Communications-Based Train Control

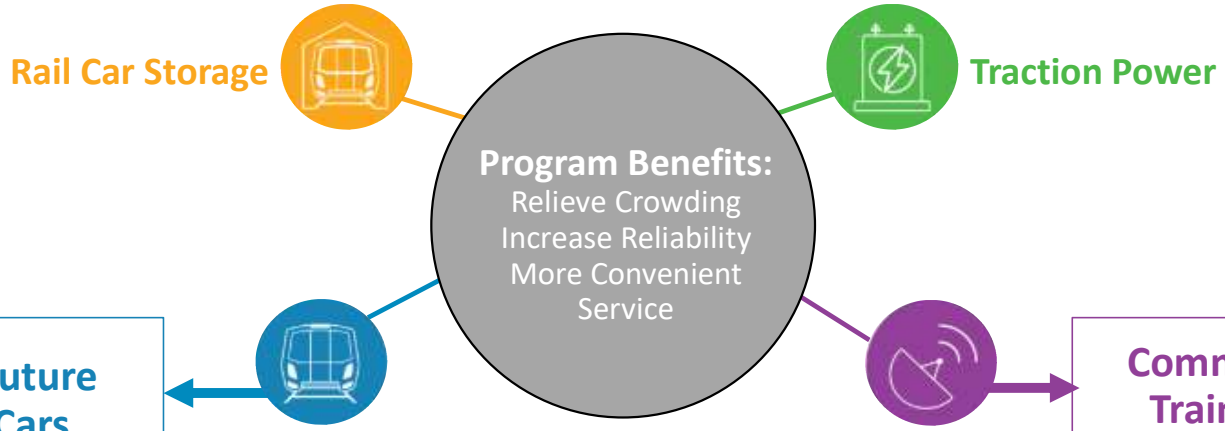
Systems Integration Delivery

BART Board of Directors | June 26, 2025

Agenda

- Transbay Corridor Core Capacity Program (TCCCP)
- Vehicle Sub Systems Interface
- Systems Integration Contract Approach
- CBTC Project Budget / Systems Integration Cost
- Risk Mitigation
- Recommendations to the Board

Transbay Corridor Core Capacity Program (TCCCP)



Fleet of the Future (FOTF) Rail Cars
Started 2012

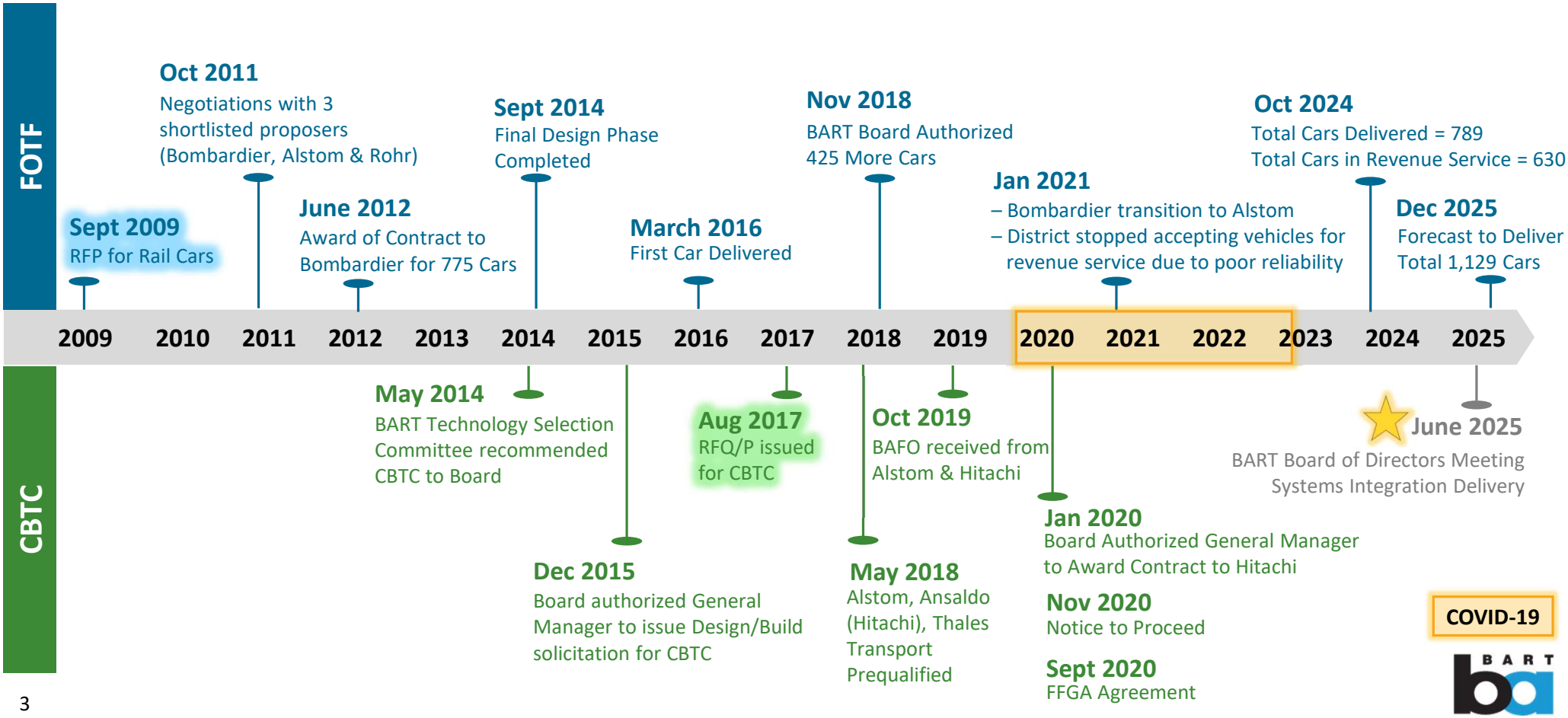
Replace aging fleet of rail cars with new, high-tech, environmentally-friendly trains.

Systems Integration Scope
One-team approach (Hitachi/BART/Alstom) to integrate FOTF with CBTC

Communication Based Train Control (CBTC)
Started 2020

Installation of a new modernized train control system that will enable BART to increase projected Transbay capacity to 30-trains per hour per direction in the core system area.

TCCCP: FOTF & CBTC Delivery Timeline



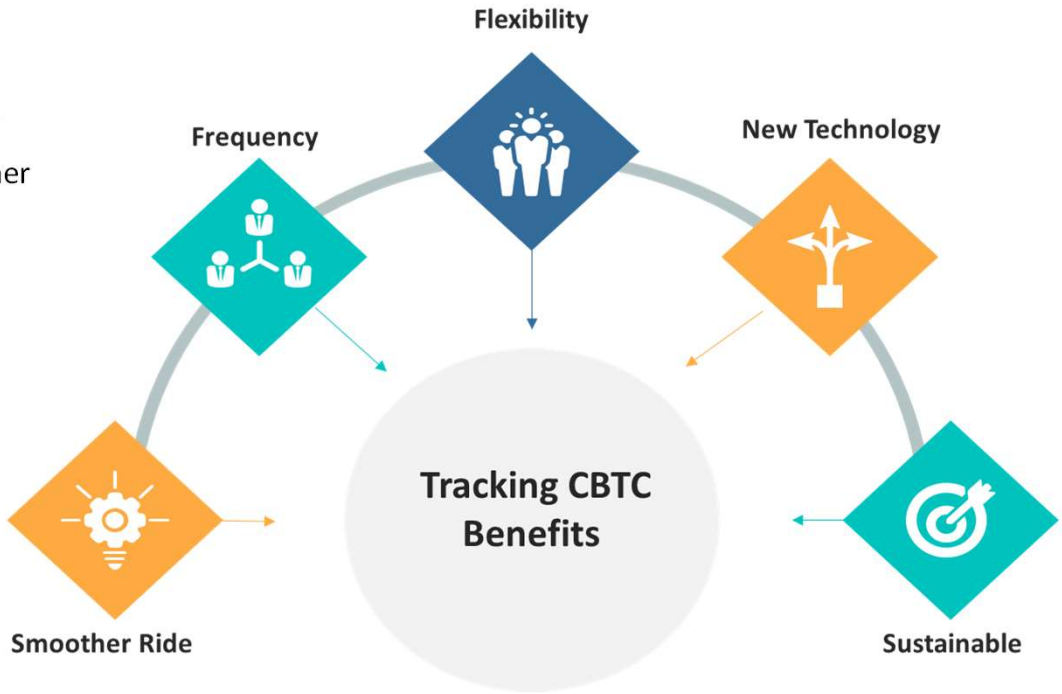
TCCCP: Modernizing BART's Train Control

Communications-Based Train Control (CBTC)

- Allows for real-time adjustments of speed and braking to allow for safe train separation while allowing trains to get closer to each other
- Increases capacity and reduces wait times between trains
- Up to 30-trains per hour through the Transbay Tube

Legacy (Current) Fixed Block Train Control System

- Vulnerable due to age of equipment; lack of parts; and difficult to maintain
- Fixed Speeds Within Track Circuit 27, 36, 50, 70, 80 mph
- Delays from Incidents Unrecoverable
- Equipment Located Within Trackway
- Environmental Impacts



"CBTC: A modern railway signaling system using real time communications between a train and trackside equipment"

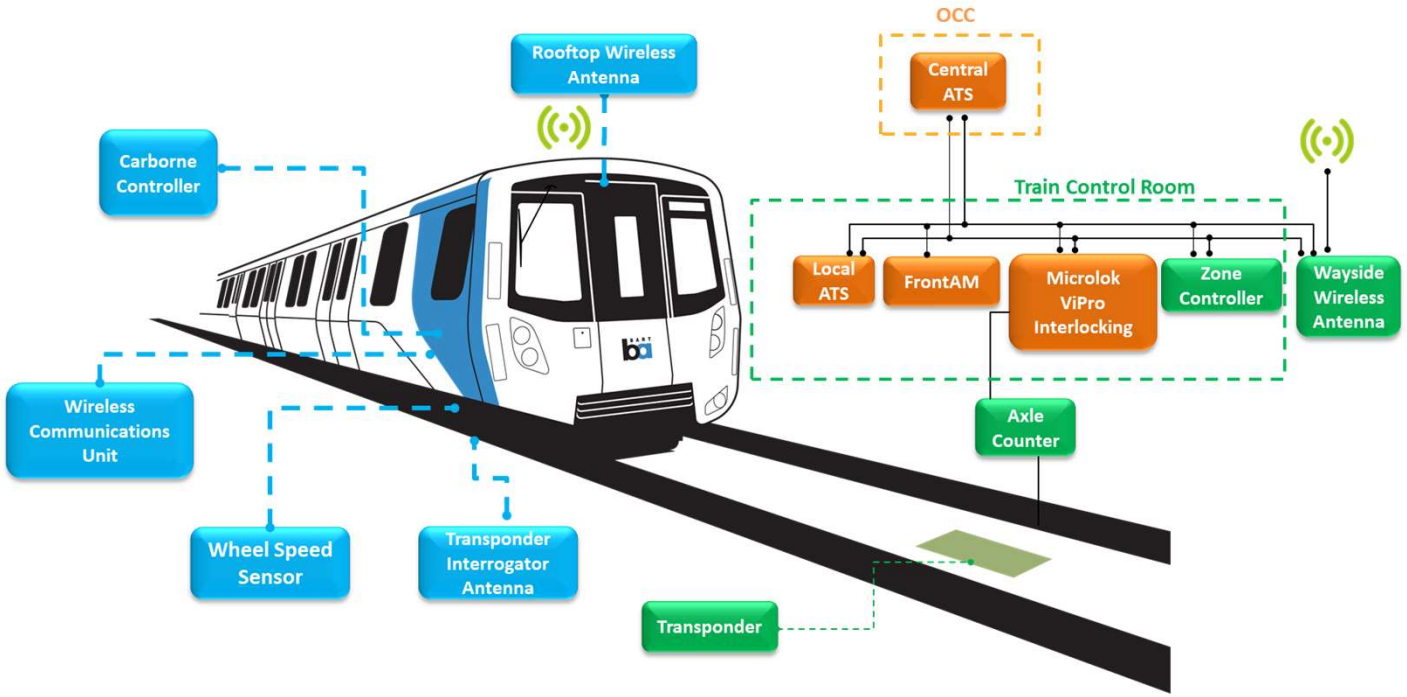
TCCCP: CBTC Elements

Software/Hardware

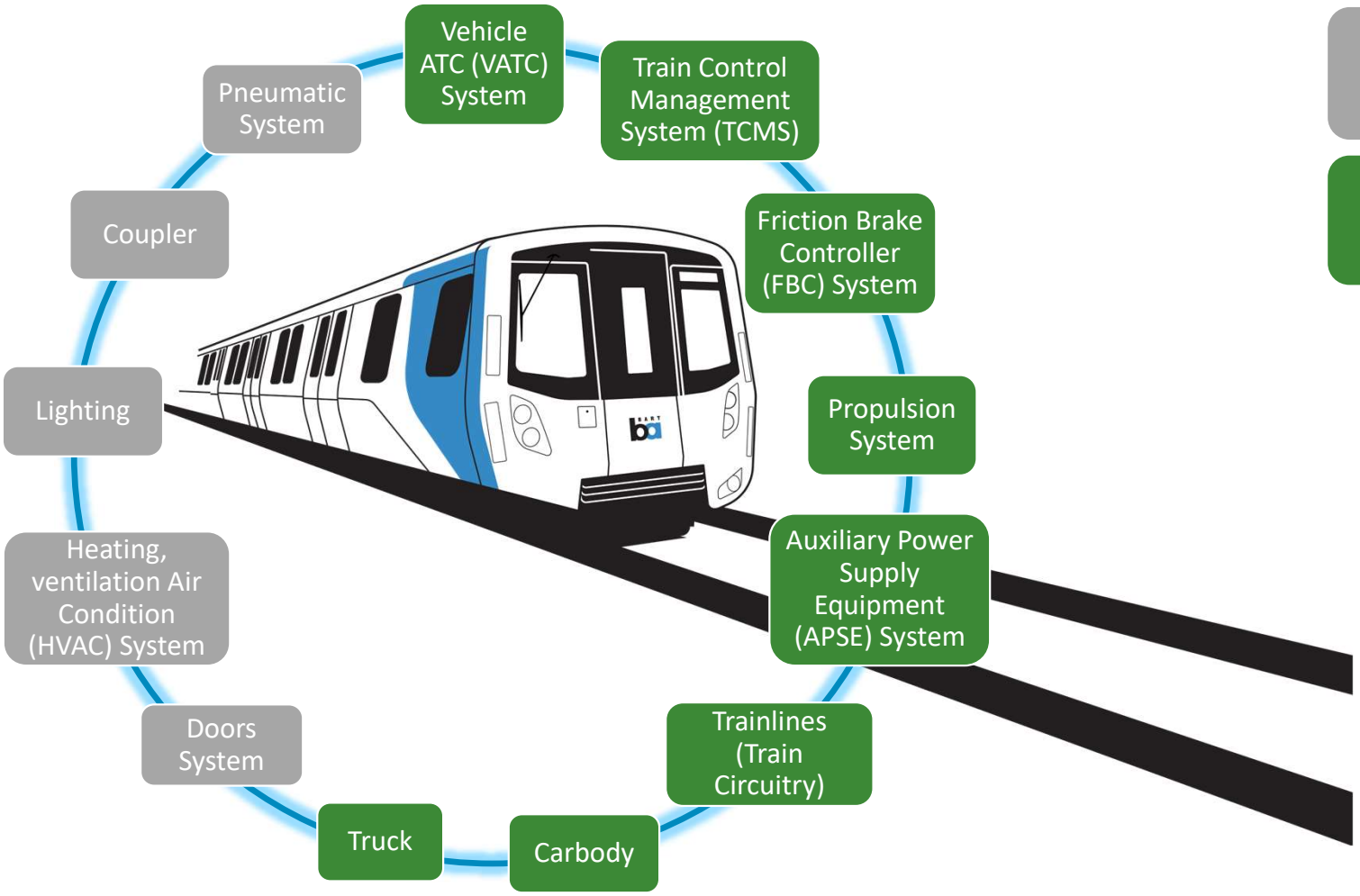
Wayside

Vehicle Systems

Vehicles include 13 Sub Systems, 8 require modification to interface with CBTC.



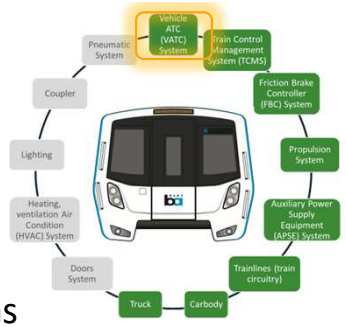
Vehicle Sub Systems Interface

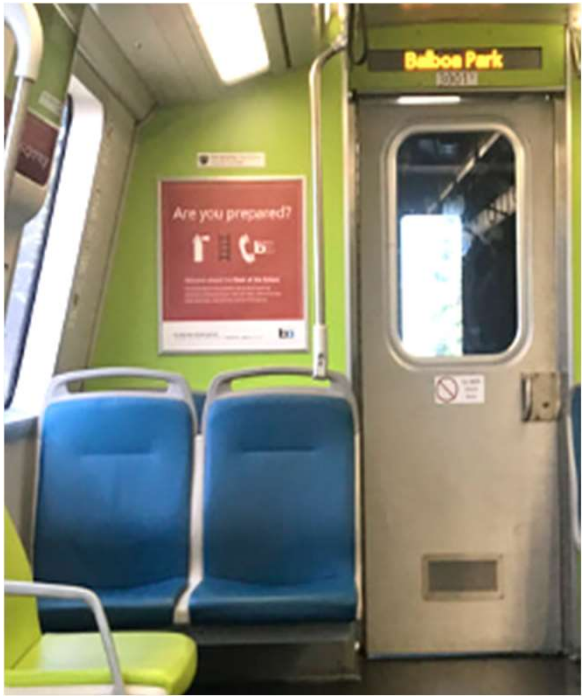


Non-Modified Systems

Modified Systems for CBTC

Sub Systems Interface: VATC

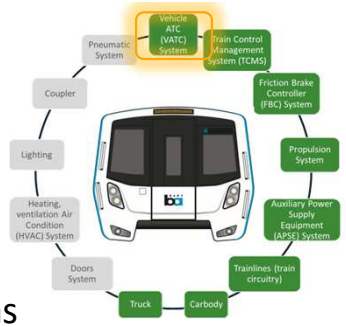




Vehicle Automatic Train Control (VATC) System:
Legacy Automatic Train Control system on board to move trains in AUTO mode

VATC System with CBTC (Dual Mode – Migration Phase)	VATC System with CBTC (Single Mode - End of Migration)
• **Hardware Change :** No Change • **Software Adaptation for CBTC:** Yes • **Function**: Provide the capability to migrate from Non-CBTC to CBTC during transition phase.	• **Hardware:** Yes – Removal of all equipment • **Software Adaptation for CBTC:** No Change • **Function**: Not Applicable
During Transition Only: Existing & New Systems	Modified System for CBTC

Sub Systems Interface: VATC



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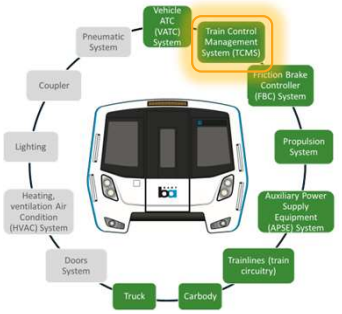
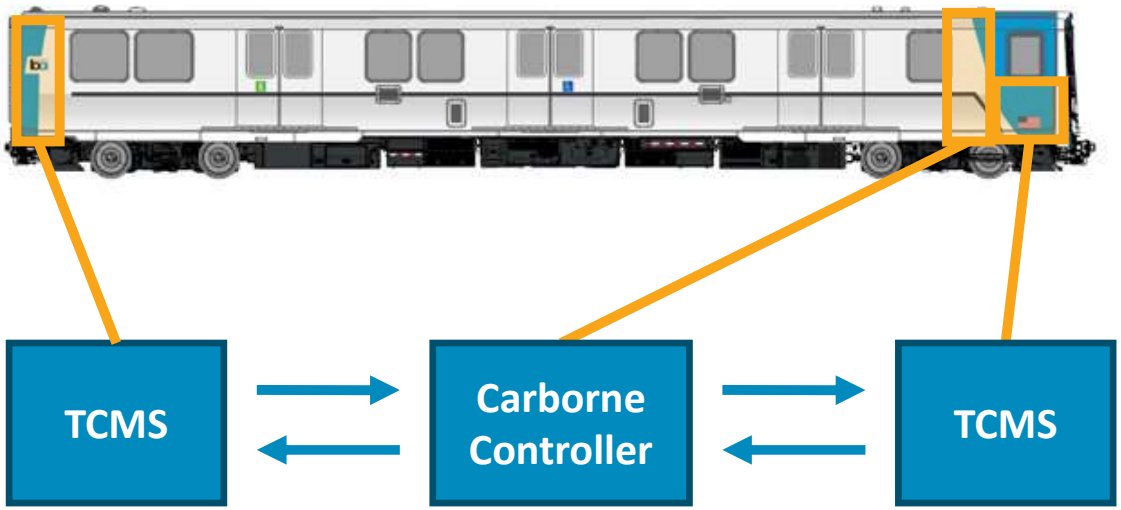
Sub Systems Interface: TCMS



Train Control and Monitoring System (TCMS):

- Provide information to the Train Operator with the Train Operator Display (TOD)
- Supervises and controls onboard subsystems such as propulsion, braking, doors, HVAC, diagnostics etc.
- Allows all systems to communicate with each other

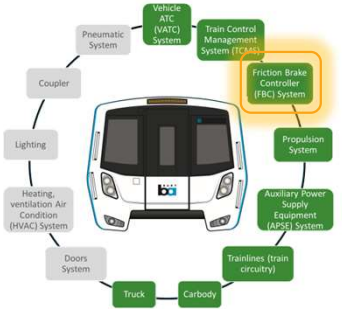


Train Control & Monitoring System (TCMS)

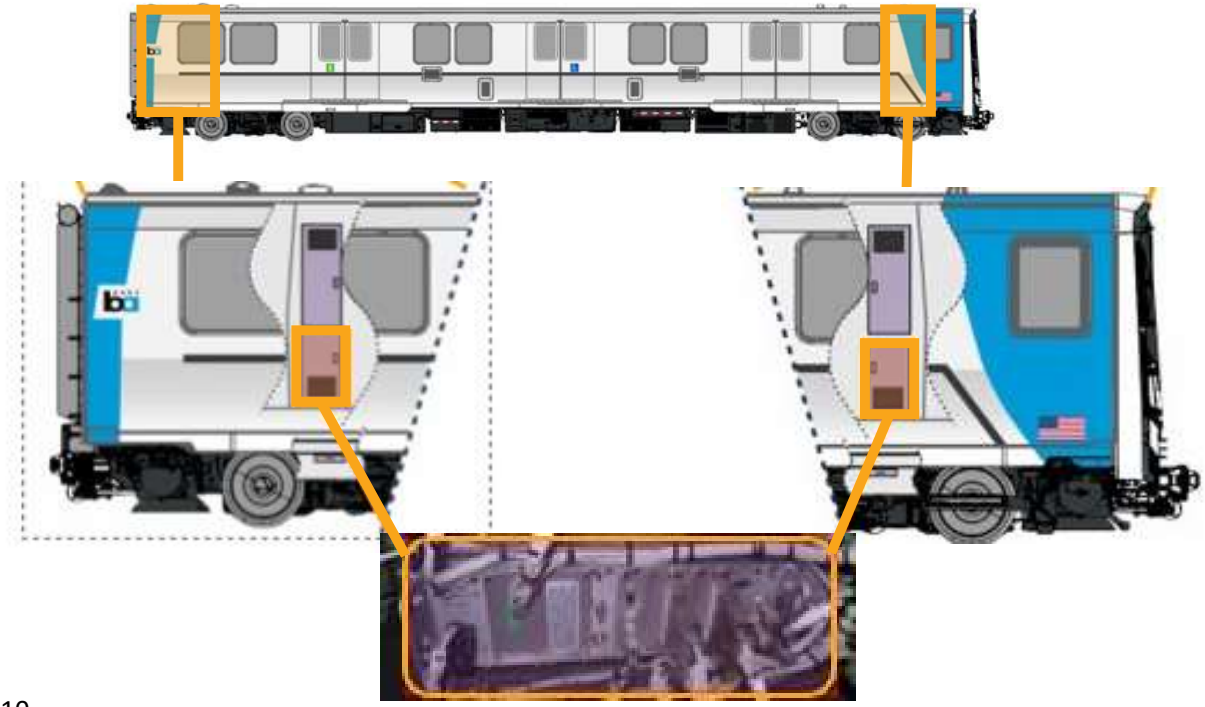
- **Hardware:** No
- **Software Adaptation for CBTC:** Yes
- **Function**: Interfaces with the carborne controller.
- TCMS provides commands to carborne controller for propulsion, brakes, doors, HVAC, lighting. Carborne Controller will process commands and send speed to TCMS.

Modified System for CBTC

Sub Systems Interface: Friction Brake



Friction Brake Controller System:
Friction brake controller is a hardware-software system that manages the application of friction brakes on the train in response to speed codes by VATC.

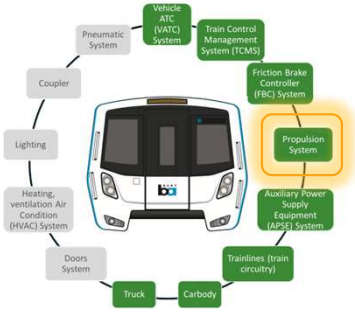


Friction Brake Controller System with CBTC

- **Hardware:** No change
- **Software Adaptation for CBTC:** Yes
- **Function**: The friction brake software undergoes key architectural and functional changes when transitioning from VATC to CBTC. CBTC requires specific additional braking info for smoother stopping accuracy

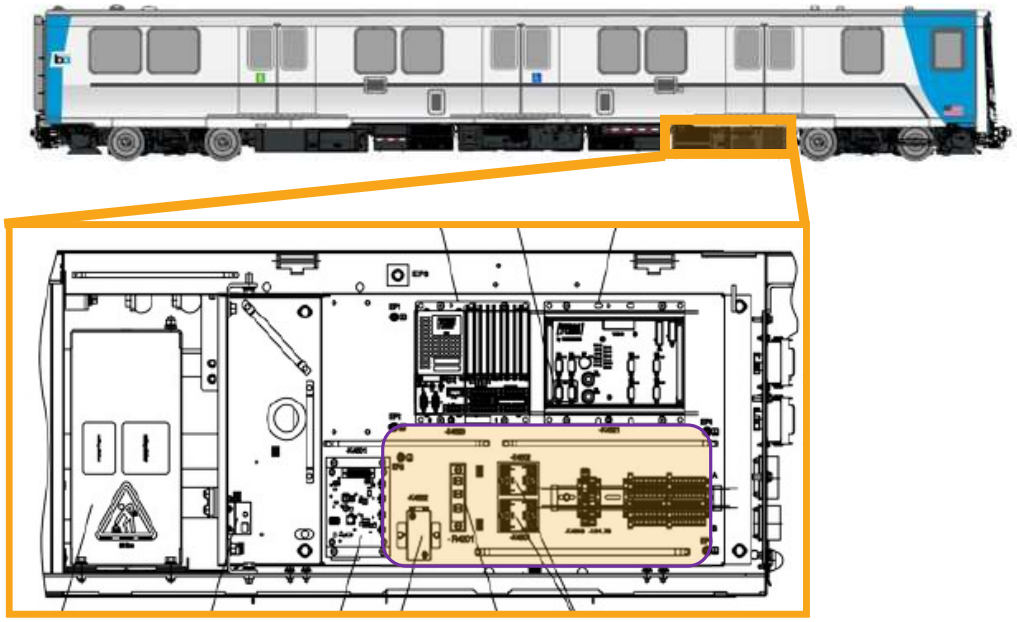
Modified System for CBTC

Sub Systems Interface: Propulsion



Propulsion System

- Command the wheels to move in the required direction and requested acceleration/deceleration
- Cut the propulsion when the train is stopped
- Slip/slide control

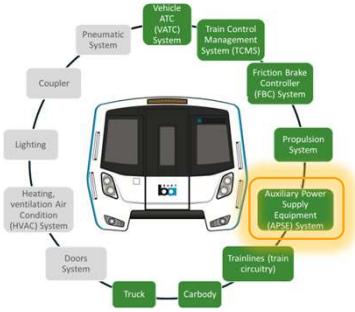


Propulsion System with CBTC

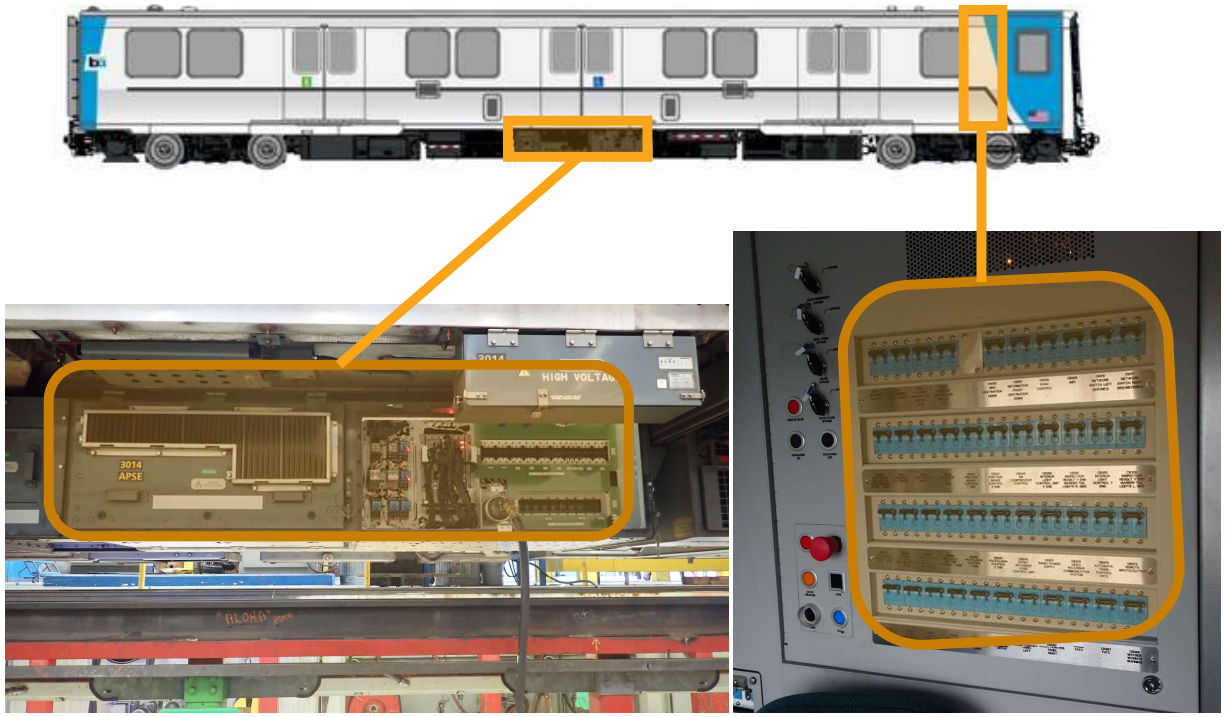
- **Hardware:** No Change
- **Software Adaptation for CBTC:** Yes
- **Function**: Interface Shift – From reacting to track-circuit based speed commands (current speed codes) to responding to continuous speed/distance targets provided by CBTC controller.
- Will activate new acceleration curves with better performance than the currently used VATC acceleration.

Modified System for CBTC

Sub Systems Interface: APSE



Auxiliary Power Supply Equipment (APSE) System
Provides power supply to all equipment in the train.

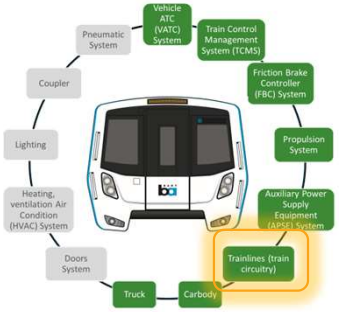


APSE System with CBTC

- **Hardware:** Yes (Partial Elements)
- **Software Adaptation for CBTC:** Not Applicable
- **Function**: Specific adaptation of the train circuit breakers for all the CBTC Equipment and fit the specificity of CBTC power system.

Modified System for CBTC

Sub Systems Interface: Trainline



Trainline System (aka Train Circuitry)

- Trainlines are bundle of cables and wires running thru the train cars carrying power, signals and connecting various systems: doors, brakes, signaling, communication, sensors etc.

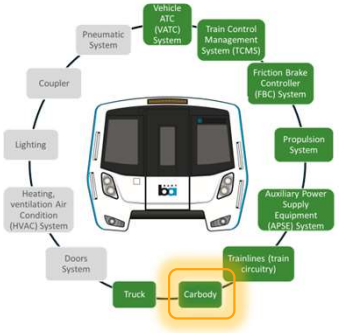
Existing
Modification for CBTC

Trainline System with CBTC

- **Hardware:** Yes (Partial Elements)
- **Software Adaptation for CBTC:** Yes
- **Function**: New cabling and wiring for sensor, carborne controllers, power supplies, connectors and control logic changes

Modified System for CBTC

Sub Systems Interface: Car Body



Car Body System

- This is the shell/structure of the Vehicle
- Provide mechanical interface to any Hardware to be installed.

Carbody System with CBTC

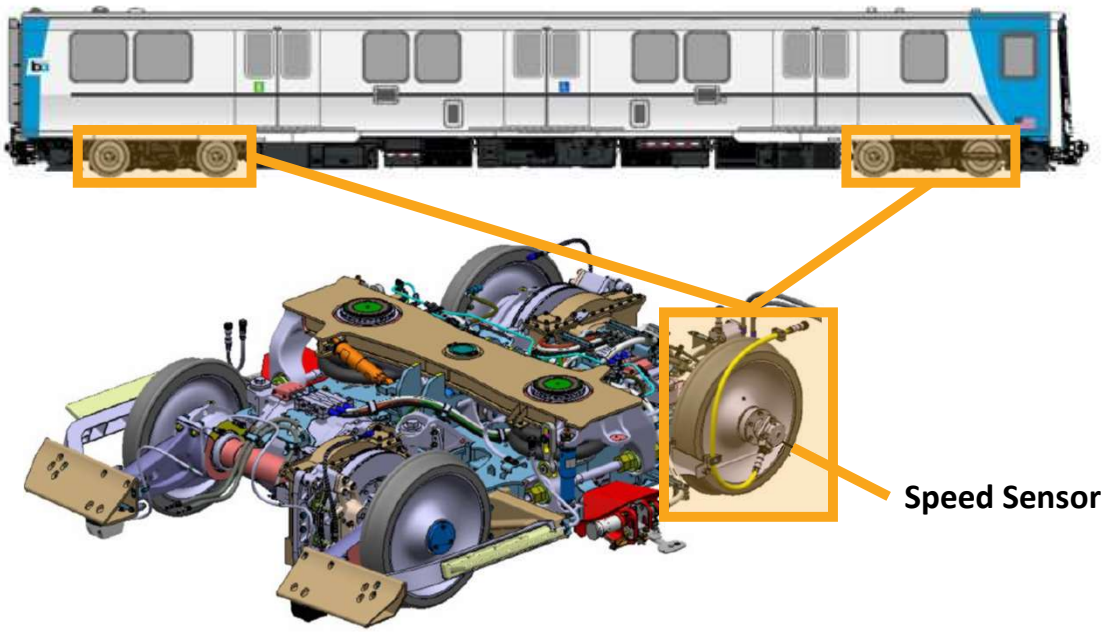
- **Hardware:** Yes (Partial Elements)
- **Software Adaptation for CBTC:** Not Applicable
- **Modifications**:
  - Roof adaptation to fit the CBTC DCS antenna
  - Interior adaptation for the CBTC locker and rackers
  - Underframe adaptation around the couplers for the CBTC Transponder Antenna
  - Cab adaptation with CBTC switches

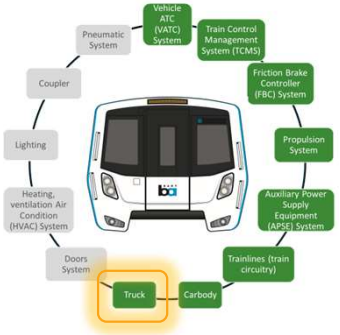
Modified System for CBTC

Sub Systems Interface: Truck

Truck System:

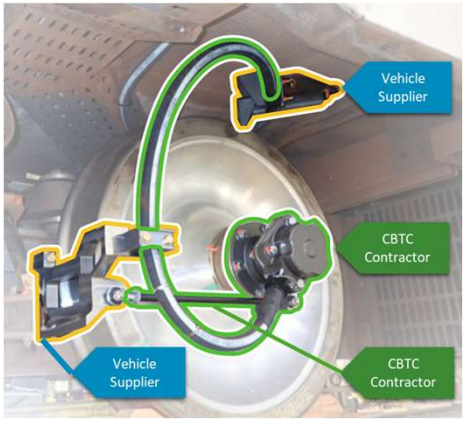
- Provide the motoring powers and effort to the axles & wheels
- Manage the Suspension
- Contains the 3rd rail mechanical interface components





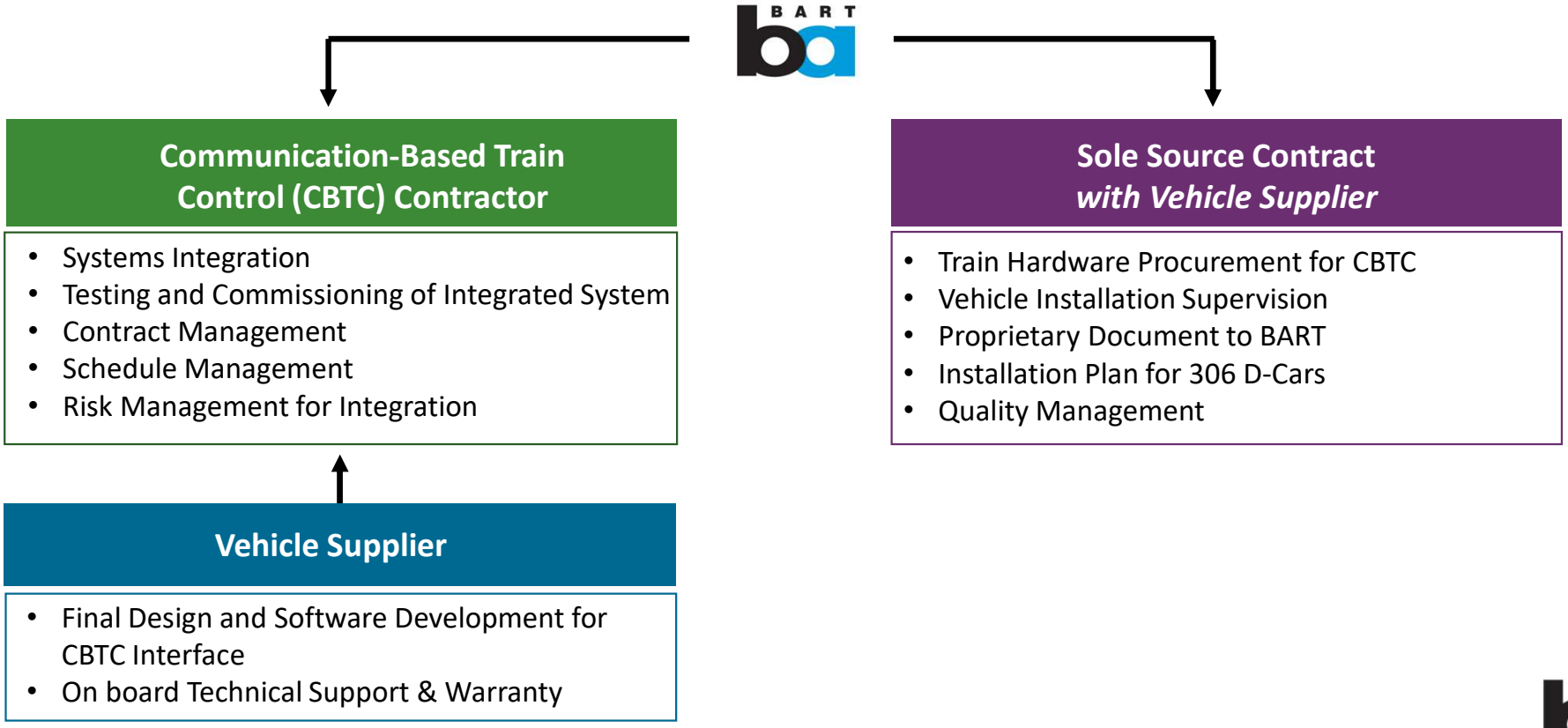
Truck System with CBTC

- **Hardware:** Yes (Partial Elements)
- **SW Adaptation for CBTC:** Not applicable
- **Function**: Adaptation of the axles to fit the CBTC Speed Sensor.



Modified System for CBTC

Systems Integration Contract Approach

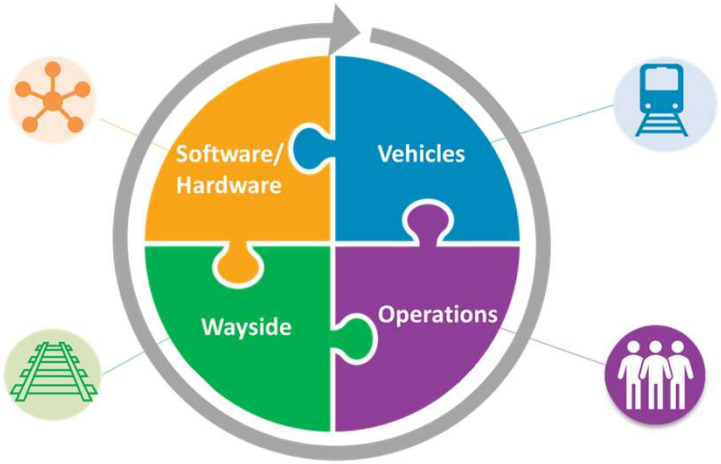


Systems Integration Contract Approach

	Board Approval July 2025	**Pilot Vehicle Design for Systems Integration** July 2025 – Mar 2027	**Pilot Vehicle Installation & Testing** Mar 2027 – Aug 2028	**Mainline Testing** Aug 2028 – Jun 2030	**RAMS** Jun 2030 – Feb 2033
Vehicle Supplier	**Vehicle Final Design** • Interface Design • Installation Plan • Support Services for Safety Integration Plan	**Software updates:** • TCMS • Propulsion • Brakes • Communication • VATC	**Vehicle Support** • Installation support for Pilot Vehicles • Testing support for Pilot Vehicles • Materials procurement (Brackets/Cables) **CBTC Test Design & Software** • Corrections as needed	**CBTC Test Design & Software** • Corrections as needed **Installation Support** • 306 cars **Software and Material Warranty**	**Material Warranty**
CBTC Contractor	**Vehicle Final Design** • Interface Design Package • Integrated Installation and Training Plan	**CBTC Software** Software (Phoenix) changes for Integration	**CBTC Material** • Vehicle Integrated Equipment & cables **CBTC Test Design & Software** • Corrections as needed	**CBTC Test Design & Software** • Corrections as needed • Integrated Vehicle Installation Support	**Revenue Service** **Warranty**

CBTC Project Budget & Systems Integration Cost

CBTC Project Budget	Amount
CBTC Contractor Contract	$789,301,920
Executed/Planned/Potential Scope Additions	$61,520,571
VTA Option 3	$119,119,848
Enabling Works Budget	$114,796,455
BART Labor/DSDC/CM	$469,223,196
CBTC Systems Integration Amendment	***$433,000,000***
Other - Materials/Equipment	$14,481,793
Contingency	$344,672,199
Total Project Budget (Fully Funded): $2,346,115,982	



CBTC Contractor (Systems Integration Amendment)	Amount
Schedule Impacts *(COVID-19, Vehicle Supplier Organization Merger, Material Shortages, Resources)*	$62,000,000
Systems Integration Scope	
Project Management	$26,800,000
Vehicle Software Interface	$53,600,000
Vehicle Mechanical/Electrical Interface	$80,496,355
Vehicle Structural Interface	$40,200,000
Deployment, Testing & Commissioning	$3,678,173
Training and Manuals	$2,384,941
Risk Mitigation	$44,666,666
Material (T&M)	$16,173,865
Sub-Total CBTC Contractor: $330,000,000	

Vehicle Supplier (Sole Source)	Amount
Vehicle Supplier Propriety Design and Software, Material Purchase, Warehousing, VATC Modification, Pilot Vehicle Oversight	$53,400,000
Sub-Total Vehicle Supplier (Sole Source): $53,400,000	

Total CBTC Systems Integration Amendment: $383,400,000

Risk Mitigation

- Completion Date – Aligned with Federal Funding Grant Agreement (FFGA) Risk-Adjusted Date
- Configuration – Software & Hardware Alignment
- Installation Coordination – Rail Cars & CBTC Equipment
- Testing & Commissioning Alignment – CBTC Equipped Fleet
- Resolving BART Interface Issue between Vehicle & CBTC Contractor
- Close Out Fleet of the Future (FOTF) Contract
- Managing Highest-Ranked Risk (FTA Risk Refresh 2023)

Recommendations to the Board

- **Authorization for the General Manager to award the Contract Amendment to Contract No. 49GH-110 with Hitachi Rail STS USA, Inc. for Systems and Vehicle Integration work for the Communications-Based Train Control (CBTC) Vehicle Interface, in an amount not to exceed $330,000,000.**

- **Authorization for the General Manager to award Sole Source Contract No. 6M8227 with Alstom Transit Inc (Alstom) to provide Equipment, Material, Installation and Modification support to the District Revenue Vehicle Fleet to support Communication Based Train Control (CBTC) project, in an amount not to exceed $53,400,000.**

  Two thirds vote required.

Thank You