



Communications-Based Train Control (CBTC)





FEASIBILITY AND IMPLEMENTATION ASSESSMENT OF ATP AND CBTC

SACRAMENTO REGIONAL TRANSIT DISTRICT (SACRT)

LOCATION

Sacramento, CA

NAME OF CLIENT

Sacramento Regional Transit District (SacRT)

PROJECT TIMELINE

2026 - 2027

PROJECT OVERVIEW

The Sacramento Regional Transit District (SacRT) initiated a systemwide feasibility study to evaluate the implementation of Automatic Train Protection (ATP) and Communications-Based Train Control (CBTC) (i.e. moving block) technologies across its light rail network. The study supports SacRT's objective to enhance safety, improve operational efficiency, and modernize its aging signal infrastructure in alignment with industry standards and targeted Grades of Automation (GoA 1-2).

Hatch, in partnership with Virginkar & Associates, Inc. (VAI), is delivering a comprehensive system evaluation, feasibility study, implementation roadmap, and grant support documentation. The team leverages extensive experience with SacRT and deep expertise in rail systems engineering to assess existing conditions and define practical pathways for modernization.

SCOPE OF WORK

- + Hatch is leading a multidisciplinary effort to evaluate SacRT's light rail system and develop a structured implementation strategy for ATP and CBTC, including:
 - + System Evaluation across signaling, traction power, communications, vehicles, and central control systems
 - + Targeted field assessments
 - + Gap analysis
- + Operational modeling and simulation utilizing Hatch's TrainOps software
- + Development of phased implementation strategies
- + Preparation of cost-benefit evaluation and grant support reports
- + Stakeholder coordination
- + QA/QC under an ISO-compliant quality management system

PROJECT HIGHLIGHTS

The project includes a systemwide assessment of legacy signaling infrastructure, application of TrainOps modeling and simulation tools to evaluate operational improvements, targeted field assessments of representative assets, integration analysis for complex operating environments including street-running segments, development of phased implementation strategies, and preparation of grant-ready technical documentation.

KEY OUTCOMES AND VALUE

This study equips SacRT with a clear understanding of system conditions and constraints, quantifies the benefits of ATP and CBTC, and provides actionable recommendations for phased implementation. The work supports future funding applications and enables SacRT to advance toward a safer, more reliable, and higher-capacity light rail system.



TRAIN CONTROL MODERNIZATION PROJECT (CBTC) DESIGN PROGRAM MANAGEMENT BAY AREA RAPID TRANSIT

LOCATION

California, US

NAME OF CLIENT

Bay Area Rapid Transit

PROJECT TIMELINE

2020 - 2030

PROJECT COST

US \$1.65 billion

PROJECT OVERVIEW

The Bay Area Rapid Transit (BART) Train Control Modernization Project Communications-based Train Control, CBTC) is part of the broader Transbay Corridor Core Capacity Program (TCCCP) which, in addition to CBTC, includes 1,200 additional railcars, 48 passenger stations, six new railcar storage yards and new traction power substations. The installation of a state-of-the-art CBTC system will increase transit capacity and improve reliability by replacing aging equipment. The implementation of CBTC will replace BART's original, early 1970's, tract-circuit-based, operator-attended Automatic Train Control (ATC) system on 125 miles of double and triple track, while minimizing the impact to revenue operations.

Currently, this is the largest CBTC project being delivered in North America and the second largest CBTC project globally. The implementation of CBTC will enable BART to increase the Transbay Tube capacity to a project 30 trains per hour in the core system area, from the current limitation of 24 trains per hour. CBTC is expected to take approximately ten years to complete; it will first be proven on a test track, then will roll out for BART main line deployment in eight geographical phases, with the ability to run 28 trains per hour through the Transbay Tube in 2027 and up to 30 trains in 2029

SCOPE OF WORK

To support implementation of the CBTC design-build contract, Hatch is providing Design Services During Construction (DSDC) including technical design, engineering, project management and implementation oversight support to the leadership team responsible

for BART's CBTC Program. Hatch serves as the Owner's Engineer for the 10-year contract duration, providing the following services:

- + Technical and Strategic Advisory
- + Design Program Management
- + Program and Construction Management
- + Project Deployment and Integration Management
- + System Integration Management
- + Risk Management and Mitigation
- + Brownfield CBTC Development and Deployment Management
- + Agency Preparedness, Training, Manual Development
- + Systems Engineering Management
- + ICS Transition Management
- + Safety and Security Design Review and Certification Management

PROJECT HIGHLIGHTS

- + Communications-based train control (CBTC) modernization across approximately 125 miles of double- and triple-track rail network
- + Part of a corridor-wide core capacity program supporting expanded fleet, stations, yards, and traction power infrastructure
- + Largest CBTC implementation in North America and one of the largest globally
- + Phased deployment across eight geographic segments while maintaining revenue operations
- + Capacity increase through the Transbay Tube from 24 to up to 30 trains per hour
Test track validation followed by systemwide mainline rollout
- + Design services during construction supporting design-build delivery
- + Owner's Engineer services including systems integration, risk management, and implementation oversight
- + Safety, security, and systems engineering management for brownfield CBTC deployment



NEW MILLENNIUM SUBWAY CARS NEW YORK CITY TRANSIT (NYCT)

LOCATION

New York, NY

NAME OF CLIENT

New York City Transit (NYCT)

PROJECT TIMELINE

1996 - Ongoing

PROJECT COST

All projects: US \$11 billion

PROJECT OVERVIEW

Hatch played an integral role in helping NYCT replace over half of its rapid transit fleet with extremely reliable “New Millennium” cars over the course of several major procurements that started in 1996.

Since 1996, Hatch has provided all-inclusive engineering and management services throughout all project phases to assist NYCT in procuring these fleets:

- + R142 – 1,030 “A” Division cars (Bombardier)
- + R142A – 520 “A” Division cars (Kawasaki)
- + R142S – 80 “A” Division cars (Kawasaki)
- + R143 – 212 “B” Division cars (Kawasaki)
- + R160 – 1,662 “B” Division cars (Alstom and Kawasaki partnership)
- + R188 – 506 “A” Division cars (Kawasaki) consisting of 126 new cars and 380 converted R142A cars – and added CBTC to both
- + R179 – 316 “B” Division Cars (Bombardier)
- + R211 – 1,612 “B” Division Cars (Kawasaki)

This large and unprecedented wave of overlapping procurements, each a major project, posed significant technical and management challenges for the agency. Hatch was an integral partner with NYCT in surmounting these challenges and together were able to successfully deliver 3,504 high-tech subway cars.

Hatch’s work continued on the R179 project to procure a total of 316 new B-Division cars to replace the oldest rolling stock in the system (R32 and R42 cars). The R179 employed several new technologies and was the first NYCT fleet to incorporate Ethernet-based network systems and a “free axle” for more accurate speed and location measurement, and compatibility with the Communications Based Train Control (CBTC) system already in use on the R143 and R188 fleets.

In 2018, Hatch began work on the next major NYCT subway car procurement, the R211. Hatch is part of the Joint Venture that is overseeing the design, production, and testing of up to 1,612 R211 subway cars by Kawasaki.

As a series of federally funded projects, these procurements required DBE participation and monthly reporting on progress towards goals, and both our contract and the specifications and terms and conditions we wrote adhered to all FAR requirements and regulations.

PROJECT HIGHLIGHTS

- + Replacement of more than half of New York City’s rapid transit fleet through multiple large-scale procurements
- + Delivery of 3,504 new high-performance subway cars across A- and B-Division fleets
- + Integration of communications-based train control (CBTC) capability into new and converted fleets
- + Engineering and management services spanning design, procurement, production, testing, and delivery phases
- + Oversight of overlapping rolling stock procurements with multiple manufacturers
- + Introduction of advanced car technologies including Ethernet-based networks and enhanced train control compatibility
- + Procurement and deployment of next-generation subway cars to replace legacy rolling stock
- + Joint venture role supporting design, manufacturing, testing, and commissioning of up to 1,612 new subway cars



WILSON FACILITY ENHANCEMENTS AND YARD EXPANSION **TORONTO TRANSIT COMMISSION (TTC)**

LOCATION

Toronto, Ontario, Canada

NAME OF CLIENT

Toronto Transit Commission (TTC)

PROJECT TIMELINE

2012- 2022

PROJECT COST

CA \$68 million

PROJECT OVERVIEW

The Wilson Yard Complex is being significantly expanded over the coming years to accommodate maintenance and dispatch of between 65 and 80 Toronto Rocket subway vehicles, requiring many additions and alterations to the facility. Works include several additional storage tracks, alteration of existing, and provision of new control systems to support an expanded layout to improve capacity and throughput. System integration requires a staged design approach including modifications to existing control systems as the new interlocking is phased in.

Thales LockTrac electronic interlocking system was selected as the new yard control system to be installed at Wilson Yard, replacing the current relay-based yard control system.

SCOPE OF WORK

Hatch is the sub-consultant and the Owner's Engineer for Systems/Signals on this assignment, responsible for the detailed design, contract administration and engineering support during construction for all signals, mechanical, electrical and communications elements of this project.

Hatch was transitioned onto this project at the 60% detailed design stage to complete the remaining deliverables related to the signaling and communications scope of the project. Hatch is responsible for progressing the 90% and 100% project technical specification and drawing packages, tender support during bid period, contract administration and compliance review of contractor signal design/testing/training package submittals. Onsite responsibilities include site layout correlation, cable routing assessments, system integration, interdisciplinary reviews and coordination with stakeholders, installation support during construction and testing & commissioning support during FAT, PICO and SAT testing stages.

Scope additions included Hatch to provide detailed signal design and engineering support to open the new Runaround Track under control of the legacy interlocking allowing early recovery of the existing Runaround Track and accelerating the project schedule.

PROJECT HIGHLIGHTS

- + Coordination with multiple stakeholders within TTC and other Contractors working within the yard.
- + Designing to incorporate current and future operating requirements of TTC.
- + Coordinating and constructing within a live, active train storage facility.
- + Multi-disciplinary design including civil, track, signals, structural, mechanical, electrical and environmental components.
- + Independent and adhoc interlocking testing on behalf of TTC.



TORONTO-YORK SPADINA SUBWAY EXTENSION

TORONTO TRANSIT COMMISSION (TTC)

LOCATION

Toronto/Vaughan, Ontario, Canada

NAME OF CLIENT

Toronto Transit Commission (TTC)

PROJECT TIMELINE

2008- 2017

PROJECT COST

\$3.1 billion

PROJECT OVERVIEW

The Toronto-York Spadina Subway Extension (TYSSE) was the largest capital program ever undertaken by the Toronto Transit Commission (TTC). Sponsored by three levels of government (federal, provincial, and municipal – City of Toronto/York Region), the TYSSE project is the first line in the TTC subway network to go beyond the City of Toronto borders to neighbouring municipalities. The 8.6 km extension of the subway includes 6.7 km of bored twin tunnels and six stations. From the existing Sheppard West Station, the subway is routed northwest through the York University campus, across Hwy. 407 and terminates at the Vaughan Metropolitan Centre. The alignment crosses beneath several buildings, railway tracks, a provincial highway and many city arterial roads, major utilities, conservation areas and watercourses.

SCOPE OF WORK

Hatch (previously as Hatch Mott MacDonald) worked with an integrated team staffed by personnel from the TTC and was also lead partner of the Spadina Link Project Managers (a Joint Venture of Hatch, Delcan, and MMM). Reporting to the TTC's Project Director, the JV Team managed the design delivery and project construction. The Team also prepared the preliminary design and contract specifications for all the rail system elements; e.g., track, train control, traction power supply and distribution, communications, integrated controls (SCADA) and fire ventilation and supported the tender process for each contract package. The Team managed the resulting Contract packages as the Owners Representative through detail design, manufacturing, installation, testing, and commissioning. Hatch also performed the following: Safety System Assurance, rail activation, system integration, and safety certification. Hatch also performed the detailed design of the tunnel under a separate contract and will place the subway system into revenue operation.

PROJECT HIGHLIGHTS

- + Project funded by three levels of government.
- + Challenging design and construction schedule.
- + Project was delivered in six major construction contracts in the traditional design-bid-build delivery method:
- + Two tunnel contracts, each incorporating a subway station.
- + Four contracts for construction of the remaining four subway stations.
- + Several advance contracts for enabling works, i.e., utilities relocations and road and creek diversions.
- + Pre-purchase of four Earth Pressure Balance Tunnel Boring Machines for use by the tunnelling contractors.
- + Pre-purchase of concrete tunnel liner segments.
- + Seven large design assignments for the tunnels and stations.
- + Extensive consultation/liaison with internal and external stakeholders and approvals authorities.
- + Permits and approvals from three levels of government, utility companies and public property owners.
- + Property acquisition from public and private owners.
- + Application of LEED.
- + Fully redundant signalling system - a microprocessor-based train control for the wayside with an overlay Communication Based Train Control System (CBTC).
- + Upgraded control from the Transit Control Centre to accommodate additional project territory.
- + Self-Healing Station and Tunnel Radio System carrying TTC, Metro Toronto/York Region Police, Fire and Ambulance systems.



METRO LINE LRT CBTC CITY OF EDMONTON

LOCATION

Edmonton, AB

NAME OF CLIENT

City of Edmonton

PROJECT TIMELINE

2011 - 2017

PROJECT COST

US \$34.6 million

PROJECT OVERVIEW

The existing Centralized Traffic Control (CTC) system provides PA/VMS functionality, real-time display of train and wayside signal statuses and allows the LRT operations staff to control the signal system in a safe manner. The system also provides historical data and alarm information based on key operational requirements and rules. The replacement system is also to provide all existing functionality for non-CBTC territories (NELRT from Stadium Station to Clareview Station, and SLRT from McKernan/ Belgravia Station to Century Park Station).

The City of Edmonton required a consultant to provide integration of the North LRT (NLRT) segment into the existing or new CBTC compatible CTC system, all to be staged and coordinated with the Construction Manager.

SCOPE OF WORK

Hatch is the lead engineer responsible for all aspects of CBTC design, construction, project management, quality management, systems engineering, systems integration, testing and commissioning in compliance with the detailed requirements.

PROJECT HIGHLIGHTS

- + CBTC system to encompass the entire NLRT segment, the entire DLRT segment, the NELRT segment from Churchill Station to the south end platform of Stadium Station, and the SLRT segment from the HSS tail track to the north end platform of McKernan/Belgravia Station.
- + Exclusive CBTC system for the NLRT segment (no underlying Wayside Signal System).
- + Propose and Provide an ability to operate trains under a fallback mode on the NLRT in the event of CBTC failure on this segment.
- + CBTC system overlaid on existing Wayside Signal System for the other segments defined above.
- + Capability for the existing Wayside Signal System to assume operative control of all overlaid segments in the event of CBTC failure over any of the overlaid segments.
- + Operational Headways of 5 minutes for the NLRT, using 5 car trains in both directions, resulting in 2.5-minute Headways for the DLRT, while under CBTC control.



SOUTH YONGE
RESIGNALING:
AUXILIARY WAYSIDE
SYSTEM SIGNAL
DESIGN SUPPORT
**TORONTO TRANSIT
COMMISSION (TTC)**

LOCATION

Toronto, Ontario

NAME OF CLIENT

Toronto Transit Commission (TTC)

PROJECT TIMELINE

2009 - 2010

PROJECT OVERVIEW

The Toronto Transit Commission's South Yonge CBTC Resignaling Project modernized the oldest and most capacity-constrained segment of the Yonge/University/Spadina Subway Line to improve reliability, safety, and throughput. The \$340-million (CDN) program introduced a Communications-Based Train Control (CBTC) system to replace aging fixed-block signaling, enabling significantly reduced headways and increased ridership capacity. A critical component of the program was the design and implementation of a fixed-block auxiliary wayside signal system to provide operational redundancy and maintain service during CBTC installation and testing. Hatch supported TTC as an extension of staff, delivering block layout design, safe-braking verification, and minimum headway analysis across the corridor. This integrated approach ensured continuous, safe operations on Canada's first subway line while enabling a phased transition to modern train control technology.

SCOPE OF WORK

Hatch's scope of services focused on supporting the Toronto Transit Commission's modernization of the South Yonge segment through the design and validation of a fixed-block auxiliary wayside signal system that would operate alongside and independently from the new CBTC system. Acting as an extension of TTC staff, Hatch led the development, production, and verification of block layout designs across the corridor, including critical interlockings, and performed detailed safe braking and minimum headway analyses. The work addressed redundancy and constructability requirements, enabling continued operations during the CBTC construction period and supporting trains and work cars not equipped with CBTC. Hatch's scope also included development of alternative signaling concepts, verification of braking parameters under multiple control philosophies, and technical reporting to ensure safe, reliable operations on Canada's oldest and most signal-constrained subway segment.

PROJECT HIGHLIGHTS

- + \$340-million (CDN) communications-based train control (CBTC) resignaling of the South Yonge segment of the Yonge/University/Spadina Subway Line
- + Modernization of Canada's oldest subway segment, originally opened in 1954
- + Implementation of a CBTC system supporting 90–105 second headways
- + Capacity improvements enabling a 35–50 percent increase in ridership
- + Design and integration of a fixed-block auxiliary wayside signal system
- + Redundant train control system supporting operations during CBTC construction and failures
- + Accommodation of non-CBTC-equipped trains and work cars on the corridor
- + Safe braking and minimum headway analysis supporting new block layouts
- + Verification of safe braking calculations at critical interlockings
- + Development of alternative block layout concepts using grade time signaling
- + Block layout design and verification across the full South Yonge segment



A/E SERVICES FOR
THE SUBWAY SURFACE
TUNNEL SIGNAL
SYSTEM REPLACEMENT
PROJECT
**SOUTHEASTERN
PENNSYLVANIA
TRANSPORTATION AUTHORITY
(SEPTA)**

LOCATION
Philadelphia, PA

NAME OF CLIENT
Southeastern Pennsylvania
Transportation Authority (SEPTA)

PROJECT TIMELINE
2023 - 2025

PROJECT OVERVIEW

SEPTA's Subway-Surface Tunnel Signal System Replacement Project modernizes the light rail tunnel that forms the core of Philadelphia's Green Line network. The approximately 2.5-mile, two-track tunnel is shared by five surface routes converging from two portals and carries roughly 90,000 passengers per day. The project replaces the existing CBTC system, originally commissioned in 2008, to improve system reliability, safety, and compatibility with a new fleet of light rail vehicles. The upgrade supports continued operations with both legacy and new vehicles while enabling a phased transition to the new signaling architecture without service disruption.

SCOPE OF WORK

Hatch supported SEPTA across all vehicle-related aspects of the CBTC replacement, addressing both existing and newly procured light rail vehicles with differing acceleration and braking characteristics. The scope included onboard computer and communications system design, modification and integration of CBTC equipment on legacy and new vehicles, and detailed evaluation of onboard equipment locations to address environmental, safety, and security constraints. Hatch also participated in developing a phased implementation strategy that allowed continued operation of existing vehicles under the new signal system while SEPTA transitions the fleet, ensuring uninterrupted service through the changeover period.

PROJECT HIGHLIGHTS

- + Approximately 2.5 miles of light rail tunnel with two mainline tracks
- + Five surface light rail routes converging through dual tunnel portals
- + Replacement of an existing CBTC system originally placed in service in 2008
- + Signal system redesign supporting both legacy and newly procured light rail vehicles
- + Integration of new CBTC equipment with vehicles having differing braking and acceleration profiles
- + Onboard computer and train-to-wayside communications system design
- + Modifications to existing and new light rail vehicles to accommodate CBTC equipment
- + Onboard equipment layout evaluation addressing temperature, water intrusion, and tamper protection
- + Phased transition strategy supporting mixed-fleet operations during fleet rollout
- + System improvements supporting high-ridership operations of approximately 90,000 passengers per day