Transportation Technology Center, Inc., a subsidiary of the Association of American Railroads

Segurança Ferroviária e o sistema PTC (Positive Train Control)

VI Brasil nos Trilhos

ANTF

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Topics

- **Positive Train Control in USA**
- **Freight and Passenger Rail Security Efforts**
- **Expanding Training for an specialized railway Engineering**

CBTC Overview - CBTC Systems Implementation

- **USA – PTC (Positive Train Control)**
  - ETMS (Electronic Train Management System – Wabtec - BNSF)
  - ITCS (Incremental Train Control System – GETS - Amtrak)
  - **ACSES II (Advanced Civil Speed Enforcement System – Alstom – Amtrak)**
  - **I-ETMS (Interoperable Electronic Train Management System – Wabtec)**
- **Europe**
  - ERTMS (European Railroad Traffic Management System) / ETCS
  - CBTC systems for metro lines
- **Worldwide (some examples)**
  - ATMS (Advanced Train Management System - Australia)
  - CBTC system (Wabtec - MRS Logística - Brazil)
  - Train licensing using satellite communication (ALL, TLSA, FCA - Brazil)
  - CTCS (Chinese Train Communications System)

PTC Overview - Brief History

- 1982 – First PTC system concepts, called ATCS then
- 1994 - The term positive train control was first introduced
- 1997 - The Railroad Safety Advisory Committee of the FRA created a PTC Working Group to specify safety objectives.
- 1999 – The Railroad Safety Advisory Committee published a report that specified how the government and the railroad industry would facilitate PTC development. That year, the North American Joint PTC (NAJPTC) project was formed to test PTC capabilities.
- 2004 - The FRA initiated a study to determine the cost and safety benefits of PTC, which estimated that costs will exceed $2.3 billion to implement a system on 100,000 miles of track.
- 2005 - The FRA published a final rule in 2005 on the functional requirements and operational parameters to achieve PTC safety objectives. These regulations are performance based rather than prescriptive, meaning that PTC systems could be technology neutral, as long as safety and functional equivalencies were met.
- **2008 - The RSIA (Railroad Safety Improvement Act) was signed into law**. Metrolink accident triggered the decision.
- 2010 – FRA issued the final rule for the implementation of PTC.

PTC Overview - What is mandated by the Act

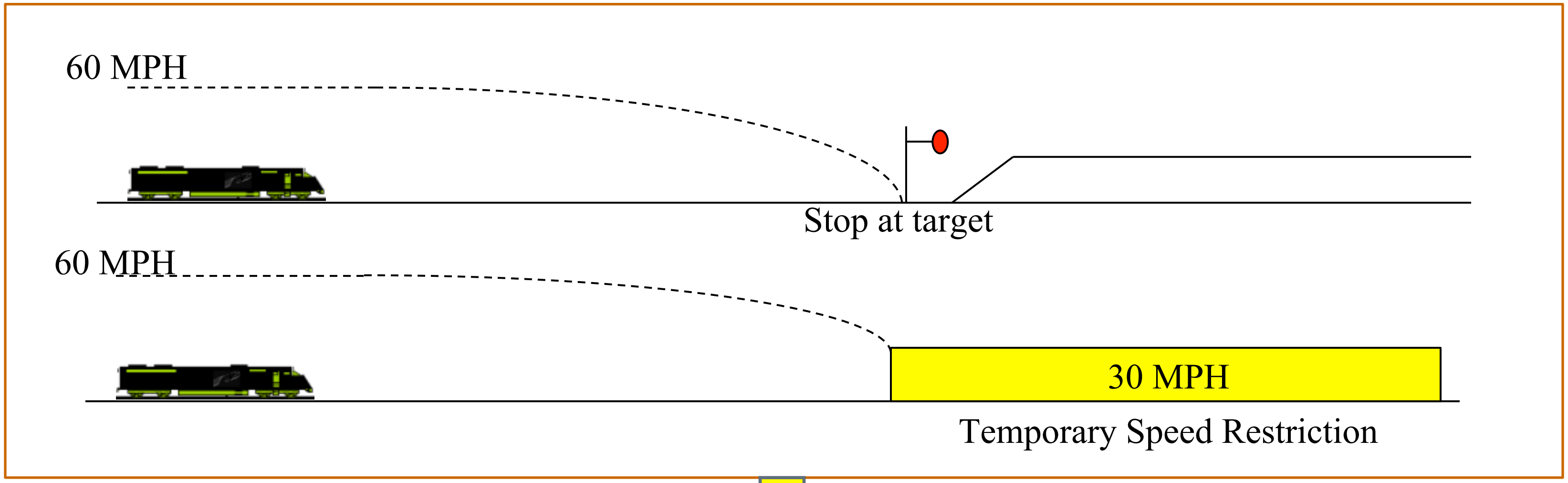
RAIL SAFETY IMPROVEMENT ACT OF 2008 (RSIA'08)

- RSIA'08 has been codified & detailed as 49CFR236 Subpart I
- Each Class I railroad carrier and each entity providing regularly scheduled intercity or commuter rail passenger transportation shall implement a PTC system by Dec 31, 2015, governing operations on:
  - its main line over which intercity rail passenger transportation or commuter rail passenger transportation,
  - its main line over which poison- or toxic-by-inhalation hazardous materials are transported, and
  - such other tracks as the Secretary may prescribe by regulation or order.

Based on a January 2012 final FRA rule, AAR estimates that PTC technology will have to be deployed on approximately 63,000 miles of U.S. freight rail lines.

PTC Overview - System Concept

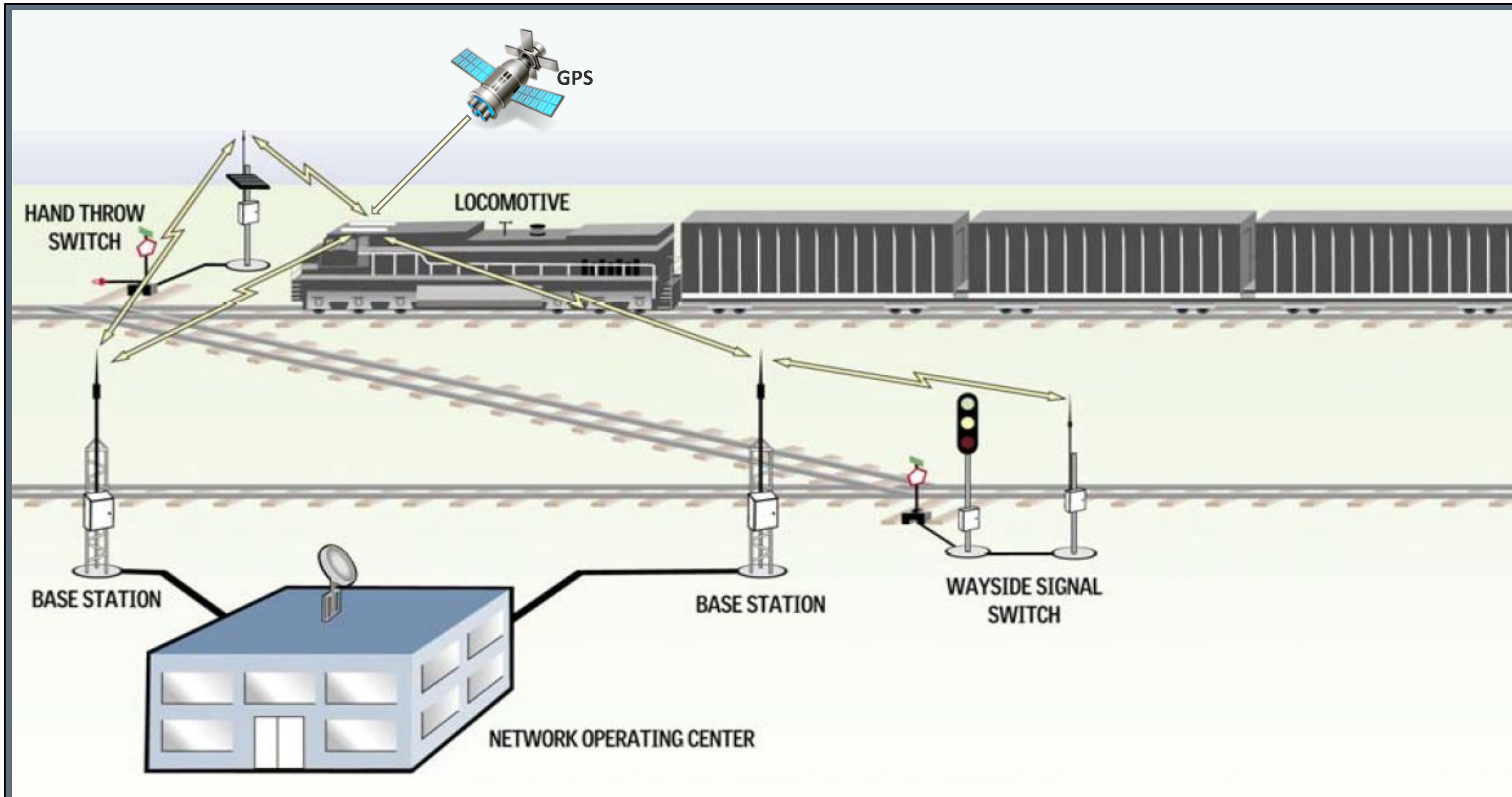
- PTC describes technology designed to automatically stop or slow a train before certain accidents occur.
- PTC is designed to prevent train-to-train collisions, derailments caused by excessive speed, unauthorized incursions by trains onto sections of track where repairs are being made and movement of a train through a track switch left in the wrong position.



System will take control and bring train to a more restrictive state in case train engineer fails to conduct according to the braking curve

PTC Overview - Overall Architecture

- **Safety Overlay** - Currently, PTC systems are being deployed as a safety overlay to existing train control systems



PTC Overview - Project Development and Management

- Currently two dominant PTC implementations are being deployed

FRA Final Rule

ITC Compliant (Freight)

- Follow the specifications from the ITC committee
- Being adopted by all freight railroads
- I-ETMS, from Wabtec is the first ITC-compliant on-board-system being deployed

ACSES Compliant (Commuter – NEC)

- Adaptation of existing ACSES system
- Being adopted by commuter railroads (such as MNR, LIRR) in the Northeast Corridor (Boston to Washington-DC)
- Alstom is a provider for the commuter RRs (ACSES II)

- Systems are distinct – applications, messages, protocols
- Radios operate within the same range (217 – 222 MHz)
- There are territories where freight trains equipped with ITC and commuter trains equipped with ACSES will operate simultaneously

PTC Overview

Main challenges

- Mandate deadline (end of 2015)
  - Finish all integration and interoperability tests
  - Be able to deploy components in the field and locomotives

Railroads trying to obtain extension to 2018

Railroad Concerns

- PTC estimated costs is approximately US$50,000 per mile and US$ 55,000 per locomotive (*)
- Unforeseen impact in railroad efficiency (train operation, interoperability, reliability)

(*) **Source:** *Federal Railroad Administration, "Positive Train Control Systems Amendments (RRR)," 77 Federal Register 28285, May 14, 2012.*

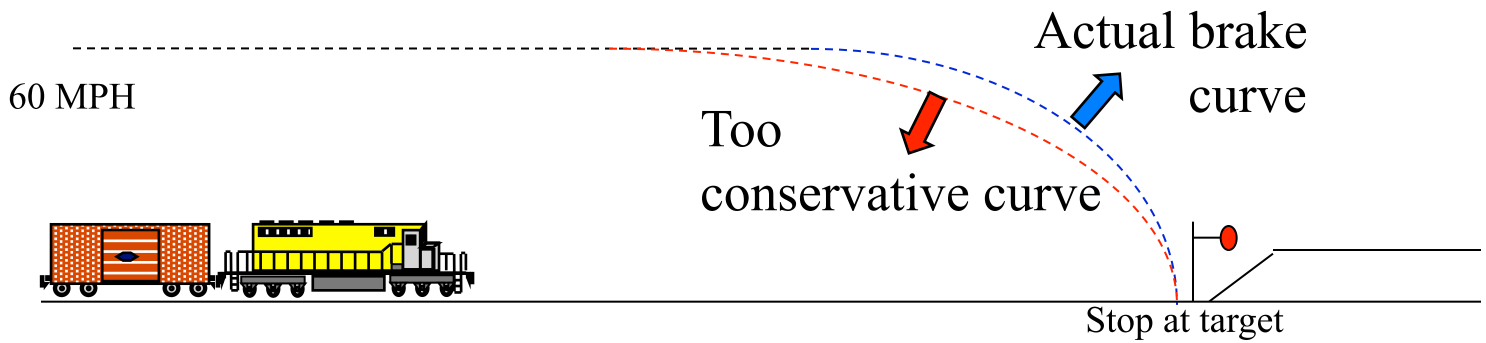
TTCI PTC Projects

- PTC Projects Where TTCI Plays a Key Role
  - PTC Train Enforcement Braking Algorithm
  - RF Network Planning and Design
  - Positive Train Location
  - PTC System and Radio Testing

PTC Train Enforcement Braking Algorithm

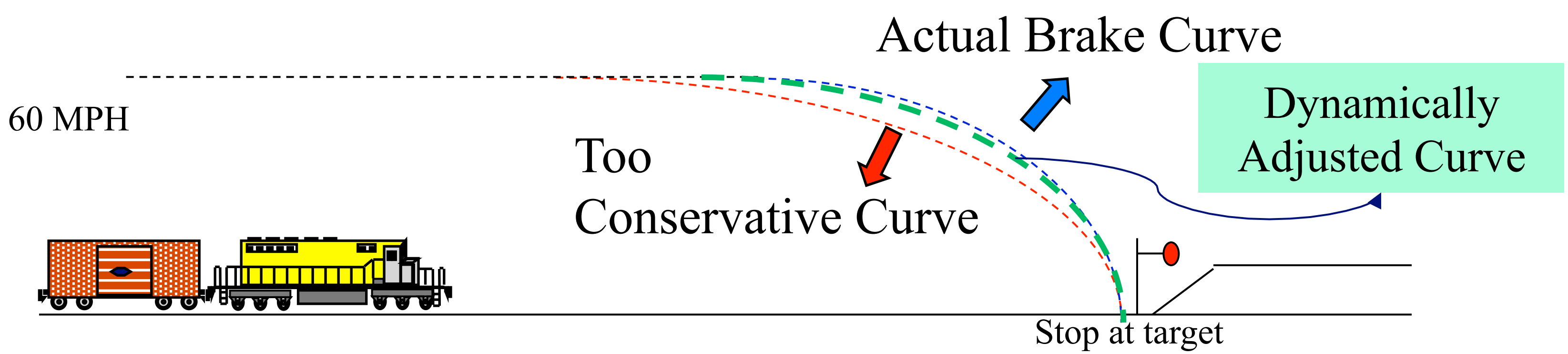
PTC Train Enforcement Braking Algorithm

- The problem
  - Braking system of train consist (locomotives, cars) is not uniform in real life.
  - Typically significant variance for freight trains.
  - Safety systems driven by conservative approach.
  - **Too conservative of a braking curve would lead to a significant loss of efficiency for the railroads.**



PTC Train Enforcement Braking Algorithm

- Adaptive Braking Algorithm Concept adjusts dynamically the train braking curve
  - Computer knows where the train is, its composition, brake pipe propagation rate and the topography of the track.
  - Computer monitors how train has been performing during previous train braking application.
  - Dynamic adjustments of the train brake curvature are made as the train moves.



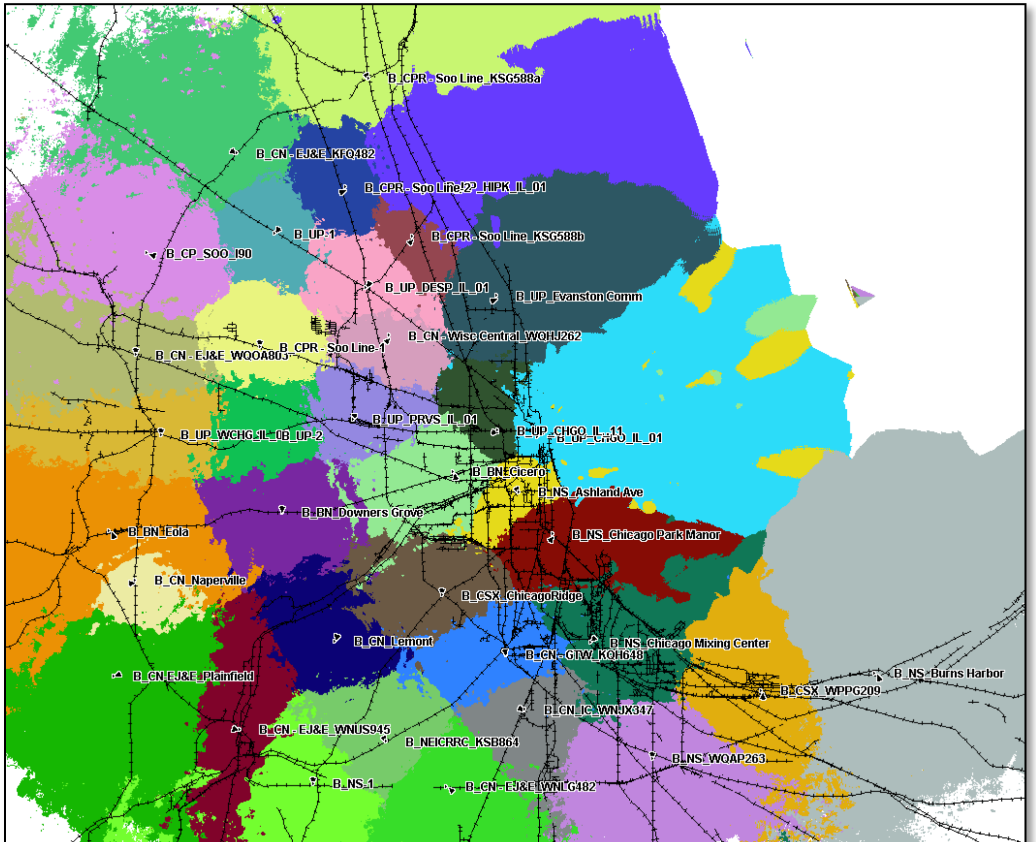
RF Network Design for Dense Urban Areas

➢ Resolution of PTC220 RF network issues in DUAs

- How much RF spectrum would be needed ?
  - WIU status messages sent periodically from wayside devices
  - Locomotive onboard computer messages exchanged with back office systems, such as track bulletins, train position, hear bit among other
- What additional resources would be necessary (e.g., new base station sites)?
- How railroads could share communication resources in those areas ?
- What is the volume of message traffic generated by all trains and WIUs combined?

PTC220 LLC hired TTCI to develop the RF network assessments & design projects for the DUAs.

➢The Dense Urban Area (DUA) Problem – Chicago Case



Characteristics of the network

- ~40 miles radius from downtown
- 11 railroads included
  - 6 Class 1 freight RRs
  - 2 Regional RRs
  - 3 Commuter lines
- Aprox. 900 route miles of tracks
- More than 25,000 simulated trains
  - During 2 weeks of simulation
  - >200 train operating simultaneously at peak times
- Approximately 36 base stations
- Approximately 800 WIU sites

Positive Train Location

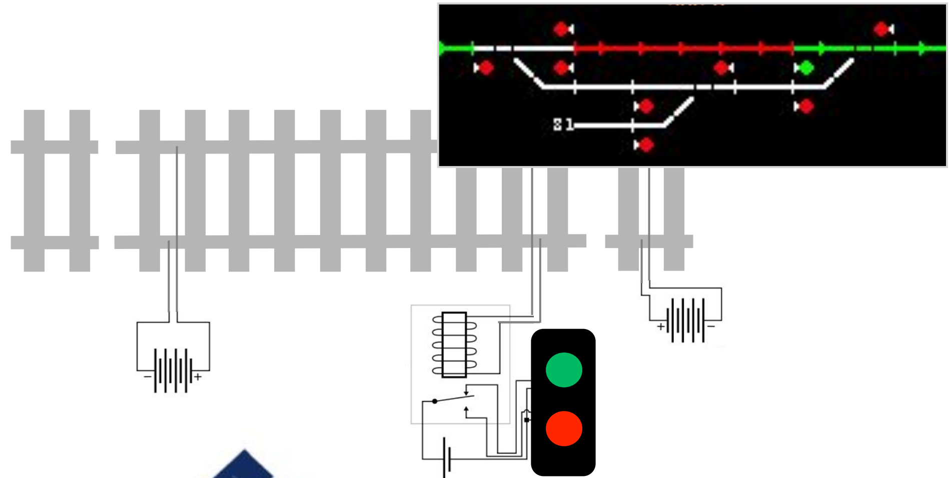
➢ Can a train location be determined?

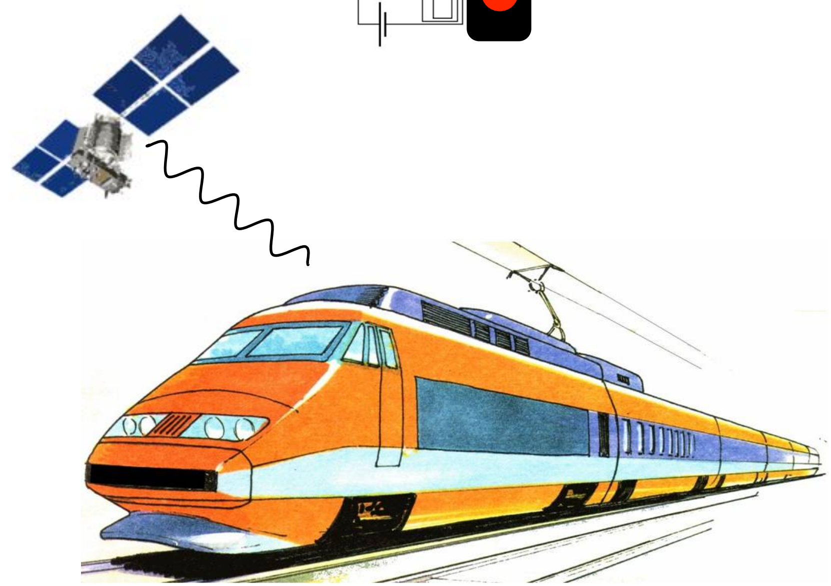
TRACK WARRANT

NO. ________ DATE: ________

TO: ________ AT: ________

1. ☐ TRACK WARRANT NO. ________ IS VOID.
2. ☐ PROCEED FROM ______ TO ______ ON ______ TRACK.
3. ☐ PROCEED FROM ______ TO ______ ON ______ TRACK.
4. ☐ WORK BETWEEN ______ AND ______ ON ______ TRACK.
5. ☐ NOT IN EFFECT UNTIL ________.
6. ☐ THIS AUTHORITY EXPIRES AT ________.
7. ☐ NOT IN EFFECT UNTIL AFTER ARRIVAL OF ________ AT ________.
8. ☐ HOLD MAIN TRACK AT LAST NAMED POINT.
9. ☐ DO NOT FOUL LIMITS AHEAD OF ________.
10. ☐ CLEAR MAIN TRACK AT LAST NAMED POINT.





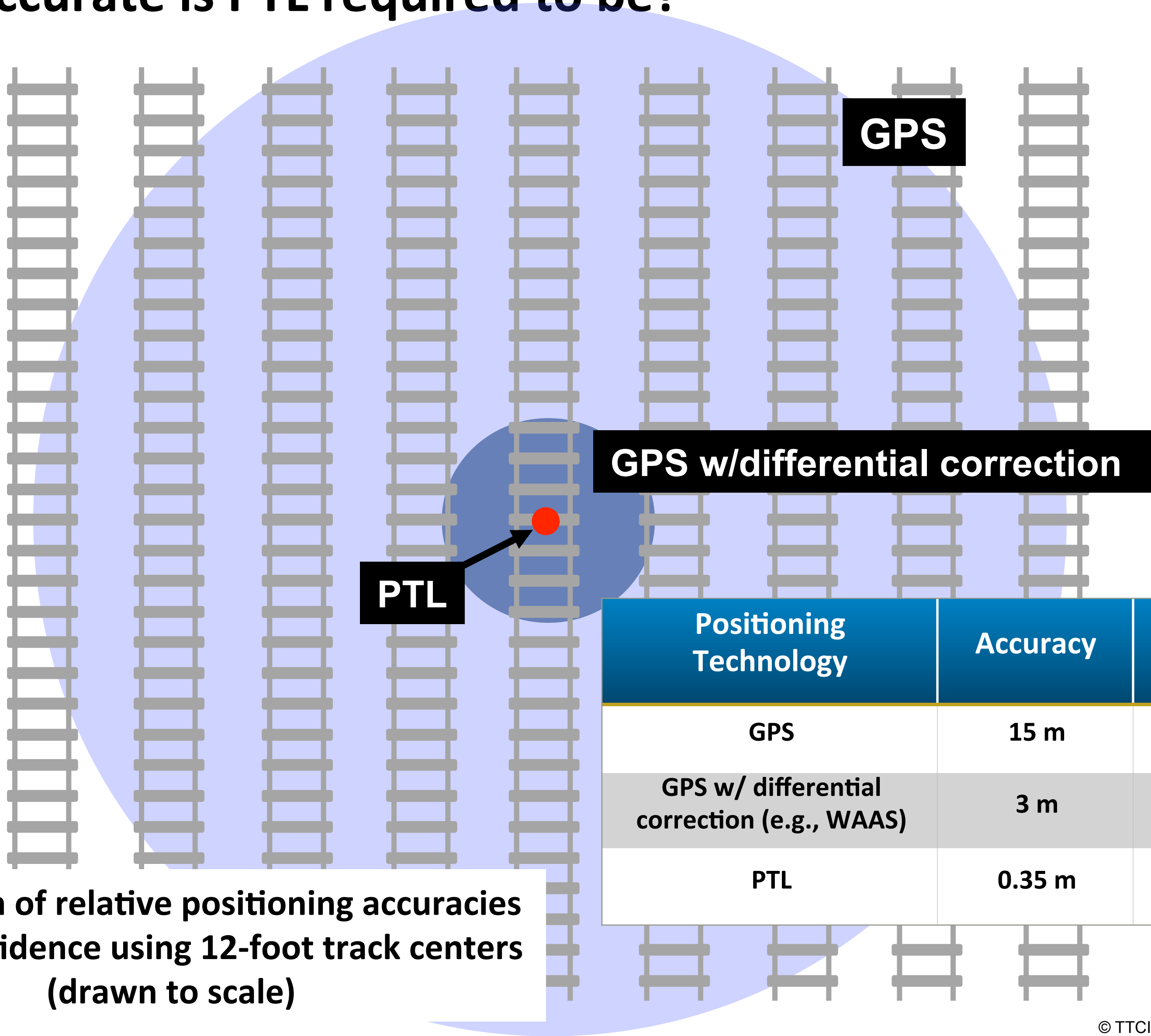
➢ Positive Train Location (PTL) Requirements

- **The PTL system currently under development is required to:**
  1) Accurately determine the position of the locomotive, and
  2) Accurately determine the position of the rear of the train

- **Key performance requirements:**

Key Performance Parameter	Value	Confidence Level
Position Error	1.2 meters	99.999999997%
Velocity Error	0.1 mph	99.99%

- How accurate is PTL required to be?



Positioning Technology	Accuracy	Confidence
GPS	15 m	95%
GPS w/ differential correction (e.g., WAAS)	3 m	95%
PTL	0.35 m	95%

Comparison of relative positioning accuracies at 95% confidence using 12-foot track centers (drawn to scale)

PTC System and Radio Testing

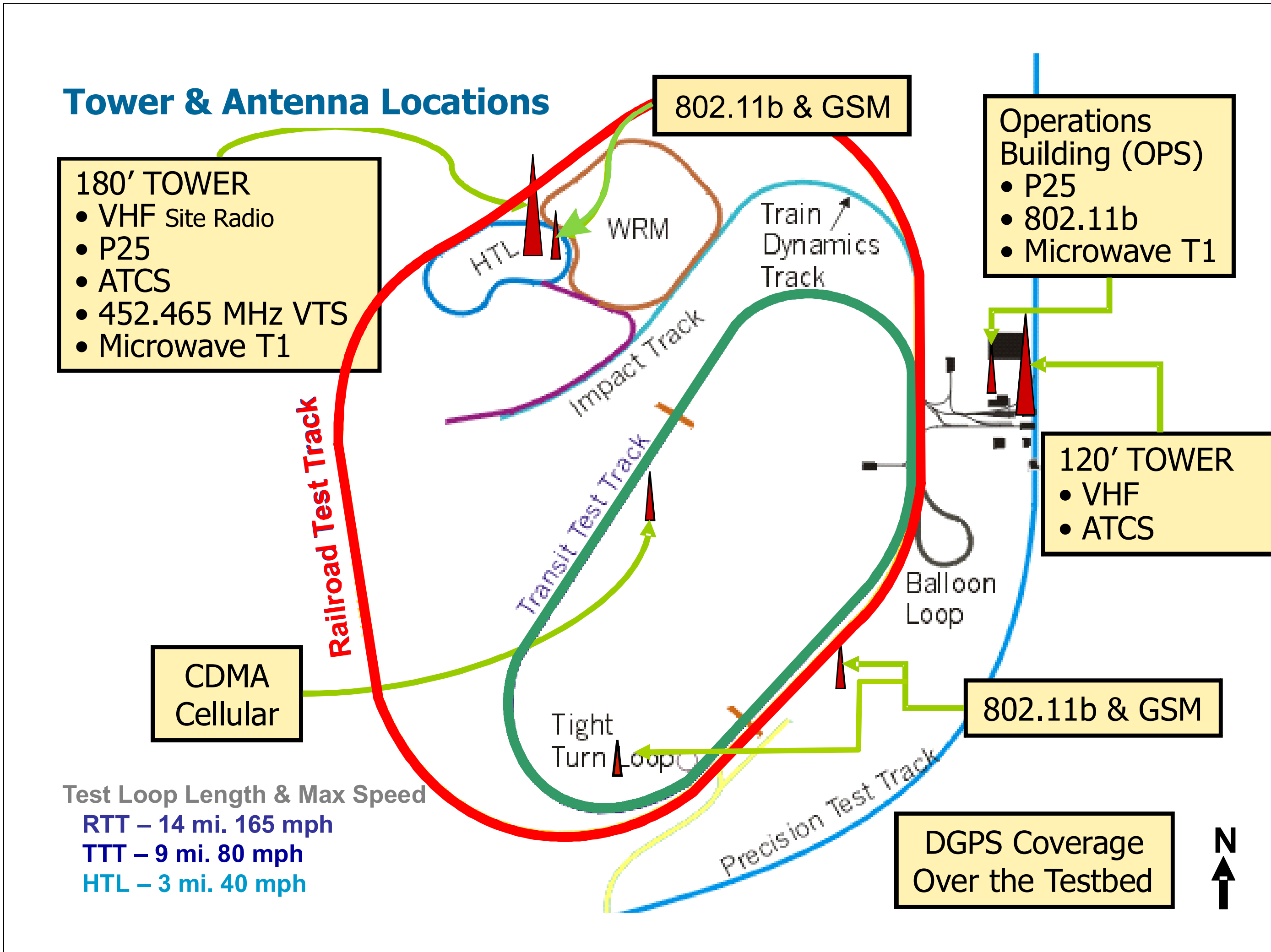
Segurança Ferroviária e o Sistema PTC

- **Complexity and safety emphasis of PTC technology demands many levels of system and component testing**
  - Component Development Testing
  - System Testing (Functional, Performance, Interoperability, Safety)
  - Acceptance Testing
- **Difficulties with testing on revenue track**
  - Must work around revenue traffic
  - Must obey all operating rules or obtain waivers from FRA
  - Repeatability of testing is difficult to achieve
  - Difficult to test performance under heavy load (stress testing)
  - Changes to vital train control equipment require lengthy V&V, significantly extending "test-fix-retest" cycle
- **Methods for more efficient, safer and more effective PTC testing**
  - Use of computer modeling/simulators
  - Dedicated PTC test bed

On-track Test Bed without Revenue Traffic and Regulations can Alleviate these Problems.

Segurança Ferroviária e o Sistema PTC

- Communications and Train Control Test Bed



Infrastructure for Testing

- **Communications Systems**
- **Train Control Systems & Components**
  - Remote Control Locomotives (RCL)
  - Other Wireless Applications
- **Test Capabilities for:**
  - Interoperability & Standards Compliance
  - Performance Evaluation
  - Proof of Concept for New Applications
  - V&V
  - Handoff Schemes
  - Security/Authentication
- **Related Systems:**
  - GPS-based Vehicle Tracking (VTS)
  - DGPS – Beacon Site Nearby

List of Communications & Train Control Projects at TTCI

Customer	Project
FRA	Braking Algorithm, Freight
FRA	Braking Model & Alg, Passenger
FRA	ITC/I-ETMS Test Bed Upgrades
FRA	ACSES Test Bed
FRA	EIC PRT Integration
FRA	HA-GPS Upgrade/Testing
FRA	Fiber Optic Sensing / Test Bed
FRA	Positive Train Location (PTL)
RRF/FRA	PTC Interoperability Support
RRF/FRA	ITC Requirements Tracing
FTA	Rail Capacity
PTC-220	RF Coord. & Network Design
URS	NICTD PTC Comms Consulting
MCC	220 MHz PTC Radio Testing
Amtrak	PTC Braking Testing

Customer	Project
CSX	F.O. Sensing
SYSTRA	LIRR PTC Consulting
SYSTRA	MNR PTC Consulting
SYSTRA	Metrolink PTC Consulting
Stantec	DART/TRE PTC Comms
Proprietary Onboard PTC PoC	

IR&D Project
Network Simulator
Test Controller/Logger (Braking Alg.)
Broken Rail Detection
PTC Test Bed
Fiber Optic Sensing

Other Topics

Freight and Passenger Rail Security Efforts

Analyze, Prevent, Protect, Detect, Response and Recovery

- **Freight**
  - Cooperation with law enforcement agencies
  - Collaboration between Rail Roads
  - Testing of articles
    - TIH, CBR
  - Training workforce for intrusion and anomalies awareness
  - Creation of information sharing center
  - Conduct vulnerability assessment and create security plan

- **Passenger**
  - Collaboration with Law enforcement agencies
  - Stablishing a system that helps prevent and Detect
  - Education of the public
  - Train and practice for response and recovery
  - Testing of cars to analyze consequence and mitigate effect of blast
  - Conduct vulnerability assessment and create security plan

Expanding Training for an specialized railway Engineering

- There is a shortage of Railway Talent
- Attrition is biggest cause
- Development of railway engineers takes time
- FRA and AAR are cooperating in a Workforce Development program
- TTCI was tasked by the AAR to help
  - Creation of internship programs with Railroads
  - Stablished a Master of Railway Engineering program with Colorado State University – Pueblo
  - Considering working with international partners to develop exchange programs
  - Developing short/Intense programs in key areas –
    - 1 day to 5 days –
      - Vehicle dynamics,
      - Derailment Analyses,
      - Tribology/Friction Modification,
      - CBTC/PTC, T
      - rack Maintenance,
      - Bridge Inspection and monitoring,
      - etc.

Obrigado!

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