Train Control, Communications and Operations Committee

Update for APTA

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AVP Transportation Systems Development
Union Pacific Railroad

June 2017 - APTA Conference

ASSOCIATION OF AMERICAN RAILROADS

Agenda

TCCO established in 2008 (1st meeting June 18, 2008)

Impact of PTC on our operations

Updated mission & focus for TCCO

New Schedule / Tempo for TCCO

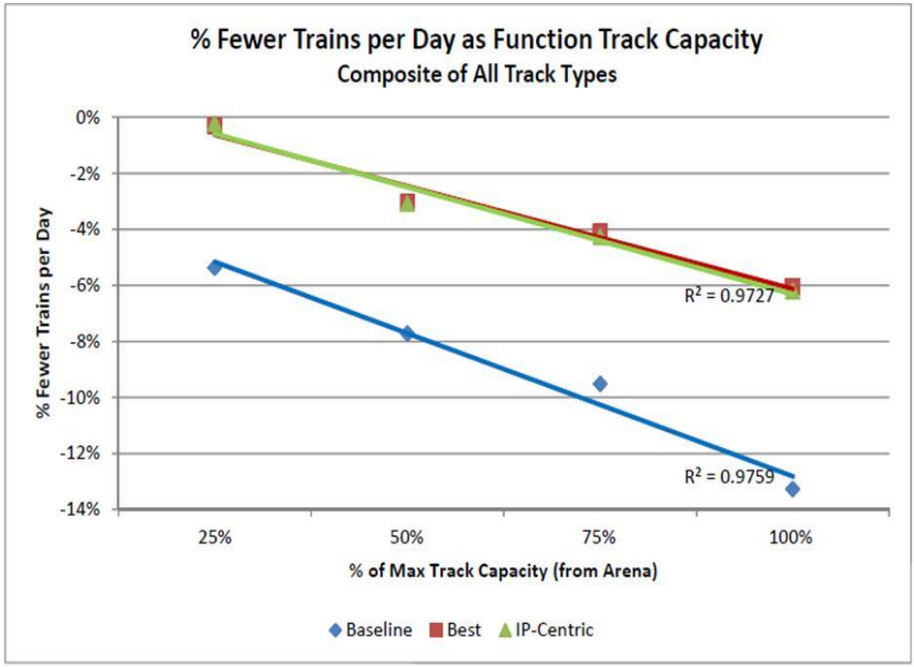
Expansion of TCCO participants beyond AAR

TCCO Projects

US PTC “Problem Space”

Method of Operation → / **Territory Configuration**	Traffic Control	Current of Traffic	Track Warrant Control	Yard Limits
Cab Signals – ATC	***X***	***X***	***X***	
Cab Signals - ACS	***X***	***X***	***X***	
No Cab Signals	***X***	***X***	***X***	
Automatic Train Stop (ATS)	***X***	***X***	***X***	
ABS			***X***	
Non-ABS			***X***	***X***
Yard Limits	***X***	***X***	***X***	

PTC Headwinds on Railroad Operations

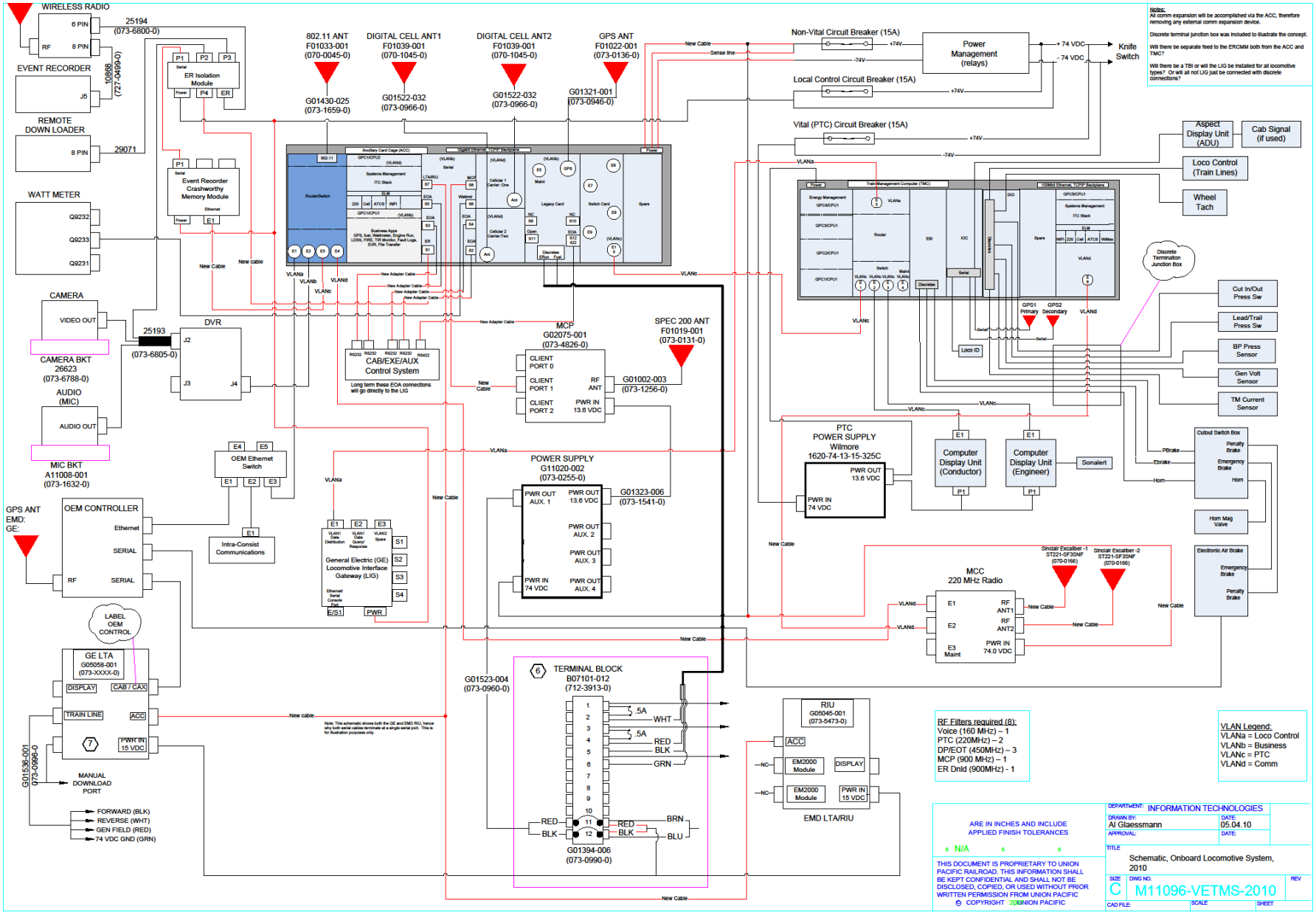


Negative Impact on Operations

- Human Factors
- Hardware/software reliability
- Conservative predictive braking
- Lost critical radio messages
- Ability of PTC system to support traditional operations

Reliability Concepts

Component	Component Reliability	Component Reliability	Component Reliability
PTC Management Computer	99.90%	99.50%	99.00%
PTC Display Unit	99.90%	99.50%	99.00%
Locomotive Control System (OEMs)	99.90%	99.50%	99.00%
Locomotive Interface Gateway	99.90%	99.50%	99.00%
Communications Management Unit	99.90%	99.50%	99.00%
Mobile Access Router	99.90%	99.50%	99.00%
PTC Reliability	99.40%	97.04%	94.15%


WIRELESS RADIO
6 PIN
8 PIN
RF
25194
(073-6800-0)
EVENT RECORDER
J5
10686
(727-0499-0)
REMOTE
DOWN LOADER
8 PIN
29071
WATT METER
Q9232
Q9233
Q9231
ER Isolation Module
Event Recorder Crashworthy Memory Module
802.11 ANT
F01033-001
(070-0045-0)
G01430-025
(073-1659-0)
DIGITAL CELL ANT1
F01039-001
(070-1045-0)
G01522-032
(073-0966-0)
DIGITAL CELL ANT2
F01039-001
(070-1045-0)
G01522-032
(073-0966-0)
GPS ANT
F01022-001
(073-0136-0)
G01321-001
(073-0946-0)
Non-Vital Circuit Breaker (15A)
Local Control Circuit Breaker (15A)
Power Management (relays)
+74 VDC
- 74 VDC
Knife Switch
Vital (PTC) Circuit Breaker (15A)
Aspect Display Unit (ADU)
Cab Signal (if used)
Loco Control (Train Lines)
Wheel Tach
Notes:
All comm expansion will be accomplished via the ACC, therefore removing any external comm expansion device.
Discrete terminal junction box was included to illustrate the concept.
Will there be separate feed to the ERCMM both from the ACC and TMC?
Will there be a TBI or will the LIG be installed for all locomotive types? Or will all not LIG just be connected with discrete connections?
CAMERA
VIDEO OUT
CAMERA BKT
26623
(073-6788-0)
AUDIO
(MIC)
AUDIO OUT
MIC BKT
A11008-001
(073-1632-0)
25193
(073-6805-0)
DVR
J2
J3
J4
CAB/EXE/AUX
Control System
Long term these EOA connections will go directly to the LIG
MCP
G02075-001
(073-4826-0)
CLIENT PORT 0
CLIENT PORT 1
CLIENT PORT 2
RF ANT
PWR IN 13.6 VDC
G01002-003
(073-1256-0)
SPEC 200 ANT
F01019-001
(073-0131-0)
OEM Ethernet Switch
Intra-Consist Communications
POWER SUPPLY
G11020-002
(073-0255-0)
PWR OUT AUX. 1
PWR OUT 13.6 VDC
PWR OUT AUX. 2
PWR OUT AUX. 3
PWR IN 74 VDC
PWR OUT AUX. 4
G01323-006
(073-1541-0)
PTC
POWER SUPPLY
Wilmore
1620-74-13-15-325C
PWR OUT 13.6 VDC
PWR IN 74 VDC
Computer Display Unit (Conductor)
Computer Display Unit (Engineer)
Sonalert
Discrete Termination Junction Box
Cut In/Out Press Sw
Lead/Trail Press Sw
BP Press Sensor
Gen Volt Sensor
TM Current Sensor
Cutout Switch Box
Penalty Brake
Emergency Brake
Horn
Horn Mag Valve
Electronic Air Brake
Emergency Brake
Penalty Brake
MCC
220 MHz Radio
RF ANT1
RF ANT2
PWR IN 74.0 VDC
Sinclair Excaliber -1 ST221-SF35NF (070-0166)
Sinclair Excaliber -2 ST221-SF35NF (070-0166)
GPS ANT
EMD:
GE:
OEM CONTROLLER
Ethernet
SERIAL
RF
SERIAL
LABEL OEM CONTROL
GE LTA
G05058-001
(073-XXXX-0)
DISPLAY
CAB / CAX
TRAIN LINE
ACC
PWR IN 15 VDC
MANUAL DOWNLOAD PORT
G01536-001
(073-0966-0)
FORWARD (BLK)
REVERSE (WHT)
GEN FIELD (RED)
74 VDC GND (GRN)
General Electric (GE) Locomotive Interface Gateway (LIG)
G01523-004
(073-0960-0)
TERMINAL BLOCK
B07101-012
(712-3913-0)
.5A
WHT
.5A
RED
BLK
GRN
RED
BLK
BRN
BLU
G01394-006
(073-0990-0)
RIU
G05945-001
(073-5473-0)
ACC
EM2000 Module
DISPLAY
EM2000 Module
PWR IN 15 VDC
EMD LTA/RIU
RF Filters required (8):
Voice (160 MHz) – 1
PTC (220MHz) – 2
DP/EOT (450MHz) – 3
MCP (900 MHz) – 1
ER Dnld (900MHz) - 1
VLAN Legend:
VLANa = Loco Control
VLANb = Business
VLANc = PTC
VLANd = Comm
ARE IN INCHES AND INCLUDE APPLIED FINISH TOLERANCES
± N/A ± ±
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DEPARTMENT: INFORMATION TECHNOLOGIES
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DATE: 05.04.10
APPROVAL:
DATE:
TITLE
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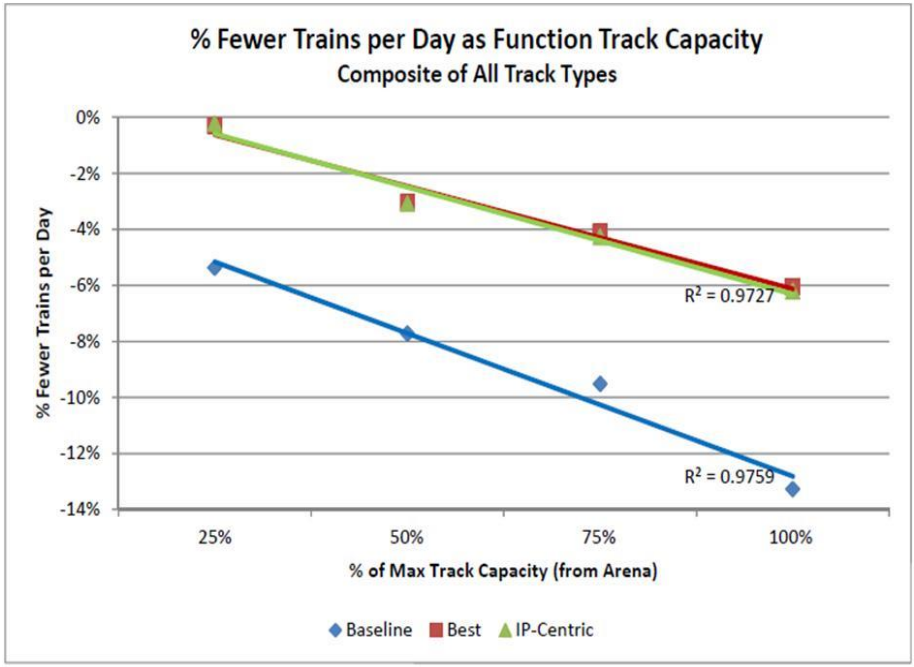
SIZE C
DWG NO. M11096-VETMS-2010
REV
CAD FILE:
SCALE
SHEET

PTC Headwinds on Railroad Operations



Phase 2 Reliability Study being Launched by AAR, adds:

- Actual hardware performance
- Software performance
- Human Factors
- Conservative predictive braking
- Ability to analyze trade offs between repair capability and train delay (Broke/Fix and Preemptive Replacement)

TCCO's New Mission & Focus 5/2015

Improve safety and deliver solutions that recover lost capacity (and improve lifecycle costs) introduced by PTC.

Capacity headwind must become a tailwind.

- Capacity gains don't necessarily have to come via the PTC system.

Solutions must show favorable ROI vs other capacity investment options.

New Schedule for TCCO Committee Meetings and Conference Calls

- Historically, one meeting per year to review progress and to introduce and rank new project concepts
- New process has regular conference calls in addition to face-to-face meetings as needed
  - Regular high-level status/review of ongoing projects
  - Review and refinement by the committee of project concepts as they are developed into project frameworks
  - Rank new project concepts throughout the year, to provide better direction for application of funding
  - Monthly project review with FRA
- Established TCCO Executive Committee
  - Detailed development of strategies, project concepts and frameworks for review/approval by full committee

FRA Involvement with TCCO Committee

Engaged FRA more regularly than in past years

Regular calls and meetings with FRA and TCCO executive committee.

Project concept and framework development with focus on key FRA metrics

1. Project alignment with DOT/FRA goals (safety, state of good repair, efficiency, competitiveness, environment impact)
2. Safety impact on RR operations
3. Technology maturity, what TRL level? New technology or ready to deploy?
4. Industry need, how much demand is there from the railroad industry?
5. Partnership and cost sharing
6. NTSB recommendation
7. Short term or long term impact on rail operations
8. Other dynamic requests from the FRA

Expansion of TCCO Participation

Objectives

To ensure project concepts offer benefits to the broad industry

- Also to increase the probability of receiving FRA funding.

To incorporate feedback from smaller railroads, commuters, etc., in development of project concepts and throughout the project lifecycle

Approach

1. Expanded participation to additional AAR member railroads
2. **Expanded participation to non AAR member railroads** – Expand TCCO Executive Committee as was done for our AAR PTC Interchange Agreement (non members)
    1. We formally invited commuters, shortlines and terminal railroads to cooperate with TCCO at a PTC meeting held at Metra/Chicago in 2015.

Current Projects

Ongoing TCCO Projects

Task Order	Project Title	Project Description	Status
339	PTC Test Bed Commissioning	Commission each of the PTC deployments in the PTC Test Bed at TTC, including both the ITC and ACSES deployments on the Railroad Test Track (RTT) and implement configuration management	Final report under review
355	Northeast Corridor PTC RF Network Design	PTC RF network design for the Northeast corridor	Completing frequency plan for MTA 08 (Boston), completing train message loading for MTA 01 (NY) and MTA 09 (Philadelphia) and completing final report
359	PTC Passenger Braking Algorithm	Perform simulation analysis on current I-ETMS and ACSES braking algorithms, identify, implement and evaluate potential algorithm enhancements	Running simulations of both I-ETMS and ACSES braking algorithms, as well as parametric analysiis
374	Railroad Wireless Communication s Roadmap	Examine railroads' wireless communication needs (current and future), categorize and quantify the needs, identify gaps and develop a time-phased roadmap to address the gaps	Developing message models for applications previously not considered in scope, developing and running simulations for quantifying wireless demand for each application
004	Next Generation Track Circuit Research – Phase 1	Identify use cases for NGTC, research rail-based technologies with potential to improve reliability and lifecycle cost-effectiveness and support future train control, and research physical characteristics of rail as a sensing medium	Preparing to distribute RFI to potential suppliers and completing research of use of rail as a sensing medium

Ongoing TCCO Projects

Task Order	Project Title	Project Description	Status
005	Evaluation of Fiber Optic Broken Rail Detection System	Evaluate the performance of a fiber optic broken rail detection system and perform a gap analysis identifying functions of a vital track circuit-based system that would be required of a vital fiber optic system	Continuing testing during normal FAST ops and performing gap analysis between conventional track circuits and FO systems.
016	Flexible Operator Location Feasibility Analysis – Phase 1	Develop concept of operations for flexible operator location system, identify and document representative sensor, data link and high-level technical requirements, and evaluate feasibility of system	Finalizing draft high-level system requirements and preparing RFI for distribution
017	Machine vision-based PTC Track Map Auditing	Develop concept of operations and define high-level functional requirements for a machine vision-based PTC track map auditing system, and perform a technology survey, including preparing and issuing a request for information to potential system suppliers	Awaiting response to RFI and preparing trade tables for analysis of responses and development of recommendations for future phases

Ongoing TCCO Projects (continued)

Task Order	Project Title	Project Description	Status
028	Interoperable EIC-PRT – Phase 1	Revise ConOps, requirements and ICDs to define interoperable EIC-PRT	Completing changes to onboard, EIC server and EIC-PRT specifications in response to comments received during CDR
030	PTC Interoperability Support	Facilitate development of requirements for processes and tools to support interoperable PTC CCM and requirements traceability, research existing tools, identify potential solutions	Reviewing background information, identifying key approach decisions, developing process framework

Ongoing TCCO Projects (continued)

Task Order	Project Title	Project Description	Status
032	Higher Reliability and Capacity Train Control	Analyze observed and potential safety and operational impacts of PTC and underlying train control, identify methods to enhance reliability and capacity, and develop ConOps and migration plan	Analyzing potential PTC operational methods, completing requirements for network simulation models, building RTC models for selected operational scenarios
041	Monitoring and Analysis of Integrated Network (MAIN)	Identify methods and tools for diagnosing PTC issues and analyzing performance, including identification of data available and needed. Develop conceptual architecture for MAIN, including data collection, aggregation, and analytics for the entire PTC network.	Developing approach for CONOPS and architecture development based on information gained from RR site visits
042	Railroad Software Defined Radio (SDR)	Develop overall requirements for an industry standard software defined radio (SDR) for use in railway applications, including overall system architecture and high-level component requirements.	Developing system requirements specification and architecture trade tables across multiple platforms

Ongoing TCCO Projects (continued)

Task Order	Project Title	Project Description	Status
N/A	ITC RF Integrity and Security	Identify risk/impact of GPS and 220 MHz radio spoofing and jamming, identify potential mitigation strategies and develop draft recommended practices for secure PTC messaging	Continuing identifying impacts of GPS spoofing and denial of service
N/A	ITC Braking Algorithm Modeling and Analysis	Perform analysis to support refinement of ITC braking algorithm and perform Monte Carlo simulation analysis on new releases	Setting up for Monte Carlo simulations of 6.3.13 and investigating simulation efficiency

Proposed Projects

Proposed TCCO Projects

Project Title	Project Description	Status
Enhanced Overlay PTC	Identify new functions, interfaces, and any issues to resolve to implement Enhanced Overlay PTC; develop draft implementation and operation plan, develop incremental safety analysis, and finalize implementation and operation plan	Proposal submitted to FRA
PTC Test Facility Assessment – Phase II	Identify the prospective range of testing that may be conducted at TTC that will maximize benefit to the railroad industry. Determine range of tests that are independent of specific locations or infrastructure, and areas TTCI could test that provide the most benefit to the industry.	Proposal submitted to FRA
Fiber Optic Acoustic Detection (FOAD) Train Tracking – Phase I	Develop test plans, engage suppliers and conduct data collection and analysis efforts supporting use of Fiber Optic Acoustic Detection (FOAD) technology for use in accurate location tracking of the head and rear end of moving trains and tracking through turnouts.	Proposal submitted to FRA
MoW Employee Safety System	Develop CONOPS and high-level requirements for MoW work zone limits monitoring device to track roadway workers and improve situational awareness with alerts.	Proposal submitted to FRA

Future Projects

Future TCCO Projects

Project Title	Project Description	Status
PTC Interoperability Support Phase 2	Procurement/development of software tools for supporting governance and configuration management of interoperable PTC throughout the system lifecycle based on the requirements developed in phase 1 and demonstrating the tools and processes with initial deployment	Concept
RTK positional reference system availability and reliability analysis	Analyze availability and reliability of potential solution for precision track discrimination for PTC using RTK correction messages sent from base station locations	Concept on hold
Completion of Fiber Optic Test Bed on RTT	Complete installation of fiber optic cable around RTT, including specialized installations to support future FOAD research, development and testing	Developing project framework
Fiber Optic Acoustic Detection - Track Degradation Monitoring	HTL Fiber Optic Acoustic Detection Test Bed reconfiguration; data collection and R&D for track structure degradation monitoring; and bridge transition study	Concept
Fiber Optic Acoustic Detection - Flat Wheel Collaborative RR Study	Continue Fiber Optic Acoustic Detection flat wheel detection and classification on railroad property in support of railroad programs	Concept
Machine Vision-based GIS Data Auditing Phase 2	Development of detailed software requirements and interface control documents for available products to support enhanced PTC track database auditing.	Concept

Future TCCO Projects

Project Title	Project Description	Status
Next Generation Track Circuit Research – Phase 2	Development of requirements based on research conducted in phase 1, RFP to potential suppliers of next generation track circuit technology to support development and testing of POC technology in phase 3	Concept
Wideband Software-defined Radio Phase 2	Gather/Analyze detailed requirements associated with SDR components for use on a variety of platforms, considering options, tradeoffs and applicability to the railroad industry.	Concept
MoW Vehicle Safety System	Develop CONOPS and high-level requirements for MoW work zone limits monitoring device to track roadway maintenance machines and reduce risk of on-track collisions.	Developing project framework
PTC Braking Enforcement Algorithm Analysis Methodology Refinement	Update and refine the methodology for analysis of PTC braking enforcement algorithms for freight operations to be more comprehensive for additional algorithm functions and operational scenarios	Concept
Analysis to Support Implementation of Adaptive Braking Algorithm	Identify potential hazards associated with use of an adaptive braking algorithm and propose mitigations and advance safety analysis required to support implementation.	Developing project

Future TCCO Projects

Project Title	Project Description	Status
Flexible Operator Location - Phase 2	Based on requirements and analysis developed in phase 1, continue feasibility analysis to include development and evaluation/demonstration of video data collection, compression and communication link, and further analysis such as human factors, risk and economic analyses	Concept
Switch machine failure predictor analysis	Research potential predictors for switch machine failure and identify potential solutions for proactive identification of switch machine failures	Concept
Motes Application Support	Specify, Develop & Test identified but yet to be developed motes functions.	Concept
EOT camera system for shoving protection Phase 1	Develop requirements and research technologies for a vision system for protection of shoving moves, followed by prototype development and testing in future phases	Concept
Automated penalty application for obstructed grade crossings Phase 1	Develop requirements and research tecgnologies for and onboard solution for detecting obstructed highway-rail grade crossings and applying penalty brake, followed by prototype development and testing in future phases	Concept
Develop testing methodology for testing of railroad interlocked crossing systems	Develop standardized requirements and testing standards for traffic control systems interlocked with highway-rail grade crossing systems	Concept
Yard Operations Safety and Efficiency Improvement Study Phase 1	Study four Class I railroad major yards to quantify sources of safety risk and operational delays and develop recommendations for solutions, such as automation to enhance safety through reduced exposure and improve operational efficiency	Concept

Future TCCO Projects

Project Title	Project Description	Status
Big Data Risk Management Software Phase 1	Develop Concept of Operations for a software system designed to reduce risk through monitoring from available input sources such as PTC, incident management systems, onboard monitoring systems (for equipment and operators), etc. Identify existing big data tools and potential data sources, both currently available and proposed. Develop plan for collection of data and analysis to develop predictive analytics for identifying risk. Assess feasibility of developing and implementing the system and make recommendations for future phases.	Concept
Consolidation of locomotive HMI	Research relating to consolidation of the screens in the locomotive cab	Concept
Track Radar Imaging and Diagnostics PoC and Demonstration (Phase 1)	Develop and test PoC hi-res track infrastrucutre imaging and defect characterization solution. Leverage ongoing Wideband Radar and SoC Development to develop a Rapidly Reconfigurable Imaging and Track Diagnostics Radar suitable for high-volume, low-cost production. Demonstrate at TTC.	Concept
Railroad Network Planning/Prediction Investigation	For real-time train dispatching and network planning tools, accuracy of inputs is key, including those from other RRs. Investigate methods used for network planning, considering quality and accuracy of data, for both Class I's and smaller RR's. Investigate tools used and available and propose methods/solutions for improving accuracy/capabilities.	Concept

Thank you