MODERN SOFTWARE TECHNOLOGY FOR NEXT-GENERATION TRAIN CONTROL SYSTEMS

5G Technology, Virtualization, and Containerization Technologies Deliver Safe and Secure Train Systems

NEXT-GENERATION RAIL TRANSPORTATION CHALLENGES

- Create the next generation of train control systems that will meet the growing safety and security requirements of modern rail transportation
- Use modern software and hardware technology that will provide performance, flexibility, and ease of updating and maintaining today's train control systems cost-effectively and efficiently

WIND RIVER SOLUTIONS

- **Wind River Helix Virtualization Platform:** A real-time, embedded, Type 1 hypervisor that can manage unmodified guest operating systems running in virtual machines, consolidating train control system applications and providing safety, performance, and flexibility for modern rail transportation operations
- **VxWorks:** The world's leading real-time operating system, enabling deterministic applications scaling from very small compute packages
- **Wind River Linux:** Industry-leading open source operating system for connecting, securing, and running IoT systems, application containers, networks, and devices
- **Wind River Titanium Cloud:** Portfolio of virtualization software products that enable a modern cloud infrastructure for train control system applications, reducing OPEX and increasing agility
- **Wind River development tools:** Powerful tools to save developers time and increase quality

THE CHALLENGE

Safe operation of locomotives and trains has been part of rail transportation since the first passenger trains in 1825. What originally started as the manual communication and control of locomotives, track operations, and rail conditions via flags, telegraph, and manual track switch levers has evolved to computerized automation, GPS, and wireless communication systems.

As rail transportation has evolved, the sheer density of trains using the tracks has increased, while faster high-speed trains have also entered the space. The combination has brought both new engine technology and higher concern for safe and secure operations. The next generation of train control systems must manage these new conditions with modern technology and faster methods of providing real-time data. These systems will utilize the latest computer platforms, software, and wireless communication technologies to provide a new level of safe and secure train operation.

THE APPROACH

Modern Technologies—Making Train Travel Safe, Secure, and Efficient

Train control systems are made up of three different areas: onboard automatic train control systems linked to train signaling systems and overall system control; wayside train signaling and track/platform assignment rail monitoring; and a back-office train management system (TMS) to collect, store, and communicate information to train and wayside rail networks. The next generation of train control systems brings new technology to each of these areas to make rail transportation safer, more secure, and more efficient.

Onboard Automatic Train Control (ATC)

A major component of a train control system is the onboard automatic train control (ATC), which monitors a train's position (GPS) and speed, enabling it to activate brakes as necessary to enforce speed restrictions and movement to prevent accidents. The three key functions of onboard ATC are: 1) acceleration of the locomotive to the appropriate speed, and control of that speed according to route location, rail conditions, and various stations or stops; 2) control and implementation of the braking system as required by the data supplied to the ATC from the back-office train control system; 3) the relay and reception of communication about the train's location, other train locations, and track conditions.

The ATC comprises many separate compute systems that provide the central system with data. These separate functional systems can be consolidated onto a single compute platform using virtualization technology. Rather than multiple single-function compute platforms—with, for example, one reading rail condition data and another controlling speed and a third operating the brake system—these systems can function as three virtual machines, managed by a hypervisor on a single compute platform for the onboard ATC system.

Wind River® Helix™ Virtualization Platform is a virtualization software technology based on the VxWorks® real-time operating system that can provide the virtual machine capability to consolidate these different functions onto a single system with real-time capability as defined by the application, communications backhaul application, or safety requirement. Communications today are provided using GSM-R wireless network and optical networks; future systems will use LTE-R, a high-speed network specifically designed for railway usage and the creation of smart trains, to quickly transmit data to the onboard ATC from the various components, sensors, and rail communications. Ultimately, 5G technologies will provide the bandwidth and speed for real-time processing of video-based data both in the train and as part of the track condition monitoring.

Wayside Rail Monitoring

A wayside system monitors and operates track signals, switches, and track circuits to communicate data permitting the onboard system to authorize movement of a locomotive and train. Additionally, wayside rail monitoring systems can assess the operational performance of infrastructure assets, rolling trains, and the surrounding environment of the track. Their management data improves performance and preventive maintenance strategies, increasing asset availability, cost optimization, and safety.

The wayside system communicates track-to-train and vice versa to connect the wayside system with the onboard ATC equipment, providing data for both systems to operate the train movement efficiently and effectively and ensure safety. The data is communicated to the back-office server system to monitor and assess train locations, wayside operations, and operation of trains across the system. The data transmission is supported by fiber-optic systems and radio equipment using the current GSM-R wireless network that is being replaced by LTE-R (and ultimately by 5G technologies).

The wayside rail monitoring system combines multiple applications, sensors, and communication systems to improve efficiencies and data speed for the next generation of systems. It will require a virtualization platform such as Helix Platform that can handle multiple applications in safety-partitioned virtual machines. Helix Platform can provide virtual machines that can run multiple operating systems, such as VxWorks, Wind River Linux, Windows, and other systems. Linux containers can run in a virtual machine on Helix Platform or on bare metal compute aligned with Helix Platform.

Back-Office Train Management System

For central monitoring and controlling of train operations, the back-office TMS is an integral part of the overall system. Safety is the primary requirement of its applications and solutions. Running on the back-office server system, the TMS will analyze the data received and send appropriate data and instructions to the onboard automatic train control and the wayside rail monitoring systems. For example, one critical application is on-board train location and detection systems, which enable trains to be "aware" of the positions of other trains. This reduces the risk of collision while enabling trains to operate safely in close proximity to one another, thereby making efficient use of track capacity.

Speed monitoring and control is another important safety application. Systems have been developed that can display train velocity for drivers and report speeds back to central control

systems. When onboard automatic train control systems are interconnected with wayside signaling systems, they can regulate train speeds or even command locomotives to stop, based on track conditions, the positions of switches, the presence of other trains on the track, and factors such as weather conditions.

The next-generation TMS needs to run on a cloud infrastructure that provides the performance and flexibility to safely, efficiently, and cost-effectively run the multiple applications, functions, and data analysis required. A modern cloud infrastructure using virtualization and containerization technologies running on the latest server technology can provide the high level of compute power, flexibility, and separation of safety applications that a TMS needs. Wind River Titanium Cloud™ provides this needed function and level of performance and flexibility. Titanium Cloud can run multiple applications in virtualized cloud infrastructure, using virtual machines or running Linux containers in a virtual machine or Linux platform. With Titanium Cloud, safety applications can run in partitioned virtual machines that will operate without interference from other applications or server functions. This ensures that the safety applications required by a TMS will be provided.

THE RESULT

Safety is the top priority of all train control systems. The next generation of train control systems needs to ensure safe operation of trains for people, cargo, and the track surroundings. Wind River provides a portfolio of products, from its proven VxWorks real-time operating system to Helix Platform to cloud solutions such as Titanium Cloud, to enable the next offering of train control equipment and systems to be more efficient, cost-effective, and secure. To request more information, contact Wind River Sales Inquiry.