5.3 LRT Communications System

LRT Communications system composed subsystems that function together in concert to provide proper operation. Closed-circuit television (CCTV) will be provided to monitor activity in park-n-Rides and parking structures, and at the station platforms. The CCTV system will be interfaced with RTD’s existing system to allow monitoring from the Operations Control Center (OCC) and from the Security Command Center (SCC). The public address/variable message sign system (PA/VMS) will provide the ability to make pre-recorded and ad-hoc announcements at the stations—from the OCC, the SCC, and locally.

The supervisory control and data acquisition (SCADA) system allows the remote control of functions from the OCC, such as the signal system, the Traction Electrification system, access control to the trackway, and passenger station functions. The fiber-optic communications transmission system (CTS) will provide the primary transmission medium throughout the Corridor, including all information to the OCC and the SCC. The central control system (CCS) will provide the capability at the OCC to monitor and control the entire system. The telephone system will provide telephones throughout the new and existing corridors. Fare collection is provided under a separate contract, but the fare collection equipment communicates through the Communications Transmission System (CTS).

Mass. Electric Construction Co. (MEC), a Kiewit affiliate, has been selected by SECC to provide and install the LRT Communications system. MEC is the largest installer of communications systems in the United States, with well in excess of $1 billion of transit and rail systems work performed to date. MEC’s close alliance with Kiewit results in a mutual understanding of the companies, many shared systems and procedures, and the ability to focus on the common goal of a successful project. Coordination between Kiewit and MEC is encouraged on a corporate basis, as is sharing of personnel, equipment, and other assets, resulting in an enhanced focus on achieving project goals.

Parsons plans to retrofit the Communications system on the existing corridors as early as possible, before the start of systems installation for the Southeast Corridor. This will benefit RTD by enabling closer train spacing, additional protection of the train stops, and enabling the new OCC that will facilitate train operations and facilitate entry to Elati Yard. This will also allow RTD personnel to familiarize themselves with the OCC before having to also adapt to the new Southeast Corridor operations. SESCO has already performed the critical technical interface to the existing Siemens-supplied SCADA equipment, which is required for the remote operation of the Traction Electrification System, as part of the Tren Urbano project in Puerto Rico and the Valencia Light Rail Transit project in Valencia, Venezuela. SESCO will perform the same technical interface again for the Pasadena Blue Line project.

MEC has selected SESCO to provide the communications equipment and design in a package that is fully integrated among its subsystems. The decision to use SESCO was based upon several factors: MEC’s experience with SESCO, SESCO’s capabilities to provide state-of-the-art engineered equipment (SESCO is ISO 9000 certified), SESCO’s position as the leading supplier of LRT communications systems, and SESCO’s position as a distributor of many lines of equipment, which provides exceptional support from the manufacturers. GEHH recently acquired SESCO, and
SESCO has emerged from the acquisition as the LRT and operations control center entity, incorporating the legacy companies GE Harris and Syseca. Additionally, the interface between the signal and communications systems is facilitated and performed by the same company. SESCO has unparalleled experience with the numerous technical interfaces between the many communications subsystems, and the co-location of its engineering staff results in a system that is compatible, efficient, consistent, and easily maintained. As RTD currently has very little in the way of communications, the selection of an industry leader for the communications system is of prime importance as additional lines are brought into service in the future.

MEC has used SESCO as a subcontractor for design and manufacture of the Communications systems for many projects. SESCO is currently a subcontractor to MEC for the communications system for the Pasadena Blue Line project in California; the Tren Urbano project in San Juan, Puerto Rico; the Valencia Light Rail Transit project in Valencia, Venezuela; and the DART Extensions in Dallas, Texas. MEC has also relied on SESCO for the communications system for the Los Angeles Green Line Light Rail Transit system, the DART Starter System in Dallas, the Whittier Access Tunnel in Alaska, MTA-sponsored light rail and heavy rail projects in Baltimore, and communications projects for the MBTA in Boston. This close working relationship at all levels of MEC and SESCO has resulted in unparalleled responsiveness and very high quality projects that have been delivered on time. The presidents of MEC and SESCO meet at least monthly.

Parsons will be responsible for systems integration for the Communications system and systems integration testing. Parsons has an extensive amount of experience with the design of communications for the RTD, as well as throughout the United States. By using Parsons as the systems integrator and for systems integration testing, Parsons becomes an independent "check and balance" provider for the communications system. Experience shows that the use of this independent body that is neither the manufacturer nor the installer results in an improved project in terms of schedule, performance and quality. Parsons is also performing the civil design and will be co-located with the systems staff, which will facilitate close coordination. Additionally, Parsons will be responsible for the final systems integration testing and input to the RTD's Safety Certification.

Parsons staff responsible for the systems integration and systems integration testing represent a large pool of talent to draw upon. MEC has worked on multiple projects with Parsons: the MTA in Baltimore (light rail and heavy rail projects); WMATA in Washington, DC; DART in Dallas, Texas; GCRTA in Cleveland, Ohio; and MBTA in Boston.

To assure RTD receives a communications system that contains all desired design features, SECC proposes holding a "kick-off" meeting closely following the Notice-To-Proceed, at which time RTD, Parsons, and the suppliers can brainstorm and discuss the system. SECC has found this kick-off meeting to be an effective means to address all concerns and to incorporate RTD's knowledge gained from their operations of the existing system. SECC also proposes that since the communications system, particularly the Operations Control Center, is new to RTD, field trips to other systems be undertaken to see similar systems in service. SECC also proposes to provide one of the Operations Control Center computers and associated software to RTD at an early stage to allow RTD to participate in the development of the highly important human interface.
Parsons will provide the designs, while Dynalectric will perform the installation to provide Xcel Energy high voltage utility power feeds to the communication equipment locations. Dynalectric provides local familiarity with the utility company, their practices, and increased responsiveness due to their long-term relationship with Xcel Energy.

SECC has carefully structured the team and delegated the responsibility for Communications system to MEC for several reasons:

- MEC will self-perform all installations and can thus control every aspect.
- MEC has unparalleled experience installing communications systems, which provides the ability to foresee and avoid problems.
- Accelerated installation of the communications system in an efficient manner will provide LRT service at the earliest possible date.
- MEC's position as the installer guarantees full MEC involvement and attention throughout the design, manufacture, installation, and testing phases. When the manufacturers are responsible for total performance, including installation and testing, they often lose interest once they have shipped their equipment.
- MEC owns the largest fleet of high rail and other specialized equipment in the industry that is required for the performance of this specialized work.
- MEC has a large force of trained personnel who can be dedicated to this project.
- MEC has excellent supplier relationships and is the largest customer for this type of specialized equipment, ensuring prompt supplier responses to issues that may arise.
- MEC has completed many projects with SESCO and Parsons, and the team knows how to work together. The Pasadena Blue Line Light Rail Transit project is a joint Kiewit/Parsons venture, with major subcontractors including MEC, SESCO, GEHH, and Dynalectric. The schedule of the Blue Line project leads this Project by approximately one year. Thus, the Southeast Corridor Project will benefit from our team’s collaboration of team members on the Pasadena Blue Line project.
- MEC’s experience with modifications and cut-ins to live track will assure minimal impact to revenue service operations.
- MEC's only business is electrical contracting, resulting in a focused and highly specialized approach.

5.3.1 CCTV, PA, VMS and SCADA

5.3.1.1 Closed-Circuit Television

a. Functions

This section describes the requirements for the closed circuit television (CCTV) system to be installed at LRT park-n-Rides and parking structures, and at station
platforms. The intent is to provide an integrated CCTV system. The CCTV system that is currently being procured by RTD for various parking facilities and stations along the Central and Southwest Corridors, will be integrated into the new system.

The intent is to provide an enterprise class, IP-based, digital CCTV system that is compatible with the digital system currently being procured by RTD. The CCTV will include cameras, recorders, and workstations. The system will provide surveillance coverage to the following Southeast, Southwest, Central, and Central Platte Valley locations:

◆ Station platforms
◆ Above- or below-grade separated passenger access points
◆ Parking structures

Cameras and recorders will be provided for the Southeast Corridor only; however, RTD’s system that is being installed on the existing corridors will be integrated into the CCTV system. Cameras and recorders are not required on the Central, Southwest, or Central Platte Valley corridors.

b. **CCTV system prior to communication system**

The RTD-procured system will consist of workstations, software, recorders, data switches, and archival equipment. The remote workstations will be located in the new SCC that will be located adjacent to the Mariposa OCC. Cameras will be located at parking facilities and station platforms; recorders will be located at the following parking facilities:

◆ Nine-Mile parking structure
◆ Mineral parking structure
◆ Mineral station
◆ Littleton parking structure
◆ Littleton station
◆ I-25/Broadway park-n-Ride
◆ I-25/Broadway station
◆ Alameda park-n-Ride
◆ Alameda station

This system will be completed prior to the start of the installation of the Southeast Corridor’s communication system. This system will be expanded by the RTD by way of a separate contract to all stations and parking facilities on the Central, Southwest, and Central Platte Valley corridors.

c. **Compatibility**

SECC will supply a system that is fully compatible with the existing system. When complete, the new system will enable the following functions to be performed from an existing or new CCTV workstation:
All equipment that is not located in an environmentally controlled enclosure will be rated to operate in the environment specified. SECC will provide a new workstation and CTS to enable central monitoring on the Central, Southwest, Central Platte Valley, and Southeast corridors. Additionally, cameras, recorders, connectors, power supplies, cabling, and other related equipment will be provided for the Southeast Corridor.

d. **CCTV computer workstations and recorders**

Workstation and recorder images will be processed such that when all cameras at a site are recording, the recorded and live images will not drop below five full frames per second per camera. This frame rate will be maintained for all images with a resolution of 320 x 240 or greater.

It will be possible to locally record and view live images simultaneously for 75% of the cameras that are connected to a particular video recorder, at a minimum of 30-frames-per-second with a resolution of 320 x 240. It also will be possible for three separate CCTV workstations to simultaneously view camera images at this same rate and resolution remotely at the OCC or the SCC for any 48 selected cameras, and 16 per workstation. This rate will be maintained while the recorders transmitting the images continue to record at the specified rate.

Hard drives for the recorders will be provided for the storage of video camera images. Recorder hard drives will be sized to accommodate two weeks of storage at the closest communication node based upon storing five full frames per camera at a resolution of 320 x 240 or greater. This capacity will assume 24 hours of motion on all of the cameras. The operating system will be based upon the latest version of Windows NT at the time of factory tests.

e. **Cameras**

The cameras will be installed in weatherproof and vandal-resistant enclosures. All cameras will be mounted at a height inaccessible to vandalism. The number and location of cameras will be as specified.

5.3.1.2 **Public Address/Variable Message Sign System**

a. **Functions**

The public address (PA) system will produce even sound levels that vary no more than ±3 dBA-SPL under the station canopies and in elevator waiting areas. The loudspeaker levels will vary automatically with background noise levels and will be held to 15 dB above those levels. Since the ambient levels are expected to be 78 dBA-SPL, the PA system will be expected to produce at least 93 dBA-SPL at a listener “ear height” of 5 ft above the platform floor.
Actual noise levels at the stations will be measured following contract award, and the results will be included with the subsequent CDR submittal. These noise levels will be used during preliminary design to establish the minimum loudspeaker output capabilities for each of the stations.

Two-channel power amplifiers will be used to drive alternating loudspeakers. This will reduce the effect of a power amplifier or loudspeaker line problem. Where two separated platforms exist, the PA system will be able to address each platform separately and simultaneously.

The station variable-message signs (VMS) will be double-sided, with each face producing two 3-in.-tall, 20-character lines of text composed of bright amber LEDs. The upper and lower text lines on the two sign faces will be addressed separately so that two messages can be displayed at once on each sign face. The signs will be mounted to ensure legibility when viewed from beneath the platform canopies.

Station PA/VMS systems will be installed at the following locations: I-25/Broadway, Mineral, Mile High, Pepsi Center, DUT, Nine Mile, and Lincoln. The systems at these sites will be accessible from the OCC and the SCC, as well as locally via portable laptop computers from within the stations. Communication from the OCC and the SCC will be through workstations at those sites and the CTS. Station system in-use “busy” indications will be delivered to the OCC and the SCC via the SCADA system.

Laptop computers will be used to make local ad-hoc and pre-recorded announcements. The computers will contain 25 audio and 25 text messages as well as the software to select the appropriate messages and to drive the local PA/VMS system. The laptops will connect to the systems through connectors contained in NEMA 3R or better housings located under the station canopies. These housings will also contain microphones for direct voice announcements. Further, the laptop computers can be used to adjust the system settings (password protected) when connected directly to the station PA and VMS equipment.

### b. Audio controllers

The station system multi-function audio controllers will adjust paging announcement levels automatically in accordance with varying background noise. The PA systems will be set to maintain a voice-over-noise margin of about 15 dBA. Allowing for 78 dBA-SPL platform noise levels, the PA subsystems will be designed to produce 93 dBA-SPL, when needed, at 5 ft. above the platform floors, the nominal height of a standing listener’s ears.

The audio controllers also include frequency filters and level-dynamics controls on each input and output. These are used, in combination with automatic level adjustment and loudspeaker choice and placement, to enhance natural voice reproduction and speech clarity. Other audio controller features include eight independent audio inputs, level-sensing input on-off gating, 10 independent audio outputs, audio bus mixing/matrixing, 32 internal control presets available for external control, a 32-point scheduler for timed events governed by an internal real-time clock-calendar, a multi-function physical control port to interface with electro-mechanical input and output control devices, an RS232 port for interface with digital control and monitoring equipment, ports for digital interface with DSP-controlled
c. **Power amplifiers**

One or more dual-channel power amplifiers will be used at each station. The station loudspeakers will be wired in alternating patterns to redundantly amplify channels to ensure that any amplifier (or loudspeaker line) failure can cause only minimal system disruption. The power amplifiers will be fitted with digital signal processors that monitor the amplifiers – and the loudspeaker lines – for anomalous operation. The modules monitor amplifier thermal headroom and distortion. Thermal limits can be set to adjust amplifier drive levels to ensure continued, though reduced, operation under adverse thermal conditions. Loudspeaker line impedances will be monitored to detect variations beyond preset limits. Excessive amplifier distortion, thermal loading and loudspeaker line impedance variations, as well as simple amplifier failure, will be reported to the OCC and the SCC through electro-mechanical means via built-in amplifier “aux” ports and the subsystem audio controller’s multifunction control port to the SCADA system.

d. **Loudspeakers**

The project’s 93 dBA or greater output level and 150% power capacity requirements combine to demand that horn-type loudspeakers be used at the stations. Horn-type loudspeakers do not lend themselves to mounting enclosures. Their self-contained mounting provisions are, however, quite flexible. The horn loudspeakers are highly weather-resistant and will include distribution-line transformers with adjustable power settings.

e. **Variable message signs**

The station signs will use extra-bright amber LEDs for visibility in bright sunlight. Brightness is, however, automatically adjusted to suit ambient light conditions. The individual LEDs are unmasked to supply the broadest possible viewing angles. Since they will operate independently via Ethernet protocol, no sign failure will disrupt the operation of the other system signs. Sign failures will be reported to the OCC and the SCC via contact closures and SCADA. The signs will be housed within four NEMA enclosures for durability and protection from damage.

5.3.1.3 **SCADA System**

a. **Functions**

Remote terminal units (RTUs), responsible for monitoring the status and control of various field devices, will be installed in communication houses and signal houses, as well as Traction Power Substations throughout the system. They will interconnect with one another and the CCS equipment via the Ethernet pathway provided by the CTS.

Traction Power Substation transfer trip will be accomplished via peer-to-peer connectivity of the PLCs via TCP/IP communication over the CTS. All RTU interaction with the OCC will be on a select-check-operate basis.
The protocol envisioned by this proposal is DF1, which incorporates CRC and block checking as well as mechanism retry to ensure reliable point-to-point communication between the CCS and the RTUs. The proposed PLC equipment is rack-mounted and modular in construction.

b. System design

The RTUs that will be supplied are part of the SLC/1746 system as manufactured by Allen-Bradley Rockwell Automation. The SLC 1746 system provides a proven approach to industrial control. SLC processors are offered in a wide range of functional design, and can be connected in a wide variety of networks for distributed processing and distributed I/O.

This Project will utilize an Ethernet pathway for the interconnection of the RTUs. The SLCs will be equipped with SLC-5/05 Ethernet processors to support this functionality. All of the RTUs being supplied for the monitoring and control of functions located at both station and signaling facilities will be provisioned similarly, with 32 inputs and 32 outputs. The RTUs that are associated with Traction Power Substations will be provisioned with 64 inputs and 32 outputs. The station/signaling configuration shall include the following:

**Figure 5.3–1 Station/Signaling Configuration**

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1746-A7</td>
<td>7 Slot Chassis</td>
</tr>
<tr>
<td>1746-L552</td>
<td>SLC 5/05 CPU W/ 32k of RAM</td>
</tr>
<tr>
<td>1746-IB32</td>
<td>(1) 32 Point 24V Input Module</td>
</tr>
<tr>
<td>1746-P1</td>
<td>Power Supply</td>
</tr>
<tr>
<td>1746-OX8</td>
<td>(4) 8-Port Output Modules</td>
</tr>
</tbody>
</table>

The TPSS configuration will include the following:

**Figure 5.3–2 TPSS Configuration**

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1746-A7</td>
<td>7 Slot Chassis</td>
</tr>
<tr>
<td>1746-L552</td>
<td>SLC 5/05 CPU W/ 32k of RAM</td>
</tr>
<tr>
<td>1746-IB32</td>
<td>(1) 32 Point 24V Input Module</td>
</tr>
<tr>
<td>1746-P1</td>
<td>Power Supply</td>
</tr>
<tr>
<td>1746-OX8</td>
<td>(4) 8-Port Output Modules</td>
</tr>
</tbody>
</table>

SLCs will be mounted to an integral panel that will contain external power supplies and terminal strips for interconnection with field devices.
c. Remote terminal units (RTUs)
The RTUs consist of rack-mounted CPU SLC-5/05. The chassis is either an Allen-Bradley 1746-A7 seven-slot or a 1746-A10 10-slot rack, depending upon the location.

Acopian 24VDC power supplies provided for status signaling and the RTU assemblies are housed in a dedicated RTU enclosure. These supplies are sized to provide sufficient power to the input circuits to enable the system’s proper operation even if the loop resistance were to increase by 50%. The modules feature input filtering, optical isolation, and built-in surge protection to ensure reliability operation.

The RTU continually scans its input points for status information, and this data is forwarded to the communication server upon demand and transmitted to the OCC.

The RTU utilizes CRC and BCC error checking to ensure communication integrity. Upon loss of communication with the communication server, RTUs revert to an automatic mode. RTU interaction with the communication server is on a select-check-operate mode.

d. Power supply
All RTU equipment provided by this contract requires 120VAC power for operation. Both AC and DC power feeds are routed through discrete Entrelec DIN switches, which will allow service personnel to safely deactivate individual feeds when required for service. RTU equipment will meet surge withstand capability tests as defined by IEEE C37.90.1. All equipment will be utilized in accordance with the manufacturers’ recommendations and contract specifications as they relate to grounding and environmental protection.

e. Availability
RTUs will meet all availability requirements that are set forth in the contract specifications.

f. Enclosures, terminal blocks and wiring
A combined cable interface cabinet (CIC/LDF) enclosure will be used for terminating and protecting outside plant cabling as well as providing the fiber-optic cable system interface. This configuration is used at all CTS nodes except the OCC. Krone terminal blocks will be utilized for both the CIC/LDF enclosures and the RTU interface panels. The advantages of these blocks are many, such as higher data throughput (16 Mbps) and more flexibility in types of wire that may be terminated. Krone terminal blocks feature a "dead front" for safety and also provide the ability to "disconnect" an individual circuit for service. All wiring and associated labeling will comply with the contract specifications.

g. Factory test
Functional and performance testing will be performed on all RTU software and firmware. Documentation regarding this subject will be submitted under separate cover upon acceptance of the final design.
5.3.2 Fiber-Optic Communications Transmission System (CTS)

5.3.2.1 Fiber-Optic Communications Transmission System

a. Functions

The intent is to provide an integrated, complete and fully functional communication transmission system (CTS). The system includes patch panels; terminal equipment; interface units; power supplies; multi-service access switch or channel banks; digital cross-connects; and management, design, and installation of interfaces to all other systems. The CTS equipment and accessories will provide present and future transmission of voice, data, and video for the Central, Southwest, Central Platte Valley, and Southeast corridors, including a communication node at district shops, located at 1900 31st Street in Denver, which facilitates communication from the LRT system to bus operations.

Primary SONET backbone communications transmission will be provided at the following locations:

- Littleton Backbone communications Node, in an 8 ft x 6 ft communications shelter, located within 25 ft of TPS11
- General Iron Backbone Communications Node, in a dedicated communications room
- Colorado Backbone Communications Node, in an 8 ft x 6 ft communications shelter, located within 25 ft of TPS19
- Orchard Backbone Communications Node, in an 8 ft x 6 ft communications shelter, located within 25 ft south of signal house and north of TPS24
- County Line Backbone Communications Node, in an 8 ft x 6 ft communications shelter, located at the north end and under the stairs of the platform, north of the signal House
- Dayton Backbone Communications Node, in an 8 ft x 6 ft communications shelter, located at the southwest end of the platform next to signal house across for TPS 30
- Mariposa Backbone Communications Node, in a dedicated communications Room at the OCC
- 30th and Downing Backbone Communications Node, in an 8 ft x 6 ft communications shelter, located within 25 ft of TPS01
- 20th and Welton Backbone Communications Node, in an 8 ft x 6 ft communications shelter, located within 25 ft of TPS02
- Convention Center Backbone Communications Node, in an 8 ft x 6 ft communications shelter, located within 25 ft of TPS03
- Pepsi Center Backbone Communications Node, in an 8 ft x 6 ft communications shelter, located within 25 ft of TPS15

SECC proposes locating the Local Communications Node equipment at the following sites:
♦ Mineral Communications Node, in a 6 ft x 6 ft communications shelter, located within 25 ft of TPS13 to the Littleton Backbone Communications Node

♦ Optical connectivity to the Littleton Traffic Management Center to the Littleton Backbone Communications Node

♦ Optical connectivity to the Arapahoe Traffic Management Center to the Littleton Backbone Communications Node

♦ Oxford Communications Node, in a 6 ft x 6 ft communications shelter, located within 25 ft of TPS10 to the Littleton Backbone Communications Node

♦ Englewood Communications Node, in a 6 ft x 6 ft communications shelter, located within 25 ft of TPS09 to the General Iron Backbone Communications Node located in the communications room

♦ Evens Communications Node, in a 6 ft x 6 ft communications shelter, located within 25 ft of TPS08 to the General Iron Backbone Communications Node, located in the communications room

♦ Optical connectivity from Englewood Traffic Management Center to the General Iron Backbone Communications Node, located in the communications room

♦ University Communications Node, in a 6 ft x 6 ft communications shelter, located at the northwest end of the platform to Colorado Backbone Communications Node

♦ Louisiana Communications Node, in a 6 ft x 6 ft communications shelter, located at the northwest end of the platform adjacent to signal house to the Colorado Backbone Communications Node

♦ Yale Communications Node, in a 6 ft x 6 ft communications shelter, located at the west of the center of the platform adjacent to signal house to the Colorado Backbone Communications Node

♦ Belleview Communications Node, in a 6 ft x 6 ft communications shelter, located at the north end of the platform adjacent to signal house to the Orchard Backbone Communications Node

♦ Arapahoe Communications Node, in a 6 ft x 6 ft communications shelter, located at west of center of the platform adjacent to signal house to the Orchard Backbone Communications Node

♦ Optical connectivity to the CDOT I-25 Communications Node to the Orchard Backbone Communications Node

♦ Dry Creek Communications Node, in a 6 ft x 6 ft communications shelter, located at the northwest end of the platform adjacent to signal house to the County Line Backbone Communications Node

♦ Lincoln Communications Node, in a 6 ft x 6 ft communications shelter, located at the north end of the platform between the substation and the signal house to the County Line Backbone Communications Node
- Optical connectivity to the CDOT I-25 Communications Node to the Dayton Backbone Communications Node
- Southmoor Communications Node, in a 6 ft x 6 ft communications shelter, located at the northwest end of the platform adjacent to signal house to the Dayton Backbone Communications Node
- Nine-Mile Communications Node, in a 6 ft x 6 ft communications shelter, located at the southwest end of the platform adjacent to the signal house to the Dayton Backbone Communications Node
- Optical connectivity to the CDOT I-25 Communications Node to the Mariposa Backbone Communications Node, located in the Mariposa communications room
- Broadway Communications Node, in a 6 ft x 6 ft communications shelter, located within 25 ft of TPS07 to the Mariposa Backbone Communications Node located in the Mariposa communications room
- Alameda Communications Node, in a 6 ft x 6 ft communications shelter, located within 25 ft of TPS06 to the Mariposa Backbone Communications Node located in the Mariposa communications room
- 29th and Welton Communications Node, in a 2 ft x 2.5 ft x 6 ft communications shelter, located within 10 ft of the Power Control Center (PCC) on platform to the 30th and Downing Backbone Communications Node
- 27th and Welton Communications Node, in a 2 ft x 2.5 ft x 6 ft communications shelter, located within 10 ft of the PCC on platform to the 30th and Downing Backbone Communications Node
- 18th and California Communications Node, in a 2 ft x 2.5 ft x 6 ft communications shelter, located within 10 ft of Power Control Center (PCC) on the platform to the 20th and Welton Backbone Communications Node
- 18th and Stout Communications Node, in a 2 ft x 2.5 ft x 6 ft communications shelter, located within 10 ft of PCC on the platform to the 20th and Welton Backbone Communications Node
- 25th and Welton Communications Node, in a 2 ft x 2.5 ft x 6 ft communications shelter, located within 10 ft of Power Control Center (PCC) on platform to 20th and Welton Backbone Communications Node
- Auraria Communications Node, in a 2 ft x 2.5 ft x 6 ft communications shelter, located within 10 ft of PCC on platform to Convention Center Backbone Communications Node
- 14th and California Communications Node, in a 2 ft x 2.5 ft x 6 ft communications shelter, located within 10 ft of PCC on the platform to the Convention Center Backbone Communications Node
- 14th and Stout Communications Node, in a 2 ft x 2.5 ft x 6 ft communications shelter, located within 10 ft of PCC on platform to Convention Center Backbone Communications Node
Southeast Corridor Constructors

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- 16th and Stout Communications Node, in a 2 ft x 2.5 ft x 6 ft communications shelter, located within 10 ft of the PCC on the platform to the Convention Center Backbone Communications Node
- 16th and California Communications Node, in a pole mount cabinet adjacent to PCC to the Convention Center Backbone Communications Node
- Optical spur forming a Communications Node at 1900 31st Street District shops to the Convention Center Backbone Communications Node
- Mile High Communications Node, in a 6 ft x 6 ft communications shelter, located within 25 ft of the Mile High Station platform to the Pepsi Center Backbone Communications Node
- Auraria West Communications Node, in a 6 ft x 6 ft communications shelter, located within 25 ft of TPS14 to the Pepsi Center Backbone Communications Node
- DUT Communications Node, in a 6 ft x 6 ft communications shelter, located within 25 ft of TPS16 to the Pepsi Center Backbone Communications Node

To the maximum extent possible, the CTS design will utilize the fiber-optic cable that is to be installed by others, which will encompass the Central, Southwest, and Central Platte Valley corridors. New optical and metallic cable will be installed in the Southeast Corridor. A 48-strand composite optical cable will be installed, consisting of 36 single mode fibers and 12 multimode fibers, to connect new Southeast Corridor backbone communications nodes. A 60-strand composite optical cable consisting of 24 single mode fibers and 36 multimode fibers will be installed to connect the new Southeast local communications nodes to the new Southeast Corridor backbone communications nodes. Traction Power Substations will have a 12-strand multimode optical cable routed to the closest communications node. Signal houses and parking facilities will have a 6-strand multimode optical cable installed to the closest communications node.

The CTS system will have the capability of transmission of contracted present and future SCADA remote I/O, telephone voice and signaling, PBX, PA and VMS, parking management information, IP-based CCTV, TVM, passenger kiosks, radio data and voice traffic between the following facilities:

- Backbone Communication Node to Backbone Communication Node, as described above
- Backbone Communication Node (BCN) to Local Communication Node (LCN), which is the aggregate of various data, voice, and video traffic from a station or parking facility, and transmitted via fiber-optic cable and equipment to the nearest BCN
- LCN to station and parking facility communication equipment
- BCN to District Shops Communication Node, located at 1900 31st Street in Denver

All equipment will be of solid-state design and construction, and models will be currently in production. All equipment and materials will be new, currently in
production, and will be the best of their respective kinds, free of corrosion, scratches, or other such defects.

b. LRT backbone communication transmission system

SONET is offered for the backbone communication transmission system. The SONET equipment along the right-of-way (ROW) is configured as a collapsed switched ring; however, other protection synergies are available. The District Shops node is provisioned as a spur off of the Convention Center backbone SONET node, with optical signal and protect modules included at both ends.

The SONET heritage rich equipment features ease of configuration, with a limited number of shelves and circuit packs required to implement the SONET architectures at the required rates. The equipment is modular in design. Major portions may be readily replaced in the field. All required architectures, including rings, are configurable via software changes within a single shelf design.

SONET shelves provide DS1 rate interface, which integrates DS0 channels (i.e., 2-W VF, 4-W VF, FXS/FXO) via a channel bank. In addition to the required DS1, an interface, DS0, (i.e., 2-W VF, 4-W VF, FXS/FXO), full duplex 10 Mbps/100 Mbps switched Ethernet ports are also provided. The Ethernet is integral to the SONET shelf.

The transmitter optical light units are equipped with a wavelength of 1310 nm. SC connectors are offered with sufficient output power to maintain a 6dB fade margin on the longest link. Receiver optical light units are equipped with a wavelength of 1310 nm, with SC connectors and receiver sensitivity to maintain a 6dB fade margin on the longest link.

Backbone Node configurations include:

- DS-1 Interfaces with provision-able line codes i.e. AMI, B8ZS
- DSX panel with test access
- IP-based traffic service for SCADA Remote I/O, PA/VMS, future passenger kiosks, CCTV, and TVM’s. Each of the above IP-based services will be assigned its own separate, dedicated high-speed virtual local area network (VLAN)

The SONET backbone will derive its primary timing from a Stratum 3 or better external clock source. This clock source provides redundancy in inputting via two PSTN DS-1 circuits currently terminated at Mariposa. Power and output cards are also configured for redundant operation to eliminate any single point of failure. Timing will be distributed to the Mariposa SONET, Digital Cross Connect, and CCS systems. If the primary timing is interrupted, all SONET multiplexers synchronize to internal clock source Stratum 4+ or better. Re-frame times upon loss of synchronization will be less than 10 milliseconds.

Where applicable, circuit packs will have faceplate LED’s to indicate an alarm or failure condition. Alarms typically will indicate one or more lines out of service (Major alarm), a potential loss of service, maintainability or loss of incoming power (Minor alarm). Contacts are provided to the SCADA I/O.
SONET Nodes will be powered via -48 Vdc nominal.

Low speed serial and VF interfaces are distributed by an Integrated Access Device (IAD). The IAD connection to the SONET multiplexer is via a dedicated DS1. Timing will be loop timed off the incoming DS1. Power is -48 Vdc nominal.

Where applicable, the IAD will have indicators (LED) for Alarm Status on the front panel. At a minimum, loss of Power, Major, and Minor alarms will be provided. Relay contacts will be provided to the SCADA I/O. The following are types of circuits offered:

♦ Voice circuits, typically FXS located in the field.
♦ RS232 data traffic to interface users, such as signal microprocessors, TPS PLC’s if required by the design, and TWC communications

Digital Cross Connects will groom, segregate, and hub DS-1 and DS-0 traffic in order to maximize bandwidth. Timing will be derived from the external stratum timing source.

Optical singlemode or multimode transceivers will be located at the Backbone Communications Node to convert Ethernet and DS1 circuits from electrical to optical for transmission over fiber-optic cable to the local communication node, where conversely it is converted back to electrical.

All transceivers used for this particular function will be of the same manufacturer and mounted in a common chassis where practical.

The previously mentioned transmitter output power and receiver sensitivity will maintain a 6 dB fade margin on the longest backbone to local communication node link.

Optical transceivers provide the following:

♦ DS1 traffic for:
  ♦ Analog voice (i.e., emergency and blue light trip phones)
  ♦ TWC RS232 and possible TPS Data
  ♦ 10/100Base Ethernet traffic for:
  ♦ Communication Backbone Node SCADA
  ♦ Local/Station Communication Node SCADA
  ♦ Signal System SCADA
  ♦ TPSS SCADA
  ♦ PA/VMS
  ♦ TVM
  ♦ CCTV
  ♦ Future passenger stations
Provisioning is achieved by a dedicated VLAN for each port. Sufficient Layer 2 10/100 Base switches are utilized.

In addition to the transceivers, the design may require fiber modems to transmit serial data from remote signal processors, TWC compiling equipment, and TPS PLCs to the nearest backbone communication node, or local communication node, in which case all fiber modems will be of the same manufacturer. Likewise, the selection of transmitter output power and receiver sensitivity will maintain 6 dB of fade margin to the longest link.

The transmission system of the district shops (located at 1900 31st Street in Denver) is a liner extension of the SONET backbone system from the Convention Center, and it provides links for the following:

- Radio consoles at the Mariposa OCC with the central electronics banks (CEBs) at the district shops. Console data and audio circuits are required
- A DS1 tie trunk to General Iron from the PBX telephone switch at the district shops

Two 10/100 Mbps Ethernet interfaces will be provided for future General Iron LAN connections. The connection can be implemented by using existing fiber-optic cable between the Terra Center cabinet on the corner of Stout and Speer on the LRT ROW and the district shops.

c. Network management system

The CTS network management system (NMS) provides a simplified GUI HIMS to enable management and operational control of the SONET network, the DACS network, and the multi-service access switch or channel bank network. The CTS NMS will manage the network from the Mariposa OCC. The CTS NMS provides a centralized alarm, event and performance data collection, testing, maintenance and provisioning. Specific elements include:

- Ability to create topology maps that graphically depict all network elements, including the DACS and multi-service access switch or channel banks
- Icon status and color in an alarm window that indicates the severity level of alarms
- Ability to manually clear alarms on any node on the system
- Ability to provision without knowledge of TL1 or PDS Snyder command language
- Ability to back up and restore database configuration
- Password-protected user access with a minimum of three levels of access
- Support for at three workstations

One functional network workstation will be integrated and mounted in the Mariposa OCC equipment room.
5.3.3 Central Control System (CCS) Function and Hardware

5.3.3.1 Functions

The proposed system encompasses retrofitting of the Central, Southwest, and Central Platte Valley corridors as well as the addition of the new Southeast Corridor.

The capacity and growth of the proposed system is:

- Number of stations = 37 (future 28)
- Number of TES substations = 25 (future 18)
- Number of signal facilities (house or case) = 100
- Number of Yards = 2 (future 1)
- Number of CCS workstations = 14
- Number of CCTV or PA/VMS workstations = 14

**d. CCS architecture**

The system architecture consists of two communication servers, two database servers, 10 workstation consoles and various programmable logic controllers (PLCs), which communicate control and status information via the CTS subsystem.

The proposed design is based upon a distributed processor architecture, with integrated automatic train supervision and supervisory control and data acquisition (ATS/SCADA) system functionality in accordance with the contract requirements. It incorporates systemwide Ethernet connectivity, both at the OCC and to each of the remote communication interface subsystems (i.e., LRT train-to-wayside facilities, stations, passenger elevators, signal system equipment, communication equipment including PA/VMS, PABX, emergency and blue light telephones, CCTV, fare collection, fire alarm, security, radio and traction power equipment). The system will integrate both the existing and the new system (i.e., PBX, Traction Power Substations, and icons systems).

At the CCC, controllers will man three console positions: one operations administrator and two rail operations controllers. Each console position (CCS) will have two displays on a Pentium class processor. Each CCS will be connected by an Ethernet connection to a separate LAN hub to provide redundancy. Each console will have a dual-screen radio communication workstation as well as a single-screen CCTV workstation, which will provide CCTV via Enterprise Class, IP-based video.

The systems manager’s area will contain a system manager’s apostrophe CCS workstation and an LAN management workstation with SNMP capability. This workstation will be identical to the CCS workstations. It will have two displays that can effectively mimic a CCS for troubleshooting or backup. It will have a backup tape and an optical disk drive for archival storage.

The security command center will contain a security command CCS workstation as well as a single screen CCTV workstation. Each CCS workstation will include the ability for an operator to construct and deliver audible and visual messages via IP addressing over the CTS. The system will permit scheduled, ad hoc and live messages, both visual and audible, to be presented over the PA/VMS systems.
The PA/VMS system will supply train arrival information such that appropriate PA announcements/messages will be triggered at the associated terminal stations. This interface will be via Ethernet (TCP/IP).

Additionally, the three control-room consoles will be provided with dual display radio control workstations, headphones and PTT footswitches.

The training/simulator workstations will have two Pentium computer. Each CCS will be connected by an Ethernet connection to a separate LAN hub to provide redundancy. The training simulator system will be provided with its own database server.

An audio recorder will allow the continuous recording of all operational central control – vehicle audio, passenger emergency telephone, voice monitor, radio, public address, service telephone communications and control room conversations of the central control operators at the CCC. Additional information is contained in other sections of this proposal that address all other systems (communications, telephone, radio, etc). For general information as well as details concerning the other systems, please refer to the associated sections of the proposal.

CCS workstations will also be provided for the operator sign-in area in the security control center, as well as the yard operations supervisors area and the maintenance-of-way shop area.

e. Communication (I/O) servers

Two communication servers will provide the centralized communications and application logic for the central control system. Each server will be a Pentium-class processor, which will be connected to two LAN hubs for redundancy. These processors will route and process data between the signal, traction power, facilities, communication systems and the operator workstations.

The communication servers will interface with the signal system via communication packet switches (for serial to TCP/IP transport of VHLC Code Line interface protocol) and Allen-Bradley PLCs (for discrete I/O information and control via TCP/IP) at each of the signal equipment rooms, signal cases and communication equipment houses and cases. This single interface will provide control and monitoring for switch and signal devices, route selection, and the monitoring of VTAG, track circuits, and other facilities status and alarms that are accessible to a communication packet switch. In the reverse direction, controller CCS commands and queries will be processed by the active communication server and forwarded to the various PLCs.

Interfacing existing Traction Power Substation PLCs will be via communication packet switches, which will convert PLC serial data to TCP/IP format for presentation to OCC front-end processors. New Traction Power Substations will interface with Allen-Bradley SLC 505 PLC processors, which will transport data directly via TCP/IP protocol at Ethernet data rates.

The communication servers will utilize Pentium III processors. These servers reside between the CTS and the CCS Ethernet LAN at the OCC and feature a RAID Level-1 Array for storage. The communication server, primary or secondary, will be able to communicate with all of the other nodes via the Ethernet LAN.
5.3.1 Database servers

The database servers are configured with a robust SQL server configuration that provides a high level of redundancy. In addition, each server is connected to a separate LAN hub to provide redundancy. They each will have a RAID Level 1, mirrored disk for database storage. The Oracle software is transaction-based to make sure that each server will have up-to-date data and will have a “consistent” database. The SQL database servers also use Pentium III processors. Information is backed up via a RAID Level-5 array.

5.3.3.2 Hardware

A redundant Ethernet switch is at the core of the Fast Ethernet LAN at the OCC (100/10BASEt). This switch interfaces all of the central equipment.

The switch will be configured with two 24-Port 100/10 chassis providing fully redundant Ethernet connections to all LAN clients. The Ethernet switch also features redundant back plane, power supplies and network management modules, representing “state-of-the-art” in LAN switching applications.

The servers and workstations interface with the Ethernet hub via 100BASEt connections made with 62.5/125 multimode fiber-optic cable.

The servers and workstations are equipped with Compaq Netelligent PCI DAS fiber NIC cards providing fully redundant, auto-sensing connections to the Corebuilder.

All commands transceived by workstations and servers are processed by direct connection via a standard SC connector.

Each of the two database servers will be Compaq ProLiant 1600 6/500 servers featuring:

- Intel Pentium III 500 MHz Processor (dual processor capable)
- 100 MHz system bus, 512Kb level 2 cache
- 32X max CD ROM, internal IDE
- 256 MB (100 MHz) ECC, SDRAM (expandable to 1GB)
- 1.44MB floppy drive
- Compaq Netelligent 100 FDDI PCI DAS Fiber-SC with LAN connectors
- Dual channel wide Ultra SCSI 3 controller
- Automatic server recovery-2 (ASR-2)
- Compaq Smart Array 221 RAID controller
- Compaq 18.1 GB pluggable wide Ultra2 SCSI drive (two for each server)
- Compaq 20/40 GB DLT external tape drive (primary only)
- Samsung Syncmaster 15-in. SVGA monitor, keyboard and mouse (shared via serve switch)

Each of the two communications servers will be Compaq ProLiant 1600 6/500 server featuring:
Intel Pentium III 500 MHz processor (dual processor capable)
100 MHz system bus, 512Kb level 2 cache
32X max CD ROM, internal IDE
256 MB (100 MHz) ECC, SDRAM (expandable to 1GB)
1.44MB floppy drive
Compaq Netelligent 100 FDDI PCI DAS Fiber-SC with two LAN connectors
Dual channel wide Ultra SCSI 3 controller
Automatic server recovery-2 (ASR-2)
Compaq Smart Array 221 RAID controller
Compaq 18.1 GB pluggable wide Ultra2 SCSI drive (two for each server)
Samsung Syncmaster 15-in. SVGA monitor, keyboard and mouse (shared via serve switch)

All of the required control consoles will be equipped in similar fashion with the exception of the system manager station, which will include a laser printer and an optical drive. Each console will be a Deskpro EN 6/500 MT offered by Compaq and will be equipped with:

Intel Pentium III 500 MHz processor, Intel 440BX chipset w/100 MHz bus
512Kb Level 2 Cache, eight slots, five bays
10 GB Smart II Ultra ATA hard drive
32X max CD ROM, internal IDE
128 MB SDRAM (expandable to 768 MB)
Premier Sound ESS 1869, embedded
Compaq Netelligent 100 FDDI PCI DAS Fiber-SC with two LAN connectors
ATI Rage Pro Turbo AGP 2x, 8 MB SDRAM (1600x1200 max resolution)
3dfx – Dual-port PCI video card
Kensington Orbit two-button trackball
Keytronics LifeTime Classic, 104 Key PS2 membrane keyboard
HP LaserJet 4050TN laser printer
HP SureStore 80ex optical drive (system manager only)

Two wall-mounted panel gas plasma displays with 16-in. x 9-in. horizontal to vertical dimension aspect ratio will be provided with a minimum diagonal measurement of 50 in.

Two display controllers will be connected, one each, directly to the CCS LAN, allowing programming and reconfiguration should the need arise.

The display controller will be Compaq Deskpro.
All controller consoles will be equipped with 20-in. LCD monitors as required. The monitor will be a Multisync LCD2010 offered by NEC.

Eight HP LaserJet 4050TN laser printers will be provided for report generation. Three line printers will be provided for the alarm log, system error and event log recording. The line printers will be model ML391T as offered by Okidata.

A print server will be utilized to provide Ethernet connectivity to all three alarm printers.

The four server computers will be connected to a single monitor, mouse and keyboard. A standard 104-key keyboard, PS2 mouse and 15-in. Samsung SyncMaster SVGA monitor will be furnished.

A system clock will be furnished to provide systemwide time information to within 1-second accuracy.

The three consoles being supplied will be configured as depicted by the specifications.

5.3.4 Central Control System (CCS) Software

The following is a listing of all commercial, “off-the-shelf” software utilized by the CCS system:

   a. CS workstation (Qty 5)
      ♦ Windows 2000 workstation
      ♦ USDATA client builder
      ♦ ORACLE forms
      ♦ ORACLE reports
      ♦ ORACLE query

   b. System manager workstation
      ♦ Windows 2000 workstation
      ♦ USDATA client builder
      ♦ USDATA FactoryLink 7.0 (development w/runtime)
      ♦ ORACLE forms
      ♦ ORACLE reports
      ♦ ORACLE query
      ♦ Microsoft VisualStudio Enterprise Edition
      ♦ Microsoft Visual SourceSafe
      ♦ RSLLogix 5
      ♦ RSLLogix 500
5.3.4.1 CCS Design Reviews
All required CCS equipment and software information will be provided in advance of the design reviews. It is SECC’s intent to work with RTD to develop and refine the TCC and console design/layout as follows:

- Provide conceptual drawings
- Provide console pictures and color chart information
- Provide pictures and specifications for furniture

5.3.4.2 CCS Performance Measurements
SECC will measure workload, response times, and utilization of the working system as required in the contract documents. A report will be provided documenting the following:
- Measured workload, response times and utilization
- Expected response times and utilization
- Expected response times and utilization against measured values
5.3.5 Conceptual Communications System Comments
SECC understands the desire to integrate the new system with the CCTV system currently being procured by RTD in various parking facilities and LRT stations along the Central and Southwest corridors. However, it has been our experience that a video surveillance system specifically designed to fulfill CDOT needs may provide a greater level of performance (i.e., a high resolution, color system), which complies with all of the functionality specified by this RFP, could be supplied at a reasonable cost.

5.3.6 Electromagnetic Interference Control Plan
Please see the Electromagnetic Interference Control Plan in Section 5.2.4.

5.3.7 Approach to Testing Communications System

5.3.7.1 General
SECC will assemble, integrate, and test all equipment and systems before shipment to the site.

SECC will control the assembly process at its facilities to control quality and to ensure that the assigned resources are sufficient to perform the required work in a timely manner.

SECC will verify that all systems are fully operational and functioning properly before they leave our facilities, and are configured to provide the SEC Project Team with a “plug and play” type of installation.

This procedure has been followed many times on our previous North American rail-transit projects. It benefits the RTD in two important ways that are related to timely project completion:

♦ Minimizes the installation risk as to unforeseen delays related to equipment malfunctions or configuration errors, since these will have been eliminated during SECC’s testing.

♦ Saves a tremendous amount of time and labor in the field as problems encountered during installation can be attributed to field conditions and resolved quickly.

SECC will assemble, integrate, and test each device before integrating it into a higher order assembly. For example, each SONET multiplexer will be configured and tested as a stand-alone device before being interconnected to all other SONET multiplexers, using the same configuration as will be installed in the field. Each SONET ring will be set up using fiber-optic cables and operated as if the system were on site. All interfaces will be tested, and documented.

This same methodology will be repeated for all other subsystems, with the end result being that all communications systems will have been completely configured and tested as an integrated system before shipment to the site.

Fail-over and redundancy mechanisms will be tested. The documentation generated by this process is invaluable, as it serves as a performance baseline to be used as a resource during installation.
Once the assembly of a subsystem is complete, a full systems integration/factory acceptance test will be performed and witnessed by SEC Project Team personnel, including the SEC Representative. The results of this test will be documented and submitted to the SEC Representative.

Once the equipment is deployed to the project site and installed, it will undergo testing and verification procedures similar to those utilized by the factory acceptance test. This allows an effective comparison between the test results obtained in a controlled factory environment and those obtained from actual field conditions. The results of this sequence of tests will be documented and submitted to the SEC Representative.

### 5.3.7.2 Documentation
The following guidelines will be followed for the preparation and submission of test documentation that will be submitted for approval by the SEC Representative:

- Certificates of Compliance for factory tests will be submitted before all shipments.
- Test reports will be prepared and submitted after completion of the tests.
- Test plan listing all factory and construction site tests to be performed, the approximate test date, and the location for each test.
- Test procedures including pass/fail criteria and test report forms for each scheduled test 60 days prior to the scheduled date for the test.

### 5.3.7.3 Specific Factory Equipment Testing
Factory equipment functional tests will be performed in full compliance with the contract specifications, for the following equipment:

- Communication equipment houses and cases
- OLIUs including add/drop multiplexers
- Fiber-optic transceivers
- Fiber-optic modems
- DACS
- Multi-service access switches
- SCADA Remote I/O PLC
- CCTV recorders or workstations
- CCTV cameras
- Battery chargers
- Central control audio system
- CCS hardware and software
- Radio antenna cable and amplifiers
VMS
PA system, including field control units
CTS network management system

5.3.7.4 On-site Tests

The following static tests will be performed in full compliance with the contract documents for equipment and installations at the construction site:

- Fiber cables including splices, connectors, pigtails, and jumpers using an OTDR
- Battery charging voltages, including both float and equalize rate and voltages for each cell
- Audio/voice, video, network, and data circuit carried on the CTS including signal levels, noise levels, data rates, bit-error rates, jitter, video test patterns, attenuation, and any other industry standard proof-of-performance tests required to demonstrate proper performance as required
- TWC interfaces
- TVM interfaces
- Ground rod installations
- CCS interface tests to confirm proper operation of all CCS equipment to confirm proper data communications to, and functioning with, each SCADA remote I/O equipment; and to confirm proper data communications to, and functioning with, the information systems interface computer, the RTD fare collection computer network and the icons traffic management computer
- Radio system coverage test including downlink and uplink in the center of the trackway and in all parking structure areas
- CCS on-site simulated operational test
- CCS on-site dynamic operational test
- Monitor SCADA Remote I/O equipment availability through completion of all on-site tests

The following operational tests will be performed in full compliance with the contract documents for equipment and installations at the construction site:

- CCTV system tests
- Station PA/VMS system tests
- Network management testing
- Integrated system testing
5.3.7.5 Inspections and Witnessing

The SEC Representative will have the right to inspect all work being performed, either on or off-site, and to reject any material, equipment, or installation that does not conform to the contract specifications.

Any rejected material, equipment, or installation will be replaced or reworked and will be subject to re-inspection by the SEC Representative. In the event of repetitive rejections, the SEC Representative will have the right to stop the manufacture or installation of the affected item until a technical resolution of the problem is presented to and accepted by the SEC Representative.

For all planned tests and inspections, the SEC Representative will be notified as follows:
- At least 21 days prior to an event at a manufacturer’s plant
- At least 7 days prior to a site event

All inspections and tests to be witnessed by the SEC Representative will be performed during regular business hours, unless as otherwise agreed to by the SEC Representative.

5.3.8 Subcontractors Responsible for Communications System

MEC will be responsible for the communications system design oversight, procurement, installation, and testing.

SESCO will be responsible for the design and supply of the communications system.

Parsons will be responsible for systems integration.

Members of the communications system team have worked together on the following projects, which are similar in nature to the Southeast Corridor Project:

| Project: | Pasadena Blue Line LRT |
| Owner: | Los Angeles to Pasadena Construction Authority |
| Contact: | Dr. Tom Stone (626) 403-5505 |

This 17-mile-long design-build project. MEC is responsible for the installation of all systems elements including Traction Electrification, signals, and communications. SESCO is designing and supplying the communications system. Parsons is the systems integrator and Traction Electrification System designer. GEHH is designing and supplying the Signal system.

| Project: | LRT Starter System – communications and Central Control |
| Owner: | Dallas (TX) Area Rapid Transit |
| Contract: | Carmen Spolar (214) 749-2803 |

MEC was responsible for the design oversight, procurement, installation and testing of a complete light rail transit communications and supervisory control system. Major subsystems included operations central control, fiber optic communications transmission, fire and intrusion detection, tunnel radio, SCADA, CCTV, tunnel ventilation control and telephones. SESCO provided LRT Communications engineering, material, systems testing and post installation technical support. The contract included vehicle radio, tunnel radio, a fiber-optic transmission system, a
switched telephone system, a wayside telephone system, CCTV, SCADA, a central control computer network including rear projection overview, control consoles, and the communications controller. The contract included spare parts, training and warranty.

Project: NC & NE LRT Extensions  
Owner: Dallas (TX) Area Rapid Transit  
Contract: Carmen Spolar (214) 749-2803

MEC is responsible for the design oversight, procurement, installation and testing of a complete light rail transit communications and supervisory control system. Major subsystems include fiber-optic communications transmission, fire and intrusion detection, tunnel radio, SCADA, CCTV, tunnel ventilation control and telephones. SESCO is responsible as the designer, systems integrator and software developer. The build-out project includes a new Operations Control Center, 17 communications and signal houses, 14 passenger stations, and 20 Traction Power Substations. SESCO is also directly responsible for radio, public address/visual signage, supervisory control system, wayside telephone, synchronous optical network/communications transmission system, fire and intrusion alarm and communications controller.

Project: TRI-MET Airport Extension  
Owner: TRI-MET (Portland, OR)  
Contact: Bob Banks, (503) 962-2172

On this 7-mile design-build extension to the existing light rail system, MEC is the installation contractor for all Systems elements including Traction Electrification, signals, and communications.

Project: Tren Urbano LRT  
Owner: DTOP (San Juan, PR)  
Contact: Howard Gregson (DMJM), (410) 576-1300

This is a 10.5-mile design-build heavy rail project. MEC is the installation contractor for all systems, including Traction Electrification, signals, and communications. Also included is the maintenance of the train control, traction power and communications systems for the first 5 years of revenue service. SESCO is designing, furnishing, and testing the Communications and radio systems for the Tren Urbano Transit System. The Communications system consists of fiber optic cable transmission system, public address, variable message signs, SCADA, CCTV, station control booths, telephone systems, data network systems, seismic event systems, emergency management panels, fire alarm, and intrusion and access control systems. The Radio system consists of the design, furnish and installation of an 800 MHz trunked radio system providing multiple frequency coverage at all above ground and below ground locations.