**Introduction:**

Clifton, Weiss & Associates, Inc. (CWA) is a DBE/WBE consultancy specializing in communications systems planning, design and construction. CWA’s expertise includes fiber optic networks, data communications, radio systems and Wi-Fi, control center systems, SCADA, Positive Train Control (PTC), real-time passenger information systems (GPS based PIS/AVL) and telephone/call center systems. CWA has highly skilled design and construction staff with many years of hands-on experience gained in the railroad, cellular and private industries. A Woman-owned business, CWA is certified as a Disadvantaged/Woman-owned Business Enterprise (DBE/WBE) by numerous agencies.

CWA’s Commuter Rail and Transit client base include:

- SEPTA
- NJ Transit
- NYCT
- New Jersey Transit
- Metro-North Railroad
- ConnDOT (Connecticut)
- Long Island Rail Road
- PATH (New York / NJ)
- DART (Dallas)
- MTA (Baltimore)
- METRA (Chicago)
- Sound Transit (Seattle), MetroLink (LA)
- SCRRRA (Santa Clara)
- SFRTA/Tri-Rail (Miami)
- MTA (New York)
- CTA (Chicago)
- GCRTA (Cleveland)
- FDOT (Florida)
- PAAC (Pittsburgh)
- M-1 Rail (Detroit)

In addition to performing as prime consultant, CWA has formed Joint Ventures with, and served as sub-consultants to, railroad and transit design A/E firms. Many successful radio and fiber optic communications projects performed by these firms were entirely the responsibility of CWA. These firms include:

- Arinc
- Macro Corporation
- Systra
- AECOM
- Gannett Fleming
- Parsons Corporation
- Parsons Brinkerhoff
- Rail Safety Consultants
- LTK
- STV
- Southwest Signal (XORail / Wabtec)
- Wilbur Smith
- Telvent Faradyne
- Battelle Memorial Institute
- Century Engineering
- Burns Group
- Hyundai-Rotem/Sojitz - United Transportation Systems

**Strategic Planning:**

CWA has prepared comprehensive communications strategies with 5 to 10 year planning horizons for customers including Metrolink, Metro-North, SEPTA, DART and GCRTA. Focused on both railroad operations and corporate IT, these plans have formed the basis for capital planning and construction.

**Design and Construction Related Services:**

CWA has primed, joint-ventured and been a sub-consultant responsible for reports, specifications, drawings and construction related services. Representative projects include:

- **PTC:** SEPTA, Metro-North/LIRR, PATH. Implementation planning & design of PTC communications and data systems, including radio, vehicle borne, ground networks, office systems and interoperability.

- **Fiber Optic Networks:** LIRR, Metro-North, GCRTA, SEPTA, Ohio Turnpike, CTA. Optical systems have included SONET, WDM, OTN, WANs and LAN for backbone, CTC/PTC and signal systems.

- **Control Centers:** NYCT ROC, SEPTA RRDCC, Metro-North OCC/ECC, NJ Transit ROC/EBF, LIRR West Side Storage Yard. Systems included CTC/PTC, voice/data radio and LAN/WAN.
• **Radio & Wi-Fi**: SEPTA - Mesh Wi-Fi for vehicle diagnostics; Metro-North/ConnDOT - VHF voice radio; DART - VHF bus radio planning; Metrolink - 900 MHz ATCS data radio failure analysis; Sound Transit - AVL data radio root cause failure analysis; SFRTA - 900 MHz ATCS data radio code line; SFRTA, SEPTA and others - cellular carrier data and voice networks.

• **Data Networks**: PTC/CTC WAN/LAN, operations control centers (virtualization, networking, VPNs), corporate data and security networks.

• **Security**: Metro North CCTV security concept design, NY MTA IESS/C3 video & security.

• **SCADA**: SEPTA Smart Stations office design; LIRR traction power construction related services.

**Design/Build:**

CWA has teamed with A&E firms, systems integrators, suppliers and electrical contractors to provide comprehensive design/build systems. Representative projects include:

• **SFRTA (Tri-Rail)**: Design/build of system-wide communications for the 72 mile double track commuter rail system from Miami to West Palm Beach, FL, including: 900 MHz ATCS data radio code line; GPS train location & reporting; Passenger station LED information signs & PA; customer call center.

• **SEPTA Silverliner V**: Design/build of a six yard mesh Wi-Fi vehicle diagnostics system for collection and centralized database reporting of vehicle health and welfare diagnostics data.

• **NY MTA C3 IESS**: Design, implementation and configuration of agency-wide communications transmission, data and video systems for security at MTA NYCT, MNR, LIRR, B&T, and Bus.

• **SEPTA Smart Stations**: Design, programming and build of a control center for Smart Stations for collecting, analyzing and displaying station data in graphic and tabular database form. Station systems monitored included fire/life safety, CCTV, security, escalators/elevators and other systems.

Of notable interest, CWA worked with SEPTA to perform a demonstration project, which remains in-service, for analysis of Wayside Interface Units (WIU) PTC data messages from multiple fixed 220 MHz base stations to a revenue service EMU rail vehicle. This trial also demonstrated a method where several adjacent base stations can share a single frequency, thereby making the most efficient use of limited spectrum, and utilized SEPTA fiber optics and Verizon 3G/4G services to interconnect the system. A similar test is underway at Metro-North Railroad.

**SEPTA PTC Wayside & On-board 220 MHz Data Radio Coverage & Data Message Traffic Testing**

Invited guests who witnessed SEPTA’s successful demonstration included the FRA, Amtrak, Metro-North, LIRR, NJ Transit and numerous representatives from PTC engineering firms. CWA has been involved in on-going technical negotiations with Class 1 RRs as both tenants and hosts utilizing I/ETMS.
The Port Authority of New York and New Jersey (PANY&NJ) has awarded a Design/Build Contract to replace the existing Newark Liberty Terminal One, which is approaching the end of its usable life.

The Terminal One Redevelopment Program will position the Airport to meet the needs of passengers and airlines alike in the 21st century. The Program will replace the Existing Terminal One building with a new terminal building. The Program provides an open, modern terminal with ease of access to improve the passengers experience and the efficiency of their travel, as well as flexibility to grow and change with the increasing demands and the evolving requirements for air travel.

CWA, as a subcontractor to the Design/Build Team, is responsible for the design and Construction Related Services (CRS) of all in-building radio communication systems including Public Safety LMR (Land Mobile Radio), Cellular/Wireless and Wi-Fi services as well as Telephony and Data Networks.

Building upon the conceptual design, CWA will work with PANY&NJ stakeholders to bring concepts to reality for the radio, voice and data communications systems throughout the new terminal.

CWA’s scope for design and construction related services includes:

- Cellular In-Building Wireless Distribution & Associated Distributed Antenna System (DAS)
- High Speed Security and Data Network
- Public Safety & Operations In-Building Radio Distribution (800 MHz, 450 MHz, others) & Associated Distributed Antenna System (DAS)
- Telephony (VoIP & Analog)
- Wireless Network Access (Wi-Fi) & connections to public internet service
- Communications Systems Integration

Wi-Fi services will be provided throughout the terminal using wireless access points (WAPS) covering 802.11ac standards ensuring compatibility with newer high-speed wireless devices as well as legacy low-bandwidth clients.
Title: Positive Train Control (PTC) Planning, Design and Implementation Support.

Clients & Status:
- Metro-North Railroad - (Design Completed)
- Long Island Rail Road - (Assignment Completed)
- SEPTA RR Div., Philadelphia - (Completed; In Service)
- MBTA, Boston - (Field Testing of Design Underway)
- The Alaska Rail Road - (Documents Completed)
- Port Authority Trans Hudson - (Assignment Completed)

Contacts:
- R. Wayne Staley, Dir. C&S, MNR
- Michael Monastero, Chief Eng., C&S, SEPTA
- Ralph Collins, PTC Technical Lead, MBTA/Keolis
- Chris Calvagna, Dir. C&S, LIRR

Synopsis:
Positive Train Control (PTC), development of FRA documents, concept planning, system radio modeling, detailed design, field testing and implementation support.

Congress and the Federal Railroad Administration (FRA) have mandated the nation-wide implementation of communications based Positive Train Control (PTC) systems by 2015 (extended to 2018) to prevent train collisions caused by human error.

CWA, as a member of several design teams, has been assigned responsibility for the planning, development, detailed design and implementation support of PTC systems. CWA’s assignments have included:

- Advance research of the FRA NPRM, vendor products and development of PTC strategies for each railroad.
- Research PTC systems including ACSES and I-ETMS.
- Develop and submit Federal Railroad Administration (FRA) mandated filings (IP/DP/SP), including pre-submittal meetings with the FRA.
- Develop schedules, risk assessment, obstacles to success and mitigation solutions to insure the 2015 implementation mandate is maintained.
- Assist in analyzing PTC radio frequencies, conducting negotiations and procurement of 220 MHz and 900 MHz radio channels.
- Assess market solutions for radio hardware and software, including COTS, HPDR and ITC.
- Assist in the development of a joint Amtrak and NEC commuter railroad radio hardware specification.
- Assist in PTC Interoperability strategy meetings with Class 1 freight railroads as both tenants and hosts.
- Design test procedures and conducting field trials of vendor wayside and on-board PTC communications equipment in live RR environment.
- Develop radio and data message traffic analyses, models, propagation studies and channel re-use assessments to insure that message traffic latency is not introduced.
- Develop overall PTC communications infrastructure, including radio networks, GBN (fiber optics, microwave, leased lines & others) and network management.
- Office system interface and communications networking for all back office function including vital safety TSR server and interoperability connectivity among tenant/landlord railroads.
- Coordinate and design communications systems interfaces and systems for Radio (BCP/MCP), Wayside (WIU), Vehicle (OBC), Ground Based Network and Office (STS) systems.
- Specification development for procurement and implementation and construction phase services.
- Develop PTC Communications Training Documents, Restoration Procedures.
Title: IndyGo Red Line Project
Client: IndyGo - Indianapolis Public Transit Corporation
Contact: Mr. Justin Stuehrenberg
         Director of Special Projects
         IndyGo
         JStuehrenberg@indygo.net
Status: In Construction
Description:
Communications System Design.

The Red Line Bus Rapid Transit route will run from Broad Ripple through downtown Indy to the University of Indianapolis. Throughout most of the day, buses will arrive every ten minutes, and the Red Line will operate for 20 hours each day, 7 days a week.

CWA, as part of the team headed by CDM Smith, lead the communications design for this project. The network was designed to serve communications-based subsystems at each of the BRT stations. CWA worked closely with IndyGo to coordinate the installation of components by differing contractors.

Red Line stations will be equipped with emergency telephones, CCTV cameras, ticket validators, ticket vending machines and passenger information signs.

CWA developed communications drawings, specifications and cost estimates for the project. CWA is currently providing construction support services.

Construction of the IndyGo Red Line is underway with system operations planned to begin in 2019.
Title: Customer Service Initiatives (CSI), Design and Construction Services for Security, Audio-Visual and Facility Enhancements at Various Metro-North Stations

Client: MTA Metro-North Railroad

Contact: Al Santini, Chief Engineer
MTA/Metro-North Railroad
420 Lexington Avenue
New York, NY 10017
Tel: 212.499.4441
santini@mnr.org

Status: Select Stations: Design Complete.

Description: Customer Service Initiatives (CSI) to improve customer communications at outlying passenger stations.

The MNR PA/VIS is a service available to MNR Passengers to access information regarding general service announcements, status of trains, train arrivals, as well as safety and emergency instructions. The information is provided in the form of synchronized audio and visual announcements to the platforms and within MNR stations. MNR PA/VIS components are scalable and can be deployed from a central controller, locally at the station, or any combination thereof.

The PA/VIS Station System consists of computers, software, Public Address (PA) systems, Variable Message Signs (VMS) and communications equipment to comply with the ADA requirements for both audio and visual messages to passengers at the station platform.

As a subconsultant, CWA has been assigned the design of the CSI at select stations. The work includes:

- Inspection and location of new or replaced systems at the station.
- Placement of new PA/CIS equipment.
- Placement of speakers and ambient noise microphones.
- Routing power and data cables and conduit to the new systems including LED train arrival/departure boards and LCD information displays.
- Assisting in the design of the new or renovated communications equipment rooms.
- Assigning the interfaces to the Metro-North system-wide fiber optic network, a system designed by CWA.
Title: FMG Railroad (Solomon to Port Headland)

Clients & Status: 
Fortescue Metals Group (FMG), Western Australia (Completed)

Contacts:
• Mike Quinlan Manager, GE Transportation

Synopsis:
Signaling, Fiber Optic Network and Radio Systems for 173 miles track – The fiber optic network and radios covered the backbone and all sub-rings connectivity between the wayside locations and the base stations.

The Fortescue Railway, owned and operated by Fortescue Metals Group (FMG), is a private rail network in the Pilbara region of Western Australia built to carry iron ore. Upon completion, the railway line was the heaviest haul railway in the world.

Construction on the 280-kilometer line from the Cloud Break mine to the Herb Elliott Port at Port Hedland commenced in November 2006. The current network consists of 620 kilometers of track. In December 2012, the line was extended to the new Solomon Mine.

Mr. AbiDaoud, a Sr. Communications Engineer at CWA, was a lead Network Engineer on the FMG project. He was responsible of:

- Designing the Fiber Optic Network of more than 20 subrings that were interconnected through MDS Intrepid Radios
- Upgrading and configuring more than 100 network switches and serial servers (RuggedCom and Moxa)
- Designing a complete IP scheme for the project

- Designing and building a Network Management System that monitors all the network elements and radios
- Writing an Operation and maintenance manual for the Network System
- Providing training materials and classes
SEPTA Trolley Routes 101 and 102, also known as the Media–Sharon Hill Line (MSHL), are light rail lines operated by the Suburban Transit Division of the Southeastern Pennsylvania Transportation Authority. The routes' eastern terminus is 69th Street Transportation Center in Upper Darby, Pennsylvania.

With recent trolley and LRV collisions and accidents nationwide, and the need for safety and more efficient management of the infrastructure and fleet, SEPTA has concluded that CBTC is a necessary addition to the MSHL.

Communications-Based Train Control (CBTC) is a railway signaling system that makes use of the telecommunications between the train and track equipment (typically radio based) for the traffic management and infrastructure control. By means of the CBTC systems, the exact position of a train is known more accurately than with the traditional signaling systems. This results in a more efficient and safe way to manage the railway traffic.

Unlike the traditional fixed block systems, in the modern moving block CBTC systems the protected section for each train is not statically defined by the infrastructure. The trains themselves are continuously communicating their exact position to the equipment in the track by means of a bi-directional link, via radio communications.

The resulting system permits trains to travel in closer proximity to one another, gaining efficiency of operation, while preventing trains from colliding by automatically applying brakes if the situation warrants.

CWA, as a member of the SEPTA MSHL design Team, has been assigned responsibility for the planning, development, and conceptual design and implementation support of communications systems for a turn-key design/build by a CBTC supplier. CWA's activities and responsibilities include:

- Survey and document existing communications system resources in signals houses, communication huts, and radio locations.
- Design the fiber optic based interface/transport method for CBTC data traffic between and among the wayside devices, office and maintenance locations.
- Measuring baseline radio noise levels on the MSHL for vendors to permit more cost effective and efficient design of their radio networks.
- Provide construction related services overseeing the implementation of the communications segment of the design/build CBTC by the selected vendor.
**Project Profile**

**Title:** LYNX Blue Line Extension (BLE).

**Clients & Status:**
- Charlotte Area Transit System - CATS (Final Phase of Construction)

**Contacts:**
- Tim Taylor, Sr. Business System, CATS
- Chuck Isenhour, Sr. Network Engineer, CATS

**Synopsis:**
Communications Systems: Fiber Optic, Network, Closed Circuit Television (CCTV), Supervisory Control and Data Acquisition (SCADA), Public Address (PA), Access Control (ACS), VoIP & Emergency Telephones (ETEL) and Ticket Vending Machines (TVM)

The Blue Line Extension extends from Ninth Street in Center City through the North Davidson (NoDa) and University areas to UNC Charlotte. The service will operate generally within the existing railroad right of way from Center City to NoDa and then remain within the North Tryon Street (US 29) right of way from Old Concord Road north, terminating on the UNC Charlotte campus.

The Blue Line Extension is a 9.3 miles line that will have:
- 11 light rail stations
- 4 park and ride facilities
- 8 Central Instrument Houses (CIH)
- 8 Traction Power Substations (TPS)
- 1 Central Communication House (CCH)
- 1 Rail Operation Center (ROC)

**Mr. AbiDaoud,** a Sr. Communications Engineer at CWA, was a lead Network Engineer on the BLUE Line Extension (BLE) project. He was responsible of:
- Writing Design Documents
- Writing and performing Test Procedures
- Designing the Fiber Optic network: FO Splicing and termination at more than 30 locations
- Designing the IP scheme in coordination with the Charlotte City IT

- Upgrading the software revision on more than 60 Cisco units
- Providing the configuration files for more than 60 Cisco switches. The models include: Catalyst 3850, Industrial Ethernet IE-3000 & IE-4000, Catalyst 6807-XL and Catalyst 4500
The ATL SkyTrain is an automated people mover (APM) at Hartsfield-Jackson Atlanta International Airport that runs between its terminals and rental car center. The SkyTrain was essential to helping the airport reduce congestion and free up space in the main terminal by moving all of its rental car operations to a single remote location.

This APM carries travelers and convention-goers on a quick, convenient and scenic ride between the world’s busiest airport, Georgia’s second-largest convention center, and the remote rental car center.

The system opened on December 8, 2009 to connect the airport’s terminals with the newly-opened rental car center and Gateway Center of the Georgia International Convention Center.

This 1.5-mile, dual-lane, pinched-loop system crosses rapid transit and freight rail tracks, and I-285, en route from the terminal station to an intermediate stop at the convention center station, the Rental Car station and then to the Maintenance and Storage Facility (M&SF).

Mr. AbiDaoud, a Sr. Communications Engineer at CWA, was a lead engineer on the ATL SkyTrain project. He was responsible of systems design and integration for the 1.5 miles Fiber Optic backbone, CCTV System, Cisco Backbone Network, Cisco VoIP and Emergency Telephone System, Public Address System and Access Control System.
The MIA Mover is an automated people mover (APM) system which opened at the Miami International Airport (MIA) in metropolitan Miami on September 9, 2011.

The MIA Mover is designed to quickly transport landside passengers between Miami International Airport’s Main Terminal and the Miami Central Station and Rental Car Center, as part of the Miami Intermodal Center (MIC).

The 1.27 miles link travels east from the MIA Station, to Central Boulevard and finally to NW 21st Street, where it curves north into the MIC Station. The ride lasts approximately three minutes. The concrete guideways are generally elevated an average of 40 feet above grade and are supported by concrete piers every 120 feet. The vehicles used are Mitsubishi Heavy Industries Crystal Movers.

The MIA Mover has two stations: the MIC Station and the MIA Station. The MIC Station is the eastern terminus of the line located on the fourth floor of the Miami Intermodal Center. The station contains direct access to both the Rental Car Center in addition to connecting by skywalk to the Miami Central Station where connections can be made to Metrorail, Amtrak, Tri-Rail, buses and taxicabs.

The MIA Station is the western terminus of the line located on the third floor of the main terminal building between the Flamingo and Dolphin Parking Garages. Constructed by MDAD, a storage and maintenance facility (M&SF) for the APM vehicles is located beneath the MIA Station. The M&SF includes the Central Operation Room for the MIA Mover.

Mr. AbiDaoud, a Sr. Communications Engineer at CWA, was a lead engineer on the MIA Mover project. He was responsible of systems design and integration for the 1.27 miles Fiber Optic backbone, Stations and Alignment CCTV System, Cisco Backbone Network, Cisco VoIP and Emergency Telephone System, Public Address System, Access Control System and the On-Board Wi-Fi System.
CWA, as a sub-consultant, is responsible for all communications for the new Woodward Avenue Streetcar Project (M-1 Rail) in Detroit.

M-1 RAIL- a Public Private Partnership (PPP) consortium of businesses, institutions, and foundations - will build and operate the streetcar system for a period of up to 10 years after construction. The system will be funded with $137 million; a combination of corporate, institutional, and philanthropic donations, and Federal assistance.

The Streetcar consists of 11 stations, with a potential twelfth station, and supporting facilities, including track work, one vehicle storage maintenance facility (VSMF), a traction power electrical system consisting of an overhead catenary, the poles supporting the catenary, and four traction power substations.

CWA’s designs include a system-wide fiber optic network, radio system, Emergency Call Boxes, Public Address, CCTV, AVL, Variable Message Signs at stations and Head End systems at the VSMF.

CWA is also developing interface control documents (ICDs) and supports systems for for traction power SCADA, street traffic signal pre-emption, duct banks and conduit, power systems and other systems that will use the fiber optic network.

CWA will continue into Construction Related Services (CRS) to assist in the construction oversight of the system to insure conformity with the design specifications.
Title: Euclid Corridor Transportation Project

Client: Greater Cleveland Regional Transit Authority (GCRTA)

Contact: Mr. Roger Spotswood
Senior Signal Engineer
GCRTA
1240 West 6th Street
Cleveland, OH 44113-1331
Tel.: (216) 566-5150

Status: Completed, on time and within budget

Description:
Communications System Design.

Cleveland was one of 10 cities selected by the FTA as a pilot for a new transportation concept known as Bus Rapid Transit (BRT). BRT systems combine attractive features of both bus and rail systems. Clifton, Weiss and Associates served as part of the design team lead by the prime consultant Wilbur Smith Associates.

The BRT transit-way will extend from Public Square in the Cleveland Central Business District to University Circle, where the transit vehicles will segue to curbside operations and continue to the Louis B. Stokes Station at Windermere in East Cleveland.

As part of the project new communications facilities are being installed along the corridor. Communications transmission is based upon new fiber optic cable and SONET transmission. The communications system supports and interfaces the following subsystems:

- Traffic Signal Control
- Passenger Information Kiosks
- Emergency Telephones
- Security CCTV and Recording
- Maintenance Telephones
- Ticket Vending
- Irrigation Control
- Data Network

Clifton, Weiss and Associates began participation in the project by performing a peer review of the preliminary communications design. CWA then took the lead in progressing to the final design, developing specifications, drawings and construction estimates for communications systems. CWA performed bid support upon award of the contract.

Construction of the Euclid Corridor Bus Rapid Transit System began in 2005 and is expected to be operational by the end of 2008.
SFRTA operates 76 miles of double track commuter rail territory on the South Florida Rail Corridor (SFRC) in Broward, Miami-Dade and Palm Beach Counties. The SFRC accommodates Tri-Rail commuter trains, CSX freight and Amtrak. Previously operated under contract by CSX from Jacksonville, control of train movement on the SFRC had become problematic and was the genesis for the new control center.

- **Code Line**
  The new OCC and BCC are linked to the field CPs via a primary AT&T Leased Digital T1 circuit and a backup Verizon Wireless (VZW) 4G LTE data circuit. Router based OSPF determines whether to use the AT&T or VZW as the code line. Further path diversity and redundancy is provided between the field sites and the primary and Backup Control Centers by routing each field site via independent pathways.

- **Train VHF Voice Radio**
  A 4 channel VHF train to Wayside voice radio providing system-wide coverage with overlap among base stations. Each control center is equipped with an AVTEC radio console that provides control of the bases and utilizes DTMF voting for call in from the wayside.
Title: Grand Rapids Silver Line Project

Client: The Rapid (Interurban Transit Partnership)

Contact: Mr. Conrad Venema
Planning Manager
The Rapid
(616) 774-1191
cvenema@ridetherapid.org

Status: Completed, on time and within budget

Description:
Communications System Design.

The Silver Line Bus Rapid Transit System transports commuters on Division Avenue from 60th Street to Michigan Street, then through downtown Grand Rapids, serving 34 stations. Each station features next-bus arrival signage, ticket vending machines, camera surveillance, and emergency phones. Clifton, Weiss and Associates lead the communications design as part of the team lead by the prime CDM Smith.

CWA worked closely with the City of Grand Rapids, Kent County, Michigan DOT and other entities identifying existing fiber optic facilities for use in the project. New fiber optic cable routes were developed to interface these facilities, resulting in fiber optic connectivity to nearly all of the stations. Based on the fiber plant, a network was designed to serve CCTV, ticket vending, fare validation, and variable message signs at each of the stations. Video from all cameras is stored centrally at The Rapid’s headquarters by transmission over the fiber-based network.

Emergency telephone stanchions automatically dial 911 facilities via a dedicated telephone line at each station. The emergency phones also signal the CCTV System to bring up the image of the phone user to security forces.

CWA developed communications drawings, specifications and cost estimates for the project. CWA provided construction support services through the entire construction period.

Construction of the Grand Rapids Silver Line was completed and the system began operations in August 2014.
The South Florida Regional Transportation Authority (SFRTA/Tri-Rail) provides service along the 71.7 mile South Florida Rail Corridor which runs through Dade, Broward and Palm Beach Counties.

Under the Double Track Corridor Improvement Program, Segment 5, CWA provided design/build services for communications. These include a new Passenger Information System (PIS), a Customer Service Call Center, an Interactive Voice Response (IVR) system, and a 900 MHz ATCS data radio network used for train control, grade crossing event recorders and train location.

The PIS utilizes Global Positioning Satellite (GPS) receivers on each train to determine train location, arrival and departure status. The IVR provides 24 hour/day automated access to schedule, fare and trip planning information.

Train ID and location are broadcast over a 900 MHz ATCS data radio network to a central computer that compares location and time against the master schedule. Train location and schedule deviations are broadcast to LED Variable Message Signs at each station. The information is automatically broadcast over Public Address speakers for ADA compliance.

Major Features of the PIS include:
- GPS Train Location and Tracking.
- 900 MHz ATCS Data Radio Network.
- Train ID, Location, Speed & Arrival Prediction Calculations.
- LED ADA compliant Variable Message Signs at all Stations Broadcast Train Status.
- Automated PA Announcements at Stations.
- Real-time PA for non-routine Announcements.
- Internet Posting of Train Tracking.
- VOIP Frame-Relay Public Address

![GPS Based Passenger Information System](image1)
![Internet Posting of GPS Based Train Tracking](image2)
**Title:** Radio Frequency Survey in Connecticut  
**Client:** MTA Metro-North Railroad  
**Contact:** R. Wayne Staley  
Director, C&S Systems  
MTA/Metro-North Railroad  
420 Lexington Avenue  
New York, NY 10017  
Tel: (212) 499-4550  
**Status:** Design and construction is complete.  
**Description:** Design of the MNR radio system to supply required coverage in the State of Connecticut.


The coverage of the radio system in the State of Connecticut is inadequate to meet the needs of the railroad and the requirements of the Federal Railroad Administration (FRA).

The purpose of this project is to analyze the existing radio network and design the necessary improvements to the radio system to supply the required coverage. Specific project tasks that CWA is engaged in include:

- Analyzing, evaluating, and planning the use and capacity of the existing and future radio network including measurements of system availability
- Integration with the new Fiber Optic Network Infrastructure including the efficient collocation of radio equipment into fiber node locations
- Integration of new radio equipment and additional radio channels into the existing control center dispatcher equipment
- Reliability-based radio coverage simulation, location selection, detailed design, and complete equipment selection for 30 radio sites
- Specification preparation, Material and recurring cost estimating, Third-party site leasing negotiating, and FCC license coordination and preparation
- Collocation and interference analysis and conflict resolution for multiple transmitter sites

Below is a photo of one of the project radio houses that CWA designed.
MTA Metro-North Railroad (MTA MNR) is the second-largest commuter line in the United States, providing more than 200,000 customer trips each weekday and some 62,000,000 trips per year.

MTA MNR has an existing voice and data communications infrastructure consisting of older fiber optic equipment, copper cable plant and leased lines. The infrastructure is used for voice and data transmission services that are central to the day-to-day operations of the Railroad. The existing infrastructure has exceeded its useful service life, and in some cases reliability of certain network elements is poor.

An extensive assessment of the existing infrastructure was undertaken and a thorough needs assessment conducted throughout the organization to analyze all aspects of the business. Traffic projections were performed and several network technologies and topologies were examined for applicability to solve immediate and long-term needs.

To accommodate existing and projected voice and data communications requirements, a hybrid telecommunications network was engineered, and construction commenced in the second quarter of 2002.

Combining OC-192/48 SONET, Asynchronous Transfer Mode (ATM), TDM, HDSL-2, DACSs, Digital Loop Carrier, advanced Network Management and other widely deployed technologies, the network design provided MNR with a scalable platform that provides a migration path for the future.

Factors that contributed to the final topology included the current state and migration of the telecommunications transmission market, the need for a standards-based network, operational and managerial requirements of the railroad, quality of service (QoS) demands, reliability and network life cycle.

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MTA/MNR System-wide SONET/ATM Network
Title: Positive Train Control (PTC) Planning, Design and Implementation Support.

Client: Southeastern Pennsylvania Transportation Authority (SEPTA)

Contact: Michael J. Monastero
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SEPTA
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Overview:
Positive Train Control (PTC); Team development of FRA documents, planning, modeling, detailed design, and implementation support.

Congress and the Federal Railroad Administration (FRA) have mandated the nation-wide implementation of Positive Train Control (PTC) systems by December 2015 to prevent train collisions caused by human error.

CWA, as a member of the SEPTA PTC design Team, has been assigned responsibility for the planning, development, detailed design and implementation support of PTC communications systems. CWA's assignments included:

- Advance research of the FRA NPRM, vendor products and development of PTC strategies for each railroad.
- Research PTC systems including ACSES and V/ETMS.
- Develop and submit Federal Railroad Administration (FRA) mandated filings (IP/DP/SP), including pre-submittal meetings with the FRA.
- Develop schedules, risk assessment, obstacles to success and mitigation solutions to insure the 2015 implementation mandate is maintained.
- Assist in analyzing PTC radio frequencies, conducting negotiations and procurement of 220 MHz and 900 MHz radio channels.
- Assess market solutions for radio hardware and software, including COTS, HPDR and ITC.
- Assist in the development of a joint Amtrak and NEC commuter railroad radio hardware specification.
- Assist in PTC Interoperability strategy meetings with Class 1 freight railroads as both tenants and landlords.
- Design test procedures and conducting field trials of vendor wayside and on-board PTC communications equipment in live RR environment.
- Develop radio and data message traffic analyses, models, propagation studies and channel re-use assessments to insure that message traffic latency is not introduced.
- Develop overall PTC communications infrastructure, including radio networks, GBN (fiber optics, microwave, leased lines & others) network security and network management.
- Office system interface and communications networking for all back office function including vital safety TSR server and interoperability connectivity among tenant/landlord railroads.
- Coordinate and design communications systems interfaces and systems for Radio (BCP/MCP), Wayside (WIU), Vehicle (OBC), Ground Based Network and Office (STS) systems.
- Specification development for procurement and implementation and construction phase services.

Projected PTC RF Coverage at SEPTA CP
Title: Interoperable Electronics Train Management System (I-ETMS) Planning, Design and Implementation Support.

Client: National Railroad Passenger Corporation (AMTRAK)

Contact: Benjamin Freid, Amtrak
Senior Engineer - PTC
30th Street Station
Philadelphia, PA 19104
215-495-9530

Status: Contract Awarded, Phase I (test bed sites)
design 30% complete

Overview:
Interoperable Electronics Train Management System (I-ETMS); planning, modeling, detailed design, and implementation support.

Congress and the Federal Railroad Administration (FRA) have mandated the nation-wide implementation of Positive Train Control (PTC) systems by December 2015 to prevent train collisions caused by human error.

Amtrak will be implementing I-ETMS as a parallel system on the NEC for interoperability with the Class 1 RRs using the NEC.

CWA, as a member of the Amtrak I-ETMS design Team, has been assigned responsibility for the planning, development, detailed design and implementation support of communications systems. CWA’s activities and responsibilities include:

- Survey existing communications system resources in signals houses, communication huts, and radio locations
- Design the interface/transport method for I-ETMS traffic between and among the wayside devices (WIU), radios (MeteorComm), and back office servers (BOS)

Initially the fiber optic based IP transport system will be implemented in an I-ETMS test bed for Class 1 railroad interoperability. This consists of six (6) locations on the Amtrak Northeast Corridor (NEC) with possible additional locations for radio placement. The designed system is to be expanded to include locations from NYC to Washington, D.C. When this expansion occurs similar communications systems survey and design and oversight will be performed by CWA.

In addition CWA has been asked to participate in an additional expansion of this I-ETMS survey and design for locations between NYC and Albany, N.Y.

Additional responsibilities include:
- A communications infrastructure survey detailing the existing network and how resources can be leveraged for the I-ETMS design
- Development of detailed communications systems design drawings for each of the field locations
- Selection of relevant network equipment such as switches or routers to accommodate I-ETMS wayside equipment such as WIUs and radios
- Development of a proposed virtual LAN (VLAN) scheme to segregate network traffic
- Detail necessary IP addresses required for all equipment to be added under the I-ETMS effort
- Evaluation of network backbone bandwidth requirements to support additional IP devices required for the I-ETMS effort
Project Profile

Title: Newark Liberty International Airport
Redevelopment of Terminal A

Client: Port Authority of New York/New Jersey (PANYNJ)

Contact: Luis Obispo
Lead Project Engineer
Two Gateway Center
Newark, NJ 07102
Tel: 973-792-4449

Status: Phase 1 Design Complete May 2013.

Description:
Phase 1 conceptual design of the replacement Newark Liberty Airport Terminal A building. The communication system design includes Public Safety Radio, Cellular and Wi-Fi communication services.

The Port Authority of New York and New Jersey has initiated a project to replace the existing Newark Liberty Terminal A which is approaching the end of its usable life. CWA, as a subcontractor to Burns Engineering, is responsible for the Phase 1 design of all in-building radio communication systems including Public Safety LMR (Land Mobile Radio), Cellular/Wireless and Wi-Fi services.

The Public Safety Radio system is planned to provide multiband off air rebroadcast coverage for VHF, UHF, 700 and 800 MHz first responder channels using Narrowband Bi-Directional Amplifiers and RF over fiber to wideband remote BDA’s. The in-building DAS system consists of a combination of discrete antennas and radiating coaxial cable. In addition, several UHF and 800 MHz NPSPAC mutual aid channels are planned to provide for interoperable communications between first responder agencies. The channels will be broadcasted on the in-building DAS system as well as above ground antennas to provide coverage in the surrounding Newark Liberty Airport area.

The Cellular/Wireless Neutral Host system will provide seamless voice and data coverage for the commercial wireless carriers over a common in-building DAS system. The system architecture provides for RF over fiber from the head end neutral Wi-Fi services will be provided throughout the terminal using wireless access points (WAPs) covering 802.11a/b/g/n standards ensuring compatibility with newer high-speed wireless devices as well as legacy low-bandwidth clients. WAP’s are to be configured with segregated, individually secured SSID’s to allow efficient and secure access for the Port Authority and general public along with WPA-2 encryption and password protection.
Title: New Payment Technologies, Zone Center Offices

Client: Southeastern Pennsylvania Transportation Authority (SEPTA)

Contact: Michael J. Monastero
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SEPTA
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Status: Design complete, programming and implementation underway

Description: Extend control functions presently performed in cashier booths at stations to five Zone Center Offices throughout the SEPTA system.

SEPTA provides commuter rail, rapid transit, bus and customized community transportation services to the Philadelphia metropolitan region.

New Payment Technologies is a program to modernize and network fare collection systems in SEPTA passenger stations and onboard SEPTA vehicles. Design and construction of the fare vending systems themselves are being completed under separate contract. The Zone Center Office task involves consolidating other functions currently performed by station cashiers that are not directly related to the fare vending system, such as elevator control, into five remote offices, each one assigned to a particular zone of the SEPTA system.

CWA, in conjunction with our prime contractor, was responsible for cataloging the functions performed by the cashiers, including a survey of all cashier booths in the SEPTA system. CWA also worked with Phoenix Contact, SEPTA’s Programmable Logic Controller (PLC) vendor for this project, to develop specifications and drawings for pre-wired PLC cases to be installed in each cashier booth by SEPTA forces. These cases will interface to existing Integrated Control Consoles (ICC) in each booth, and will allow all of their existing control and monitoring functions to be performed remotely while still allowing local control.

Based upon earlier experience with the Smart Stations Control Center project, SEPTA elected to again use the Wonderware System Platform to provide the remote monitoring and control. CWA is responsible for all programming and User Interface (UI) development of the new Wonderware system.

After reviewing several leading products, CWA identified the Wonderware System Platform as a best-of-breed solution to meet not only the technical requirements of the project, but also the need for a single, open, extensible platform for both current and future applications.

In addition to the Wonderware interface to existing ICCs, CWA and the project team were also responsible for specifying expansion of other existing systems – including Emcom Customer Information Telephones (CIT), Genetec IP Video terminals and servers, Nortel Business Communication Managers and SEPTA Centrex – to meet the needs of the new Zone Center Offices.
Dallas Area Rapid Transit (DART) supports bus fleet operations with a 900 Mhz Integrated Radio System (IRS). The IRS provides voice communications among dispatchers, buses and non-revenue vehicles, as well as data telemetry for Automatic Vehicle Location (AVL) and health and welfare status. DART must operate, maintain and support the IRS until approximately 2011.

As a subconsultant, CWA was charged with the development of a ten-year strategic plan for the IRS that encompassed the following scope-of-services:

- Perform an Inventory of IRS equipment and Software.
- Analyze current maintenance support and make recommendations for improving maintenance support efforts.
- Identify items that are currently obsolete or unsupportable and provide the rationale for the items identified.
- Analyze current operations and maintenance support documentation and make recommendations for improvements and changes.
- Identify items that will be obsolete or unsupportable in the next ten (10) years.
- Analyze spare parts stock levels and make recommendations on stock items and stock levels.
- Identify critical systems and subsystems of the IRS (verify and update system block diagram).
- Develop a matrix of systems or subsystems identified for priority replacement by criticality and supportability.
- Recommend replacement hardware and software by type, model and version, including specifications and pricing.
- Analyze current levels of IRS utilization and make recommendations on improving system utilization.
- Identify elements of the IRS that are not Y2K compliant.
- Identify critical elements of the IRS that lack redundancy.
**Title:** Silverliner V New Vehicle Procurement, Wayside Communications Network

**Client:** Southeastern Pennsylvania Transportation Authority (SEPTA)

**Contact:** Daniel J. Gibbone  
Manager, Engineering  
New Vehicles Program  
SEPTA  
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**Status:** Detailed Design Complete, installation in progress.

**Description:** Design and construction of a train-to-wayside communications network for enhanced vehicle services utilizing multiple technologies.

SEPTA is procuring a new fleet of rail vehicles, the Silverliner V. These new vehicles will incorporate several advanced features – such as onboard diagnostics, automatic passenger information systems, onboard Form D printing etc. – that will require multiple types of train-to-wayside communications. CWA, as a subcontractor to Meister Electronics, Inc., is the design-build supplier of the wayside communications network.

The wayside comms at rail yards and at Suburban Station will consist of meshed 802.11b/g Wi-Fi access points using 802.11a for backhaul traffic. The existing SEPTA WAN, using a mix of owned and leased facilities, will be expanded by this project to meet the bandwidth demands of the new applications.

In addition to Wi-Fi, voice and low-speed data communications with the car will be available via the existing SEPTA VHF radio network. CWA is designing and implementing changes at the SEPTA Railroad Division Control Center (RRDCC) that will allow Passenger Information Specialists to make live, on-board PA announcements on a per-train, per-division or global basis. Prerecorded audible and textual messages that had been previously uploaded to the vehicle via the WiFi network at Rail Yards will be triggered automatically by GPS positioning, or alternately by manual trigger via VHF radio from the Passenger Information Specialists. Finally, the Automated Train Crew Dispatching System will also be able to issue Form D orders directly to on-board printers.

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**Vehicle Diagnostic Data Flow – Typical Rail Yard**

**Onboard Live Public Address – Data Flow**
Title: Communications Technology Plan

Client: Southern California Regional Rail Authority (SCRRA / MetroLink)

Contact: Stephen H. Lantz
Director, Comms. and Development
Metrolink
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Los Angeles, CA 90017
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Status: Completed.

Description: Agency-wide Communications Technology Plan (CTP) to develop a strategic plan and implementation strategy for a ten-year operating horizon to meet every increasing operating and customer service needs.

Southern California Regional Rail Authority (SCRRA/MetroLink) operates over 142 trains per weekday on 7 rail lines. The area of operation covers approximately 500 route miles with 39 locomotives and 150 railcars.

To meet ever growing operations and customer service needs, MetroLink has decided that an agency wide Communications Technology Plan (CTP) be developed to provide guidance in evaluating, initiating, developing, operating and maintaining an integrated communications system.

The goal of the CTP is to ensure that the appropriate communications tools are identified and strategically implemented to best support a sustainable, scalable and cost effective communications network that enhances the mission, goals and objectives of the Agency.

To achieve this goal, the CTP will examine the processes for developing and implementing major communications technology projects that are necessary to support current year initiatives, through the identification of existing and future communications capacity requirements, operational requirements and customer satisfaction issues. The CTP will serve as a tool to prioritize implementation of the initiatives from the perspective of:

1) Impact on current organizational processes and operations, 2) Technical ease of integration with existing communications infrastructure to best maintain seamless operations, 3) New communications technologies and potential applications, 4) Procurement costs, 5) Staffing, operating and maintenance requirements, and 6) Cost/benefit analysis.

In addition to supporting SCRRRA initiatives, the CTP will also identify processes and requirements necessary for the development and operation of a successful communications program. This effort will entail the development of integrated business cases for specific communications projects as well as the development of a comprehensive communications assessment that will be used to guide the phased implementation and operation of all the integrated initiatives.
The Port Authority of Allegheny County rebuilt 13 miles of trolley lines to modern light rail standards in the early 1980’s as Stage I, forming the LRT System known as the “T.” Stage II delivered the reconstruction and modernization of the Overbrook Line and other system improvements, including a new, expanded Operations Control Center, an improved Traction Power and Overhead Contact System, improvements to the signal and SCADA systems, and a major expansion and update to the Communications System.

Clifton, Weiss & Associates, Inc. served as the principle communications designer for this project. CWA developed specifications and drawings, reviewed submittals, and provided construction support.

CWA was contracted to perform the following communications system design under Stage II:

- Fiber optic outside plant. Fiber optic cable installed on all major lines, serving all stations.
- SONET-based communications transport system installed serving all stations. Used by all communications subsystems.
- Passenger Information System including public address system and variable message signs. Major upgrade to existing system and expansion of system to new stations.
- Two-way radio system expansion and upgrade. Radio System designed to provide coverage to new line and improve coverage to existing lines. System-wide radio propagation & interference studies performed. Radio System Integrated with new Operations Control System.
- Telephone System including Patron Emergency Telephones, Blue Light Emergency Phone System and expansion of PBX.
- CCTV System upgraded to fiber-based system. Designed new viewing, recording and control system at the PAAC Security Headquarters. System expanded to selected stations.
The Southern California Regional Rail Authority (SCERRA) operates the METROLINK commuter railroad in the Los Angeles area using an Advanced Train Control System (ATCS) data radio network.

Clifton, Weiss & Associates, Inc. (CWA) was tasked with investigating the performance and capacity of the ATCS radio network.

CWA tested the network by installing network monitoring equipment at various field sites and the control center.

CWA then analyzed the test data to detect anomalies and determine network throughput. The capacity was also calculated to provide the SCERRA with a complete understanding of the existing conditions and the capabilities of the network to support future growth.

Recommendations on what changes should be made to improve performance and expand the network were also provided in the project report.

Project features included:

- Trainborne and field-site testing of network performance simultaneously at 5 different test points.
- Detailed network traffic analysis including anomaly resolution and complete performance calculations.
- Preparation of short-term, performance-improving recommendations as well as long-term strategic plans for maintaining and growing the ATCS radio network.
Title: Bus Detection System Analysis
Client: LTK Engineering Services for Sound Transit
Contact: William E. McConnell, PE
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625 5th Avenue South
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206-398-5308
Status: Completed.
Description: Testing and analysis of the Bus Detection System to identify and mitigate issues affecting system reliability.

The Downtown Seattle Transit Tunnel (DSTT) is a public transit tunnel that runs under the Seattle downtown district. In 2005 the DSTT was closed for construction to accommodate both buses and light rail vehicles (LRV). It reopened to buses in 2007, and it is planned to be opened to LRV traffic within the next two years.

The DSTT Joint Use Signal System detects both LRVs and buses. Track circuits are used for LRV detection. Bus detection is accomplished through the use of Radio Frequency Identification (RFID) tags and readers. At the time of this project the Bus Detection System was not detecting buses reliably. The purpose of this project was to capture and analyze data in order to make recommendations to mitigate the identified system anomalies.

The first phase of the project was to conduct an off-site assessment to examine and document system failures. Through this assessment, CWA developed a test plan that addressed three system areas: the reader RF environment, the serial data lines used to transmit reader data, and the system LAN used to transmit data to the system processors.

The test plan concerning the RF environment included testing for “intentional” and “unintentional” interference sources in the RF environment. RF testing included using a spectrum analyzer with an antenna held in a position that simulated the reception of the reader under test while not affecting the reader’s functionality. To capture serial data traffic the test plan called for connecting laptop computers running serial data capture and testing software. An additional laptop running LAN monitor software was used to capture LAN traffic. Upon conclusion of the data gathering, CWA immediately began analysis of the data. A multi-step analysis process was used to put the test data into a usable form.

The analysis resulted in a set of observations and lists of short-term and long-term recommendations. Changes implemented in the bus detection system resulted in reducing missed buses to nearly zero.