U.S. Department of Transportation
Federal Railroad Administration

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

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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

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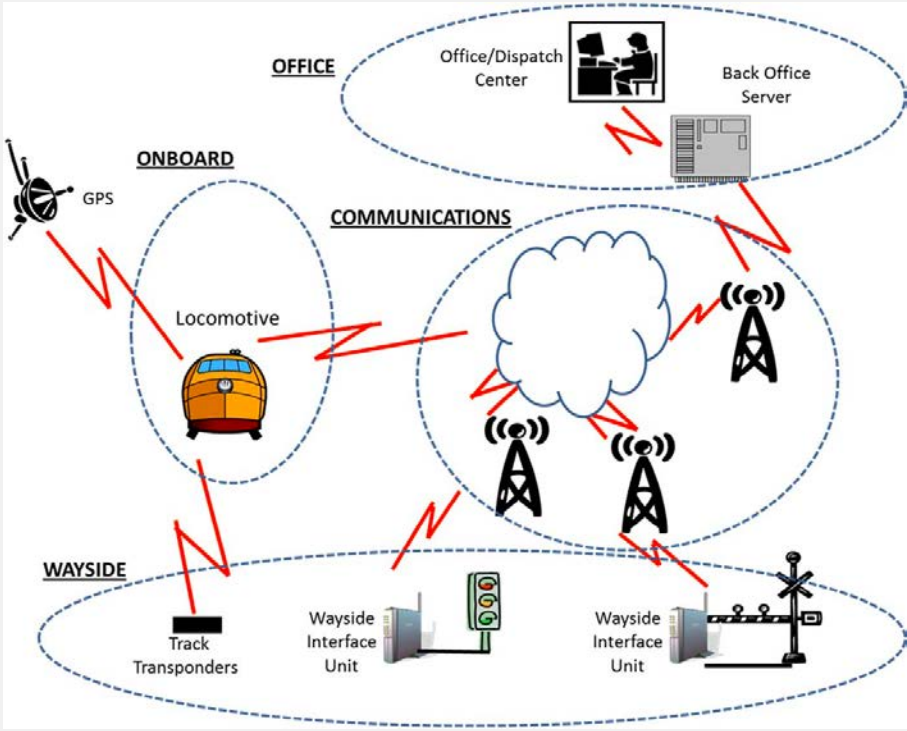
What are the typical components of a PTC system?

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



Example diagram of a PTC system architecture.

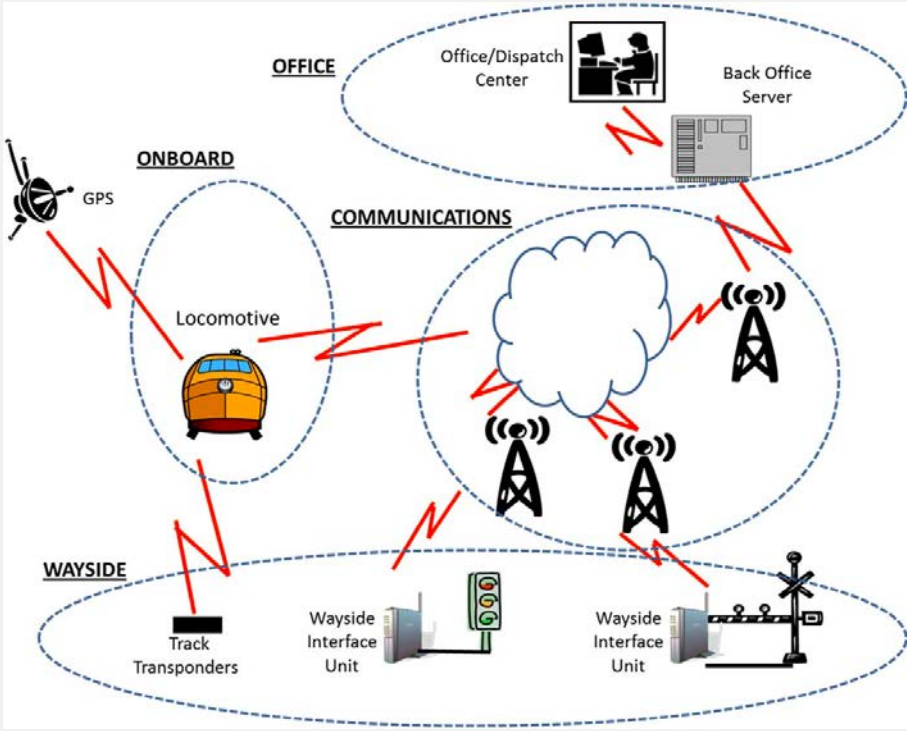
What are the typical components of a PTC system?

Communications Infrastructure:

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

Back Office:

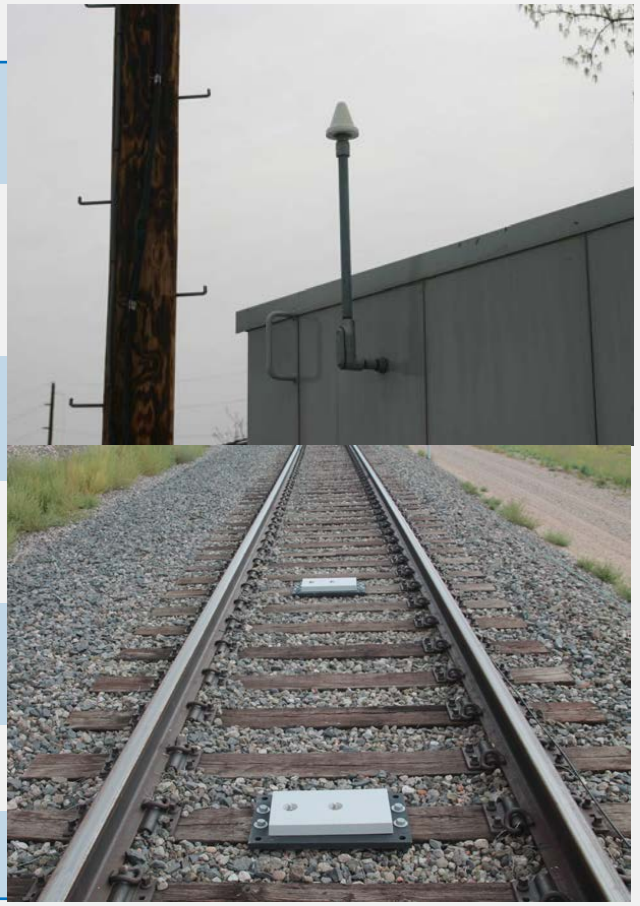
- Back Office Servers (BOS)
- Dispatch center



Example diagram of a PTC system architecture.

What types of systems are currently under development?

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



GPS antenna (top), ACSES transponder (bottom)

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

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)*

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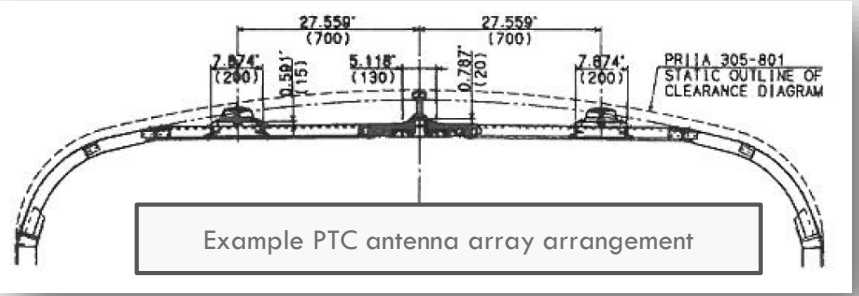
PTC engineering considerations – on-board equipment

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 PTC antenna array arrangement


Example of retrofit components potentially blocking brake valve

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PTC engineering considerations – infrastructure

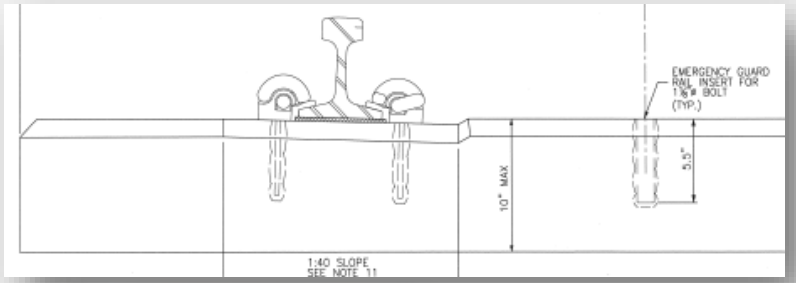
Design and installation of wayside equipment must be coordinated with relevant disciplines

- 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



Examples of various methods for attaching transponders to track

PTC engineering considerations – communications

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

Example of a (small) communications tower

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PTC engineering considerations – systems integration and testing

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.

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PTC engineering considerations – systems integration and testing

Ensure plans are submitted in a timely manner, an **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.

Guidance documents and helpful information

Current Regulation (www.ecfr.gov)

- Title 49, Subtitle B, Chapter II – Part 236

Interim and Final Rules (www.federalregister.gov)

Templates and Guidance Documents (www.fra.dot.gov/Page/P0621)

- PTC Implementation Plan Template Example
- Risk Prioritization Methodology for PTC Implementation

Research – FRA eLibrary (www.fra.dot.gov/eLib)

- 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)

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