

INSIGHT

Positive Train Control implementation and evolution into a digital twin

Part 1

December 31, 2020 was the deadline for full implementation of Positive Train Control (PTC) on 57,536 miles of U.S. freight and passenger railroads. Two days before the deadline, the Federal Railroad Administration reported that the technology was fully operational and interoperable where required[1].

The background of PTC

While the concept of automated train control goes back as early as 1906, the technology was not practical for another 100 years. In 2008, several high-profile train incidents led Congress to pass the Rail Safety Improvement Act of 2008 (RSIA08; P.L. 110-432)[2]. The regulation required that communication, sensor and signaling systems be put into place to prevent incidents caused by train operators or a dispatch error. A deadline of December 31, 2018 was established, which Congress later extended to 2020. In the end, railroads invested approximately $20 billion implementing the PTC system.

While PTC required massive investments in hardware for signaling systems, locomotive operations and communications, one of the most challenging aspects has been providing the highly accurate data about the railroad necessary to make the system work. Precise locations of railroad assets had to be determined. Processes for managing change and validating and integrating the data into an operational system had to be built, tested and scaled up. Ultimately, to solve the problem railroads needed to represent their physical operations in a virtual, up-to-date, digital model.

Building a digital twin through PTC data

PTC has been, and continues to be, expensive and challenging for the railroad industry. However, it has become the digital backbone of the railroad network. As the industry moves beyond PTC, transformational opportunities abound to augment the PTC data and management in ways that move toward a much more complete digital twin.

A digital twin is a high-fidelity model of a real-world system that can be used to understand and simulate that system entirely in virtual space. It captures the locations of static and moving assets as well as their relationships and interactions with each other.

The backbone for the digital twin is provided by existing PTC investments. It is made up of digital representations of 3D track, switches, signals and other features necessary to calculate safe stopping distances. The locations of these assets are typically collected using survey-grade LiDAR, which requires specialized equipment, software and skilled operators.



Next steps for PTC data

Additional investment is needed to capture other assets and business information with the same level of accuracy, which will enable accurate simulations. The data model itself must be expanded to represent all the ways these elements of the model relate to each other. For example, signaling systems require electrical power. That same power source might be tied to switching machines and sensors such as equipment readers. Those objects now share a common relationship that could be critical for some decisions or simulations.

Much of this data may already exist in other business systems, spreadsheets or even paper records. Furthermore, it is probably scattered throughout the organization with various groups and individuals keeping a close-hold on their "silo" of the business. A critical element in this process is to recognize that quality of the data is more critical than the quantity. Therefore, an assessment is needed to determine if existing data is accurate, timely and maintained regularly enough to be used as part of a digital twin. If it is, then the next step is to decide how to integrate those systems and capture past records. Fortunately, advances in low-code and no-code tools have made it easier than ever to build system integrations and customized business applications.

PTC has laid the foundational digital backbone network for railroads and is the base for everything to follow. In future posts we will explore topics that address how new technologies and approaches are changing the railroad industry beyond PTC.

Footnotes:

1 - Positive Train Control (PTC) \| FRA (dot.gov)

2 - Positive Train Control (PTC): Overview?and?Policy Issues (congress.gov)