



**INFORMATION TECHNOLOGY SERVICES
NETWORKING GUIDELINES**

Acronyms

AHJ	Authority having jurisdiction	NVP	Nominal velocity of propagation
ANEXT	Alien near-end crosstalk	OD	Outside diameter
ANSI	American National Standards Institute	PCB	Printed circuit board
ASTM	American Society for Testing and Materials	PE	Professional Engineer
AWG	American wire gauge	pF	Picofarad(s)
BICSI	Building Industry Consulting Service International	PSACRF	Power-sum attenuation-to-crosstalk ratio far-end
C	Celsius	PSAACRF	Power-sum attenuation-to-alien crosstalk ratio far-end
CDT	Cable Design Technologies	PSANEXT	Power-sum alien near-end crosstalk
CMP	Communications plenum	PSELFEXT	Power-sum equal level far-end crosstalk
CMR	Communications riser	PSNEXT	Power-sum near-end crosstalk
CP	Consolidation point	RU	Rack unit [45 mm (1.75 in)]
CSC	Construction Specifications Canada	RFQ	Request for quote
CSI	The Construction Specifications Institute	TBB	Telecommunications bonding backbone
dB	Decibel(s)	TDR	Time domain reflectometer
DC	Direct current	TE	Telecommunications enclosure
EF	Entrance facility	TGB	Telecommunications grounding busbar
EIA	Electronic Industries Alliance	TIA	Telecommunications Industry Association
ELFEXT	Equal level far-end crosstalk	TMGB	Telecommunications main grounding busbar
ER	Equipment room	TO	Telecommunications outlet/connector
F	Fahrenheit	TR	Telecommunications room
Ft	Foot/feet	U	Rack unit [45 mm (1.75 in)]
Gb/s	Gigabits per second	UL	Underwriters Laboratories
IDC	Insulation displacement contact	WA	Work area
IEC	International Electrotechnical Commission		
IEEE	Institute of Electrical and Electronics Engineers		
In	Inch(es)		
ISO	International Organization for Standardization		
Kg	Kilogram(s)		
Lb	Pound(s)		
Lbf	Pound-force		
LC	Limited fuel		
LSOH	Low smoke zero halogen		
LSZH	Low smoke zero halogen		
M	Meter(s)		
MHz	Megahertz		
Mm	Millimeter(s)		
N	Newton(s)		
NEXT	Near-end crosstalk		
nF	Nanofarad(s)		
ns	Nanosecond(s)		

INTRODUCTION

1. Statement

Florida A&M University, hereinafter referred to as the University, is seeking competitive quotes for providing and installing an information transport system to support high-speed data communication, including broadband transmissions.

2. Statement of Purpose

This Request for Quote (RFQ) aims to secure the services of an experienced Belden-authorized Certified System contractor to design, provide, install, and a certified Belden structured cabling system.

3. Terms of Agreement

4. Issuing Office

The sole point of contact with Florida A&M University for purposes of this RFQ is the “Issuing Office.” The contact information is listed below:

Wayne Dunwoody
Florida A&M University
Enterprise Information Technology
1610 S. MLK Blvd Ste. 118
Tallahassee, FL 32307
Ph. 850-599-3560

5. RFQ Timelines

The timeline applies to this solicitation as follows:

Request for quote issued: **TBD**
Sealed Quotes **MUST** be received in the Purchasing Office by 2:00 P.M., EST on **TBD**.
Posting of Intent to Award: **TBD**
Anticipated Contract Start: **TBD**

APPROVED VENDOR QUALIFICATIONS

Under the provisions of this request for a quote, the Vendor shall provide the following qualifying documents at the time of quote acceptance. Vendors' failure to provide such documents will be disqualified as nonresponsive:

- The bidder must be an Authorize Belden Alliance Partner Networking Installer. The bidder must have successfully completed all design and installation training provided by Belden. The Vendor shall provide proof of current Belden Alliance Partner status and a letter from the Belden representative stating that the Vendor is fully certified to perform the scope of work in compliance with specifications.
- Employees of the Vendor shall install the Belden REVConnect® 10GX System. Systems Contractor shall directly employ a minimum of six (6) capable systems installers with current I Belden REVConnect® 10GX System course certificate of completion. The Vendor shall provide the names of the staff performing the installation.
- All installation and testing shall be performed by a Belden Alliance Partner Networking Installer and supervised by individuals qualified to install and test the Belden REVConnect® 10GX System by Belden requirements. The supervisor(s) shall have successfully completed the Belden installation training provided by Belden.
- The Vendor shall be licensed and registered with the State of Florida Department of Business Professional Regulation and is, and who has been regularly engaged in providing and installing non-residential, communication and technology systems
- The Vendor shall provide proof of one (2) RCDD on staff as permanent employees.
- The Vendor shall provide names, addresses, and telephone numbers of references for the three (3) projects. Proof shall be required at the time of quote acceptance that the Vendor is an established organization within (20) miles of the project.

Information Technology & Communications Overview

The following is an overview of the requirements for furnishing and installing a telecommunication cabling infrastructure for retrofitting or new construction at Florida A&M University. A balanced twisted-pair CAT6A / FIBER cabling system capable of supporting 10/100/300 Gb/s Ethernet networking.

Networking Switching, Wireless & Routing Infrastructures

The University has standardized and built a Secure Network Infrastructure around the Cisco Systems Hardware & Security platform. The Director of Network Infrastructures provides additional information upon request. **ALL INFRASTRUCTURE DESIGNS MUST BE APPROVED BY THE UNIVERSITY DIRECTOR OF NETWORKING INFRASTRUCTURES**

Copper to the Desktop

All communication outlets will be equipped with but not limited to two (2) Category 6A, twisted pair copper station wiring, both terminating in an RJ45 modular jack. Unless specified in the design phase, all cables will terminate to a Category 6A patch panel within the wiring closet. A Category 6A patch panel will be installed to connect with the telephone company demarcation point. All connections between the active data equipment and the voice patch panels to the Category 6A station wiring patch panel will be accomplished through Category 6A RJ45 jumpers.

Wireless Network

All new and retrofitted facilities are required to have wireless communications. Refer to the Wireless Network Documentation and Director of Networking Infrastructures for the unique design due to the rapidly changing wireless technology.

Classrooms/Teaching Labs

Smart Classrooms

All Teaching Labs and Classrooms must be equipped with Smart Teaching Technology. The University has standardized Crestron as the Smart Classroom equipment for unilateral installation across campus classrooms. All Classroom Retrofit / Upgrade to Smart Technology requests must be submitted to University's ITS Networking Director or University's Instructional Media Director for Design specifications and Cost. The departments will meet with requesting customers, design according to University standards, and meet the requestor's needs.

Three (3) floor-level boxes will contain brass cover plates, sub-plate hardware, and fittings as required. One (1) floor box shall be for a quad electrical outlet and quad datacom outlet. Two (1) floor boxes shall be for audio/visual connectivity. The A/V floor boxes shall have a minimum of 1 ½" & ¾" pathways.

Floor boxes shall be installed approximately 5' from the front wall & 5' from the side wall (front corner of the room), and the opposite side of the room from the entrance door. The total footprint of floor boxes shall be less than 24" x 24".

All floor boxes shall have continuous pathways installed from the floor box to above the ceiling for projector connectivity. The exact projector location must be verified before installation. A ceiling-mount duplex electrical outlet and data outlet will also be next to the projector.

General

All station wiring will be a continuous wire from the Telecommunications Spaces (EF/ER/TE/TR) to the communication outlet,

All Telecommunications Spaces (EF/ER/TE/TR) terminations shall be 100% cross-connected per the ANSI/TIA/EIA-568-B and its addenda specifications.

To facilitate future cable installations, a new pull string shall be installed in conduits simultaneously with the pull-in of the cable.

All Telecommunications Spaces (EF/ER/TE/TR) shall be provided with one or more grounded 19" by 84" EIA standard wiring rack(s) and Category 6A patch panels/rack mount fiber enclosures or splice housings in quantities necessary to terminate the required cables. Appropriate wire management hardware will be provided to support the routing of patch cables in a neat and organized manner.

The electrical work shall include the installation of a minimum 1" conduit from each communication outlet and "stubbed" up above ceiling level. A pull string and appropriate junction or "pull" boxes shall also be provided in each conduit run to facilitate future cable installation (s). Cable trays shall be installed to route the station cable to the telecommunications spaces (EF/ER/TE/TR).

All I Telecommunications Spaces (EF/ER/TE/TR) and connecting blocks must be identified appropriately according to specifications provided by the Information Resource Manager.

All cable pairs in copper riser cables or the copper entrance cable must be terminated on Category 6A, 110 style to RJ45 patch panels and identified according to ANSI/TIA/EIA 606-A specifications.

Fiber runs between Telecommunications Spaces (EF/ER/TE/TR) shall consist of a 12 Fiber OM4 cable and a 12-fiber OS2 cable terminated in SC connectors and placed in appropriate fiber patch panels. All communication outlets not in use, either wired or empty, must have a blank plate covering the outlet.

All modular jack assemblies must be labeled and identified according to ANSI/TIA/EIA 606-A specifications.

All wiring inside of rooms should be protected by conduit or other means such as wire mold.

The cable may be run exposed above ceilings. This cabling is supported independently of other utilities, such as conduits, pipes, ceiling support systems, and cable trays. It is not laid directly on the ceiling panels—cable to be plenum rated.

The contractor will provide all patch cables, copper, and fiber at completion. All copper patch cables must be Category 6A compliant and 7' in length. All Telecommunications Spaces (EF/ER/TE/TR) patch cords should be 3 meters SC-SC type.

Terminations

Faculty/Administrative Offices - Each office shall have one communication outlet per 80 square feet. ((2) CAT6A per outlet)

Clerical/Staff Offices - One communication outlet per designated occupant plus one spare cabled outlet for every two (2) occupants or a fraction thereof or one communication outlet per 80 square feet, whichever is greater. ((2) CAT6A per outlet).

Secretary/Administrative Assistant Offices - One communication outlet per designated occupant plus two outlets per office area, two extra outlets per five people, or one communication outlet per 80 square feet, whichever is greater. ((2) CAT6A per outlet) This additional facility allows for future growth and/or high-density office/business machines used concurrently with other staff activities.

Conference Rooms - One communication outlet per 80 square feet with two CAT6A per outlet with a minimum of (1) Wireless Access Point with a presentation system per conference room. Power should be installed underneath the conference table, and (1) media mount should be installed on top of the table to support Laptops, Tablets, smartphones, etc., to display content to Projector or LED.

Dormitories - One data communication outlet and one F-type coaxial outlet for each planned occupant per dormitory room. (1) RJ45 (CAT6A) per pillow. If the unit is a single room or multiple occupancy units, the above specifications will apply to the room. All dormitory building facilities will also have a direct fiber optic connection to the campus backbone. This connection will consist of (12) OM4 multimode fibers and (24) OS2 fibers.

Each dormitory facility will also include a Main Telecommunications Space to house the active (NETWORK SWITCH DESIGN varies to the size of the facility) equipment and the terminated fibers to the campus backbone. DETERMINED BY IT STANDARDS.

Facilities

Trunk and Access Facilities

Copper (Twisted Pair / Coaxial) cables from the communication outlets described in the previous section should be connected to accessible Telecommunications Spaces (EF/ER/TE/TR) close to the center of the terminations on each floor rather than in the single (or main) communications room for the building. The fiber cables from the communication outlets described in the previous section should be routed through accessible telecommunications spaces (EF/ER/TE/TR) close to the center of the terminations on each floor and either a home run or fusion splice onto high-count riser cables that lead to the Main Telecommunications Space, where all data communications electronics will be located.

Spaces for a communications trunk to support future instructional needs must interconnect the laboratory, classroom, office pad areas, and the building communications equipment room.

A cable tray (preferred and greater than a 6-inch cross-section) or a 4" conduit is an appropriate facility (raceway) if the actual needs are not known.

Telecommunications Spaces

General

Space for connecting the building circuits to the outside plant should be provided as a separate room and not shared with other utility services, particularly the electrical service. When possible, it will not be adjacent to the electrical distribution room.

The minimum room size for the Main Telecommunications Spaces is 3m (10ft) x 3.4m (11ft), and the minimum room size for the other Telecommunications Spaces is 3m (10ft) x 2.4m (8ft). The project architect/Engineer must, during the initial (Schematic-Preliminary) Planning stage, engage in coordinated efforts of the Information Resource Manager's Office, Facilities Management, and the Using Agency to ensure the appropriate size, location, and arrangement of the Telecommunications Spaces (EF/ER/TE/TR). Special size requests must be discussed and signed off by the Director of Networking Infrastructures to ensure the University meets OSHA Standards and presents a safe work environment for Network engineers.

Each Telecommunications Spaces (EF/ER/TE/TR) must have OPEN OPTIONS MAG-LOCK proxy card readers installed at doors.

ITS shall determine which Telecommunications Spaces (EF/ER/TE/TR) will accommodate non-ITS equipment (i.e., Fire control panels, access control panels, burglary equipment, etc.).

Telecommunications Spaces (EF/ER/TE/TR) shall have a portable fire extinguisher (e.g., with appropriate ratings) mounted as close to the entrance as possible and shall not have water pipes installed above the ceiling.

Telephone - At least 1 Telephone per Telecommunications space (EF/ER/TE/TR).

Lighting - All Telecommunications Spaces (EF/ER/TE/TR) shall have a light intensity of 50–70-foot candles at 30 inches above the floor.

Dust Elimination - The walls, floors, and ceilings of all Telecommunications Spaces (EF/ER/TE/TR) shall be painted or otherwise treated to eliminate dust. If the walls are painted, light-colored, latex-type paint should be used.

Backboards - All Telecommunications Spaces (EF/ER/TE/TR) shall have gray fire-retardant 8'x4'x3/4 "A/C grade plywood backboards mounted on the back and side walls. The plywood backboard shall be affixed to adequately support the weight of the cable, terminals, and other equipment attached to it. The plywood backboard shall be treated with fire-retardant material.

Vertical Risers - Telecommunications Spaces (EF/ER/TE/TR) contain vertical cable riser space. The communications equipment rooms shall provide vertical riser sleeves and bushings through the floor and ceiling to other vertically stacked communication equipment rooms. All sleeves shall be a minimum of 4 inches in diameter or sized to support the actual cabling requirements, whichever is greater. Every communications equipment room should have a minimum of 5 riser sleeves; 2 for voice, 2 for data, and 1 for video or any additional sleeves as required by cable needs.

The communication equipment rooms shall be centrally located to optimize the cable run length to the telephone outlets. The length of a cable run shall not exceed 290 feet. In multi-level buildings, the communications equipment rooms should be located over the vertical cable riser space,

Room Temperature and Humidity

The HVAC should:

1. Maintain continuous and dedicated environmental control (e.g., 24 hours per day, 365 days per year). If emergency power is available, the designer should connect it to the HVAC system that serves the telecommunication spaces.
2. Maintain a positive pressure with a minimum of one air change per hour in the Telecommunications Spaces.

The ambient temperature shall be maintained between 68- and 72- degrees Fahrenheit and the relative humidity shall be held between 20 and 50 percent unless otherwise specified. Temperature and humidity requirements are on a 24-hour, 7-day-a-week basis, regardless of the heat generated by normally operating communication equipment.

Special ventilation may be required for a battery backup system in some buildings.

Electrical Facility Relationships

Building earth ground must be provided for all communications equipment rooms such that the DC resistance from the rooms to the building's earth ground in the longest run does not exceed 0.5 ohms.

Telecommunications Spaces (EF/ER/TE/TR) shall have two (6) L6-20 AMP 220V twist lock dedicated, non-switched electrical outlets, one (1) 30 AMP 220V dedicated, non-switched electrical outlet, and (2) quad 120V, 20 amp convenience outlets installed behind equipment racks and (1) quad 120V 20 amp on each side wall. Convenience outlets shall be 1.83 m (6ft) apart. Outlets must be isolated from any motors, and air conditioning or lighting circuits must be provided, irrespective of room size. A separate small sub-panel with integrated surge suppression would provide the proper isolation in the Telecommunications Spaces (EF/ER/TE/TR)

Behind the Rack

- (6) L6-20 twists lock
- (1) tie in for 10k Liebert UPS
- (4) 110 Quad outlets

Each side wall

- (1) 110 quad outlets

All outlets tied into emergency generators

<https://www.cisco.com/c/en/us/products/collateral/switches/catalyst-9400-series-switches/nb-06-cat9400-series-line-data-sheet-cte-en.html#EnergyEfficientEthernet>

UPS maintains battery design life, and operates the UPS in an ambient temperature of **59°F to 77°F. (15°C to 25°C)**. 4. DC-to-DC. Converter. Raises the DC voltage.

Power-over-Ethernet switches to support them. **PoE switches generate almost five times more heat than data-only switches.** However, heat has to be taken into account in the switch-closet design.

<https://www.networkworld.com/article/2268806/considerations-for-poe-deployments-in-switch-closets.html#:~:text=As%20companies%20supplant%20digital%20handsets,account%20in%20switch%2Dcloset%20design.>

Considerations for PoE deployments in switch closets

PoE switches generate almost five times more heat than data-only switches, which must be considered in switch closet design.

www.networkworld.com

Each communication outlet (equipped or wired for) must have 120V, 20 amp circuits with a duplex outlet whose feed is isolated from any motors, air conditioning, or lighting circuits.

Lock

All rooms or spaces containing voice or data equipment will be accessed through one uniform master key system. The standard key for all communications spaces shall be a unique key under the Best Lock grand master key system and The University standard proxy card mag-lock **DNA FUSION OPEN OPTIONS with Security cameras that tie into the University FAMUPD system.** Key Bank shall not issue a key without the signed approval of the CIO.

The purchase, installation, configuration, and integration of all access control and electronic locks shall comply with the University's DNA Fusion standards and specifications. All requests concerning access control and electronic locks for new construction and renovations shall be made to the Director of Network Services, who will provide the certified integrator's contact information.

Security

All Telecommunications Spaces (EF/ER/TE/TR) must have Proxy access and a vandal-resistant IP camera connected to the FAMU Police Department. The Director of Network Infrastructure and CIO must approve all users.

Outside Plant

All new building construction planning must include a connection into existing tunnels or manholes and should connect via five (5) 4" conduits. These conduits would only be for the data, voice, and video facilities.

Whenever possible, all abandoned cables should be removed from tunnels, manholes, and conduits. If it is not feasible to remove the said cable, it should be tagged as abandoned and reported to the Information Resource Manager.

No cable should be installed in any facilities (raceways) other than those intended for that use. Gas and water pipes must not be used for conduit under any circumstances.

All new construction planning must include a connection to the campus fiber optic backbone, which terminates in the Perry-Paige building. This backbone connection must have a 48-strand composite fiber optic cable (36- OS2 and 12 OM4).

Outside Plant Fiber Optic Cable Specifications

The 48-strand composite cable shall consist of 12 OM4 fibers and 36 OS2 fibers with two sub-groupings distributed as follows: 1 OM4 sub-grouping containing 24 OM4 fibers each and 1 OS2 sub-grouping containing 24 single-mode fibers. The OM4 sub-grouping will be individually color-coded. The OS2 sub-grouping will be individually color-coded and imprinted with a black stripe or hash mark on the buffer tube.

Multimode Fibers:

All multimode fibers will be OM4 fibers. All cables shall be rated for their use and constructed with the following fiber specifications:

- Max. Tensile Strength, Long Term 1500N
- Max. Tensile Strength, Short Term 4500N
- Fiber Core Diameter 50 μ m
- Minimum Effective Modal Bandwidth (EMB) 5350 MHz*km / -
- Maximum Attenuation 3.0 dB/km / 1.0dB/km
- Min. Overfilled Launch (OFL) Bandwidth 3500 MHz*km / 500 MHz*km
- Serial 1 Gigabit Ethernet 1100 MHz*km / 600 MHz*km
- Serial 10 Gigabit Ethernet 600 MHz*km
- Wavelengths 850 nm / 1300nm

Single-mode Fibers:

All OS2 fibers will be OS2 fibers. All cables shall be rated for their use and constructed with the following fiber specifications:

- Max. Tensile Strength, Long Term 810N
- Max. Tensile Strength, Short Term 2700N
- Maximum Attenuation .4 dB/km / 0.4 dB/km / 0.3 dB/km
- Wavelengths 1310 nm / 1383nm / 1550 nm

Network Design

Each building or physically connected building complex will support user connections at a minimum of 1G full duplex switch Ethernet speed. The main switch for the building shall be equipped with a Gigabit switch capable of performing LES/BUS/LANE functions should its connection from the campus backbone become inoperative and should connect to the campus backbone via redundant load-sharing Gigabit OS2 or Multimode links.

Network Switching Equipment

Each network switch will have, as a minimum, the following functions.

Backplane support for switched GBPS speeds Ethernet.

Backplane support for Gigabit switching

Uplink capability forms the switched Ethernets to the Gigabit switch fabric.

Each switch shall include redundant load-balancing power supplies capable of N+1 redundancy.

Full SNMP Management of all chassis/bridging functions.

Support the current LANE, PNNI, and MPOA standards at the time of acquisition.

Support upgrades to Layer 3 switching as the standards become established.

Full RMON support for all RMON groups standardized at the time of acquisition.

Per port RMON / RMON II support for all switched Ethernet ports as well as port replication.

Support for out-of-band/side-band network management via isolated 1000 MB or 10GigE Ethernet

Wiring Closet Power Supplies

Each wiring closet will have one or more rack-mounted uninterruptable power supplies of sufficient capacity to power all active data equipment within the closet.

Each UPS will be fully SNMP manageable or shall be capable of being managed through the switching equipment.

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Division 27 – Communications

27 00 00 Communications

27 05 00 Common Work Results for Communications

27 05 26 Grounding and Bonding for Communications Systems

27 05 26.01 General

- 27 05 26.01.A The facility shall be equipped with a telecommunications bonding backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current-carrying conductor. The TBB shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations found in ANSI-J-STD-607-C, *Commercial Building Grounding (Earthing), and Bonding Requirements for Telecommunications*.
- 27 05 26.01.B The main entrance facility/equipment room (EF/ER) in each building shall be equipped with a telecommunications main grounding busbar (TMGB). Each telecommunications enclosure (TE) and/or telecommunications room (TR) shall be provided with a telecommunications grounding busbar (TGB). The TMGB shall be connected to the building's electrical entrance grounding facility. The intent is to provide a telecommunications grounding system that is equal in potential to the building's electrical grounding system. This will minimize the ground loop current potential between the telecommunications equipment and the electrical system that supplies power to the equipment.
- 27 05 26.01.C All metal equipment racks, cabinets, backboards, cable shields, strength members, splice cases, cable trays, and the like entering or residing in TEs/TRs/ERs/EFs shall be grounded to the appropriate TGB/TMGB using a minimum 6 AWG stranded copper bonding conductor and compression connectors.
- 27 05 26.01.D All wires used for telecommunications grounding purposes shall be identified with green insulation or green tape. Non-insulated wires shall be identified at each termination point using green tape. All cables and busbars shall be identified and labeled in accordance with ANSI-J-STD-607-C.
- 27 05 26.02 Grounding and bonding system installation:
- Contractor shall install and verify a bonding and grounding system that is designed and compliant with the ANSI/TIA-607-C standard or provide verification that the existing bonding and grounding system meets the ANSI/TIA-607-C standard.
- 27 05 26.02.A The TBB shall be designed and/or approved by a qualified Professional Engineer (PE), licensed in the jurisdiction where the work is to be performed. The TBB shall adhere to the recommendations found in ANSI-J-STD-607-C and shall be installed in accordance with industry best practices.
- 27 05 26.02.B A licensed electrical contractor shall perform the installation and termination of the main bonding conductor to the building service entrance ground.

27 05 28 Pathways for Communications Systems

Contractor shall bid projects based on installing a complete, TIA/EIA 569 standards compliant cable support system. All cable pathways shall provide required support of cables and follow standards guidelines. The approved cable support system will be comprised of basket tray and J-hooks. J-

Hook spacing shall be between 48" to 60" maximum. Wire Basket tray shall be supported a minimum of every 5'.

Approved Manufacturers:

Ladder rack, racks and wire Management inside the MDF, TC or IDF: **Belden**

J-Hooks, (Metal only): Caddy, B-Line or approved equal

Wire Basket Tray: Cable Management Solutions (Snaketray) or approved equal

27 05 53 Identification for Communications Systems
27 05 53.01 General

27 05 53.01.A Labeling shall be in accordance with the recommendations found in TIA/EIA-606-B, the manufacturer's recommendations/installation guides, and industry best practices.

27 05 53.01.B Label stock shall be polyester-base material self-laminating for cables (wrap-around), wall outlets, terminal blocks and patch panels. It shall be durable and must be smudge and smear resistant as soon as they are made, will not fade over time or rub off, will not peel or loosen and will withstand specific component temperature and humidity requirements.

27 05 53.01.X Ordering information for Belden labels can be found in ANNEX B

27 08 00 Commissioning of Communications

27 08 01 System Documentation
27 08 01.01 General

27 08 01.01.A Upon completion of the installation, the successful bidder shall provide three comprehensive sets of documentation to the **FAMU IT Department** of the **Belden System 10GX (Category 6A)** for approval. Documentation shall include the items detailed below.

27 08 01.01.B Documentation shall be submitted within 10 working days of the completion of each testing phase (e.g., subsystem, area, floor). This includes all test results and draft as-built drawings. Draft drawings may include hand-written annotations. Printer-generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase. At the request of the owner of the Belden System 10GX, the successful bidder shall provide copies of the original test results in electronic format, for example a Fluke Networks (*.flw) Linkware file or a Microsoft Excel (*.xls) file. Approved testers include AEM TestPro Certifiers and their viewing software.

27 08 02 Test Results Documentation
27 08 02.01 General

27 08 02.01.A The test equipment shall meet the requirements found in the TIA/EIA568C series of standards.

- 27 08 02.01.B Test documentation shall be provided on permanent media within three weeks after the completion of the project. The media shall be clearly marked on the outside front cover with the words "Project Test Documentation", the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or connector) ID, measurement direction, reference setup, and technician name(s). The test equipment name, manufacturer, model number, serial number, software version, and last calibration date will also be provided. Unless the manufacturer specifies a more frequent calibration cycle, proof of annual calibration must be documented for all test equipment used in this installation.
- 27 08 02.01.C Printouts generated for each cable by the test equipment shall be submitted as part of the documentation package. Alternately, the successful bidder may furnish this information in electronic format on permanent media. The media shall contain the electronic equivalent of the test results as defined by the bid specification, in a file format such as Fluke (*.flw) Linkware file format, AEM TestPro software or compatible with Microsoft Word or Microsoft Excel.
- 27 08 02.01.D When repairs and re-tests are performed, the problem(s) found and the corrective action(s) taken shall be noted. Both the failed and passed test results shall be documented.
- 27 08 03 As-Built Drawings
- 27 08 03.01 General
- 27 08 03.01.A Drawings must include cable routes and telecommunications outlet/connector (TO) locations. Each TO location shall be referenced by its unique identifier. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. The owner of the Belden System 10GX will provide scaled floor plans in paper and electronic (DWG, AutoCAD Release 14) formats, to which as-built construction information can be added. These documents will be modified accordingly by the successful bidder to denote as-built information as defined above and returned to FAMU.
- 27 08 03.01.B The successful bidder shall annotate the base drawings and provide both print (same plot size as originals) and electronic (AutoCAD Release 14) versions of the modified files.

27 10 00 Structured Cabling

27 10 01 Scope

27 10 01.01 General

- 27 10 01.01.A This document describes the requirements for furnishing and installing a telecommunications cabling infrastructure for retrofitting or new construction at Florida A&M University. A balanced twisted-pair cabling system capable of supporting 10 Gb/s Ethernet networking is described.
- 27 10 01.01.B All cables and related support, termination, and grounding hardware shall be furnished, installed, tested, labeled, and documented by the successful bidder as detailed in this document.
- 27 10 01.01.C General product specifications, design considerations, and installation guidelines are provided in this document. Specific site-related requirements are provided as an attachment to this document. In case of conflict, this document shall take precedence. The successful bidder shall meet or exceed all requirements for the cabling system described in this document.

27 10 02 Regulatory References

27 10 02.01 General

- 27 10 02.01.A All workmanship and materials shall be in full conformance with applicable building, electrical, and other codes, as determined by the authority having jurisdiction (AHJ).

- 27 10 02.01.B All cabling system components shall be Underwriters Laboratories (UL) or ETL Listed and shall be marked as such.

27 10 02.02 Reference list

- 27 10 02.02.A The product specifications, design considerations, and installation guidelines provided in this document are in part derived from recommendations found in recognized telecommunications industry standards. The following are used as reference:

1.Pathways & Spaces

ISO/IEC 18010:2002 – Pathways and Spaces for Customer Premises Cabling
TIA-569-D (2015) – Commercial Building Standard for Telecommunications Pathways and Spaces
TIA-942-A (2012) – Telecommunications Infrastructure Standard for Data Centers

2.Grounding

ANSI-J-STD-607-C (2015) – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

EN 50310, Application of Equipotential Bonding and Earthing in Buildings with Information Technology Equipment

3.Cabling Systems

ISO/IEC 11801 2nd Edition 12/07/07 Information Technology – Generic cabling for Customer Premises
TIA-568-D.1 (2017) and associated Addenda – Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements
TIA-568-C.2 (2009) and associated Addenda – Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components
TIA-862-B (2016) – Building Automation Systems Cabling Standard for Commercial Buildings
TIA-942-A (2012) – Telecommunications Infrastructure Standard for Data Centers
TIA-4966 (2014) - Telecommunications Infrastructure Standard for Educational Facilities
TIA-1179 (2010) - Telecommunications Infrastructure Standard for Healthcare Facility
TSB-162 Telecommunications Cabling Guidelines for Wireless Access Points

4. Cabling Administration

ISO/IEC 14763-1:1999 – Implementation and Operation of Customer Premises Cabling – Part 1: Administration
TIA-606-B (2012) – Administration Standard for Commercial Telecommunications Infrastructure

5. Networking

IEEE Standard 802.3an – *10GBASE-T* (10 Gb/s Ethernet operations over balanced twisted-pair cabling)

6. Design

The current edition of the BICSI Telecommunications Distribution Methods Manual (TDMM)

7. Installation

The current edition of the BICSI Information Transport Systems Installation Manual (ITSIM)

27 10 02.02.B In cases where product specifications, design considerations, and installation guidelines provided in this document are in conflict with the references listed above, the more stringent requirements shall apply. All references listed above were current during development of this publication. The bidder is responsible for referencing to the most recent releases when developing bid proposals.

27 10 02.02.C This document does not take precedence over any code, either partially or wholly.

27 10 03 General Condition – Approved Vendor

27 10 03.01 General

27 10 03.01.A The bidder must be an authorized Belden Alliance Partner Networking Installer. The bidder must have successfully completed all design and installation training provided by Belden. ***The bidder shall provide a copy of their current/valid Belden Partner Alliance Certification at the time of the bid.***

27 10 03.01.B The bidder shall demonstrate proven expertise in the implementation of network cabling. Expertise can be illustrated through the inclusion of details of at least three projects involving the design and installation of an Augmented Category 6 (Category 6A) balanced twisted-pair cabling system within the past two-year period. Names and contact information for each of the three projects shall be included.

27 10 03.01.C The successful bidder shall hereinafter be referred to as the Vendor.

27 10 03.01.D The Vendor shall accept complete responsibility for the design, installation, acceptance testing, and certification of the Belden System 10GX.

- 27 10 03.01.E The Vendor shall provide proof of its current Alliance Partner status and shall deliver Belden System Certification for the installed Belden REVConnect® 10GX System, and shall deliver Belden's Best-In-Class Warranty which includes a 25-Year Product Warranty and Lifetime Application Assurance for the installed Belden Systems.
- 27 10 04 General Condition – Approved Installer
27 10 04.01 General
- 27 10 04.01.A The installation of the Belden System shall be performed by employees of the Vendor. No sub-contractors of the certified Installer shall be used.
- 27 10 04.01.B All installation and testing shall be performed by a Networking Contractor (who is part of Belden's PartnerAlliance Program) and supervised by individuals qualified to install and test the Belden System in accordance with Belden Inc. requirements. The supervisor(s) shall have successfully completed Belden IBDN installation training provided by Belden Inc.
- 27 10 05 General Condition – Approved Products
27 10 05.01 Approved products
- 27 10 05.01.A Approved balanced twisted-pair cable: Belden.
- Workstations & WAP's:** Belden 10GXS Cable Series, small diameter C6A cable
- 27 10 05.01.B All workstation jacks and patch panel jacks/terminations. Belden REVConnect jacks
- Workstations:** Belden REVConnect 10GX, C6A UTP Green Jacks
- 27 10 05.01.C For any approved direct connect applications: Belden REVConnect Mod-plugs
- Direct Connect:** Belden REVConnect 10GX UTP Field Installable Mod-Plug
- Belden REVConnect patch panels, (Pre-loaded or unloaded and fielded loaded with jacks)
- 27 10 05. 01.E Approved Cross-Connect System: Belden Inc.
- Belden 10GX IDC System
- 27 10 05. 01.F Approved patch cords: (Category rating to match the Category of the system installed)
- Belden 10GX, standard diameter Modular green patch cords, (Equipment Racks & workstation end)
- 27 10 05. 01.G Approved workstation outlets:
- Belden KeyConnect Faceplates, (color to match electrical outlet)

Fiber optic components: all cable and connecting hardware shall be **Single Mode, UPC**

Fiber Optic cable: Belden Fiber cable for the application

Fiber enclosures: Belden ECX Series, rack mount,

All unused slots in the fiber enclosures shall be filled with blanking panels

Belden splice on connectors

To qualify for a 25-Year Product Warranty and Lifetime Application Assurance, only products made or approved by

Belden Inc. shall be used to ensure the end-to-end performance of the Belden Cabling System.

27 10 07 Work Included

27 10 07.01 General

27 10 07.01.A The work included consists of all labor, equipment, products, and supplies required to design, install, test, and warranty the Belden Cabling System in compliance with project specifications.

27 10 07.01.B The work included consists of (but is not limited to) the following:

1. Furnishing and installation of a complete balanced twisted-pair telecommunications cabling infrastructure capable of supporting:

Workstations & WAP's: ANSI/TIA/EIA Category 6A, 10 Gb/s network cabling that meets or exceeds ANSI/TIA/EIA Category 6A requirements for all wireless access points.

2. Furnishing, installation of, and termination of all cabling runs.

3. Furnishing and installation of all TOs, patch panels, and cordage.

4. Furnishing and installation of all required cable runways, cabinets and/or racks in TEs, TRs, and/or ERs.

5. Furnishing of any other material required to implement a complete system.

6. Testing all installed cabling runs and furnishing a summary report confirming the Pass status of each run.

7. Furnishing all test and labeling information in both electronic and paper formats.

8. Providing training and complete documentation, including the Belden End-User Guide, Application Guidelines, and as-built drawings.

27 10 08 Drawings Specifications

27 10 08.01 General

- 27 10 08.01.A All drawings and plans provided with this document are diagrammatic. They are included to show the scope of the project in order to assist in the development of bid documents. The Vendor shall make allowances in the bid proposals to cover the work required to comply with the intent of the drawings and plans.
- 27 10 08.01.B The Vendor shall verify all dimensions at the site and is responsible for their accuracy.
- 27 10 08.01.C Prior to submitting a bid, the Vendor shall indicate:
- 1.Any specified materials the Vendor believes to be inadequate.
 - 2.Any necessary items of work omitted from the bid specification.
- 27 10 09 Pre-Project Submittals
- 27 10 09.01 General
- 27 10 09.01.A Under the provisions of this document and prior to the start of work, the Vendor shall:
- 1.Submit proof of status in the PartnerAlliance Program of their company and the names of all individuals that will be performing the installation and testing to the owner of the Belden System.
 - 2.Submit details of all cabling system products to be used to the owner of the Belden System.
- 27 10 09.01.B Work shall not be performed without the written approval of the submitted items by the **FAMU IT Department**.
- 27 10 09.01.C The Vendor must obtain approval from Belden Inc. and from the **FAMU IT Department** for any substitution of submitted products. No substituted items shall be installed without written approval.
- 27 10 10 Delivery, Storage, and Handling
- 27 10 10.01 General
- 27 10 10.01.A Delivery and receipt of project materials shall be coordinated with the **FAMU IT Department** in advance.
- 27 10 10.01.B All cable to be used in the project shall be stored according to manufacturer's recommendations. In addition, all cable must be stored in a protected area. If cable is stored outside, it must be covered with opaque plastic or canvas for protection from the elements, with adequate ventilation to prevent condensation. If air temperature at the cable storage location will be below 4.4 °C (40 °F), the cable shall be moved to a heated location [minimum 10 °C (50 °F)]. If necessary, cable shall be stored off-site at the Vendor's expense.
- 27 10 10.01.C If the Vendor intends to provide a trailer on-site for the storage of project materials, prior approval must be obtained from the **FAMU IT Department**.
- 27 10 11 Structured Cabling Overview
- 27 10 11.01 General
- 27 10 11.01.A The **Workstation Cabling system and Wireless Access Point Cabling System** shall meet the following specifications:
- 1.The balanced twisted-pair cable shall be available in Bonded pair and non-Bonded pair configurations.

2. The balanced twisted-pair cabling system shall support 10 Gb/s networking and shall provide guaranteed performance up to 625 MHz for a 4-conductor, 100 m (328 ft) channel.

NOTE: 4-conductor refers to one TO, one consolidation point (CP), and two cross-connect panels in a TE/TR/ER (one for horizontal cables and one for equipment pigtails).

3. The balanced twisted-pair cabling system shall offer an option to handle up to 100 watts of power to support PoE Type 4 (90 W).

27 10 11.01.B At a minimum, the **Workstation Cabling system and Wireless Access Point Cabling system** will exceed the critical performance parameters for Cat 6A found in TIA/EIA-568-C.2 Category 6A standard over the specified frequency ranges by the values listed below. The balanced twisted-pair cabling system shall also meet all the requirements of ISO/IEC 11801:2002 Ed. 2 / Amendment 2.

Belden 10GX System Performance						
10GX System	10GXS UTP	10GX UTP	10GX F/UTP			
Bandwidth 625 MHz						
Data Rate Capacity 10 Gb/s						
Frequency Range	1-500 MHz	500 – 625 MHz	1-500 MHz			
	500 – 625 MHz	1-500 MHz	500 – 625 MHz			
Parameter	*** Worst-Case Margin ***					
Insertion Loss	8% ¹	8%	3%	-	3%	-
Return Loss	2 dB	2 dB	2 dB	2 dB	2 dB	2 dB
NEXT	5 dB	2 dB	2.5 dB	-	2.5 dB ²	-
PSNEXT	6 dB	3 dB	3.5 dB	1.5 dB	3.5 dB ²	1.5 dB
PSACRF	12 dB	10 dB	10 dB	8 dB	10 dB	8 dB
PSANEXT	4 dB	4 dB	2 dB	-	10 dB	10 dB
PSAACRN	8 dB ³	8 dB	3.5 dB ³	-	11.5 dB ³	10 dB
PSAACRF	12 dB	12 dB	-	-	12 dB	12 dB

Notes:

Values proposed or statements represent guaranteed 10GX channel margin against ANSI/TIA-568-C.2-2009 Category 6A standard.

The margin is the additional headroom (in dB or %) compared to the minimum specified value for Category 6A at each frequency point over the specified frequency range.

The worst-case margin is determined at the frequency where the measured data point is closest to the limit line.

The Category 6A limit line equations are used to determine the worst case margin over the frequency range from 500 MHz to 625 MHz. This margin applies for worst-case short and long channel configurations as defined in ANSI/TIA-568-C.2 Annex J.

Notes

27 10 12 Testing and Acceptance 1. In the frequency range from 20 MHz to 500 Hz.

2. NEXT and PSNEXT margins can be lower for short channels with more than two connectors using

27 10 12.01 10GX Shielded Modular Jacks.

General Labeling

- 27 10 12.01.A All terminated cabling runs shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements found in the TIA/EIA 568-C series of standards. All pairs in each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation, including (but not limited to) cables, connectors, patch panels, and cordage shall be repaired or replaced in order to ensure 100% usability of all installed runs.
- 27 10 12.02 Copper channel testing (see TIA-1152 TESTING STD)
- 27 10 12.02.A All balanced twisted-pair cable links shall be tested for basic continuity and length, as indicated below. Additional testing shall be performed to verify compliance with Category 6A performance for the parameters listed in Section 27 10 11.01.B of this document. The extent of testing shall be in accordance with the end-customer's testing requirements. Belden recommends 100% testing of permanent links for Insertion Loss, Return Loss, NEXT, PSNEXT and PSACRF. These tests are performed at the same time as the Continuity test using an automated tester, such as the Fluke DTX1800 OR AEM TestPro Certifier.
- Testing shall follow the testing criteria specified in ANSI/TIA-568-C.2 standard.
- 27 10 12.02.B Continuity – Each pair in every installed cabling run shall be tested using a test set that detects and identifies opens, shorts, polarity and pair reversals, crossed pairs, and split pairs. The results shall be recorded as Pass/Fail (as indicated by the test set) and referenced to the appropriate cable identification number and circuit/pair number. Any fault shall be corrected and the run re-tested prior to final acceptance.
- 27 10 12.02.C Length – Every installed cabling run shall be tested for installed length using a time domain reflectometer (TDR) device. The cable length shall not exceed 90 m (295 ft). The cable length shall be recorded, referencing the cable identification number and circuit/pair number.
- 27 10 12.02.D **Category 6A** performance testing shall be done according to the published standards.
- 27 10 13 Warranty and Services
- 27 10 13.01 Qualification of system
- 27 10 13.01.A The installed Belden Cabling System shall be covered by the **25 Year PartnerAlliance Program Warranty, issued by Belden Inc.** and delivered by the Networking Contractor.
- 27 10 13.01.B Telecommunications spaces and pathways in new buildings or in those buildings having undergone major renovations in the preceding three years should conform to the recommendations outlined in TIA/EIA-569-B. In cases of installation in restrictive spaces and pathways (where it is not possible to implement the standards-based recommendations), no cabling run shall exceed 90 m (295 ft) in length nor be installed in any manner that limits the performance of the Belden System 10GX.
- 27 10 13.01.C The installed Belden Cabling Systems shall conform to all applicable local building and electrical codes.
- 27 10 13.02 PartnerAlliance Program Warranties
- 27 10 13.02.A To qualify for System Certification, the Belden Cabling System shall be designed, installed, and tested by a PartnerAlliance Networking Contractor.

- 27 10 13.02.B To qualify for System Warranties, the installed cabling system shall fully comply with all relevant Belden IBDN design and applications guidelines, including any pre-approved deviations as specified in the latest release of the Belden IBDN Certification Guide.
- 27 10 13.02.C To qualify for System Warranties, only products made or approved by Belden Inc. shall be used to ensure the end-to-end performance of the Belden Cabling Systems. The Belden Inc. 25-Year Component Warranty and Lifetime Application Assurance can only be provided to installations consisting of products supplied by Belden Inc.
- 27 10 13.02.D Belden Inc. will not provide certification or warranty coverage for products manufactured by other entities.
- 27 10 13.032 5-year component warranty
- 27 10 13.03.A The Belden PartnerAlliance Program shall provide a twenty-five (25) year warranty for all Belden passive components used in the installed Belden Cabling System. Defective and/or improperly installed products shall be replaced and/or reinstalled at no cost to the owner of the Belden System 10GX.
- 27 10 13.04 Lifetime application assurance
- 27 10 13.04.A The Belden PartnerAlliance Program shall provide the assurance that all present and future commercially available applications engineered for the performance level of the installed cabling system in accordance published standards will work for the lifetime of the certified Belden Cabling System.
- 27 10 13.04.B Should the certified Belden Cabling Systems fail to support the networking technologies designed to operate over it—at the time of cutover, during subsequent use, or after upgrading active network devices (e.g., migrating to 10 Gigabit Ethernet switches from Gigabit Ethernet switches)—Belden Inc. and the Vendor shall take prompt corrective action.
- 27 10 13.05 Owner responsibility
- 27 10 13.05.A The Vendor shall provide a Belden End-User Guide to the owner of the Belden Cabling System. This document describes essential system elements and specifies the owner’s responsibilities for maintaining the integrity of the installed cabling system over time. The Belden End-User Guide contains guidelines for cabling system modifications (e.g., relocations, additions, changes to services), in addition to labeling and record-keeping maintenance requirements.
- 27 10 13.05.B The owner of the Belden Cabling System accepts that the benefits offered by the warranty are revoked if non-approved products are introduced to the installed Belden Cabling Systems. To regain the benefits of the warranty in such cases, a Networking Contractor must apply and validate all corrective modifications deemed necessary by Belden Inc.
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27 11 00 Communications Equipment Room Fittings

27 11 16 Communications Cabinets, Racks, Frames, and Enclosures 27 11 16.01 Racks

- 27 11 16.01.A All racks shall provide cable management and support elements for cordage at the front of the rack. They shall also provide cable management, support, and protection elements for the cables and/or equipment pigtails placed along the legs of the rack.
- 27 11 16.01.B Free-standing racks shall be available in welded and knock-down assembly versions and equipped with two vertical and two universal channels.
- 27 11 16.01.X TC and IDF racks, wire manager and accessory configuration:

Belden Part Number	Description
Racks and wire managers	
BHRR194	7' AL Rack, 12-24 tapped holes black, (Top waterfall separate)
BHTT196	19" top waterfall for 3" deep racks
XDRGIK-19	Isolation pad for 3" deep rack
BHVHH03	84" h x 3 5/8" w x 18.8" d, Front/Rear Vertical Manager with doors
BHVHH06	84" h x 6" w x 18.8" d, Front/Rear Vertical Manager with doors
BHH191UCFR	1U, duct style with hinged doors, front/rear, BLACK
BHH192UCFR	2U, duct style with hinged doors, front/rear, BLACK
Ladder rack	
BLRT252-12B	12" UNIVERSAL CABLE RUNWAY BLACK
BLWAS421-12B	12" WallAngleSup Kit, Cbl Rnw
BLTSB312-12B	12" TriangSupBrckt Kit, Alum
BLJSU302-15B	UL ClassJunction-Splice Kit-BK (Corner splice kit)
BLBSU301-15B	UL Class Butt-Splice Kit-BK
BLVWB608-00B	Vert Wall Bracket, pair, Black
BLFK309-01B	CABLE RUNWAY FOOT KIT
BLPEC642-002	EndCaps for 1-1/2"x3/8" Rnw(2)
BLRRD100-12B	12" Rnw Rad Drop, XMember-BK
BLCRP596-06B	Retaining post
BLRTR595-9B	3" CRacktoRnw MPlate 9-12"-BK (19" top plate)
<i>18" ladder rack and fittings also available</i>	

- 27 11 16.02 Rack installation
- 27 11 16.02.A Racks shall be securely attached to the concrete floor using a minimum 9.5 mm (0.375 in) hardware or as required by local codes.
- 27 11 16.02.B Racks shall be placed with a minimum of 914 mm (36 in) clearance from the walls on all sides of the rack. When mounted in a row, there shall be a minimum of 914 mm (36 in) clearance from the wall behind the racks, in front of the row of racks, and from the walls at the ends of the row.
- 27 11 16.02.C All racks shall be grounded to the TGB in accordance with Section 27 05 26 of this document.
- 27 11 16.02.D Rack-mount fasteners not used for installing patch panels and other hardware shall be bagged and left with the rack upon completion of the installation.
- 27 11 16.02.E Rack-mount termination equipment shall be installed in accordance with the manufacturer's recommendations and installation guides.
- PDU's: Each enclosure and rack shall have PDU's installed per the **FAMU IT Department** requirements.
- 27 11 16.02.F Wall-mount termination equipment shall be installed on 1.2 m x 2.4 m x 19 mm (4 ft x 8 ft x 0.75 in) void-free plywood. The plywood shall be mounted 0.3 m (1 ft) above the finished floor. The plywood shall be painted with two coats of gray, fireretardant paint.
- Approved Backboard Mfg; Readyspec pre-made backboards
- Or field fabricated to meet physical and fire rating requirements of the Florida Building Code.
- 27 11 16.02.G Wall-mount termination equipment shall be installed in accordance with the manufacturer's recommendations and installation guides.
- 27 11 19 Communications Termination Blocks and Patch Panels
- 27 11 19.03 Patch panels
- 27 11 19.03.A The patch panel system shall provide a centralized termination, identification, and service assignment point for Cat 6A cabling and cordage in TEs/TRs/ERs.
- 27 11 19.03.B The patch panels used to terminate the 4-pair balanced twisted-pair cable shall have the following characteristics:
- 1.The patch panel offering shall be available in 24-port 1U, 48-port 1U, 48-port 2U, and 72-port 2U in flat and angled configurations.
 - 2.The patch panel offering shall include a front accessible panel with 1-port modularity to facilitate installation in tight spaces.
 - 3.The rear cable management for the patch panels shall be integrated in the design of the panel and require no additional accessories to dress terminated cables.
 - 4.The transmission characteristics of the patch panels shall be guaranteed to 625 MHz for all ports.

- 27 11 19.05 Copper termination hardware installation
- 27 11 19.05.A Cables shall be dressed and terminated in accordance with standards-based recommendations, the manufacturer's recommendations/installation guides, and industry best practices.
- 27 11 19.05.B The twisted pairs shall be guided, positioned and secured at the connector termination point using a termination device that locks the pairs in place to prevent untwisting of pairs into the cable when terminating the conductors.
- 27 11 19.05.C The termination device holding the wires in place at the rear of the connector shall withstand a tensile force of 15 lbs minimum applied to the cable without impacting the cable/connector continuity
- 27 11 19.05.D The connector termination method shall involve no pair separation making bonded-pair cable quick and easy to terminate.
- 27 11 19.05. E Cables shall be neatly bundled, dressed, and routed to their respective termination connectors. Each patch panel shall terminate a cable bundle separated and dressed back to the point of cable entrance into the equipment cabinet or rack.
- 27 11 19.05.F Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support element(s). Labels obscured from view shall not be acceptable.

27 13 00 Communications Backbone Cabling

27 13 13 Communications Copper Backbone Cabling

- 27 13 13.01 Backbone cables
- 27 13 13.01.A The backbone cabling is the portion of the cabling system that links the termination fields in different TEs/TRs/ERs within a building (and between buildings in a campus environment). It is commonly installed between floors in a vertical orientation.
- 27 13 13.02 Backbone cable installation
- 27 13 13.02.A Backbone cables shall be installed in accordance with standards-based recommendations, the manufacturer's recommendations/installation guides, and industry best practices.
- 27 13 13.02.B A plastic or nylon pull cord with a minimum test rating of 90 kg (200 lb) shall be co-installed with the cable in any conduit.
- 27 13 13.02.C Where cables are routed using conduits, the backbone and horizontal cables shall be installed in separate conduits.
- 27 13 13.02.D Where cables are installed in an air return plenum, any non-plenum cable shall be installed in metallic conduit.
- 27 13 13.02.E Where backbone cables and horizontal cables are installed in a cable tray or wireway, backbone cables shall be installed first and segregated from the horizontal cables.
- 27 13 13.02.F All backbone cables shall be securely fastened to a wall of the TE/TR/ER served.

- 27 13 13.02.G Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip as well as on alternating floors or as required by local codes. For backbone cables intended to carry 10 Gb/s transmission, suitable means shall be provided to separate the cables that are bundled together in a wire mesh grip, for example using sleeves or spacers between cables.
- 27 13 13.02.H Vertical cable runs shall be supported by messenger strand, cable ladder, or any other method that provides adequate support for the weight of the cable.
- 27 13 13.02.I Large bundles of backbone cables and/or heavy cables shall be attached to support elements using metal clamps and/or metal banding.

27 15 00 Communications Horizontal Cabling

27 15 13 Communications Copper Horizontal Cabling

- 27 15 13.01 Topology
- 27 15 13.01.A The horizontal cabling shall be installed using a star topology, typically extending from centralized TRs to individual TOs in work areas (WAs).
- 27 15 13.01.B No run shall exceed 90 m (295 ft), as measured from the cable termination point at each end. An additional 10 m (33 ft) is allowed for cordage at both ends, for a maximum allowable end-to-end or channel length of 100 m (328 ft).
- 27 15 13.02 Horizontal cables
- 27 15 13.02.A The 4-pair balanced twisted-pair cables shall be available in Bonded pair and non-Bonded pair configurations. The characteristics listed below shall apply to both configurations.
- 27 15 13.02.B The cables will be available in plenum (CMP), non-plenum (CMR) and low smoke zero halogen (LSOH/LSZH), and limited combustible (LC) versions. The minimum recommended installation temperature shall be 5 °C (40 °F). The temperature rating shall be 60 °C (140 °F).
- 27 15 13.02.C The C6A cables shall include a polymer pair separator (EquiSpline design) and an effective noise barrier (EquiBlock barrier technology) to optimize internal near-end crosstalk (NEXT) performance and minimizes alien near-end crosstalk (ANEXT) coupling between cables.
- 27 15 13.02.D The effective C6A cable OD on the cables shall be 0.273 (6.93 mm) on the CMR version and 0.265 (6.73 mm) on the CMP version. The effective cable OD is the diameter of a six-around-one cable bundle divided by 3.
- 27 15 13.02. E The minimum bend radius of the cable shall be 1.10 in (29.94 mm) for CMP and the CMR versions.
- 27 15 13.02.F The cable conductors shall be 23 AWG solid copper.
- 27 15 13.02.G The guaranteed values for the primary transmission characteristics of the cable are as follows:

Maximum DC resistance (at 20 °C)	9.38 ohms/100 m (328 ft)
Maximum DC resistance unbalance	5%
Maximum mutual capacitance	5.6 nF/100 m (328 ft)
Maximum capacitance unbalance	330 pF/100 m (328 ft)
Maximum propagation delay skew	25 ns/100 m (328 ft)
NVP – plenum	72% @ 10 MHz
NVP – non-plenum	68% @ 10 MHz

- 27 15 13.03 Horizontal cable installation
- 27 15 13.03.A Horizontal cables shall be installed in accordance with standards-based recommendations, the manufacturer’s recommendations/installation guides, and industry best practices.
- 27 15 13.03.B A plastic or nylon pull cord with a minimum test rating of 90 kg (200 lb) shall be co-installed with the cable in any conduit.
- 27 15 13.03.C Cable raceways shall not be filled greater than the TIA-569-D recommended maximum fill for the particular raceway type, of initially no more than 25%.
- 27 15 13.03.D Cables shall be installed in continuous lengths from origin to destination. An exception is made for one CP in any cabling run.
- 27 15 13.03.E Where cables are installed in an air return plenum, any non-plenum cable shall be installed in metallic conduit.
- 27 15 13.03.F If CPs are used, they shall comply with the provisions indicated in ANSI/TIA-568-D.0 and be placed in accessible locations and housed in enclosures intended and suitable for that purpose.
- 27 15 13.03.G If a J-hook or trapeze system is used to support cable bundles, all horizontal cables shall be supported at every 1.2 m to 1.5 m (48 in to 60 in) intervals. It is recommended that the support surface is rounded without any sharp edges and at least 2 inches wide. Do not exceed the manufacturer’s recommended quantity of cables for the cable support system. At no point shall cable(s) rest on acoustic ceiling grids or panels.
- 27 15 13.03.H Horizontal cables shall be bundled in groups of no more than 48 cables. Cable bundle quantities in excess of 48 cables may cause deformation of the bottom cables within the bundles, which will degrade the performance of those cables.
- 27 15 13.03.I Cable shall be installed above fire-sprinkler systems and shall not be attached to such systems or any associated ancillary equipment or hardware. The cabling system and its associated pathways shall be installed so that they do not obscure any valves, fire alarm conduit(s), boxes, or other control devices.
- 27 15 13.03.J Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the Vendor shall install appropriate carriers to support the cabling.

- 27 15 13.03.K Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Vendor prior to final acceptance at no cost to the owner of the Belden System 10GX.
- 27 15 13.03.L Cables shall be identified by a permanent self-adhesive label in accordance with Section 27 05 53 of this document and TIA/EIA-606-B. The cable label shall be applied to the cable behind the faceplate, on a section of cable that can be accessed by removing the cover plate.
- 27 15 13.03.M Balanced twisted-pair cable shall be installed so that there are no bends smaller than 4 times the OD of the cable at any point in the run or at the termination points.
- 27 15 13.03.N The pulling tension on any 4-pair balanced twisted-pair cable shall not exceed 110 N (25 lbf).
- 27 15 43 Communications Faceplates and Connectors
- 27 15 43.01 General
- 27 15 43.01.A Each horizontal cable shall be terminated at its designated WA in a modular connector assembly using modular jack designed to snap into a faceplate.
- 27 15 43.01.B The WA modular connector assembly/faceplate shall accommodate:
1. A minimum of two cabling runs.
 2. Blank fillers, to be installed in any outlet port in the faceplate that is not occupied by a modular connector assembly.
- 27 15 43.01.C Multiple WA outlets that are in close proximity on drawings (and not separated by physical barriers) may be combined in a single faceplate. The Vendor shall be responsible for determining the optimum compliant configuration.
- 27 15 43.01.D The same orientation and positioning of modular connector assemblies on faceplates shall be used throughout the project. Prior to installation, the Vendor shall submit the proposed configuration(s) for WA modular connector assemblies/faceplates for approval by the owner of the Belden System 10GX.
- 27 15 43.01.E All WA outlets shall accommodate printed label strips for outlet identification purposes. Printed labels shall be permanent and shall comply with TIA/EIA-606-B. Hand-written labels shall not be accepted.
- 27 15 43.02 Faceplates
- 27 15 43.02.A The faceplate housing the modular connector assemblies shall provide a symmetrically centered appearance for the modules.
- 27 15 43.02.B The faceplate housing the modular connector assemblies shall have no visible mounting screws.
- 27 15 43.02.C The faceplate housing the modular connector assemblies shall have builtin labeling windows to facilitate outlet identification.
- 27 15 43.02.D The faceplates shall be available in 2 different styles: fixed-port design faceplate (wall-mounting) and adapters (modular furniture, surface-mount) as well as modular design (field-configurable).
- 27 15 43.02.E All faceplates designs shall be compatible with UTP, F/UTP and multimedia modules.

- 27 15 43.02.F All plastic faceplates shall be made of UV-stable fire-retardant UL 94V-0 material.
- 27 15 43.02.G All plastic faceplates shall have the option of being mounted on adapter boxes for surface mount installation.
- 27 15 43.02. H The field-configurable faceplate shall have a modular design that allows connectors to be inserted and removed from the frame without unscrewing it from the wall.
- 27 15 43.03 Connectors
- 27 15 43.03.A The modular jack assemblies used to terminate the 4-pair balanced twisted-pair cable shall have the characteristics listed below.
- 27 15 43.03.B The connectors shall be modular in form, with available mounting options for TOs, CPs, rack-mount panels, and wall-mount panels.
- 27 15 43.03. C The connector termination method shall involve no pair separation making bonded-pair cable quick and easy to terminate.
- 27 15 43.03. D The connector termination method shall offer the possibility to change the connector interface without having to re-terminated the cable (ex.: Change jack color or replace a jack by a plug interface)
- 27 15 43.03.E The connectors shall incorporate crosstalk compensation circuitry at their plug interfaces, using flexible printed circuit board (PCB) technology in order to meet the TIA 568-C.2 mated connection requirements extended in frequency up to 625 MHz for C6A.
- 27 15 43.03.F When coupled to cordage, the transmission characteristics of the connectors will be guaranteed to 625 MHz for Category 6A applications. The minimum guaranteed values at 625 MHz will be as follows:
- NEXT @ 625 MHz 37.1 dB
 PSANEXT @ 625 MHz 56.1 dB
 Return loss @ 625 MHz 13.0 dB
- NEXT = Near-end crosstalk
 PSANEXT = Power-sum alien near-end crosstalk
- 27 15 43.04 Work area installation
- 27 15 43.04.A Work area TOs shall be installed in accordance with standards-based recommendations, the manufacturer's recommendations/installation guides, and industry best practices.
- 27 15 43.04.B Cables shall be dressed and terminated in accordance with standards-based recommendations, the manufacturer's recommendations/installation guides, and industry best practices.
- 27 15 43.04.C Slack cable shall be coiled in flush or surface-mount TOs if adequate space is provided to house the cable coil without exceeding the manufacturer's bend radius limitations. In hollow-wall installations where box eliminators are used, cable slack can be stored in the wall. No more than 300 mm (12 in) of slack shall be stored in a TO, modular furniture raceway, or insulated wall. Excess slack may be loosely coiled and stored in the ceiling above each WA.

- 27 15 43.04.D The twisted pairs shall be guided, positioned and secured at the connector termination point using a termination bar that locks the pairs in place to prevent untwisting of pairs into the cable when terminating the conductors.
- 27 15 43.04.E Bend radius of the cable in the termination area shall not be less than 4 times the OD of the cable.
- 27 15 43.04.F Data outlets (unless otherwise noted in drawings) shall occupy the bottom positions on faceplates. Data outlets in horizontally oriented faceplates shall occupy the right-most positions.
- 27 15 43.04.G Voice outlets (unless otherwise noted in drawings) shall occupy the top positions on faceplates. Voice outlets in horizontally oriented faceplates shall occupy the left-most positions.

27 16 00 Communications Connecting Cords, Devices, and Adapters

27 16 19 Communications Patch Cords, Station Cords, and Cross-Connect Wire

- 27 16 19.01 Rope
 - 27 16 19.01.A The work area cords, patch cords, and equipment cords/pigtails shall have the characteristics listed below.
 - 27 16 19.01.B The cordage shall use 23 AWG solid copper conductors in a bonded pair configuration for reliable long-term channel performance to 625 MHz for Category 6A applications. A cross-web element shall be used for consistent pair separation and minimal NEXT coupling. The patch cables shall use a dual jacket construction with an internal screen sandwiched between the two jackets to maintain pair symmetry with respect to screen when manipulating the cable and to provide the highest alien crosstalk isolation.
 - 27 16 19.01.C The maximum cable diameter of the cordage shall be 6.73 mm (0.265 in). The minimum bend radius shall be 26.9 mm (1.06 in).
 - 27 16 19.01.D The cordage shall be installed with a **blue jacket**.
 - 27 16 19.01.E The management bar technology of the modular cord shall have tightly controlled and centered plug NEXT performance. The tolerance on plug NEXT is within half the range specified in Annex G of the TIA 568-C.2 (Category 6A) standard for 3-6 / 4-5 pair combination.
 - 27 16 19.01.F When mated to a connector, the transmission characteristics of the cordage will be guaranteed to 625 MHz for WAP's. The minimum guaranteed values for a mated connection at 625 MHz shall be as follows:

NEXT @ 625 MHz	37.1 dB
PSANEXT @ 625 MHz	56.1 dB
Return loss @ 625 MHz	13.0 dB

NEXT = Near-end crosstalk
PSANEXT = Power-sum alien near-end crosstalk
 - 27 16 19.01.G The transmission characteristics of individual cords and their corresponding channels shall comply with the requirements for Category 6A performance when tested in a:
 1. Worst-case "bundled" configuration, where 6 other cords surround the cord being tested bound every 8 inches.

ANNEX A: ADDITIONAL INFORMATION

Division 07 – THERMAL AND MOISTURE PROTECTION

07 80 00 Fire and Smoke Protection

07 84 00 Firestopping

07 84 13 Penetration Firestopping

07 84 13.01 Firestop system

07 84 13.01.A A firestop system consists of the item or items penetrating the fire-rated barrier, the opening in the barrier, and the materials used to seal and restore the fire integrity of the penetrated barrier. Firestop systems serve as an effective block against fire, smoke, heat, vapor, and pressurized water streams.

07 84 13.01.B All penetrations through fire-rated building structures (e.g., walls, floors) shall be sealed with an appropriate firestop system. This requirement applies to “through” penetrations (complete penetration) as well as “membrane” penetrations (through one side of a hollow structure). Any penetrating items (e.g., riser slots and sleeves, cables, conduits, cable trays, raceways) shall be properly fire stopped.

07 84 13.01.C Firestop systems shall be UL Classified to ASTM E814 – *Standard Test Method for Fire Tests of Through-Penetration Fire Stops* (UL 1479) and shall be approved by a qualified PE licensed in the jurisdiction where the work is to be performed. One or more drawings illustrating the deployment of the proposed firestop system(s), stamped or embossed by the PE, shall be provided to the owner of the Belden Cabling Systems prior to installing the firestop system(s).

07 84 13.02 Firestop system installation

07 84 13.02.A All firestop systems shall be installed in accordance with the manufacturer’s recommendations/ installation guides and shall be available for inspection by the local AHJ prior to acceptance.