Telecommunications will specify locations on DD prints for locations of access points. It is the contractor’s responsibility to ensure that these access points are placed within a 1’ diameter of the specified location. If the access points are not placed as specified, it is the contractor’s responsibility to move and pay for putting the access point in the position specified.
- Wireless access points cannot be installed prior to building completion as drywall dust blocks the heat exhaust fans causing them to overheat.
- In order to properly quote the cost for wireless access point, ACNS/Telecommunication need to know:
  - The Room Size
  - The Ceiling Height
  - Description of room usage, e.g.: classroom, conference room, lab space, maximum occupant count
8.2 Wall Mounted Wireless:
- Provide a recessed 4-11/16 deep electrical box with a 2-gang plaster ring
- Mount box with ring flush to finished surface
- Mount wireless box minimum 7’ to maximum 12’ above finished floor
- Mount wireless box no less than 1’ from center of box to ceiling, adjacent walls, ducts, plenums or other permanent obstructions
- Mount box vertical (plaster ring mounting holes top to bottom)
- See Appendix C

8.3 Suspended Ceiling Mounted Wireless:
- Provide a 4-11/16 deep electrical box above ceiling tile with a cover plate
- Insure minimum 1’ clearance from center of box to any obstructions
- If ceiling height exceeds 15’ above finished floor mount wireless on nearest wall rather than ceiling. Notify ACNS/Telecommunications of change since this will require a different type of wireless access point.
- ACNS/Telecommunications needs minimum 30-day notice of ceiling grid and tile selection
- See Appendix D

8.4 Open Ceiling Wireless:
- Provide 4-11/16 deep electrical box no higher than 14’ above finished floor.
- If ceiling height exceeds 15’ above finished floor mount wireless on nearest wall rather than ceiling. Notify ACNS/Telecommunications of change since this will require a different type of wireless access point.
- Insure minimum 1’ clearance from center of box to any obstructions
- Wireless access points shall be located below any building duct work, piping and other obstructions and in no case higher than 12’ above finished floor height.
- See Appendix E
8.5 **Outdoor Mounted Wireless:**
- Provide a 4-11/16 deep electrical box with a ground
- Insure minimum 2’ clearance from center of box to any obstructions
- Provide a weatherproof cover plate
- Mount box with cover plate flush with finished surface
- Lightning/Surge protection is required
- See Appendix F

8.6 **Hard Lid Ceiling Mounted Wireless:**
Provide a 4-11/16 deep electrical box with a 2-gang plaster ring mounted flush to finished surface
Insure minimum 1’ clearance from center of box to any obstructions
If ceiling height exceeds 15’ above finished floor mount wireless on nearest wall rather than ceiling. Notify ACNS/Telecommunications of change since this will require a different type of wireless access point.
See Appendix G

9 **VOIP**

Phone service for University locations is provided by ACNS/Telecommunications. All installations are to support current VOIP standards. Consultation with ACNS/Telecommunications contact as listed in table 1 is required to ensure compliance with all current standards. Contractor is required to provide drawing to the ACNS/Telecommunications contact as listed in table 1 so comments can be provided for the DD phase.

10 **TV/Video**

Network electronic and video equipment specifications shall be respectively provided on a case-by-case basis to ensure that the latest technology and lowest price is applied to the project. Please refer to the contact in Table 1.
11 Emergency and Inter/Intra Building Life and Safety Infrastructure

Colorado State University has contracted with Rave Wireless for Rave Alert. Rave Alert is an emergency text notification service that delivers emergency notification to subscriber’s cellular devices. Emergency text notifications will be composed by CSU emergency/police and/or public relations personnel in case of an emergency on campus and/or an outside event that affects the campus community. Rave Alert is an optional subscription service for registered students and faculty and staff.

12 Classroom Standards

12.1 Introduction

Colorado State University seeks to create world-class academic spaces that enable learning of the highest caliber. The following document encapsulates current thinking about academic technology that delivers the best in-person and online learning environments. CSU Classroom Support Services should be consulted at all phases of the design and construction of new academic spaces for interpretation of the standards defined below, and to pursue variation for innovative and creative approaches to the application of technology in the learning environment.

CSU Classroom Support Services maintains a current list of defined hardware standards, which are updated regularly as technology evolves. While this document reflects defined standards and is updated frequently, the hardware standards should be considered as always up to date regardless of the RFP process and requirements.

Hardware Standards: See the Classroom Support Services web site: https://www.acns.colostate.edu/classroom-support-services/
12.2 Description of General Assignment Classrooms

- CSU classrooms are designed with consistent characteristics to make it easier for faculty to operate the classroom systems.
- Lecterns are two rack units wide with a Crestron touch screen mounted on the top panel for control functions.
- The Crestron system provides controls for all AV equipment in the room.
- Cables for laptop connection, network and any other equipment are routed through a cable nook inset into the top surface of the lectern.
- For rooms seating 50 or more, a raceway must be provided from the lectern to a practical PTZ camera placement location suitable for a lecture capture camera.
- Lecture capture rooms should be equipped with ceiling mounted microphones.
- Suspended lighting fixtures are mounted clear of the sight lines for projectors and cameras.
- All AV equipment with a network port is connected to the CSU network.
- All projectors are laser type.
- Whiteboards are installed on the front wall and sometimes also the side walls of classrooms. There must be a substantial amount of whiteboard space available to teachers even when the projection screens are fully lowered.
12.3 Large Classroom, 100+ Seats

- One or more motorized 16:10 powered projection screens, laser projector(s), ceiling PA speakers, ceiling and wireless microphones, lectern, touch screen control, LED monitors where appropriate. All large classrooms are lecture capture rooms; see section 1.6 for more information.
- Equipment for the Large classroom:
  - All video monitors must capable of at least 1920 x 1200 resolution.
  - Projectors must be laser, capable of at least 1920 x 1200 resolution. Control via CAT6A cable.
  - Data projector must use industry standard (typically Cat6A STP) cable to the switcher’s HDBaseT-compatible port.
  - Larger rooms often have 2 (two) projectors with ability for the user to put matrix-switched different content on each.
  - Where whiteboards are located behind screens, programming allows user to power off each projector and raise the screen individually to use the whiteboard. Control also allows user to raise and lower each screen individually while leaving the projector powered on to illuminate the whiteboard.
  - Projection screens are powered with housings recessed into the ceiling. Screens actuate automatically with projector power and can be overridden (retracted) via lectern-mounted touch panel control.
  - A two-bay lectern houses the A/V equipment unless an A/V closet is used; in that case, A/V controls, laptop connection, touch screen monitor, DVD player and document camera must still be user-accessible and located on the lectern.
  - Touch-screen monitor shall be mounted on the desktop with mount located centrally on the lectern desktop to allow full range of motion. Mount shall be adjusted to eliminate 360-degree rotation which can damage connecting cables and monitor connectors.
  - Monitor cable installation will include strain relief to protect the cables and the monitor connections.
  - Additional large screen (supplemental) monitors may be required around the room for breakout group sessions. Need for monitors is determined on a room by room basis in design phase.
  - Each supplemental video monitor shall have a wireless presentation device, and wall plate HDMI connections shall also be provided adjacent to each monitor.
  - Each supplemental video monitor shall be connected to the CSU Network.
  - Each supplemental monitor output and input shall be routed to the room matrix switcher to allow display of any source on or from any source to any display.
Display sources located in/on the lectern:

- Laptop (HDMI output and RJ-45 network connections are required)
- Document camera
- Blu-Ray player with wired network connection and
- Touch screen monitor for computer.
- Wireless connection device mounted inside lectern.
- Two CAT6A STP cables must be run from the lectern to a practical camera placement location suitable for a PTZ camera.
- There will be one or more ceiling mounted digital microphones depending on the size of the room.
- The lectern shall have one wireless microphone system; output is to be fed to room PA and any recording or lecture capture system.
- Crestron DMPS unit with appropriate switching capacity for the equipment installed, with Crestron touch panel mounted in lectern top.

Auditorium installations often use additional matrix switchers and audio equipment. These installations require additional A/V rack spaces which are normally provided in an AV closet location.
12.4 Medium Classroom: 50-100 Seats

- 16:10 powered projection screen, projector, touchscreen control on lectern, ceiling speakers for playback. These rooms are to be lecture-capture ready, with rough-in to support installation of PTZ cameras and ceiling-mounted microphones.
- All video monitors must capable of at least 1920 x 1200 resolution.
- Projectors must be laser, capable of at least 1920 x 1200 resolution. Control via CAT6A cable.
- Data projector must use industry standard (typically Cat6A STP) cable to the switcher’s HDBaseT-compatible port.
- Projection screen shall powered, with mount recessed in ceiling.
- Additional large screen (supplemental) monitors may be required around the room for breakout group sessions. Need for monitors is determined on a room by room basis in design phase.
- Each supplemental video monitor shall have a wireless presentation device, and wall plate HDMI connections shall also be provided adjacent to each monitor.
- Each supplemental video monitor shall be connected to the CSU Network.
- Each supplemental monitor output and input shall be routed to the room matrix switcher to allow display of any source on or from any source to any display.
- A two-bay lectern houses the AV equipment.
- Crestron DMPS unit will be installed with appropriate switching capacity for the equipment installed and Crestron touch panel mounted on lectern top.
- Wireless presentation device outputs shall be connected to the DMPS control unit or matrix switcher for classroom display.
- Wireless microphone as specified above may be installed depending on design.
- Ceiling microphone may be installed depending on design.
- PA speakers may be wall or ceiling mounted depending on room design.

If Medium classroom will have lecture capture, see lecture capture specifications.
12.5 Small Classroom: Fewer than 50 Seats
Specifications and equipment are same as medium classroom.

- Lecterns may not be used in some rooms that are small enough to double as conference rooms; in those cases, the Crestron touch panel will normally be placed on a table.
- No wireless microphone is needed in small classrooms unless lecture capture is to be installed. If lecture capture is to be used in the room, a wireless QLX series microphone (belt pack and lavaliere mic) and charger as specified above are required.

If small classroom will have lecture capture, see lecture capture specifications.

12.6 Conference Rooms

- Most conference rooms seat 6-12 people and use a video flat panel rather than a projector and screen. Standard video display is a wall-mounted video monitor, 65” or larger, capable of at least 1920 x 1200 resolution.
- Lecterns are generally not used in conference rooms, but there are exceptions. Check with CSU Classroom support to confirm.
- Crestron controls may be used if the amount of equipment to be installed justifies it; this decision is made on an individual room basis.
- Regardless of the control system, there must be a means of turning displays on and off and selecting display inputs without using buttons on the monitor or a TV remote control.
- Connections to the monitor are generally routed via HDMI cable from the conference table area to the monitor.
- The video monitor shall be connected to the CSU Network.
- If not routed through a floor box, at least two HDMI connections to the monitor shall be enclosed in a floor box, or shall be provided on a wall plate adjacent to the monitor.
12.7 All Rooms with Lecture Capture Function, Any Size:

- All rooms of any size should be roughed in for lecture capture. All rooms seating more than 50 students shall be fully equipped with lecture capture including microphones, camera and connections for digital recorder.
- Each room will have a PTZ camera mounted on the wall opposite the lectern and presentation screen; the current model is
- A CSU network port and an AC power outlet shall be located next to the camera.
- There shall be two CAT6A cables run between the camera mount and the interior of the lectern, with HDMI transmitter/receiver units on one cable for the camera signal.
- HDMI connections for the camera and for the video sent to the room projector shall be provided inside the lectern.
- Program audio out from the DMPS unit to a 1/8” jack shall be provided for the lecture capture device.
- The audio for the classroom and ceiling microphones must be programmed as a constant/line level output, and must not mute to the lecture capture recorder when the mic is muted in the room PA system.
- Lights in the room shall be mounted so as not to obstruct the camera view of the presentation area.
- Ceiling mounted whiteboard lights are strongly discouraged. If they are used, they must not hang down from the ceiling far enough to intrude into the camera view or the projector image path.

12.8 Standard Lectern Design

Fixed lecterns are standard.

Classroom Lecterns

- When lecterns will be included in the design of a room, all AV control equipment should be located within the lectern. Absent a lectern, AV equipment should either be housed within an in-room equipment rack, or in a dedicated AV systems room within allowable distance.
- CSU classrooms use a two rack-bay wooden lectern. Each room is configured to be a user-friendly teaching station with an intuitive touch panel control system designed with ease of control over media sources. Current lectern suppliers: CSU Facilities or Growling Bear Company of Greeley CO: 1-970-353-6964. Note: CSU is willing to consider accessible lectern options – please consult with Classroom Support Services when specifying accessible lecterns in designs.
• Lecterns will have a document camera mounted on the lectern top surface on the right side. All lecterns will have removable panels (normally hinged doors on the back side) to provide full access for service and maintenance.
• (See Section 7.1 for lectern electronics) Open spaces in any rack shall be filled with blank metal panels to block user access to the interior rack space. If the electronic equipment fills only one rack, the open side of the lectern shall be equipped with rack rails on the front, to which a dark-tinted Plexiglas or Polycarbonate panel covering the open enclosure shall be mounted. If the electronic equipment also requires all or part of the second rack space, a full front and back rack unit shall be installed with blank metal panels blocking access to the unused rack spaces.
• No immovable objects may be located within 30 inches of the access doors or within the access path for AV electronics to protect access for maintenance.
• Lecterns should be supplied with power and conduit to support data and AV equipment connectivity directly from below the lectern.

12.9 Lectern Power and Data Requirements
• Power strips mounted to the rear of mounted equipment with surge protection appropriate to the number of devices in the lectern shall be provided in each lectern. Two open and available powered outlets shall be provided for future equipment installation.
• Two 4-Plex 120V AC outlets per side (on the inner walls of the lectern) coming up through the rear of the lectern on flex from a combined 20amp circuit.
• One network cable shall be provided from the in-lectern switch to the top surface of the lectern for user connectivity.
• Locks: lectern doors shall be equipped
• Three conduits with long radius sweeps shall be run to each podium, one conduit for electrical power, one 2" conduit dedicated to central data and voice communications, and one 1 1/4" conduit run from the podium to the digital projector in the ceiling. The projector shall be centrally located below the room’s false ceiling with the wiring and conduit permanently attached to the ceiling structure. The projector will require one data jack. Electrical power shall also be run to the ceiling-mounted projection system.
• A network switch will be specified by ACNS/Telecommunications for providing data to devices in the podium.
12.10 Equipment Specifications

Display Input Sources – source switching specifications:

- The input signal path must handle a wide range of input resolutions up to 1920x1200.

Video Outputs:

- Minimum four HDMI outputs to serve room display, lecture capture, touchscreen monitor on lectern, and one spare. All shall be HDMI scaled outputs. More may be required depending on room design.

Audio Outputs:

- One line-level, variable stereo program output from analog and HDMI sources, combined with variable mic output to power amp.
- Microphone –two outputs, wireless mixed and level controlled.
- One audio output for Echo360 Pod recorder with program audio integrated on the HDMI video input to the recorder; one fixed mic audio output is required with a 1/8" analog plug for the mic input on the Echo360 recorder.
- One additional fixed stereo program (mic plus all other devices) output for lecture capture. This output will have program and mic audio.
- In lecture capture rooms, mute functions must not mute the program or the mic audio feed to the lecture capture device.
12.11 Video, Data Projector and Lighting Specifications

Projector Design Specifications:
- CSU uses only laser projectors at wide screen (16:10) resolution. Wall displays are usually 16:9.
- HDMI input must comply with the latest HDCP specifications.
- Ethernet connection is required on all projectors and wall displays.
- Crestron connection capability is required on all projectors.
- Projectors shall use the latest LCD or DLP technologies available on the market, capable of 1920 x 1200 resolution. Wall displays are commonly 1920 x 1080; not 1920 x 1200.

Lighting
- Ceiling mounted whiteboard lights are strongly discouraged. If they are used, they must not hang down from the ceiling far enough to intrude into the camera view or the projector image path. They must also be capable of being turned off from the lectern separately from all other room lighting.
- No suspended lighting in any classroom shall hang down from the ceiling far enough to intrude into the camera line of sight or the projector image path. All lights must be mounted at least 12 inches above the centerline of the projector lens.
- Light controls shall be configured so that the row of lights closest to the display screen can be controlled separately from the rest of the room lighting. Using the 50/50 model of light control to enable 50% lighting or no light on that row of lighting is appropriate.

12.12 Control System Specifications

Control Graphics
- CSU Classroom Support Services programs and supports classroom control systems. Crestron products are required for all new installations and upgrades. Control graphics shall conform to CSU design and visual practice.
The basic system in each lectern is comprised of:

- **Controller** – normally Crestron DMPS series with network port. If additional controllers are needed, Crestron units are added.
- **Touch Panel** – TPW-760 – color touch panel.
- **Integration capability** with Crestron Roomview and Fusion must be included.
- **Crestron program and Xpanel software** for each room are to be supplied to Classroom Support.
- **CSU Crestron shut down code** shall be included in the code for each room. It is available from Classroom Support and shall be included in the code for each room.
- **Touch screen design samples**: See Appendix J
- **Current graphics and layout** are available from CSU Classroom Support Services.
- **Contact CSU Classroom Support Services** before finalizing touch screen graphics or controls.

### 12.13 Control Design Specifications

- **Programming files, Xpanel files and as-built diagrams** for all installations become property of CSU and shall be provided to CSU Classroom Support.
- **All graphics, control screen layout and design, controls and functions** in each classroom must be reviewed and approved by CSU Classroom Support Services before project signoff.
- **Final control and touch panel files** are to be given to CSU as part the project signoff.
- **Intuitive designs following CSU graphics practices** are required, with user-friendly ability to control the room without prior instruction.
- **All classrooms should have the ability** to dim the lights nearest to the projection screens, with that control separate from the classroom lighting.
- **All electric powered screens** are to be controlled via the lectern touch panel.
- **Projectors are controlled via RS232 or Ethernet** – with run hours, filter hours and reset for both provided in the programming and on the touch panel service page.
- **Source / switcher selections** shall be controlled either by RS232 or Ethernet.
- **Program audio** shall be volume controlled and muted separately from microphone audio.
- **Audio controls and indicators** for both program and microphone audio shall be easily accessible on all touch panel screens, including mute control.
- **Blu-ray control pages** are to be included with control via IR or RS232.
A maintenance / service page shall be provided, with these features:

- Panel setup access
- Lift controls in rooms with projector lifts
- Executive modes with executive mode on/off toggles for switcher control

12.14 Audio System Specifications

Design Consideration - Evenly distributed and clearly audible sound is required for both audio program material and wireless microphone audio.

- Audio source selection – separate controls for program out and microphone volume, with mute button for each.
- Audio source and mic volume control – if not DMPS unit, A/V switcher via RS232 commands.
- Audio source amplification shall be a stereo power amp.
- Speakers shall be wall speakers or multiple ceiling speakers; speakers are not to be located immediately behind or above the lectern to minimize audio feedback.
- Microphone – Shure QLXD wireless system noted in section 1.1 above; for medium or large classrooms, two microphone systems (with one each belt pack and handheld transmitters) shall be provided.

12.15 Network Design

Design Consideration - No private vendor, building or project networks (separate from the building network) will be created or used for A/V functions and controls. Network connections for all systems, wired and wireless, must use the CSU campus network.

- CSU Classroom Support and ACNS will assign static IP addresses to all networkable AV equipment in classrooms.
- All wireless equipment installed in a classroom must connect to and use the CSU wireless infrastructure already in place; no new wireless networks shall be created in the classroom.
- Lecterns shall have two CAT6a network drops, wired back to the nearest telecom room, terminated within the lectern. At least one of the drops will support installation of a network switch to which all in-lectern equipment will be connected. The second drop to be utilized for a VOIP phone.
12.16 Build Specifications

Lectern Equipment Locations:

- Standard Equipment rack is a Middle Atlantic 4-post rack similar to the CFR series, providing 14 RU of rack space. There will be two (2) racks in a large Lectern.
- Equipment racks are to be prewired and tested before being installed at the installation site.
- Crestron Connect It TT-100 cable holder shall be built into lectern top to provide AC power, VGA and HDMI connectors, and a network Ethernet cable for laptops.
- User interface equipment (PC and Blu-Ray Players) is to be located at or near the top left side of the lectern rack mount.
- All other equipment including the A/V controllers: switchers, and audio amps, receivers and equalizers (if any) are to be located below the user access area and placed behind a hinged, lockable Plexiglas enclosure which uses the standard CSU key set.
- This cover may enclose only the part of the rack containing A/V equipment, leaving the PC and DVD player user-accessible.
- At least one rack unit (1 RU) of space shall be provided between equipment located in the rack to provide for proper heat ventilation and dissipation.
- Lectern back side main access panel/door shall not be located closer than thirty-six inches (36”) from any fixed furniture or object to provide maintenance access.
- Any open rack space in lecterns is to be blocked off by either blank rack panels or smoked Plexiglas.

Wire/Cable Specifications:

- All lecterns shall be accessed by 1 x 1 ¼” and 1 x 1 ½” conduit provided for AV and data cabling for floor-box and poke-through installations. If in the case where the lectern is not set over a floor-box or poke-through, at least a 2” conduit pathway will be necessary for any installment.
- Shielded CAT6A Crestron DM or Extron XTP or equivalent. Cat5e cable is acceptable for short runs which are not parallel to AC power cables.
- RS 232 control: Belden 9451- 2 conductor, 22 AWG, stranded, shielded.
- Speaker: Belden 5200U or equivalent (audio), minimum 18 gauge.
- Quality Extron cables or equivalent for all HDMI and VGA lectern cabling.
Terminations and Connectors

- RS232 –soldered DB-9 connectors with proper hoods are used for RS232 connections
- CAT6A cables are to be terminated with the EIA/TIA - T568B standard; connections are to be tested and verified for proper termination.
- In rooms with camera signals run to the lectern, the cable termination shall be an HDMI connector.
- All HDMI cables in lecterns and connected to AV equipment must have locking connectors (not screw-type locks).
- In rooms with lecture capture, the program video sent to the projector must also be available via an HDMI connector in the lectern.

Lectern Wiring and Cable Management

- All video, data and control wires are to be labeled and numbered in correspondence with the system diagram.
- An as-built wiring diagram is to be placed inside the Lectern on the rear equipment side door, and the computer file with that wiring diagram is to be provided to Classroom Support Services; a Microsoft Visio file is preferred.
- Proper wiring dress, maintenance loops, and cable separations are to be employed.
- Lectern is to be secured and bolted to the floor, normally using L-brackets.
- All wires connected from the lectern to ancillary equipment or connections are to be secured under a bolted down cable threshold or through provided conduits with cable sheathing.
- Wiring that is routed to above the ceiling from the lectern shall be inside an installed cable raceway; the portion traversing the wall shall resemble the color of the wall or be painted to match.
- Conduit cable pulls should not exceed 50% of the permissible conduit size.
- Nylon pull strings should be left in place after cables are pulled.
- Each lectern shall have two (2) network jacks (see earlier specification) installed on an internal block.
- Each data projector location shall have 1 (one) network jack installed next to the projector for network connectivity.
- A/V closets shall have a number of network jacks installed; the number to be determined in consultation with Classroom Support and ACNS.
- All lecterns shall be equipped with Altinex CNK241 Cable Nook complete with two AC power outlets included.
Projector Mounting
CSU recognizes and adheres to the ICIA / Infocomm Video Systems Installations Handbook standards and recognizes installers certified with the CTS and CTS-I certifications from this organization. A copy of this book is available from CSU Classroom Support Services.

- Projectors shall be mounted as high as practical in each room to reduce the potential for vandalism and unauthorized personnel tampering with the connections. Typical mounting height is level with the top of the projection screen.
- Ceiling tile replacement type mounts are typically used in rooms with drop ceilings - Premier PPFCMA Ceiling Tile replacement – secured to ceiling structure. Standard 1.5" piping is used to drop the projector down to the proper mounting position to minimize any Keystone effect and subsequent electronic keystone adjustments.
- All cables are routed through the 1.5" pipe – including power; a power outlet mounted on projector mounting plate is standard.
- Projector mount is to be a universal mount by Chief manufacturing model RPM-U Projector Mount (Key Code "A")
- All projector HDMI Receivers are to be located either in the plenum or above the projector on the ceiling tile replacement unit.
- All cables not routed through conduit are to be above the ceiling grid on J-hooks.
- Plenum cable is to be used on all and any plenum air space ceiling or raised floor installations.

Projector screen specifications

- Screen by Dalite is standard in all new installations – model varies depending on the size of the room. Recessed electric screens are preferred in new installations.
- Manual screens are sometimes used in smart classrooms. Examples:
  - Projection screens shall be mounted high enough to prevent line of sight problems for students sitting in the back of the classroom; in most cases, this means the top of the projector screen image area should be as close to the ceiling as possible.
  - Projectors shall be mounted so that the placement of room lighting systems does not interfere with the projected image.
  - Da-Lite screen, Model C w/CSR, 69" x 110", matte white, white case - #34734
  - Da-Lite screen, Model B w/CSR, 57.5" x 92", matte white, white case - #36457
- Screens are to be installed according to manufacturer specifications for model type and weight.
Monitor Wall Mounting

- All wall mounted monitors in conference rooms shall have user accessible controls either provided in a wall-mounted control box or a Crestron touch panel. The options on the control box or Crestron panel must include at least on/off and source input selection.
- All wall-mounted monitors in classrooms shall be controlled from the lectern Crestron controller and one additional HDMI input port must be provided below or adjacent to the monitor for individual user connection and input.
- All wall-mounted displays including monitors of any type must have a network port connected to the CSU Network, and AC power outlet located behind or adjacent.

Lighting Specifications

- If suspended lighting is used in a classroom, the bottom surface of the lights between the data projector or camera must hang no lower than 12 inches above the center line of the data projector or camera installed in the room, whichever is higher.
- If it is not possible to hang suspended lighting at least 12 inches above the projector or camera, then recessed lighting shall be used for all lights located between the camera and the front of the room in a 60 degree field of view centered on the lectern.
- Light controls shall be provided on the touch panel in each classroom. This shall include the ability to dim the row of lights closest to the data screen independently of other room lights, in order to reduce glare on the screen.
Equipment Security Specifications

- **Lectern:**
  - Each lectern will have access panels allowing A/V maintenance and repair, secured by key locks using a CSU standard key set.
  - As noted earlier, lectern access panels will be located no closer than 36 inches to permanently mounted objects such as tables and walls.

- **Video Projector:**
  - ¼” aircraft type cable securely connected to the projector and fastened in the ceiling with a padlock.
  - Sonic Shock audio alarm also adhered to the projector and looped into the ceiling.

- **Document Camera:**
  - Camera base shall be bolted through the top of the lectern or fastened to lectern with security cable.

- **Video Projector**
  - ¼” aircraft type cable securely connected to the projector and fastened in the ceiling with a padlock.
  - Sonic Shock audio alarm also adhered to the projector and looped into the ceiling.

- **Document Camera:**
  - Camera base shall be bolted through the top of the lectern or fastened to lectern with security cable.

12.17 Networks

- All equipment with network connectors purchased under these standards shall be IPV6 compatible.
- No private control network (separate from the building network) shall be installed within the classrooms.
- All equipment will be connected to a CSU building or campus network and must be accessible to control access via the CSU network.
- Any necessary network switches must be pre-approved by CSU Telecom.
- As noted in 6.4, all wireless equipment installed in a classroom shall connect to and use the CSU wireless system already in place; no new wireless network shall be created or set up in the classroom.

12.18 Final System Checks and Testing

**Documentation:**

- Copies of receipts or purchase orders itemizing serial numbers on each device for all Crestron equipment installed must be provided to the CSU Classroom Support Supervisor for CSU to obtain credit with Crestron for equipment purchased.
- All systems must be checked out fully for functionality, installation integrity and build documentation. All controls and functions in each classroom must be reviewed and approved by CSU Classroom Support Services before signoff.
Functionality Tests:
- Touch Panel External Buttons Labeled
- Power On Projector
- Select Laptop - Check Video and Audio
- Select Doc Cam - Test Video and Controls
- Select Video Mute and test
- Audio up / down and mute work properly
- Switcher / Scaler is set to the Projectors’ native resolution

Projector Alignment:
- Screen Functional and properly positioned
- Image Properly fills the screen on all images
- Brightness and Contrast check
- Image Keystone set
- Image is sharp and in Focus
- Fan is set to High Altitude mode

Lectern Tests / Checks:
- Little Light Functionality
- Check A/C Power in Cable Nook
- User Network Cable active at Cable Nook
- Plexi / Lexan or Rack Blanks installed in blank spaces
- Inside the Lectern: wired neatly and clear of extra parts
- Lectern Top Clean and void of leftover parts
- Wires Labeled and Block Diagram provided inside the Lectern

Cable Tests:
- Network cable infrastructure to be tested and documented with results provided to ACNS/Telecom Project Team Lead (see Table 1)
13 Miscellaneous

13.1 Security and Access to Communication Rooms

- Introduction: Physical keys are restricted to a small set of staff: ACNS/Telecom, CSUPD and a limited set of Facilities staff. Primary access is to be via cardkey.
- ACNS/Telecommunications requires that all communication rooms be secured with the campus cardkey standard.
- Physical cylinders must be the Medeco Q-Series.
- Access via key or cardkey is approved by the Director of ACNS/Telecom
- Access to communication rooms cannot be blocked by gates, doors or fences not utilizing campus master key system.

13.2 Communication Room Numbering

- Communication Rooms to be numbered starting with a "T".
13.3 Building automation provisioning and permanent network solution:

- New Construction requires testing of Building Automation Systems (BAS), Fire Alarm Systems, Elevators, etc. To test these a building data network is required. ACNS/Telecommunications would prefer a permanent network installed but can install a temporary solution for an additional charge. This additional charge will need to be worked out with ACNS/Telecommunications in advance of any installation. To ensure permanent networking can be installed, the required communications rooms (MDF and IDF) will need to be completed three weeks prior to any BAS Testing. If neither of these options are reasonable, the contractor can have a temporary point to point connection installed at their expense.:

- For a permanent network to be installed, the MDF and any required IDF will need to be completed. Completion is defined as clean, dust free (including dust from any outside construction taking place), locked and accessible to ACNS/Telecommunications employees only, with ¾ A/C Plywood installed per specifications. Further definition requires permanent power to be in place, all cooling installed and completed, drywall operations complete, cable tray and conduit work completed and that the room is not being used for storage.

- Temporary network solution: For an additional charge, ACNS/Telecommunications can install a temporary data network to be used for testing of building systems. This additional charge includes temporary switches, cleaning and re-calibrating test equipment, professionally cleaning the communications rooms prior to installation, cleaning all fiber connections after the temporary network has been removed and before the permanent network is installed.

- Please refer to the ACNS/Telecommunications contact from Table 1.
Appendices

Appendix A – Network Switch Protocol Specifications

Spanning-Tree: 802.1W (RSTP)
- Switch is not set as a root switch nor is the default priority reduced
- No loop or BPDU protect settings on feed port to campus switch. Campus switch port should be configured as a regular data port

LLDP
- LLDP supported and enabled

SNMP
- SNMP v3 support
- SNMP community changed from the default
- Read/write disabled unless necessary

VLANs
- 802.1q support
- No central VLANs are to be configured on exempt switches
- Trunking
- LACP

Username/password and switch access
- username/password Changed from the default
- RADIUS authentication support
- SSH support
- https support

Multicast/IGMP
- Enabled for all VLANs and port connecting to campus switch

Naming/labeling
- Switch description defined in switch configuration including Building name, room number

Routing
- Disabled

IPV6
- Supported
Appendix B – Communication Room Layout

Power Requirements:

1. See CSU Telecom Standards for room finish and 4. The bottom of the ladder rack will be installed.
2. Top of all rounding bar on higher than 7' A.F.
3. Need to have a ladder rack.
4. All Communication Rooms will have a ladder rack.
5. Need to be able to fit the entire room.
6. Need to have any communication room being installed.

General Note:

(1) Need room size per ANSI/IEEE 694-D)
Appendix D – Suspended Ceiling Mounted Wireless
Appendix E – Open Ceiling Mounted Wireless

Powers 58

Open Ceiling Wireless

FRONT VIEW

Type of Wireless Access Point.

Since this will require a different

mtby osu telecom/ancs of chancel

nearest wall rather than ceiling.

finished floor mount wireless on

If ceiling height exceeds 15' above

conduit

Above finished floor.

and in no case higher than 12'

work, piping and other obstructions

located below any building duct

Wireless Access points shall be

Provide a 4-1/16" deep electrical box
Appendix F – Outdoor Mounted Wireless

SIDE VIEW

Ensure minimum 2" clearance from center of box to any obstructions.

Provide a weatherproof cover plate.

Provide a 4-1/16" deep electrical box with 1" conduit.

Finished surface, provide a weatherproof cover plate. Ground mounted box with cover plate flush with ground.
THIS WILL REQUIRE A DIFFERENT TYPE OF WIRELESS ACCESS POINT.

IF THIS OCCURS PLACE NOTIFY CSU TELECOM/ANS OF CHANGE SINCE
MOUNT WIRELESS OR NEARSET WALL MOUNT IT THAN CEILING

IF CEILING HEIGHT EXCEEDS 15' ABOVE FINISHED FLOOR

MOUNTED Flush To Finished Surface.

Provide A 4"x4"x6" Deep Electrical Box With A 2-GANG PLASTER RNG.
Appendix H – Main Building Ground

ANSI/TIA J-STD-607-A

5.3.1
Appendix I - Typical grounding and bounding scheme for a multistory building.
(It is intended as a guide rather than explicit instructions.)
Appendix J: Touch screen design samples

Start-up screen:

Operational screen:
Revision History - 22.2 Jan. 1 2020