POSITIVE TRAIN CONTROL

Engineering Basics and Lessons Learned

FRA Program Delivery Conference – October 2015
Outline

1. Positive Train Control (PTC) introduction and background
2. Engineering considerations
3. Lessons learned
4. Guidance documents and technical assistance
What is PTC?

A type of train control required on most passenger and certain freight routes – with limited exceptions

It is required by law by under the Rail Safety Improvement Act of 2008 (RSIA)

By statute a compliant PTC system must:
- Prevent train-to-train collisions
- Prevent over-speed derailments
- Prevent incursions into established work zones
- Prevent movement of a train through a switch left in the wrong position
- Be Interoperable

For discussion purposes only. Not the official position of FRA/USDOT.
What are the typical components of a PTC system?

**On-board (locomotive):**
- On-board computer
- Displays
- Event recorder
- Antennas/transponder readers
- Radios, and GPS

**Infrastructure (track):**
- Wayside interface units (WIU)
- Transponders
- Switch monitoring systems
What are the typical components of a PTC system?

Communications Infrastructure:
- Radio/cellular towers
- GPS antennas
- Fiber (or copper) backbone

Back Office:
- Back Office Servers (BOS)
- Dispatch center

Example diagram of a PTC system architecture.
What types of systems are currently under development?

<table>
<thead>
<tr>
<th>Railroad</th>
<th>System</th>
<th>Type</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>BNSF</td>
<td>IETMS</td>
<td>Non-Vital Overlay</td>
<td>Certified for Use</td>
</tr>
<tr>
<td>UP, CSX, NS, CN, CP, KCS &amp; Most non-NEC Passenger/Commuter</td>
<td>IETMS</td>
<td>Vital* Overlay</td>
<td>Type Approved (In Development)</td>
</tr>
<tr>
<td>NEC Carriers</td>
<td>ACSES /Cab Signals</td>
<td>Vital Overlay</td>
<td>Certified for Use</td>
</tr>
<tr>
<td>AMTRAK (Michigan)</td>
<td>ITCS</td>
<td>Vital Overlay</td>
<td>Approved for Use</td>
</tr>
<tr>
<td>PATH</td>
<td>CBTC</td>
<td>Vital Stand Alone</td>
<td>Development</td>
</tr>
<tr>
<td>CALTRAIN</td>
<td>I-ITCS</td>
<td>Vital Overlay</td>
<td>Development</td>
</tr>
<tr>
<td>Tri-Met, SMART, AAF</td>
<td>EATC</td>
<td>Vital Overlay</td>
<td>Type Approved</td>
</tr>
</tbody>
</table>

*Note: Some carriers may elect to implement a non-vital version of IETMS*

For discussion purposes only. Not the official position of FRA/USDOT.
A brief overview of the PTC system certification process

Phase 1 – Implementation Planning
- Establish how a system will comply with the applicable regulations, or provide justification for exemption
- **Submittals:** Implementation Plan (PTCIP)

Phase 2 – System Development
- Details technology to be used and how it will work
- **Submittals:** Development Plan (PTCDP), Notice of Product Intent (NPI), or Type Approval Identification & Variance

Phase 3 – System Deployment & Testing
- Designs finalized, installation & testing begin
- **Submittals:** Test Plans

Phase 4 – Certification & Full Deployment
- System functionality is verified and deployment continues until fully implemented
- **Submittals:** Safety Plan (PTCSP)
PTC engineering considerations – on-board equipment

Real estate is limited – component installation requires careful planning and functionality verification

Fleet type – unique equipment may require special solutions and incur higher lifecycle costs

Designs and installation should be coordinated with proper mechanical, signal, communications and operations staff

Example of retrofit components potentially blocking brake valve

For discussion purposes only. Not the official position of FRA/USDOT.
PTC engineering considerations – infrastructure

Design and installation of wayside equipment must be coordinated with relevant disciplines

- INCLUDING construction / installation team!

Switch monitoring for interlockings can be a complex issue

- track access will likely only compound the issue

Project schedules must account for available track time and reasonable installation rates during those windows

For discussion purposes only. Not the official position of FRA/USDOT.
Spectrum availability must be managed against the potential for interference

Spectrum procurement is on the secondary market

Installation of communications towers must follow the proper FCC approval process
Do not underestimate the time required for testing and validation

FRA will only approve field testing when effective configuration management program is in place and operating

Early and frequent coordination with FRA and host/tenant roads will help avoid unnecessary delays

Integrated testing on PTC territory with hi-rail.
PTC engineering considerations – systems integration and testing

Ensure plans are submitted in a timely manner, and be of good quality for FRA review.

- Numerous revisions to submittals are often the leading cause for delay in approval.

FRA will only approve “Revenue Service Demonstration” after:

- all subsystems and systems are functional;
- integration, qualification, and end to end testing are successfully completed.

Integrated testing on PTC territory at turnout.
General considerations from lessons learned

Performance based rules/requirements leaves the burden of specifications on the entities actually implementing the technology

- Railroads/agencies must have sufficient technical staff or contract support (there is no “off-the-shelf plug & play” technology)

Freight needs and requirements do not always align with passenger operation needs

- “Vital” systems are more complex and require a higher level of effort to be validated and certified.
- Regulations require “Vital” systems only to support high speed operations

Technology changes frequently – it takes much longer to implement that technology into a safe and reliable PTC system.

For discussion purposes only. Not the official position of FRA/USDOT.
Guidance documents and helpful information

Current Regulation ([www.ecfr.gov](http://www.ecfr.gov))
- Title 49, Subtitle B, Chapter II – Part 236

Interim and Final Rules ([www.federalregister.gov](http://www.federalregister.gov))

Templates and Guidance Documents ([www.fra.dot.gov/Page/P0621](http://www.fra.dot.gov/Page/P0621))
- PTC Implementation Plan Template Example
- Risk Prioritization Methodology for PTC Implementation

- Component noise/interference for various locomotive models
- Wireless spectrum/radio research information
- Brake algorithm research

Other Standards:
- IEEE-1483 Standard for Verification of Vital Functions in Processor-Based Systems Used in Rail Transit Control
- CENELEC Standards (EN50129, EN50155)
FRA Contacts

General Questions:
Devin Rouse
Project Manager
Office of Railroad Safety
Federal Railroad Administration
(202) 493-6185
devin.rouse@dot.gov

Technical Questions:
Mark Hartong
Senior Scientific Technical Advisor
Federal Railroad Administration
(202) 493-1332
mark.hartong@dot.gov

or

David Blackmore
Staff Director, Positive Train Control
Federal Railroad Administration
(312) 835-3903
david.blackmore@dot.gov