Federal Railroad Administration
Research and Development
Program Review

Highlights of R&D Activities for PTC Implementation

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March 12, 2009
PTC Implementation
Related Projects

• Adaptive braking algorithm
• Employee-in-charge portable terminal
• Support for communication spectrum and throughput improvement
• Communication protocol testing
• Interoperable communication-based signaling project
• Data security
• Universal on-board platform
• High accuracy GPS tracking
• Risk assessment methods
Adaptive Braking Algorithm

Objectives

0.05 probability of undershoot

500 ft @ < 30 mph
1,000 ft @ ≥ 30 mph

0.000005 probability of overshoot

With Close-loop Iterations, zero-in

- Brake Propagation Rate
- Accurate Train Weight
- Brake Efficiency
Adaptive Braking Algorithm

Loaded, 40-car on flat grade from 40 mph

IDOT Algorithm Mean
Stopping Position – 20800 feet

Distribution when braking efficiency is known
Distribution when train weight is known
Distribution when propagation time is known

Base Case Distribution

Target

Stopping Position (ft)

Probability Density

21500 22000 22500 23000 23500 24000

IDOT Algorithm Mean Stopping Position – 20800 feet

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Highlights of PTC R&D Activities
• Proposed Subpart I governing mandatory PTC 2015 deployment states one of the requirements for PTC is to reliably and automatically prevent incursions into established work zone limits – EIC PRT will fulfill this requirement.

• Pilot project will be initiated to interface with BNSF ETMS II System.

• Software is to be portable so that it can be installed on a laptop, a tablet PC or a PDA. The communication link between the gateway and locomotives is system specific.

• Safety analysis in the form of Subpart H PSP is completed.

• Demonstrated with PDA in RSAC PTC Working Group meeting on February 25 and AAR WCC/RESC on March 11– received very well by the railroads and the labor groups.
Communication Network is the backbone of PTC systems
• Assist railroads to petition FCC for waivers of “build or lose” provision for the 220 MHz spectrum. (UP and NS have acquired 5 channels of 25 KHz each)

• Conduct RF demand study using a basic territory model of a metropolitan area and based on the newly defined messages. (to be completed end of March)

• Develop other measures to improve throughputs and channel use: concatenate messages, use directional antennas, limit power etc

• Continue the development of HPDR (Higher Performance Digital Radio) with MeteorComm.
  – 12 Phase 1 MeteorComm HPDR Radios received at TTCI for testing
  – MeteorComm continues on schedule on Phase 2 development
Communication Protocol Testing

Application Specific / Data Dictionary

Mobile App.
EMP Router
EMP-ITP Bridge
MMGW
MWGW
Mobile Radio
Base Radio
OWGW
OMGW
EMP-ITP Bridge
EMP Router
Office App.

Class D/C
TCP/UDP

EMP

ITP

Native (TBD)

RF(TBD)

Internal

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Highlights of PTC R&D Activities
• ITP – Interoperable Transport Protocol
  – A proposed upper-layer, routable transport protocol
• EMP – Edge Message Protocol
  – A proposed upper-layer message envelope
• Class C
  – A proposed IP-based multicast protocol
• Class D
  – A proposed TCP/IP-based point-to-point protocol
• Standard architectural components:
  – MWGW – Mobile Wireless Gateway
  – MMGW – Mobile Message Gateway
  – OWGW – Office Wireless Gateway
  – OMGW – Office Message Gateway
Interoperable Communication-based Signaling (ICBS)

Communication–based on-board and wayside signaling equipment from four suppliers interoperable with each other

- Demonstration in Syracuse, NY attracted 50 attendees in January 2009
- Presented to RSAC and the railroads in February 2009
- Experience learned can be applied to the Interoperable PTC testing
- With the railroads, evaluating the potential of replacing form authorities with vital virtual signaling in dark territories
• Proposed Subpart I will require data security to insure authentication and integrity of communication data.

• Confidentiality will be optional.

• Minimum expected would be MAC and HMAC schemes – but any algorithm recognized by National Institute of Standards or other standards organization will be acceptable.

• Pending BAA submission by universities/railroads partnerships to address reducing message overheads, increasing throughputs and key management.
Universal Onboard Platform

- Joint Project with AAR Locomotive Committee and the Railway Electronics Standards Committee
- Develop a common on-board architecture, standard data messaging, and standard protocol for command/control services

- Develop a set of data elements to be used in this environment.
- Cooperating with Locomotive OEM’s to enhance this data element list.
- Final goal is to develop a cost-effective platform to integrate and maintain on-board applications including PTC within the locomotive LAN environment.
• Evaluate High Accuracy NDGPS methodology for suitability for track discrimination with probability of success greater than 0.999999 in PTC implementation
  – GPS – 15 meters average accuracy
  – DGPS – 3 to 5 meters with 95% confidence
  – HA-DGPS – 10 cm to 30 cm resolution

• Upgrade Pueblo NDGPS base station site to be functional equivalent of the first operational High Accuracy Nationwide Differential GPS (HA-NDGPS) site in North America

• Conduct demonstrations & tests to show potential benefits for train control, track database maintenance, and other railroad applications

• Project will proceed when Coast Guard approves the Engineering Change Request (ECR) for the Pueblo upgrade. The approval of ECR is expected to be in April, 2009
Risk Assessment Methods

- A Practical Risk Assessment Methodology by Union Switch & Signals
  - Start with Tolerable Risk Level (TRL) based on the Base Case
  - Iterate the design of the new system until TRL is reached
  - 4 page Research Results and a detailed report are under review and to be published soon

- A Generalized Train Movement Model by DecisionTek, Inc
  - Phase 2 close to completion – pending addition of a few minor features which arose from discussion with BNSF on the Beardstown Subdivision (ETMS I territory) simulation results
  - Phase 3 will soon initiate to incorporate failures and hazard event simulations