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Development of a Switch Point Monitoring System in Non-Signaled Territory

SUMMARY

The key objective of the Switch Point Monitoring System (SPMS) is to monitor, detect, and report improperly aligned switches on main tracks, which could compromise the safe movement of trains in non-signaled territory. When an improper switch point alignment is detected, the system will convey the information through a wireless network to the train dispatch system, allowing the train dispatcher to provide safe mitigation of the reported switch anomaly. SPMS provides an innovative, low-cost, closed-loop technology for improvement of freight and passenger train railway safety, affording a safer transportation environment at the community and industry levels by preventing train collisions and derailments.

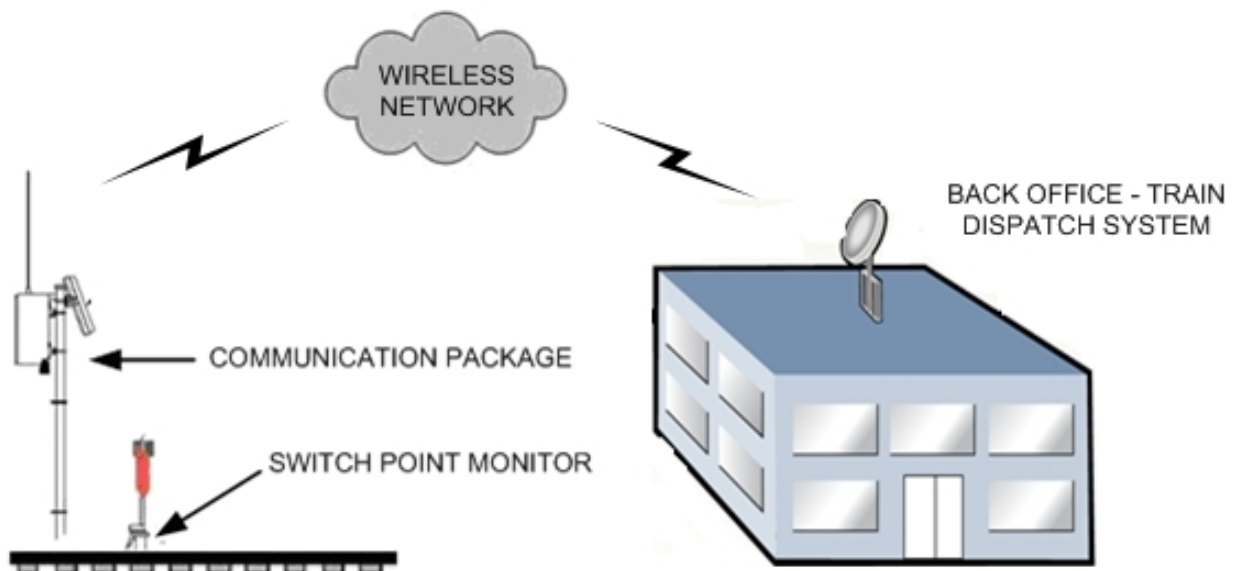


Figure 1. High-Speed Wireless Data Network for Railroad Operation



INTRODUCTION

The rail industry continues to experience incidents caused by switches improperly lined in main track non-signaled territory. In 2004, eight accidents resulted in injuries to eight railroad employees; in January 2005, three major accidents were caused by improperly lined switches in main track non-signaled territory.

As a result of this ongoing issue troubling the rail industry, the BNSF Railway and the Federal Railroad Administration (FRA) are piloting a project demonstrating a method of monitoring switches in non-signaled territory to safely find and correct situations where switches are left in an improperly lined position.

TECHNICAL OBJECTIVE

As its name suggests, SPMS aims to monitor, detect, and report switch point gapping for switches on main tracks in non-signaled territory in order to prevent unsafe train movements. Improper switch point alignments are discovered and conveyed through a wireless data radio to the train dispatch system, allowing the train dispatcher to provide safe mitigation of the reported switch anomaly. SPMS also adds the benefit of a low-cost, easy-to-implement technology toward the improvement of freight and passenger train railway safety.

The current environment in non-signaled main track territory has the train dispatcher relying on verbal communication with train or ground crews to determine if switches are left lined for the main track. The implementation of SPMS to detect and show improperly aligned switches in non-signaled main track territory would essentially eliminate the need for verbal communication and lower the potential for human errors occurring in that medium of communication.

The demonstration system involves the installation of switch position monitoring devices on areas of track where switches are outside of signal systems and restricted limits operations. These monitoring devices communicate through a data radio to a data network, then onto a train dispatching system. The dispatching system software checks the position of the switches before allowing the issuance of track warrants, thus eliminating the potential of issuing a track warrant over a switch that was not properly lined for train movement.



Figure 2. Apparatus at the Switch

SYSTEM OVERVIEW

The SPMS monitoring project is comprised of a wireless communication system that interfaces with switch point monitoring devices known as switch circuit controllers (SWCC). The communication link provides the means to transmit switch position information in a closed-loop methodology to the back office computer-aided dispatch system.

Closed-loop methodology safeguards against loss of communication from the wayside to the back office and assures that the switch position reported from the wayside is timely and not latent information. In the event that the communication



Figure 3. Solar-Powered Wayside Interface with Radio

link with the wayside is lost, the safest mode of operations is assumed from an operating rules perspective to protect train movements over a non-communicating switch monitoring device.



The switch position information received from the monitoring device is interlocked into the current train dispatch system to provide the train dispatcher with near real-time alerts of switches in non-signalized territory that are in a position other than what is expected by the train dispatcher.

These exceptions are brought to the train dispatcher's attention through a graphical user interface (GUI) from the train dispatch system, which allows him or her to intercede regarding any unsafe train movements.

This switch monitoring approach allows for the migration into a current technology being tested on the Beardstown Subdivision for a positive train control- (PTC) type overlay system known as the Electronic Train Management System (ETMS). This ETMS technology allows switch positions to be conveyed directly to the locomotive for predictive enforcement of train movements over switches with exceptions.

SPMS will be developed as a safety closed-loop overlay that works in conjunction with existing operating rules and processes.

Installation of the field equipment and office software would allow the dispatcher to determine the actual position of switches under track warrant control. This ability would cross-check the communication with personnel who have thrown or reported switch position. Determination of the actual switch position through indications to the dispatch system allows checks to be performed automatically, eliminating the need for dispatch personnel to record these separately.

The ability to automatically determine the switch position allows the dispatcher, using the dispatch system, to issue movement authorities over those properly lined switches without the need for the train crew to stop their train at the switch. Conversely and more importantly, switches that are improperly lined for the movement would be automatically indicated to the dispatch system. Therefore, the dispatcher will not issue a track warrant, which could potentially send the train to the incorrect track and cause a collision or derailment.

IMPLEMENTATION AND TESTING

The field portion of the demonstration project will be on BNSF's Avarad Subdivision, which runs between Avarad (northwest), OK, and Tulsa (northeast), OK. There are currently 49 SPMS locations installed and being monitored in the State of Oklahoma on

the Avarad Subdivision. SPMS automatically relays information about switch point integrity to the train dispatch system located in Fort Worth, TX, at the Network Operations Center.

The technology being used is a mix of mature and proven products, as well as technology applied in rail and other industries. The SPMS will build upon this proven foundation to provide an additional layer of protection in train operations. The technology and infrastructure is transferable to existing networks of other railroads, allowing this innovative, closed-loop technology to improve freight and passenger train safety industry-wide.



Figure 4. A Typical Installation

The infrastructure required to support SPMS is comprised of wayside switch monitoring equipment, office dispatch system software, and data communication equipment. Propagation studies have identified the distribution of the radios required for system operation.

The switch monitoring devices (SWCCs) are standard signal devices used in wayside signal systems. The US&S U-5 vital switch controllers are used in detecting the switch position. The data radios are Meteorcomm's 545C packet data radio operating at 44.58 MHz. This data radio is currently in use with BNSF's ETMS and Hy-Rail Limits Compliance System (HLCS). The interface between the SWCC and packet data radio is an I/O interface module that is currently being used for ETMS.

The wayside equipment, office software changes, and operational procedures have been augmented during the evaluation of this project. The office segment was developed and deployed during the test and evaluation phases. Several changes were made as the evaluation continued. It should be pointed out that SPMS was developed as a safety critical closed-looped overlay. There is no single point of failure in the



system design that does not report the failure to the dispatch system. The failure reporting would initiate human intervention to prevent and/or mitigate an unsafe switch position in track warrant control territory.

The SPMS has been in service on the Avarad Subdivision since November 2005. Since that time, minimal issues have arisen that can be addressed easily. There were occasional commercial telecommunication outages, and sporadic maintenance was needed to adjust the switch points. These are normal day-to-day anomalies that the railroads experience in their typical daily operation. Very infrequently, a wayside radio may lock itself out from communicating with the network, until it is reset. When this happens, the crew is instructed to inspect the switch points visually before traversing the switch. This issue is with the radio firmware, which will be addressed after this evaluation period.

MIGRATION PATH

This switch point monitoring technology allows for its migration into other technologies being developed. The components that are used at the switch location can be used to provide power-assist remote control of a switch in non-signal territory from remote train dispatch central offices. This migration step would provide additional protection and security, along with the ability to improve safety, increase operational efficiency, and enhance train velocity.

The SPMS can also migrate to be used with PTC systems. It has been specifically designed to integrate with ETMS, a PTC system currently being tested on the Beardstown Subdivision. This integration allows the wayside device to use ETMS technology and transmit switch position information directly to the locomotive for predictive brake enforcement of trains when switches are improperly aligned.

NEXT STEPS

The SPMS has been successful on the initial implementation pilot area. Since then BNSF Railway has further implemented this system partially on another subdivision and is reviewing other areas where this system can provide benefits.

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