

GUIDELINES

HAS/IT/Design Division
Houston, Texas

ProjectTitle
Proj./CIP No.

(These Guidelines are basic minimum criteria to be met in preparing the final specifications for this section, which is the responsibility of the Designer/Contractor/Installation Team.)

SECTION 272100 DATA COMMUNICATION NETWORK EQUIPMENT

(REV. 09-30-2024-TAB)

PART 1 - GENERAL

1.01 SUMMARY *(Designer to provide a detailed project summary)*

- A. Provide the Local Area Network (LAN) active components and interfaces to be implemented and utilized in the Houston Airport System network to support present and future communications systems requirements.
- B. Provide HAS wireless connectivity for all new construction and/or remodel.

1.02 REFERENCES

- A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.
- B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
- C. Related Work:
 - 1. Section 270553: Identification and Labeling of Communication Infrastructure
 - 2. Section 271045: Restroom Monitoring System
 - 3. Section 271100: Communication Cabinets and Equipment Rooms
 - 4. Section 271300: Backbone and Riser Media Infrastructure
 - 5. Section 271500: Horizontal Media Infrastructure
 - 6. Section 270528: Interior Communication Pathways
 - 7. Section 270543: Exterior Communication Pathways
 - 8. Section 270526: Telecommunications Grounding and Bonding
 - 9. Section 272200: PC, Laptop, and Server Equipment
- D. Conflicts.
 - 1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
 - 2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.
- E. References:
 - 1. National Electrical Manufacturers Association (NEMA)
 - 2. American Society for Testing Materials (ASTM)

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3. National Electric Code (NEC)
4. Institute of Electrical and Electronic Engineers (IEEE)
5. UL Testing Bulletin
6. American National Standards Institute (ANSI) X3T9.5 Requirements for UTP at 100 Mbps

1.03 DEFINITIONS

- A. *ANSI* – American National Standards Institute
- B. *ATM* – Asynchronous Transfer Mode
- C. *EIA* – Electronics Industries Alliance
- D. *Gbps* – Gigabits per second
- E. *IEEE* – Institute of Electrical and Electronic Engineers
- F. *ISO* – International Organization for Standardization
- G. *Mbps* – Megabits Per Second
- H. *MIMO* – Multiple-In and Multiple-Out
- I. *Multi-path* – The possible multiple routes of a single source of RF energy due to reflection, refraction, or diffraction.
- J. *NEC* – National Electrical Code
- K. *NEMA* – National Electrical Manufacturing Association
- L. *RF* (Radio Frequency) – Signal generated by a radio transmitter and sent out through an antenna. The frequency of the transmission is described in terms of the number of cycles per second or Hertz (Hz).
- M. *SFP* – Small Form-Factor Pluggable – Hot-pluggable transceiver used for both telecommunication and data communication applications. Comes in both copper and fiber.
- N. *SNMP* – Simple Network Management Protocol
- O. *TIA* – Telecommunications Industry Association
- P. *TR* – Telecommunications Room

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- Q. *UL* – Underwriter’s Laboratories
- R. *VoIP* – Voice over Internet Protocol
- S. *WAP* – Wireless Application Protocol
- T. *WPA/WPA2* – WiFi Protected Access / WiFi Protected Access II – IEEE 802.11i-2004

1.04 DESIGN AND PERFORMANCE STANDARDS

- A. Standards supported should include, but be not limited to, IEEE 802.3, 10BASET, IEEE 802.3u, 100BaseTX, 1000BaseFX, IEEE 802.11, IEEE 802.3ae-2002, Ethernet MIB (RFC 1643), SNMP MIB II (RFC 1213).
- B. All designs must adhere to HAS Cyber Security Standards.

1.05 SUBMITTALS

- A. Qualifications: Demonstrate compliance with requirements of Paragraph 1.07.A.
- B. Submit Technical Implementation Plan in accordance with 2.06.
- C. Submit manufacturer’s technical data for each product provided.
- D. Submit technical and operations manuals. Manuals shall describe function, operation, and programmable parameters for each card and port for each device to be installed. Manuals shall include required maintenance to be performed.
 - 1. Manuals shall describe function, operation, and programmable parameters for each card and port for each device to be installed. Manuals shall include required maintenance to be performed.
 - 2. Manuals shall be suitable for the training of future personnel by the City, and for use as a reference by currently employed personnel in performing work assignments.
- E. As-built documentation. Notes shall be kept during initial installation and shall be made a permanent part of the installation manual pages as required.
- F. For each active device installed, provide a printed configuration including a printout of the device as displayed on the network management system. Printed configuration parameters for each port on the device shall accompany the written report.
- G. Other information in support of the design, fabrication, and installation of the LAN system.

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- H. An implementation schedule listing dates for LAN equipment installations for approval by the City Engineer. The dates of LAN equipment installations shall be in accordance with dates for installation of the various special systems and users. It is incumbent upon the LAN implementers to include the dates for special system and user installs into the schedule.
- I. Include spares list to be approved by HAS IT Project Manager for approval.

1.06 CONTRACTOR'S DUTIES

- A. Perform all work, coordination, systems integration, engineering design, and testing, and shall provide all products required in order to ensure a fully operative system and proper installation of equipment. System operability and proper installation shall be verified via completion of the acceptance test plan.
- B. Coordinate all installation activities and details with the Houston Airport Systems' Information Technology (HAS IT) Representative. The HAS IT Representative shall be responsible for approving the final configuration of all equipment supplied as part of this specification.
- C. Provide all system documentation and submittals.
- D. Provide warranty and maintenance support as specified.
- E. Provide all calculations and/or analysis to support design and engineering decisions as specified in Submittals.
- F. Provide and pay for all labor, materials, and equipment. Pay required sales, gross receipts, and other taxes.
- G. Secure and pay for plan check fees, permits, fees, and licenses necessary for execution of Work as applicable for the project.
- H. Give required notices.
- I. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities that bear on performance of Work.

1.07 QUALITY ASSURANCE

- A. Contractor Qualifications:
 - 1. The contractor must be certified by the manufacturer of the products to be installed adhere to the engineering, installation and testing procedures, and utilize the

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authorized manufacturer components and distribution channels in provisioning this Project.

2. All members of the installation team must be certified by the manufacturer(s) as having completed the necessary training to complete their part of the installation.
 3. Contractor shall provide five references for projects of approved equivalent scope, type and complexity of work completed within the last five years.
- B. Equipment and materials supplied for the LAN shall be a standard product of manufacturers regularly engaged in the manufacture and installation of information backbone technologies and shall be the manufacturer's latest standard design. Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components. Electrically powered equipment shall be UL approved. Electronic equipment shall meet the requirements of the FCC (Federal Communications Commission) Title CFR 47 Part 15.
- C. All hardware, software, firmware, and/or operating system requirements given are the minimum requirements. The Contractor's product shall meet or exceed these requirements. The product selected shall meet the operational, functional, and performance requirements specified herein. Additionally, due to the rapid advancement and antiquation of technology related products, the supplied product shall be the "contemporary technical equivalent" of that specified. "Contemporary technical equivalent" shall be based on a comparison of technology at the time of publication of specification to the technology at the time of the first product submittal. Final product approval is at the sole discretion of the City.

1.08 MAINTENANCE AND SUPPORT

- A. Provide the manufacturer's standard maintenance and support services for all hardware and software associated with this system at no additional charge for a period of not less than three years. It will be the responsibility of the HAS IT Representative to provide the operational maintenance and support of the installed system. Coordination through the City Engineer and the HAS IT Representative shall be required by the installation contractor to ensure that all documentation for the manufacturer's maintenance and support programs are in place.
- B. All lead technicians performing installation shall have a minimum of two years experience on the proposed system and be manufacturer certified on all hardware/software applications.

1.09 EXTENDED WARRANTY

- A. Provide the manufacturer's warranty for all equipment installed at no additional charge for a period of not less than three years. The warranty shall ensure that the installed

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equipment will conform to its description and any applicable specifications, and shall be of good quality for the known purpose for which it is intended. The warranty shall allow for replacement or repair at the discretion of the City Engineer and shall include all upgrades for firmware and/or operating systems.

- B. Software License
 - 1. Required software licenses shall be identified and supplied by the Contractor. Licenses shall be "Site Licenses" which shall cover all equipment installed now or in the future.
 - 2. All software licenses and warranties shall be registered in the name of Houston Airport System.

1.10 PROCUREMENT

- A. Procure equipment specified in this document as dictated by the timeline in Appendix B in order to make sure that the technology is acquired in a timely fashion, but not outdated by the installation date.
- B. Submit a copy of Appendix B "Technology Implementation Schedule" as a part of the equipment submittals required elsewhere in this document. The Contractor shall complete the columns headed "Quantity", "Procurement Lead Time", "Start Date or Dependent", and "Installation Duration".
- C. The "Procurement Lead Time" shall be expressed in days or weeks, and shall include time required for the contractor's personnel to order and receive the material. Substantiation may be required.
- D. "Start Date or Dependent" and "Installation Duration" should be an accurate estimate based upon known facts in the project. Substantiation may be required.
- E. The Contractor shall not purchase any materials requiring submittals until the HAS IT approves the submittal for that material and the Technology Implementation Schedule.
- F. The Contractor shall not purchase any materials requiring submittals until the date established by the HAS IT as the Purchasing Authorized Date. The Purchasing Authorized Date will be reflected in the "Purch Auth" column of Appendix B as a part of the Submittal Review process.

PART 2 - PRODUCTS

2.01 EQUIPMENT MANUFACTURERS

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- A. LAN Equipment: Unless otherwise specified, furnish products manufactured by Cisco Systems. Substitutions for specified Cisco Systems components are NOT permitted.
- B. Uninterruptible Power Supply (UPS): Eaton or submitted and approved equivalent.
- C. Workstations: Reference Specification 272200 – PC, Laptop and Server Equipment.
- D. Network Printers: Reference Specification 272200 - PC, Laptop and Server Equipment.
- E. Wireless Access Point: Aruba or submitted and approved equivalent.
- F. Wireless Access Point Enclosure: American Access Technologies, Inc. or submitted and approved equivalent.
- G. For cabinets/racks and cabling infrastructure: Reference Specification 271100 – Cabinets and Equipment Rooms.
- H. Courtesy Phone: CEECO or submitted and approved equivalent.
- I. Cat 6 Media extenders Veracity Global or submitted and approved equivalent.

2.02 GENERAL LAN REQUIREMENTS

- A. The LAN configuration shall be a hierarchical star utilizing centralized core switches that star out to individual edge level devices located throughout the premises in designated areas. Single Mode Fiber Optic Cable (provided in Section 271300) provides the connectivity between all devices. Each edge level device services the HAS communications equipment (Administrative LAN workstations, building management stations, etc.) via UTP Copper Cabling.
- B. All LAN equipment shall provide Internet Protocol (IP) switching across all types of network technologies and topologies, including Ethernet, Fast Ethernet and Gigabit Ethernet.
- C. The LAN architecture shall be based on 10 Gbps between the two core networking switches located in the MDF and the edge level networking equipment located in the TR. In addition, the edge level equipment shall be dual homed to the separate core devices where applicable.
- D. Each active device shall be accessible from a network, console or auxiliary RS-232 port. A configuration specialist shall be able to enter supervisory mode and change default configurations as appropriate for required operation of special system components.

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- E. Each active device shall be capable of generating Simple Network Management Protocol (SNMP) or SNMP3 alarms. The device shall be respondent to RMON inquiries from an expert level network management inquirer.
- F. All network equipment shall be compliant to physical and operational parameters. The equipment shall be capable of responding to SNMP, SNMP3 and/or RMON network management program calls from the Network Management System.
- G. Network equipment shall provide multimedia and multicast support through use of Protocol Independent Multicast (PIM), Internet Group Management Protocol (IGMP).
- H. Network equipment shall support full-duplex connectivity on links (10Base-TX, 100Base-TX, 1000Base-TX, 100Base-F/TX, and 1000Base-FX).
- I. All fiber interfaces on network switches must support Digital Optical Monitoring (DOM) feature.
- J. All network equipment shall be Virtual Local Area Network (VLAN) compatible based on both port and MAC addresses. VLAN assignments shall be configurable from a centralized administrative console.
- K. Network equipment shall not require re-configuration of end-station network interface cards or network interface card drivers to accommodate intra-VLAN and inter-VLAN traffic.
- L. Network equipment shall support automated VLAN creation and administration capabilities.
- M. Network equipment shall support port mirroring. This shall be done by sending frames directly from a specified port to another switch port or from an external network analyzer.
- N. Network equipment for use in the main MDF and TRs shall belong to one family of product. The equipment must allow for common sparing of all Interface Processor Modules and all Supervisor Modules.
- O. Network equipment shall support Terminal Access Controller Access Control System (TACACS), in order to provide secure port filtering. The equipment must enable individual ports to allow access only to certain workstations.
- P. All active LAN devices shall include all software as required for interconnectivity. All active devices shall have fully functional network management options installed.
- Q. No equipment shall be purchased if it is on the manufacture's "end of life" or "end of support list" in the next year.

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2.03 LAN HARDWARE REQUIREMENTS

- A. All equipment shall be rack mountable in standard 19-inch racks. Contractor is responsible for providing fans, shelves, drawers, special power wiring, ground connections, and adapters of any kind necessary to accommodate the system installation, operation, testing, or maintenance. Contractor shall provide the appropriate factory or custom rack mount adapters for all equipment installed in the equipment rack, whether specifically itemized or not. Contractor shall cover unused slots using blank panels.
- B. Fiber and Copper Patch Cords – Adequately sized fiber and copper patch cords shall be provided for each installed port in the LAN under Section 271500, “Horizontal Media Infrastructure.”
- C. Core Networking Equipment
 - 1. The core layer networking equipment shall be located in the MDF as shown in the contract drawings.
 - 2. The chassis shall accommodate a minimum of nine (9) interface modules and provide connectivity to mixed network topologies. The use of a chassis is to support networking topologies without the use of external bridges or routers. The chassis shall have redundant power supplies, in the form of hot-swappable modules which can equally share the chassis power load. If one power supply fails the system shall notify the network manager and also provide a display on the front of the chassis. The chassis shall support quality of service through support of IP Precedence, Resource Reservation Protocol (RSVP), and 802.1p.
 - 3. The switch backplane shall provide a minimum of 1440 Gbps switching fabric on the network bus.
 - 4. The chassis shall include modules with a minimum of 24 Gigabit Ethernet (single mode fiber) ports to be connected to distribution layer switches in the Terminal MDFs.
 - 5. The chassis shall support:
 - a. Redundant supervisor modules.
 - b. Hot swappable line cards.
 - c. Layer 2 and Layer 3 IP switching.
 - d. Up to 192 10 Gigabit or 25 Gigabit Ethernet ports.
 - e. Support broadcast suppression.
 - f. Support IGMP snooping and pruning.
 - 6. The core switching equipment shall, at a minimum, a Cisco Catalyst 9606 with the following modules:
 - a. Two Supervisor modules(C9600-SUP-1/2).
 - b. 48-port 25/10/1 Gigabit Ethernet module(s) with enough SFP/+ ports to

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support the connectivity requirements for core to core and core to distribution switch uplinks(C9600-LC-48YL). All ports shall include Long Wavelength / Long Haul (25/10/1 Gigabit LX/LH) SFPs (single-mode).

- c. Four 2000W AC power supplies (C9600-PWR-2KWAC).
- d. Software License - DNA Advantage 3 Year (C9600-DNA-A-3Y)
- e. Smart License – Prime Infrastructure Lifecycle Smart License (PI-LFAS-T)
- f. License – Prime Infrastructure Lifecycle 3 Years Term (PI-LFAS-AP-T-3Y)

D. Edge Level Equipment

1. The edge level networking equipment shall be located in the individual TR as shown in the contract drawings unless noted otherwise.
2. The devices shall provide a minimum of 10 Gbps switching fabric.
3. The device shall include a module(s) with the appropriate RJ45 Category 6 UTP 10/100/1000BaseTX ports to support the port requirements shown on the contract drawings. In addition, the device shall have the capability to “stack” with additional devices to increase the available port count.
4. The edge level devices shall have the capability to simultaneously accommodate a minimum of two Gigabit Ethernet uplinks and 24 10/100/1000 VoIP Ethernet ports.
5. The devices shall support the bonding and trunking of Fast Ethernet and Gigabit Ethernet ports.
6. The edge level switching equipment shall be Cisco Catalyst C9300-24U-E or submitted and owner-approved equivalent. Use 24 port switch if 16 ports or less are active. Upgrade to the 48 port switch (C9300-48U-E) if more than 16 ports are active. Switches must also come with network module C9300-NM-8X (8 x 10gb), single-mode SFP+, and three year term license (C9300DNA-E-24-3Y for 24 port and C9300DNA-E-48-3Y for 48 port). Switches are to be ordered with the following power supply - PWR-C1-1100WAC – 1100W AC power supply.
7. The edge level equipment for industrial environment applications shall be Cisco IE-3200-8P2S-E or submitted and owner-approved equivalent. The switch supports 8 POE/POE+ copper connections and 2 SFP ports for uplinks. Power supply to be provided is PWR-IE170W-PC-AC= and 2 single-mode SFPs.

2.04 UPS HARDWARE REQUIREMENTS

- A. Room wide UPS is the preferred type of UPS for all Telecommunications rooms. Eaton model 93PM for all three-phase UPS applications. The three-phase UPSs shall not be installed in IDF/MDFs. The electrical engineer must size the UPS for 25 percent future growth and must be approved by HAS Technology project manager. The preferred UPS design is two or more centralized UPSs in parallel for redundancy and ease of maintenance. UPS power distribution (depending on application) shall be 480v and step down to 240v at the nearest electrical room nearest the IDF. Unit must have enough batteries to keep all equipment attached to the unit running for minimum of one (1) hour.
 1. Lithium batteries are to be installed.

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2. External maintenance bypass switch must also be installed along with the UPS.
 3. The optional Energy Saver System(ESS) shall be provided.
 4. Environmental Probe Gen 2(EMP Gen2) shall be provided.
 5. Eaton gigabit network card(Network-M2) shall be provided.
- B. If a room wide UPS is not installed provide a rack-mounted UPS in equipment cabinet in the Telecommunications Room that houses LAN equipment. The UPS shall have an output capacity of 5KVA (3750 Watts). All remaining TRs shall be supported by a UPS as well. Unit must have enough batteries to keep all equipment attached to the unit running for minimum of one (1) hour. If specified UPS cannot be installed due to space restraints a smaller UPS (Eaton 5PX1500RTN) can be substituted if submitted and owner-approved prior to installation, runtime requirements and environmental probe are still required.
- C. The UPS interface port shall have an RS-232 communications port and a 10/100 Base-T Ethernet for LAN management. Include optional environmental probe (Eaton part # 42R4317).
- D. The control panel shall have a LED status display for load and battery bar-graphs in addition to replace battery and overload indicators.
- E. The Output Connections shall include as a minimum one NEMA L6-30R, two NEMA L6-20R, and eighteen NEMA 5-15R.
- F. Input connection shall be nominal 208 V via L6-30P plug.
- G. Include software and interface card to provide Web/SNMP management through 10/100Base-T Ethernet port. Management software shall include the following attributes:
1. Shall allow complete configuration of the UPS devices from a remote location
 2. Shall provide periodic UPS self-tests
 3. Shall provide full control over UPS transfer settings
 4. Shall provide user name and password security
 5. Shall log all power events with a description
- G. UPS shall be Eaton 9PX5KTF5 5000VA RM 5U 208V series with Web / SNMP Management Card for Ethernet and optional environmental probe, or submitted and owner-approved equivalent.
- 2.05 WIRELESS ACCESS POINT
- A. General: One 802.11ax Wireless Access Point shall be installed per the Drawings.

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B. INDOOR Access Points

1. AP-630 series specifications
 - a. AP-635 or AP-634 (depending on the application)
 - b. 2.4- GHz (287 Mbps max), 5-GHz (1.2 Gbps max) and 6-GHz (2.4 Gbps max) radios (total 3.9 Gbps).
2. AP type: Indoor, tri radio, 6 GHz 802.11ax, 5 GHz 802.11ax and 2.4 GHz 802.11ax
3. 4x4 MIMO with three spatial streams and up to 1.733 Gbps wireless data rate
4. Supported frequency bands:
 - a. 2.4000 GHz to 2.4835 GHz
 - b. 5.150 GHz to 5.250 GHz
 - c. 5.250 GHz to 5.350 GHz
 - d. 5.470 GHz to 5.725 GHz
 - e. 5.725 GHz to 5.850 GHz
 - f. 5.850 to 5.895 GHz U-NII-4
 - g. 5.925 to 6.425 GHz U-NII-5
 - h. 6.425 to 6.525 GHz U-NII-6
 - i. 6.525 to 6.875 GHz U-NII-7
 - j. 6.875 to 7.125 GHz U-NII-8
5. Available channels: Dependent upon configured regulatory domain
6. Dynamic frequency selection (DFS) optimizes the use of available RF spectrum
7. Supported radio technologies:
 - a. 802.11b: Direct-sequence spread-spectrum (DSSS)
 - b. 802.11a/g/n/ac: Orthogonal frequency-division multiplexing (OFDM)
 - c. 802.11n/acv2: 4x4 MIMO with up to three spatial streams
8. Supported modulation types:
 - a. 802.11b: BPSK, QPSK, CCK
 - b. 802.11a/g/n: BPSK, QPSK, 16-QAM, 64-QAM
 - c. 802.11ac: BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM
9. Transmit power: Configurable in increments of 0.5 dBm
10. Maximum (aggregate, conducted total) transmit power (limited by local regulatory requirements):
 - a. 2.4-GHz band: +21 dBm (18 dBm per chain)
 - b. 5-GHz bands: +21 dBm (18 dBm per chain)
 - c. 6-GHz bands: +21 dBm (18 dBm per chain)
11. Advanced cellular coexistence (ACC) feature to effectively deal with interference from cellular systems
12. Maximum ratio combining (MRC) for improved receiver performance

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13. Cyclic delay diversity (CDD) for improved downlink RF performance
14. Short guard interval for 20-MHz, 40-MHz and 80-MHz channels
15. Space-time block coding (STBC) for increased range and improved reception
16. Low-density parity check (LDPC) for high-efficiency error correction and increased throughput
17. Transmit beam-forming (TxBF) for increased reliability in signal delivery
18. Supported data rates (Mbps):
 - a. 802.11b: 1, 2, 5.5, 11
 - b. 802.11a/g: 6, 9, 12, 18, 24, 36, 48, 54
 - c. 802.11n: 6.5 to 450 (MCS0 to MCS23)
 - d. 802.11ac: 6.5 to 1,300 (MCS0 to MCS9, NSS = 1 to 3)
19. 802.11n high-throughput (HT) support: HT 20/40
20. 802.11acv2 very high throughput (VHT) support: VHT 20/40/80/160
21. 802.11n/acv2 packet aggregation: A-MPDU, A-MSDU

C. Power

1. Maximum power consumption: 25.3 watts, plus up to 5.9 watts for attached USB device and internal overhead.
2. Power sources sold separately
3. Direct DC source: 12 Vdc nominal, +/- 5%
4. Power over Ethernet (PoE): 48 Vdc (nominal) 802.3af or 802.3at-compliant source
 - a. Efficient mode PoE – power save with 802.3af PoE and limited functionality
 - 1) USB port disabled
 - 2) Second Ethernet port disabled
 - 3) 2.4-GHz 802.11n radio in 1x3:1 spatial-stream mode
 - 4) 5-GHz 802.11ac radio operates without restrictions*
 - b. Unrestricted functionality with 802.3at PoE+
5. *With ArubaOS software 6.3.0, the 5-GHz 802.11ac radio operates in 2x3:2 spatial stream mode when the AP is powered by 802.3af PoE. This restriction has been removed in 6.3.1.

D. Antennas

1. AP-634: Four RP-SMA connectors for external dual-band antennas. Internal loss between radio interface and external antenna connectors (due to diplexing circuitry): 1.5 dB in 2.4 GHz and 3.0 dB in 5 GHz. Chose the appropriate antenna to the installation application.
2. AP-635: Eight integrated down-tilt omni-directional antennas for 4x4 MIMO with maximum antenna gain of 3.5 dBi in 2.4 GHz and 4.5 dBi in 5 GHz. Built-in antennas are optimized for horizontal ceiling mounted orientation of AP-635.

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E. Other interfaces

1. Two 10/100/1000BASE-T Ethernet network interfaces (RJ-45)
 - a. Auto-sensing link speed and MDI/MDX
 - b. Load balancing support to achieve platform throughput greater than 1 Gbps
 - c. 802.3az Energy Efficient Ethernet (EEE)
 - d. PoE-PD: 48 Vdc 802.3af PoE or 802.3at PoE+
2. DC power interface, accepts 1.7/4.0mm center-positive circular plug with 9.5 mm length.
3. USB 2.0 port (Type A connector)
4. Serial console interface (RJ-45, TTL levels)
5. Visual indicators (LEDs):
 - a. Power/system status
 - b. Ethernet link status (2x; ENET0, ENET1)
 - c. Radio status (2x; RAD0, RAD1)
6. Bluetooth Low Energy (BLE) radio
 - a. --Up to 4 dBm transmit power (class 2) and -91 dBm receive sensitivity
 - b. --Integrated antenna with roughly 30 degrees downtilt and peak gain of 5.1 dBi (AP-634/IAP-634) or 2.2 dBi (AP-635/IAP-635)
7. Kensington security slot
8. Reset button

F. Mounting

1. Included with AP:
 - a. Mounting brackets (2) for attaching to 9/16-inch or 15/16-inch T-bar drop-tile ceiling
2. Optional mounting kits:
 - a. Chose the appropriate mounting kit for the specific mounting application. Mounting kits are NOT included with the APs.

G. Environmental

1. Operating:
 - a. Temperature: 0° C to +50° C (+32° F to +122° F)
 - b. Humidity: 5% to 95% non-condensing
2. Storage and transportation:
 - a. Temperature: -40° C to +70° C (-40° F to +158° F)

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H. Regulatory

1. FCC/Industry of Canada
2. CE Marked
3. R&TTE Directive 1995/5/EC
4. Low Voltage Directive 72/23/EEC
5. EN 300 328
6. EN 301 489
7. EN 301 893
8. UL/IEC/EN 60950
9. EN 60601-1-1 and EN 60601-1-2

I. Regulatory Model Numbers

1. AP-634 and IAP-634: APIN0634
2. AP-635 and IAP-635: APIN0635

J. Certifications

1. CB Scheme Safety, cTUVus
2. UL2043 plenum rating
3. Wi-Fi Alliance certified 802.11a/b/g/n/ac

K. Warranty

1. Limited lifetime warranty

L. Minimum operating system software versions

1. ArubaOS 6.3.0.0
2. Aruba Instant 4.0.0.0

M. RF Performance Table

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	Maximum transmit power (dBm) per transmit chain	Receiver sensitivity (dBm) per receive chain
802.11b 2.4 GHz		
1 Mbps	18.0	-92.0
2 Mbps	18.0	-92.0
5.5 Mbps	18.0	-90.0
11 Mbps	18.0	-88.0
802.11g 2.4 GHz and 802.11a 5 GHz		
6 Mbps	18.0	-88.0
54 Mbps	16.0	-75.0
802.11n HT20 2.4 GHz and 5 GHz		
MCS0/8	18.0	-88.0
MCS7/15	14.0	-71.0
802.11n HT40 2.4 GHz and 5 GHz		
MCS0/8	18.0	-85.0
MCS7/15	14.0	-68.0
802.11ac VHT20 5 GHz		
MCS0	18.0	-88.0
MCS9	12.0	-65.0
802.11ac VHT40 5 GHz		
MCS0	18.0	-85.0
MCS9	12.0	-62.0
802.11ac VHT80 5 GHz		
MCS0	18.0	-82.0
MCS9	12.0	-59.0

N.

O. Enclosures

1. Wireless Access Points shall be installed in lockable, stainless steel Nema 4 Enclosure when mounted outdoors or in garage spaces.
2. Include back-plate, ground bus-bar, cable management, document holder, pole/wall mount adapters.
3. Provide 120VAC@15A quad receptacle with surge protection per drawings.
4. Enclosure shall be bonded to ground per NEC.
5. All conduit penetrations shall be made to prevent water ingress through the connections.
6. Enclosure size per drawings.

P. Wireless Access Point Ceiling Enclosure

1. The 802.11ac wireless access point shall be installed in a lockable enclosure mounted to the ceiling. The enclosure shall meet the following specifications:
 - a. Enclosure shall be Oberon Wireless model # 1075-WA or submitted and owner approved equivalent.
 - b. The WAP is installed in such a manner that the antennas, or face of WAP if antennas are integrated, are largely
 - c. within the ABS plastic dome; there is little impact on WAP coverage with antennas largely inside dome
 - d. Back-box is 16 ga. aluminum; door and bezel are textured, white powder-coated steel; RoHS compliant

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- e. Dome is 10" x 10" x 1 ½"; textured white ABS dome (-WA) is UL 94-5VA classified, and clear polycarbonate dome (-CP) is UL 94-5VB classified
- f. Size: Bezel is 15" x 15", back-box is 12 ¾" x 12 ¾" x 3" deep
- g. Knockouts for AC receptacle, (2) keystone jacks, (2) ¾" trade conduit connector
- h. Maximum weight to be installed inside the unit is 25 lbs.
- i. De-rate upper operating temperature limit from +50°C to +40°C when AP in the enclosure
- j. Enclosure must be supported by the tile bridges; when installed in the ceiling, enclosure must be supported by the building structure, independent of the suspended ceiling

2.06 OUTDOOR ACCESS POINTS

A. AP-670 series specifications

- 1. AP-675 and IAP-675
 - a. 2.4-GHz, 5-GHz and 6-GHz radios, each with Multi-User MIMO and three integrated omni-directional antennas
- 2. AP-677 and IAP-677
 - a. 2.4-GHz, 5-GHz and 6-radios, each with Multi-User MIMO and three combined, diplexed external antenna connectors

B. Wireless radio specifications

- 1. AP type: Outdoor, dual radio, 5-GHz 802.11ax and 2.4-GHz 802.11ax
- 2. Supported frequency bands (country-specific restrictions apply):
 - a. 2.4000 GHz to 2.4835 GHz
 - b. 5.150 GHz to 5.250 GHz
 - c. 5.250 GHz to 5.350 GHz
 - d. 5.470 GHz to 5.725 GHz
 - e. 5.725 GHz to 5.875 GHz
 - f. 5.850 to 5.895 GHz U-NII-4
 - g. 5.925 to 6.425 GHz U-NII-5
 - h. 6.425 to 6.525 GHz U-NII-6
 - i. 6.525 to 6.875 GHz U-NII-7
 - j. 6.875 to 7.125 GHz U-NII-8
- 3. Available channels: Dependent upon configured regulatory domain
- 4. Dynamic frequency selection (DFS) optimizes the use of available RF spectrum
- 5. Supported radio technologies:
 - a. 802.11b: Direct-sequence spread-spectrum (DSSS)

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(These Guidelines are basic minimum criteria to be met in preparing the final specifications for this section, which is the responsibility of the Designer/Contractor/Installation Team.)

- b. 802.11a/g/n/ac: Orthogonal frequency-division multiplexing (OFDM)
- c. 802.11n/ac: 4x4 MIMO with up to three spatial streams
- d. 802.11ax: Wi-Fi 6 dual radio, 5 GHz 4x4 MIMO and 2.4 GHz 2x2 MIMO
6. Supported modulation types:
 - a. 802.11b: BPSK, QPSK, CCK
 - b. 802.11a/g/n: BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM (with TurboQAM clients)
 - c. 802.11ac: BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM
 - d. 802.11ax: BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024 QAM
7. Transmit power: Configurable in increments of 0.5 dBm
8. Maximum (aggregate, conducted total) transmit power (limited by local regulatory requirements):
 - a. 2.4-GHz band: +25 dBm (22 dBm per chain)
 - b. 5-GHz bands: +25 dBm (22 dBm per chain)
 - c. 6-GHz bands: +25 dBm (22 dBm per chain)
9. Advanced cellular coexistence (ACC) feature to minimize interference from cellular systems
10. Maximum ratio combining (MRC) for improved receiver performance
11. Cyclic delay diversity (CDD) for improved downlink RF performance
12. Short guard interval for 20-MHz, 40-MHz, 80-MHz and 160-MHz channels
13. Space-time block coding (STBC) for increased range and improved reception
14. Low-density parity check (LDPC) for high-efficiency error correction and increased throughput
15. Explicit transmit beam-forming (TxBF) for increased reliability in signal delivery
16. Supported data rates (Mbps):
 - a. 802.11b: 1, 2, 5.5, 11
 - b. 802.11a/g: 6, 9, 12, 18, 24, 36, 48, 54
 - c. 802.11n (2.4GHz): 6.5 to 300 (MCS0 to MCS15, HT20 to HT40)
 - d. 802.11n (5GHz): 6.5 to 600 (MCS0 to MCS31, HT20 to HT40)
 - e. 802.11ac: (5 GHz): 6.5 to 3,467 (MCS0 to MCS9, NSS = 1 to 4 for VHT20 to VHT160)
 - f. 802.11ax (2.4GHz): 8.6 to 574 (MCS0 to MCS11, NSS = 1 to 2, HE20 to HE40)
 - g. 802.11ax (5GHz): 8.6 to 4803 (MCS0 to MCS11, NSS = 1 to 4, HE20 to HE160) 802.11ac very high throughput (VHT) support: VHT 20/40/80/160
17. 802.11n/ac packet aggregation: A-MPDU, A-MSDU Power
 - a. Maximum (conducted) transmit power (limited by local regulatory requirements):
 - 1) 2.4 GHz band: +22 dBm per chain, +25dBm aggregate (2x2)
 - 2) 5 GHz band: +22 dBm per chain, +28dBm aggregate (4x4)

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- 3) Note: conducted transmit power levels exclude antenna gain.
18. Power over Ethernet (PoE): 48 Vdc (nominal) 802.3at-compliant source
19. Bluetooth 5 and 802.15.4 radio
 - a. 2.4 GHz
 - b. Bluetooth 5: up to 8dBm transmit power and -95 dBm receive sensitivity
 - c. Zigbee: up to 8 dBm transmit power and -97 dBm receive sensitivity
 - d. Up to 4 dBm transmit power (class 2) and -91 dBm receive sensitivity
20. AP-675: Built in omni-directional antennas for 4x4 MIMO with maximum antenna gain of 5 dBi in 2.4 GHz and 5 dBi in 5 GHz. Built-in antennas are optimized for horizontal mounted orientation of AP-675.

C. Other interfaces

1. One PoE+ PD port 10/100/1000BASE-T Ethernet network interface (RJ-45)
2. One port 100/1000BASE-T (RJ-45)
3. AC power interface, power cords sold separately
4. Serial console interface (USB-C)
5. Reset button
6. Visual indicator (LED):
 - a. Power/system status; automatically disabled after initial operation period

D. Mounting

1. Must be ordered separately
2. Optional mounting kits:
 - a. Mounting kits are NOT included with the APs. Chose the appropriate mount for the appropriate application.
3. Operating:
 - a. Temperature: -40° C to +65° C (-40° F to +150° F)
 - b. Humidity: 5% to 95% non-condensing
4. Storage and transportation:
 - a. Temperature: -40° C to +70° C (-40° F to +158° F)
5. Operating Altitude: 3000m
6. Chassis Rating: IP66 and IP67
7. Wind Survivability: Up to 165 mph
8. Shock and Vibration: ETSI 300-19-2-4 spec T41.E 4M3

E. Regulatory

1. FCC/Industry of Canada
2. CE Marked
3. R&TTE Directive 1995/5/EC

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4. Low Voltage Directive 72/23/EEC
5. EN 300 328
6. EN 301 489
7. EN 301 893
8. UL/IEC/EN 60950
9. EN 60601-1-1, EN60601-1-2

F. Regulatory Model Numbers

1. AP-677 and IAP-677: APEX0677
2. AP-675 and IAP-675: APEX0675

G. Certifications

1. CB Scheme Safety, cTUVus
2. UL2043 plenum rating
3. Wi-Fi Alliance certified 802.11a/b/g/n/ac

H. Warranty

1. Limited lifetime warranty

I. Minimum operating system software versions

1. ArubaOS 6.4
2. Aruba Instant 4.1 (planned availability mid 2014)

J. RF Performance Table

	Maximum transmit power (dBm) per transmit chain	Receiver sensitivity (dBm) per receive chain
802.11b 2.4 GHz		
1 Mbps	23.0	-92.0
2 Mbps	23.0	-92.0
5.5 Mbps	23.0	-90.0
11 Mbps	23.0	-88.0
802.11g 2.4 GHz and 802.11a 5 GHz		
6 Mbps	23.0	-88.0
54 Mbps	18.0	-75.0
802.11n HT20 2.4 GHz and 5 GHz		
MCS0/8	23.0	-88.0
MCS7/15	17.0	-71.0
802.11n HT40 2.4 GHz and 5 GHz		
MCS0/8	23.0	-85.0
MCS7/15	17.0	-68.0
802.11ac VHT20 5 GHz		
MCS0	23.0	-88.0
MCS9	16.0	-65.0
802.11ac VHT40 5 GHz		
MCS0	23.0	-85.0
MCS9	16.0	-62.0
802.11ac VHT80 5 GHz		
MCS0	23.0	-82.0
MCS9	16.0	-59.0

K. Enclosures

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1. Wireless Access Points shall be installed in lockable, stainless steel Nema 4 Enclosure when mounted outdoors or in garage spaces.
2. Include back-plate, ground bus-bar, cable management, document holder, pole/wall mount adapters.
3. Provide 120VAC@15A quad receptacle with surge protection per drawings.
4. Enclosure shall be bonded to ground per NEC.
5. All conduit penetrations shall be made to prevent water ingress through the connections.
6. Enclosure size per drawings.

L. Ethernet Surge Protection Device (SPD)

1. Use in field for outdoor applications. Device shall be rated for outdoor use.
 - a. Transtector 1101-935(Gigabit POE) No exceptions.
 - b. Transtector ALPU-L130(Gigabit POE+) No exceptions.
 - c. Transtector ALPU-F140(Gigabit POE++) No exceptions.

2.07 Ethernet and PoE+ Extension Unit

- A. The Enable-IT™ 828 Gigabit Ethernet and PoE+ Extension Unit.

2.08 PoE + POWER Injector

- A. Enable-IT 360 60W- 56VDC IEEE 802.3AT Gigabit PoE + Injector.

2.09 LAN PERFORMANCE REQUIREMENTS

- A. The wired system shall perform as designed providing a minimum of 10/100/1000 Mbps to each end user device and 1Gbps from edge switch to core switch on the backbone.

2.010 TELEPHONE SYSTEM HARDWARE REQUIREMENTS

A. Courtesy Telephones

1. Courtesy Telephone stations shall be class of service restricted to internal calls only, i.e. no local, collect, long distance toll (1+), toll free, (800, 888, 877, 866), operator assisted (0,0+), or directory assistance (411, 555-1212, etc.) calls shall be allowed.
2. Each Courtesy Telephone shall be capable of dialing 9+911 for an emergency and have the capacity to dial six-digit internal directory numbers (DN).
3. Each Courtesy Telephone shall transmit its DN to internal called parties.

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4. Each Courtesy Telephone shall have a call party name display (CPND) associated with its DN.
5. Each Courtesy Telephone shall be manufactured by CEECO:
 - a. Model SSP-311-F--IVC-VoIP- White Courtesy Phone for HAS
 - b. CALL RESTRICT Stainless steel wall telephone, chrome tone dial, MCRK-2 P.C. board, Lexan 32” armored cord, WHITE handset, pushbutton volume control and confidence. CAC 6.00 software.
 - c. 301-037 Security tool – 5/32” #9020 BLUE. Required for installation.
 - d. CEEC Contact – pmccreary@ceeco.net – 1-888-357-0798
6. Courtesy Phone Stainless Steel Backboards
 - a. “COURTESY PHONE” Letters 1-1/4” Height Helvetica Medium engraved and painted black.
 - b. Distributed by Volume Millwork Inc.
 - c. Part#: 10-SPTELLETTTE
 - d. Description: Courtesy Tellette
 - e. Contact: Edwin Chatoor– (713) 538-1451 - robin@vmillwork.com
 - f. Must be lockable using key (contractor to request in writing from HAS Technology what key the lock shall be keyed to)

2.011 CAT 6 Media extender

- A. Manufactured by Veracity Global
 1. Model – Outreach Max XT
 - a. POE/POE + compatible
 - b. IP 66 rating
 - c. Can be wall mounted but preferred method is inside of aNEMA enclosure
 - d. RJ45 connectors

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install components in accordance with contract drawings, manufacturer’s instructions and approved submittal data.
- B. System installation and construction methods shall conform to the requirements of the Federal Communications Commission.
- C. The Contractor shall install all system components including furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and adjustments required for a complete and operable system.

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- D. Grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.
- E. The HAS IT Representative shall perform final configuration of the network equipment. This includes, but is not limited to: VLAN configuration, IP addressing schemas, final port assignments, and trunking/bonding configurations. Installation contractor shall ensure that the proper documentation is provided to assist in the final system configuration.
- F. The Contractor shall coordinate with the cabling contractor with the installation if the iPatch/imVision crossconnect panel to create a true cross-connect per iPatch/imVision standards.

3.02 PRODUCT HANDLING

- A. The Contractor shall be responsible for any and all loss or damage in the shipment and delivery of all material until transfer of title to the City.

3.03 HARDWARE INSTALLATION

- A. The Contractor shall obtain written permission from the City Engineer before proceeding with any work which requires cutting into or through any part of the building structures such as, but not limited to, girders, beams, concrete, carpeted or tiled floors, partitions or ceilings. The Contractor shall also consult with the City Engineer before cutting into or through any part of the building structures where fireproofing or moisture proofing could be impaired.
- B. The Contractor shall take all steps necessary to ensure that all public areas remain clear or are properly marked during installation or maintenance.
- C. The Contractor shall develop a detailed network map to be utilized as a road map during the implementation of the LAN. This map shall show all segments, all interconnects between segments and all active network devices. This network map shall not include the individual nodes interconnected to each concentrator, but will have the modules, interfaces, protocols, addresses and other identifying features for each concentrator and other active device.
- D. The Contractor shall also develop a Cable Plant interconnectivity chart showing all fiber patch panels and individual identifiers for each fiber associated with the interconnectivity of each network device.
- E. Prior to installing Wireless Access Points, conduct and document an RF site survey to determine the maximum operating range between an AP (fixed location) and mobile

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stations for a specified transmit power level. Survey shall also identify holes of coverage due to multi-path, interference sources, and interference from other wireless installations.

- F. The contractor shall place materials only in those locations that have been previously approved. The City Engineer shall approve any other locations, in writing.

3.04 SYSTEM STARTUP

- A. The Contractor shall not apply power to the system until after:
 1. System and components have been installed and inspected in accordance with the manufacturer's installation instructions.
 2. A visual inspection of the system components has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
 3. System wiring has been tested and verified as correctly connected as indicated.
 4. All system grounding and transient protection systems have been verified as properly installed and connected, as indicated.
 5. The City Engineer and the HAS IT Representative have approved the installation.
- B. Satisfaction of the above requirements shall not relieve the contractor of responsibility for incorrect installations, defective equipment items, or collateral damage as a result of contractor's deficient work/defective equipment.

3.05 ACCEPTANCE TESTING

- A. The contractor shall develop and execute an onsite acceptance-testing program.
- B. The plan shall address all requirements identified in this specification and test all contractor supplied cabling and hardware components. The plan shall follow accepted industry testing practices and have a method of independent verification described.
- C. Any specified item that does not satisfy the requirements of this specification shall be replaced, upgraded, or added by the contractor as necessary to correct the noted deficiencies. After correction of a noted deficiency, re-testing shall be performed to verify the effectiveness of the corrective action.

3.06 IDENTIFIERS, LABELS AND LABELING SYSTEM

- A. All Identification and Labeling shall follow Specification: 270553–Identification and Labeling of Communication Infrastructure. **Any deviation from the specification must be approved by HAS IT prior to installation.**

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END OF SECTION

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APPENDIX A

LAN Equipment Schedule (EXAMPLE)

Item	Qty
COMM ROOM 11611	
WS-C3650-24PS	3
GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode	6
COMM ROOM 11715	
WS-C3650-24PS	1
GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode	2
COMM ROOM 11908	
WS-C3650-24PS	2
GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode	4
COMM ROOM 12015	
WS-C3650-24PS	1
GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode	2
COMM ROOM 11812	
WS-C3650-24PS	2
GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode	4
COMM ROOM 12606	
WS-C3650-24PS	3
GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode	6
MDF	
WS-X6848-SFP-2T (for 6509)	4

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Item	Qty
GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode	36
WS-X6824-SFP-2T (for 6509)	2

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APPENDIX B

TECHNOLOGY IMPLEMENTATION SCHEDULE (EXAMPLE)

	(from Designer)		(Contractor Submittal)				(Submittal Response)		
	Product Description	Spec. Ref.	Qty.	Procurement Lead Time	Start Date or Dependent	Installation Duration	Submittal Approved	Purch. Auth.	Remarks
1	WS-C3650-24PS	2.04.D							
2	GLC-LH-SMD – 1000BASE-LX/LH "long haul" SFP Single-mode	2.04.D							
3	WS-X6824-SFP-2T (for 6509)	2.04.C							
4	General Workstation	2.04.G							
5	Network Printer	2.04.H							
6	Cisco Wireless Access Point	2.04.I							
7	Wireless Access Point Enclosure	2.04.J							
8	Cisco 16-port 10 Gigabit Ethernet Copper Module with DFC4 WS-X6816-10T-2T	2.04.E							
9	Cisco 48-port SFP fiber Gigabit Ethernet Module with DFC4 WS-X6848-SFP-2T	2.04.E							
10	Cisco Gigabit Ethernet Module WSX6848-GE-TX	2.04.E							
11		2.04.E							
12	Cisco IOS® Software	2.04.E							

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	Release 15.05Y or higher								
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