U.S. Department of Transportation
Federal Railroad Administration

RESEARCH RESULTS
FRA OFFICE OF RESEARCH, DEVELOPMENT & TECHNOLOGY

RR 22-03 | **January** 2022

INTEROPERABLE EMPLOYEE-IN-CHARGE PORTABLE REMOTE TERMINAL (EIC-PRT)

SUMMARY

The Federal Railroad Administration (FRA) provided a grant to the Transportation Technology Center, Inc. (TTCI) to support industry in defining a core set of functional and interface requirements for the interoperable Employee-in-Charge (EIC) portable remote terminal (PRT) to allow for the interoperable use of this equipment throughout the rail network equipped with the I-ETMS Positive Train Control (PTC) system. The goal of this effort is to develop an interoperable EIC-PRT, as a safety overlay system that integrates with PTC, to protect maintenance-of-way (MOW) workers by placing the entry of trains into work zones (WZ) under the EIC's control.

Collaborating with the North American railroad industry, TTCI developed systems engineering documents defining the EIC-PRT system, including interoperable requirements for the EIC-PRT, EIC server, and onboard segments. Additionally, TTCI and its subcontractors developed a prototype roadway worker terminal application per the interoperable requirements and tested the application to demonstrate compliance with the requirements.

BACKGROUND

In the Rail Safety Improvement Act of 2008 (RSIA '08), Congress mandated each Class I freight railroad and other entities providing regularly scheduled intercity or commuter rail passenger transportation to implement a PTC system on designated main lines with regularly scheduled passenger service or on lines where hazardous materials are transported. PTC systems, as defined by RSIA '08, are designed to prevent:

- Train-to-train collisions
- Over-speed derailments
- Incursions into established WZ limits
- Movement of a train through a switch left in the wrong position

The I-ETMS OTC system has been certified as compliant with the PTC statute and regulations. But an outcome of the early PTC development was the recognition of the desire for the industry to develop addition technology so enable WZ boundaries to be enforced by the PTC system until the EIC of an MOW work gang provides permission for an approaching train to enter the WZ.

The EIC-PRT system allows the EIC to interface with a PTC system to authorize the movement of the train into the WZ for which the EIC is responsible and set the maximum allowable speed through the WZ. Figure 1 shows the interoperable EIC-PRT system architecture. The EIC-PRT application is independent of the communication network used to transport messages between the EIC-PRT and the EIC server.

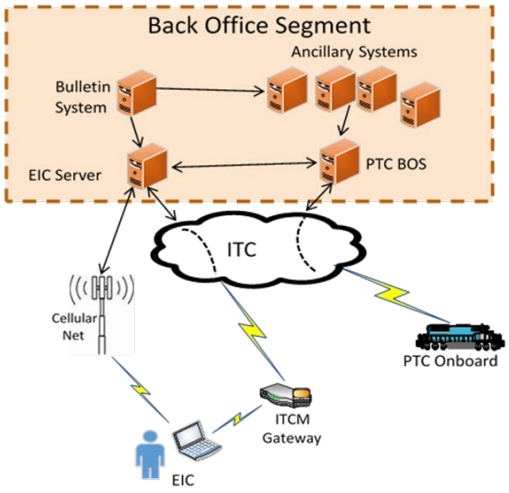

Figure 2 illustrates how an EIC uses the EIC-PRT system to provide instructions to a PTC-equipped train as it approaches a WZ. Note that, as illustrated, the EIC-PRT is an overlay to existing operating practices; thus, voice communication between an EIC and a train crew is maintained.

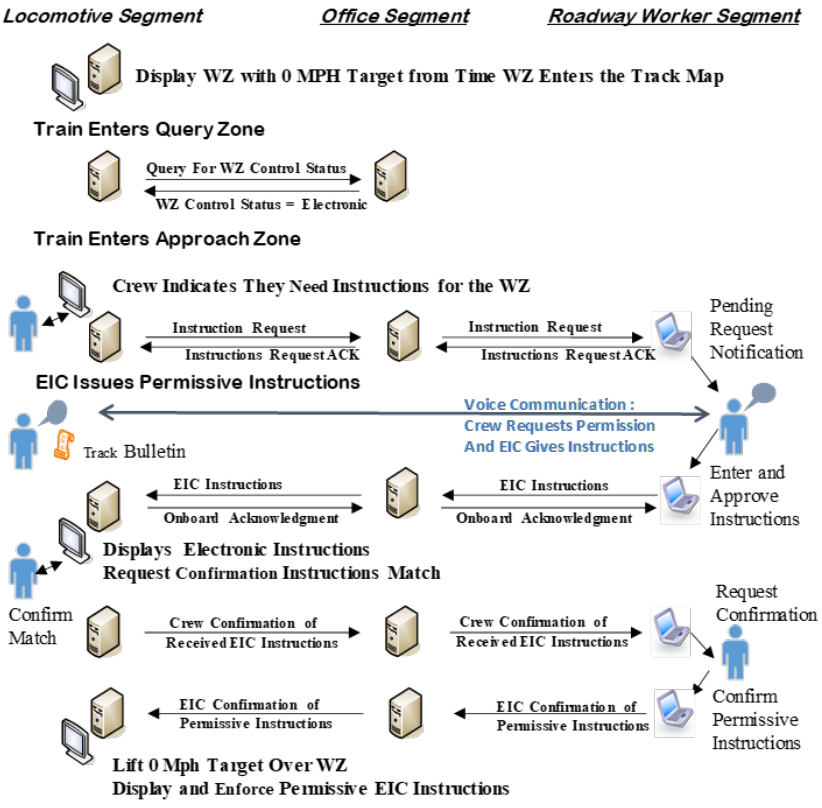

Figure 2. EIC Instructions to Trains

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OBJECTIVES

The key objectives of the EIC-PRT project were:

- Preparation of Interoperable EIC-PRT engineering documents
- Submission of documents to the Association of American Railroads (AAR) for consideration for the *Manual of Standards and Recommended Practices* (MSRP) publication
- Implementation of test tools
- Implementation of a Roadway Worker Terminal (RWT) application
- Unit testing of RWT application
- Laboratory Integration Nearest Neighbor (LINN) testing of the interoperable EIC-PRT
- Revision of safety documentation (critical assumptions, hazard log, risk assessment, etc.)

EIC-PRT systems engineering and safety assessment documentation and RWT application source code developed in previous work were incorporated and retained, to the extent possible, while meeting these project objectives.

METHODS

TTCI collaborated with the railroad industry throughout the project. Working sessions addressed technical details as they arose, and formal preliminary and BNSF Railway hosted critical design reviews. Participants in these reviews included representatives from TTCI, FRA, Class I freight railroads, an onboard supplier, the developer for the EIC-PRT application, and a safety consultant.

The outcome of the collaborative work was EIC-PRT systems engineering documents. Drafts of these documents were submitted to the TAG for final review and approval. After iterative review, the systems engineering documents were approved as a step toward submission of those documents to AAR for possible inclusion in the MSRP.

Later in the project, the EIC-PRT roadway worker application was modified to satisfy industry-approved interoperability requirements and testing. This was accomplished by developing unit test cases using a requirements verification and criteria matrix. Unit testing was then performed of the EIC-PRT RWT application.

RESULTS

EIC-PRT project accomplishments:

- Development of interoperable EIC-PRT systems engineering and requirements documents, including:
  - Interoperable EIC-PRT Concept of Operation
  - Interoperable EIC-PRT Roadway Worker Segment Requirements
  - Interoperable EIC-PRT Back Office Segment Requirements
  - Interoperable EIC-PRT Locomotive Onboard Segment Requirements
  - Interoperable EIC-PRT RWT – Back Office System Interface Control Document
  - Interoperable EIC-PRT Locomotive Onboard Segment – Back Office System Interface Control Document. (This document was produced by Wabtec with the input/guidance of the TAG and TTCI and was included in the documentation provided to AAR.)
  - EIC-PRT RWT Application Software Requirements Document
- Implementation of test tools per EIC server simulator requirements
- Implementation of prototype RWT application
- Successful completion of unit testing of RWT application

- Revision of safety documentation (critical assumptions, hazard log, risk assessment, etc.)

LINN tests were not completed as part of this project due to circumstances outside the control of TTCI and the FRA Office of Research, Development, and Technology. LINN tests are conducted between adjacent system segments, such as the EIC-PRT RWT application and the EIC server. However, development of EIC-PRT functions within PTC back-office systems and PTC locomotive onboard equipment has been delayed, impacting the LINN testing schedule.

The finalization of the EIC-PRT fault tree analysis and integration of the EIC-PRT fault tree with the PTC onboard fault tree was not completed as part of this project due to similar circumstances.

CONCLUSIONS

TTCI worked together with the industry to define and develop the interoperable EIC-PRT system, thereby enhancing the safety benefit of PTC. The EIC-PRT system will increase the protection afforded to MOW personnel by providing the PTC onboard segment with enforceable EIC instructions equivalent to those issued by voice to the train crew. The first build addresses the EIC-PRT project main safety objectives:

- Prevent failure of train from stopping at WZ boundary, as could happen if the locomotive engineer incorrectly indicates permission received to travel through the work zone.
- Prevent train over-speed within WZ limits.
- Mitigate train/gang collisions within WZ limits.
- Mitigate EIC located outside of work zone protected time by providing warnings when a WZ is about to expire (configurable option).
- Prevent instructions to the Onboard by unauthorized third party.

FUTURE ACTION

To facilitate the integration of the EIC-PRT system into current railroad operations with the I-ETMS PTC system, the following steps are recommended. These future work tasks will provide the industry with the confidence to deploy the EIC-PRT system in interoperable operations.

1. LINN testing between the RWT and back office upon railroad completion of implementation of back-office segment EIC-PRT function support
2. LINN testing between the onboard and back-office segments upon completion of back-office and onboard segment EIC-PRT function support
3. Field integration testing
4. Field service testing with review of user experience feedback
5. Complete safety assessment.

Additionally, further development of the EIC-PRT documents is recommended for integrating the EIC-PRT system into high-automation train operations. TTCI recommends development of high-automation EIC-PRT addenda for the EIC-PRT systems engineering documents. These addenda will describe how the previously developed concepts and requirements for the EIC-PRT would need to be modified to provide for the high automation of the EIC-PRT function to minimize required crew prompts.

REFERENCES

1. Rail Safety Improvement Act of 2008. (2008). Pub. L. No. 110-432, 122 stat. 4848.

ACKNOWLEDGMENTS

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KEYWORDS

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