SECTION 17830
FARE COLLECTION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for the Ticket Vending Machines (TVMs) and for the Clipper Network Card Interface Devices (CIDs) as a subsystem of the station communications.

1.02 REFERENCE STANDARDS

A. Institute of Electrical and Electronics Engineers (IEEE):

1. 802 Local and Metropolitan Area Network Standards

B. International Organization for Standard (ISO):

1. 9001 Quality Management Standards

C. National Fire Protection Association (NFPA):

1. 70 National Electric Code

D. Telecommunications Industry Association/Electronics Industries Alliance (TIA/EIA):

1. 568-B Commercial Building Telecommunications Cabling Standard

E. Pheripheral Component Interconnect (PCI)

1. PCI Security Standards

F. Underwriters Laboratories, Inc. (UL):

1. 444 Communications Cables

2. 1863 Accessories Communications-Circuit

1.03 SYSTEM DESCRIPTION

A. The fare collection system consists of both the technical and administrative requirements for interfaces between the station Communications Equipment Room (CER), station Distribution Cabinets (DCs) and the station TVMs and CIDs. In absence of CER, some Caltrain stations may still utilize outdoor Station Communications Cabinets (SCC) also sometimes referred to as Communications Interface Cabinets (CIC). It is Caltrain's intent to phase out the SCC's/CIC's and upgrade to the CER's. Unless specifically required, in this document, for simplicity, the terms "SCC" and "CIC" are omitted; and the term "CER" is used instead as a universal substitute for these various types of station central Communications architecture.

B. Caltrain TVM Network System Description and Configuration:

1. Multiple TVM's at each station are networked to a Caltrain TVM Virtual LAN (TVM VLAN) to consolidate data through the Distribution Cabinets (DCs) at the CER Caltrain LAN.

2. Dual Caltrain Ethernet switches' ports at DCs and the CER shall be provisioned at 100 Mbps for a separate Caltrain TVM Virtual Local Area Network (TVM VLAN) to segregate this traffic from all others on the network. Also, the SNMP monitoring is to be established for monitoring the SNMP capable Caltrain Network devices (i.e. Switches, UPS, PA, etc.)

3. The Station TVM VLAN shall have existing connectivity to the Caltrain WAN/LAN and subsequently to a Fare Collection Data Storage Computer (DSC) located at Caltrain Headquarters in San Carlos. If the station Private Virtual Circuit (PVC) is not established, the Contractor shall assist Caltrain with enabling and programming of such PVC to enable Caltrain WAN/LAN connection. This connectivity shall allow data to be exchanged between individual Station TVMs and the Data Storage Computers. The TVM VLAN shall always be assigned to the highest priority among other station VLANs dedicated to all other remaining subsystems at the Caltrain station LAN. This shall be done to ensure other subsystems' communications could not interfere with the passage of information between the Caltrain station Fare Collection equipment and the Caltrain DSC.

4. The station TVM shall be a direct 10/100 Mbps Ethernet connection to its assigned Caltrain network switch. For redundancy, where multiple TVMs are assigned to the Caltrain dual Ethernet Switches at the same location (DC or CER), the TVMs shall be divided into two equal groups. The first group shall be assigned to the first switch ports and the second group shall be assigned to the second redundant switch ports. If a TVM design provides for dual network connectivity, connect first TVM port to the port at the first switch and connect the second TVM port to the port at the second switch.

5. The station fiber optic backbone ring (used by TVM VLAN) shall be physically diverse using dedicated fiber optic cable and raceway. Connectivity between the TVM and its assigned distribution switch shall be made with Category 6 UTP cable.

6. In the event that the cable distance from the distribution switch is greater than 300 feet, a single-mode fiber optic cable and the corresponding media converters shall be used to provide the necessary Ethernet connectivity.

7. All TVMs and the communications equipment for the TVM operations shall utilize UPS-backed power. The UPS shall be rated to ensure TVM uninterrupted service for at least 90 min (in case of loss of station utility power).

8. TVM VLAN communications utilizes Caltrain station LAN networking devices and Caltrain station physical fiber-optic backbone. To ensure

fare collection transactions are never interrupted or lost as a result of the updates to the station infrastructure; or any activities, which may involve changes to the station LAN networking devices, racks and cabling; and Caltrain station physical fiber-optic backbone, shall be done during non-revenue hours. Prior to commencing such activities, the Contractor shall submit for approval to the Engineer the description of activities, affected equipment, cutover, testing and fallback procedures. After completion of these activities, all Caltrain station TVM's functionality shall be verified, tested and witnessed (at the station and at the DSC headend) by the designated Caltrain personnel. See also Section 17000, Basic Communications Technical Requirements, for related and additional submittal requirements.

C. Clipper Card Interface Devices (CIDs) Network System Description and Configuration:

1. Clipper is a regional fare collection system that is designed and administered by the San Francisco Bay Area Metropolitan Transportation Commission (MTC). Multiple CIDs at each station are networked to a Clipper LAN (CID LAN) to consolidate data through the Distribution Cabinets (DCs) at the CER Clipper CID WAN/LAN.

2. The Clipper Contractor (working under MTC) provides for a separate Wide Area Network connection (at MPOE) between Clipper Network WAN and the station CID LAN.

3. CID Ethernet switches are separate from Caltrain dual Ethernet Switches. CID LAN is typically non-redundant and implemented as traditional star topology LAN utilizing 1Gbps fiber-optic backbone connections between the CER and DC switches.

3. CID Ethernet Switches' ports at DCs and the CER are provisioned at 100 Mbps for a CID Local Area Network (CID LAN).

4. Even though CID LAN network devices share Caltrain station physical fiber backbone cabling (and fiber-optic and CAT6 patch panel equipment), CID station LAN and Caltrain LAN network devices are physically segregated to avoid any type of communications interface between these two LANs.

5. The CID LAN Network devices are furnished and programmed by the Clipper Contractor. This includes CID Router, CER CID Ethernet Switch, DC CID Ethernet Switches and actual CID card readers to be installed at the CID poles.

6. Caltrain furnishes CID poles and CID poles temporary covers. The Clipper Contractor is responsible for their installation.

7. The Clipper Contractor is also responsible for provision and installation of all remaining station equipment serving CID equipment, such as: rack space; junction boxes, all interconnecting conduits and comm/power wiring; and provision, installation and termination of all necessary 24VDC

power supplies in DC cabinets (one power supply per two CID devices), etc.

8. Clipper Card Interface Devices (CIDs) are typically installed near the station TVM shelters.

9. The CIDs are powered by 24VDC power from the station Distribution Cabinets. The corresponding 24VDC Power Supplies shall be powered by the UPS-backed power. The UPS shall be rated to ensure TVM uninterrupted service for at least 90 min (in case of loss of station utility power).

10. The CIDs communications cabling shall be Cat 6 cables or Single-Mode fiber cables from the associated CID Ethernet switch. The CID communications and power cables shall be routed within the same Communications conduits.

11. Clipper LAN communications utilizes Caltrain station LAN networking patch-panel equipment, racks and Caltrain station physical fiber-optic backbone. To ensure CID transactions are never interrupted or lost as a result of the updates to the station infrastructure; or any activities, which may involve changes to the mentioned above station LAN equipment, shall be done during non-revenue hours. Prior to commencing such activities, the Clipper Contractor shall submit to the Engineer for approval the description of activities, affected equipment, cutover, testing and fallback procedures. After completion of these activities, all Caltrain station CID's functionality shall be verified, tested and witnessed (at the station and at the Clipper headend) by Caltrain and Clipper personnel. See also Section 17000, Basic Communications Technical Requirements, for related and additional submittal requirements.

1.04 SUBMITTALS

A. Refer to Section 17000, Basic Communications Technical Requirements, for related and additional submittal requirements.

B. Preliminary Design Technical (PDT) Requirements:

1. Complete product data including description and model number, shop drawings, catalog cuts and technical literature for the following equipment and material:

   a. Data switch

   b. Fiber and copper interconnection equipment

   c. Media conversion equipment (if applicable)

   d. Cable

2. Fare Collection (TVM and CID) LANs logic diagram and overall system description.

3. Interface description between the TVM VLAN and other Communications subsystems required to complete the transfer of Caltrain Fare Collection data from TVMs to DSC.

4. Proposed Ethernet switch operating software with descriptive documentation, including, but not limited to:

    a. Release Notes

    b. Product Bulletins

    c. Applicable Field Notices

    d. Design Guides

5. Equipment operating instructions or details

6. Mounting and installation details, rack layouts

7. Complete End-to-End wiring diagrams

8. Inside Plant (ISP) and Outside Plant (OSP) cable routing, pair, and fiber strand usage diagrams

9. Intra and Inter rack wiring

10. Patches

11. Power and grounding

C. Final Design Technical (FDT) Requirements: Include the following information as part of the Final Design submittal package for the Fare Collection equipment:

1. Updated PDR information. All drawings, calculations and design information shall reflect a final design.

2. Fiber optic link loss budgets for all fiber optic spans between the CER and the Fare Collection network devices sufficient to show that all proposed spans meet published link loss budgets.

D. Installation Work Plans: Submit the following installation document for each site prior to the scheduled installation activities. The Installation Work plan shall include:

1. Drawings showing plan and elevation details of equipment including conduit interface

2. Cable and wire requirements

3. Grounding details

E. Calculations or Certifications: Submit fiber span loss calculations (as required in the Design Review Sections) to validate switch distances.

F. Product Samples: Submit and demonstrate product samples when requested by the Engineer.

G. Cutover Plan and Test Plan and Procedures. To ensure Fare Collection transactions are never interrupted or lost as a result of the testing, cutover or installations; any activities, which may potentially affect the station TVM VLAN / CID LAN and/or related equipment, shall be done during non-revenue hours.

1. Test Program Plan: Include all the required information for the Fare Collection equipment in the Test Program Plan as outlined in these Specifications including routing, network paths, device and software functions (i.e. programmable alarm and SNMP settings), which shall include testing equipment required; any Caltrain, Clipper and/or Contractor personnel required (including their locations); tested functions, test sequence and pass/fail criteria. All elements/functions, which failed as a result of Contractor's errors shall be corrected.

2. Factory and Inspection Test Procedure: Submit a complete factory test and inspection procedure to satisfy all the requirements outlined under "Source Quality Control" in this Section.

3. Field Test Procedure: Submit a complete field test procedure to satisfy all the requirements outlined under "Testing and Inspection" in this Section.

4. Cutover Test Plan: Submit for approval to the Engineer the description of activities, all affected subsystems and equipment, cutover sequence, successful cutover variation criteria and fallback plan/procedures.

5. End-to-End Acceptance Test: End-to-End Test shall be performed for all communication wiring between CID Router and all CID Switches; all power and communication wiring (including fiber, if applicable) between CID switches in DCs and CID poles at station.

6. System Integration Test (SIT): Provide qualified personnel to support the Fare Collection integration test as described under "Testing" in this Section. The Engineer will direct the SIT.

H. Test Records: Submit the Test Records for review one week after the completion of each test in accordance with these Specifications.

I. Manufacturer Qualifications: Submit qualifications for any manufacturer differing from those specified herein and obtain Engineer's prequalification and approval. Acceptability of the manufacturer shall be based on the manufacturer's experience, qualifications, certifications (i.e. ISO-9001), equipment reliability, compliance with standards specified herein, and full compatibility with Caltrain's existing systems.

J. As-Built Documentation: Submit complete As-Built documentation and drawings, as specified in Section 17000, Basic Communications Technical Requirements, and the following requirements.

1. Include complete equipment data with operating instructions.

2. Accompanying each interface drawings package shall be a written interface specification that details the functional, electrical and mechanical interface properties.

3. Default or As-built Configuration and Provisioning Information for each programmable piece of equipment to allow system integration by follow-on contractors and consultants, including:

   a. Programming passwords

   b. Programmable feature settings

   c. Board level switch/strap settings

   d. Node addressing information

   e. Programmable alarm and SNMP settings

4. Card layout or slot configurations (component equipment inventory).

5. Any other configuration or provisioning which deviates from manufacturer's default state.

1.05 QUALITY ASSURANCE

A. Applicable Standards and Codes: Design, fabrication, inspection, installation and testing shall comply with all applicable Standards and Codes as listed herein. All equipment and methods shall comply with the standards listed under Reference Standards herein.

B. Material and Workmanship Requirements:

1. All equipment provided under this Section shall be UL listed.

2. All products specified herein shall be subject to the Engineer's approval based on the Contractor's ability to demonstrate adherence to these Specifications and Engineer's approval of the manufacturer's quality process.

3. All products shall be compatible with existing WAN and DSC elements in order to perform the intended use set forth by the Engineer. WAN and DSC elements are networking components to connect the station to the CCF or other remote monitoring and control locations.

4. Use no discontinued or end-of-life product models, refurbished equipment, or products scheduled for end-of-life, end-of-sale, or end-of-service within one calendar year of the installation date.

PART 2 - PRODUCTS

2.01 FARE COLLECTION MATERIALS AND EQUIPMENT

A. Owner-furnished materials and equipment: Ticket Vending Machines (TVMs), TVM pedestals, Card Interface Device (CID) Poles and Poles' temporary covers.

B. Clipper Contractor furnishes, installs and performs the required programming the WAN/LAN Connection, CID Router, CER CID Ethernet Switch, DC's CID Ethernet Switches and actual CID card readers (to be installed at the CID poles). TVM and CID equipment quantities vary with each project (see the Contract documents for the specific project quantities)

C. Install TVM Pedestals, CID poles and CID poles temporary covers and the associated grounding equipment.

D. Provide and install of all remaining station equipment serving station TVM and CID equipment, such as: rack space; all interconnecting conduits and comm/power/grounding wiring (power conductors, Category 6 or fiber optic cable as indicated on the Contract Drawings); and provision, installation and termination of all necessary CID 24VDC power supplies in DC cabinets (one power supply per two CID devices), etc.

E. Provide TVM LAN field fiber-to-copper media converter/switch (if applicable).

F. Provide Caltrain switch and TVM IP address, subnet, and default gateway. Establish highest priority for TVM VLAN. Assist Clipper Contractor personnel with programming and testing of CID network devices.

G. Provide Simplified Network Management Protocol (SNMP) Management Application and alarm monitoring/management for Caltrain network devices.

H. Provide, install, and test all TVM Fare Collection software applications from the Caltrain's Headquarters Fare Collection Network.

2.02 CALTRAIN DATA SWITCH

A. All network equipment shall come with the latest secure IOS image supporting SSH, cryptomap, etc.

B. All network equipment shall be PCI compliant.

C. TVM VLAN shall utilize TCP/IP as the transport and network layer service protocol. Physical Ethernet interface settings shall be set to 100 Mbps, Full Duplex.

D. TVM VLAN shall utilize the Caltrain dual redundant Ethernet switches placed within CER and DCs as shown in the Contract documents.

E. CID LAN shall utilize the Clipper Router and Ethernet switches placed within CER and DCs as shown in the Contract documents.

2.03 SOURCE QUALITY CONTROL – FACTORY TESTING AND INSPECTION

A. Notify the Engineer in writing at least 10 days prior to each scheduled test.

B. Conduct Factory Testing on individual equipment or assembled subsystems after all mounting, installation, wiring and other activities to support turn-up are complete.

C. Perform diagnostic testing for all equipment and all communications ports.

D. Perform functional testing and validation of equipment settings on all equipment.

E. Any commercial off-the-shelf equipment that shares a common interface shall be assembled, integrated, and factory tested for compatibility.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment shall be installed as shown in the Contract Drawings, and in accordance with the manufacturer's recommendations.

B. Install data transmission equipment, media conversion (if applicable), and interconnection equipment at the CER or DC to each TVM or CID per the Contract Drawings. Install 24VDC power wiring for the CIDs per the Contract Drawings.

C. Coordinate closely all Work described in this Section with the Engineer of the Fare Collection Vendor.

D. Coordinate details of all interface requirements with the Engineer and be responsible for End-to-End testing.

E. Coordinate all civil Work and installation of all facilities, equipment and cables with the Engineer.

F. Cables and Wiring:

1. Provide copper or fiber optic cable from each TVM and CID routing through assigned conduits to networking equipment located in the CER or Distribution Cabinets per the Contract Drawings. Terminate and test all fiber optic strands or copper pairs (including 24VDC power wiring for CID's) , whether assigned working or spare (dark).

2. Provide a Fiber Distribution Panel (FDP), Fiber Slack Enclosures, fiber patch cords, SC-type connectors; splice trays, and other components for a complete structured cable system in accordance with these Specifications.

3. Provide proper Category 6 UTP cable termination hardware and circuit protection in accordance with these Specifications.

4. Install UPS electrical power from assigned UPS distribution panels to each TVM and CID Power Supplies per the Contract Drawings. Ensure proper grounding and lightning/surge protection for all TVM and CID equipment installations.

5. Prior to TVM or CID installation, seal and protect exposed ends of power and signal cables, and coil at least 12 feet of service length in the TVM junction box or pull-box for future termination or at the top of the CID Pole and the Pole Temporary Cover.

G. TVM and CID equipment quantities and locations shall be in accordance with the Contract Drawings.

3.02 TESTING AND INSPECTION

A. Perform the following inspection and test on the Fare Collection equipment at each installed location. Notify the Engineer in writing at least 10 days prior to each scheduled test. Any testing, which may potentially disrupt or hinder the performance of the operational Fare Collection equipment shall be performed during non-revenue hours.

B. Factory Test and Inspection: See Source Quality Control herein.

C. Field Inspection: Field inspection of the Fare Collection equipment shall verify the following:

1. Equipment damage in transit

2. Equipment, port, and cable labeling

3. Power supply integration and mounting

4. Cable routing

5. Unobstructed air flow to vented equipment

D. Field Test: The following tests shall be performed in the presence of the Engineer:

1. Functional testing from each TVM to the Data Switch interface. If required, utilize a data test set at the demarcation point to validate connection, TVM VLAN priority and data transfer from each TVM.

2. Failover testing (for TVM equipped with local switching and ring protection): Disconnect one side of dual port field media converter/switch and ensure TVM maintains networking. Restore connections and remove opposite path fiber ports and repeat testing.

3. Verify power connections and grounding for proper gauges, continuity, ground resistance/faults, acceptable voltage levels, cross-talk, etc., test and record the results.

4. Test all fiber or copper distribution cabling per TIA/EIA 568-B standards.

E. End-to-End Acceptance Test: Test all communication, power and grounding wiring for station CID equipment.

F. Cutover Testing: Cutover activities shall be performed during non-revenue hours only. If failed, the Cutover shall be repeated only when the problem(s) is discovered and fixed.

1. Data Cable tests: Prior to cutover testing, all data cable shall first be tested. The test results shall be submitted 2 weeks prior to cutover date

to the Engineer for review and approval. Do not begin cutover without the Engineer's approval of the data cable test results.

2. Ensure all functional testing for each TVM was successful.

3. Disconnect the existing station Caltrain WAN/LAN Router from the leased line and connect the CER dual switches to the new station Caltrain WAN/LAN router and communications equipment.

4. Conduct System Integration Test (see below) and verify the updated communications for the involved devices (including Caltrain TVM's)

G. System Integration Test: Provide sufficient technical staff to support the following testing activities during the Owner's systems integration test.

1. Full path Ethernet connectivity testing between TVMs and Fare Collection DSC.

2. Functional end-to-end testing between Fare Collection DSC and each networked TVM.

3. TVM intrusion alarm operation and reporting.

4. Assist Clipper Contractor personnel with the CID equipment testing and troubleshooting.

5. Conduct TVM and CID testing in the event of updates to the station infrastructure or any other activities, which involve changes to the station networking equipment, which may potentially affect performance of the TVM or CID equipment.

END OF SECTION