Agenda

1. Program Overview
2. Needs analysis for Secondary Train Control
3. Technology Selection /
4. Cost vs Benefits
5. Questions
BART System Needs Additional Throughput Capacity

Peak direction trains between East Bay and SF are full.
- 23 TPH in each direction
- Ridership growing (+100k daily since 2010)
- System is expanding
- Core exceeds FTA crowding standards

Transbay Core Capacity Program will increase capacity between East Bay and SF by over 30% in 2023 (< 30 TPH)
Fleet acquisition will provide some additional capacity between 2018-2023
BART’s Peak Hour TransBay Modal Share

**AM PEAK HOUR TRAFFIC (WESTBOUND)**

- **14,200** people in cars* per hour move over the Bay at rush hour
- **27,000** people per hour move under the Bay at rush hour

*Assumes average of 1.7 persons per vehicle (Caltrans)
BART’s Core Capacity Program

Fleet of the Future

Train Control Modernization

Hayward Maintenance Complex

+ Core Capacity Improvement Program (including traction power upgrade)
Train Control Modernization Program Objectives

Technology Evaluation Study completed 2013 - Consensus to replace Fixed Block train control with CBTC. Resulting TCMP Objectives:

- Achieve and maintain a state of Good Repair
- Line capacity increase from 24 to ~30 TPH
- Improve Reliability, Availability & Maintainability
- Keep the Bay Area Moving throughout program (no unplanned interruptions to service)
Train Control Modernization Program

- Not a typical train control procurement; this is not “business as usual”
- Deployment, minimize development (i.e. not an R&D project) - lessons learned from previous programs
- BART’s TCMP contract will be the largest CBTC re-signaling contract ever awarded in North America and among the largest CBTC re-signaling projects underway around the world
- The TCMP is the most critical component of BART’s strategic capital investment program to better serve the Bay area in the coming decades
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Maintenance Vehicle Operations
Permanent Way

- Steel wheel/solid axles that shunt the track circuit and therefore provide positive occupancy
- May operate during or overlapping with revenue service
- A works train involving multiple permanent rail vehicles can possibly split or recombine into one or more units
- Works trains are not train-lined (difficult to determine train length)
Maintenance Vehicle Operations
Permanent Way

- Powered Flat Car x 4
- Rail Grinder x 2
- Loco x 3
- Unpowered Ballast Car
Maintenance Vehicle Operations
Permanent Way

There are a number of MVs or Work Trains that operate in proximity to, or overlap with revenue service:

<table>
<thead>
<tr>
<th>Heavy Maintenance Vehicles (Positive Shunt)</th>
<th>Type</th>
<th>Current</th>
<th>Future</th>
<th>Speed Limit (mph)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rail Grinding Train</td>
<td>180</td>
<td>2</td>
<td>0</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>Powered Flat Car</td>
<td>200</td>
<td>4</td>
<td>0</td>
<td>25</td>
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<tr>
<td>Flat Car Unpowered¹</td>
<td>210</td>
<td>3</td>
<td>0</td>
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<tr>
<td>Ballast Car 25 Yard Capacity¹</td>
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<tr>
<td>Geometry Car²</td>
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<td>1</td>
<td>1</td>
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<tr>
<td>50 Ton Wide Gauge Locomotive</td>
<td>2</td>
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<td>Ribbon Rail Train¹</td>
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<td>2</td>
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<tr>
<td>Tamper</td>
<td>2</td>
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<tr>
<td><strong>Total Quantity:</strong></td>
<td><strong>22</strong></td>
<td><strong>14</strong></td>
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Notes:

1) Moved by powered car or equipped locomotive
2) Existing Geometry car will be removed from service
3) Plan to convert existing two car A-B consist to Work Trains
Maintenance Vehicle Operations
Hi-Rail

- More than 100 with planned procurements
- May enter from yards or set-on/off points along guideway
- Many diverse types, but do not operate with trailers
- Do not operate during or overlapping with revenue service (except in emergencies or for failure management)
- Hi-Rails are equipped with a Maintenance Vehicle Detection Device (MVDD) (non-vital) that forces a zero speed signal into the track circuit
Maintenance Vehicle Operations
Hi-Rails

- Pick-up truck
- Welder
- Dump Truck
- Rail Heater
Mainline signals

Lunars to support “Make/Breaks” – replaced by in-cab signals on Train Operator Display (TOD)

Route Aligned Signals located on new sections of alignment

May retain only at terminal locations where “breaks” can result in train driven from hostler panel (no TOD)

Signals to be retired and replaced by in-cab signals on TOD
Mainline signals

Directional Signals at certain switch locations (existing)

5400 INFORMATIONAL SIGNALS
Informational signals convey information only. Informational signals do not authorize movement and do not verify route alignment.

<table>
<thead>
<tr>
<th>Yellow Arrow</th>
<th>Directional Yellow arrow indicates switch position at selected mainline locations.</th>
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<tbody>
<tr>
<td>Green Arrow</td>
<td>Directional Green arrow indicates switch position at selected mainline locations.</td>
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</table>

Signals to be retained, interface only to switch machines
Need for Secondary Train Control

- In the existing track circuit based railway:
  - Permanent rail vehicles shunt the track circuits and therefore provide a positive track occupancy
  - Hi-Rails are equipped with a Maintenance Vehicle Detection Device (MVDD) that relies on the track circuit
- With the loss of track circuits MVs would not be detected
- With increasing service levels and associated maintenance, cannot rely only on procedure for protection (no signals)
- Not practical or cost effective to equip all MVs with CBTC – must continue to rely on procedure and human operators
- STC would allow detection of non-communicating trains including MVs or Hi-Rails by block occupancy
- Could provide supplementary detection by block occupancy of CBTC equipped MVs or Work Trains where necessary
- Back-up ATP not required, since not intended to operate service without CBTC – therefore only Secondary Train Detection required, not Control
Maintenance Vehicle Operations
Permanent Way

- Plan to equip with CBTC specific MVs or Work Trains that operate in proximity to, or overlap with revenue service:

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Technology – Track Circuits vs Axle Counters

- Axle Counters provide many advantages over Track Circuits, including following:

  - Can overlay - difficult to replace existing track circuits with new system while maintaining revenue service
  - Detect all vehicle types (no shunt required)
  - Detects wheel set, including direction of travel, speed and approx. train length
  - Lower maintenance and installation costs

- It is planned to conduct a trial on the BART mainline

- Arranged at block boundaries, to count axles into and out of block

Frauscher RSR180
Secondary Train Control

• Detection blocks would be implemented around:
  - Cross-overs and interlockings, sidings and mainline storage locations
  - Station exits (in some cases in both directions)
  - Mainline set-on/off locations for Hi-Rails
  - Entry/exit points between yards and mainline
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Cost vs Benefits

- Compared to alternative which is to equip all MVs and Work Trains with CBTC (over 130 diverse types)
- Additional Capital costs include:
  - Secondary Train Detection system using axle counters
  - Additional Ultrasonic Test Equipment (required anyway for SOGR) to replace limited broken rail detection capabilities of existing track circuits
- Secondary Train Detection estimated to be approx. ½ the capital cost, with lower life-cycle costs
- Unequipped MVs can be added or replaced without consideration to CBTC
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