WIND™

The Internet of Trains

Building Secure Intelligent Networks for Safety and Performance

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EXECUTIVE SUMMARY

With global passenger traffic expected to double by 2020, the railway industry worldwide faces pressure to improve the passenger experience. To passengers, that might mean improved on-time performance, more onboard amenities, and more timely information. For railway operators, however, the most important part of the experience is getting passengers safely to their destinations.

Legacy infrastructure, aging communication systems, and slow adoption of automation and protective technology pose enormous safety risks. The Internet of Things (IoT), or in this case, the "Internet of Trains," holds the promise that rail systems can leapfrog these issues and modernize rapidly. The Internet of Trains refers to the use of networks of intelligent onboard devices connected to cloud-based applications to improve communication and control systems. The same network that strengthens safety can also deliver data that serves a variety of applications across the rail system to reduce costs and improve operations.

IoT has already begun taking shape. This document outlines the opportunities for rail operators to improve safety, manage system capacity, and reduce operating and maintenance costs through the more efficient use of infrastructure. And it outlines some initiatives by Wind River®, in collaboration with developers and their railway customers, to help make this vision a reality.

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TRAIN MANAGEMENT SYSTEMS

The world's aging transportation infrastructure is gradually being replaced by train management systems (TMS). In a TMS, trains become interconnected communication hubs, transmitting data among themselves and to network control centers, and receiving instructions from the control centers. Machine-to-machine communication, centrally managed in a cloud-based architecture, enables operators to utilize equipment, tracks, and stations more efficiently while dramatically reducing safety risks.

Safety is the primary requirement of IoT applications and solutions for a TMS. For example, one critical application is on-board train location and detection systems that enable trains to be "aware" of the positions of other trains. This reduces the risk of collisions while enabling trains to operate safely in close proximity to one another, thereby making more 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 monitoring systems are interconnected with wayside signaling systems, they can regulate train speeds or even command trains to stop based on track conditions, the positions of switches, the presence of other trains on the track, and other factors.

FROM MORE EFFICIENT OPERATIONS TO NEW BUSINESS MODELS

Once the infrastructure is in place to connect safety applications, it can also be used for non-safety-critical applications, enabling operators to leverage their investment. By transmitting real-time, system-wide location data to control centers, onboard systems help operators optimize the deployment of equipment and allocation of track capacity to avoid bottlenecks and congestion. Metro and commuter trains can utilize train data to relay departure, arrival, or train delay information to customers via mobile apps.

Besides bringing greater safety and efficiency to the movement of rail traffic, IoT can also help keep equipment performing reliably while maximizing time on the tracks with preventive maintenance. Onboard sensors monitor equipment for signs of wear and alert operators when critical parts are in need of attention. This cuts costs and helps optimize asset utilization by reducing the need to take trains out of service for routine inspections and preventive maintenance—or for costly repairs after a failure has occurred.

More than operations and maintenance, though, IoT has the potential to alter the prevailing business models that rail system operators and their suppliers have always run on. Instead of selling equipment to operators, manufacturers or distributors can lease it based on usage metrics that remote sensors can track—for example, distances travelled or weight of cargo carried. This gives the manufacturer a steady source of revenue while turning the operator's cost from a capital to an operating expense. A number of heavy equipment industries are exploring this concept, and it could also apply to railroad engines and cars.

OVERCOMING CHALLENGES

Clearly, the Internet of Trains creates a wide range of opportunities. A barrier for many operators, however, is that they have a substantial investment in legacy systems and equipment that have performed independently and were not designed for connectivity. While operators may be keen to reap the economies, efficiencies, and opportunities that IoT promises, they also have an understandable interest in protecting that investment. The challenge for developers of IoT solutions is to find ways to connect these previously unconnected systems so that operators do not have to rip out and replace their entire infrastructure in order to realize the benefits of IoT.

Interrelated with the issues of safety and connectivity is the matter of security. As rail systems rely more on wireless connectivity, they become more vulnerable to outside interference and intrusion. The consequences of even a small disruption become particularly severe as trains become more powerful, carry more passengers, and travel faster. Systems that are critical for safe operation can be compromised by a simple electronic device, a mobile phone, or a small piece of malicious code downloaded from the Internet. When passenger safety and lives are at stake, strong security becomes a fundamental requirement.

THINKING END-TO-END

Addressing the issues of safety, connectivity, and security and opening up the possibilities of IoT call for innovative thinking and an end-to-end vision, from the smart devices on trains that generate data to the gateways that aggregate it to the applications in the cloud that analyse it. Wind River is collaborating closely with its partners, developers, and customers in the rail industry to develop solutions based on this holistic vision.

Wind River Helix™ is a comprehensive portfolio of software, technologies, tools, and services for addressing the system-level challenges and opportunities created by IoT. It encompasses everything from the embedded software running edge devices to the systems used to monitor and manage those devices remotely. By using Wind River pre-integrated, pre-validated components together, developers of IoT solutions can significantly accelerate and streamline the development process, while more efficiently complying with the rail industry's stringent safety certifications. The goal of Helix is to enable developers to deliver high-quality, safe, and dependable solutions more quickly, to a market that demands nothing less.

VxWorks®, the industry-leading real-time operating system, delivers intelligence at the device level. Proven reliable in literally billions of smart, interconnected devices, it has been optimized for safety-critical functions with Safety Profile for VxWorks and Virtualization Profile for VxWorks.

Safety Profile adds advanced time partitioning (application scheduling) to the space partitioning (physical separation) in the core VxWorks platform. Taken together, time and space partitioning allow multiple applications, including both safety- and non-safety-critical, to run on a single processor without interfering with one another. Virtualization Profile, meanwhile, integrates a real-time embedded hypervisor into the core of VxWorks, making it possible to consolidate multiple stand-alone hardware platforms onto a single multi-core platform. This significantly reduces costs while boosting device functionality.

VxWorks is also designed with multiple layers of sophisticated security functionality to detect and prevent intrusions, and to render malicious code useless should it enter the system.

Securely connecting edge devices to the cloud is the next challenge. Wind River, together with Intel®, has led the evolution of gateways from simply connecting and routing data to performing intelligent functions. Wind River Intelligent Device Platform XT is a customizable middleware development environment that provides security, connectivity, rich networking options, and device management. It simplifies the development, integration, and deployment of IoT gateways. Leveraging Wind River operating systems, Intelligent Device Platform supports a wide variety of communication protocols for transmitting data from devices through the gateway to the cloud.

Once devices are connected to the cloud, operators need a means of monitoring and managing them remotely, as well as analyzing the data they deliver. Wind River Helix Device Cloud is a cloud-based middleware stack that serves as a centralized console for an IoT solution. It enables operators to centrally manage, monitor, and exchange data with edge devices. Once data is in the Device Cloud server, it can be integrated with data from enterprise systems for analysis and reporting. An agent configured in VxWorks automates the integration with Device Cloud, creating a seamlessly connected end-to-end solution.

Wind River Titanium Server is the industry's first fully integrated, open source, feature-complete Network Functions Virtualization (NFV) server. It enables developers of train communication networks to meet the industry's exacting demands for reliability, performance, and security.

Working together under the Helix umbrella, this combination of components enables developers to skip the long and difficult process of building their own infrastructure and custom-coding software, and to focus their energies and resources on perfecting their solutions. This adds up to substantial savings for both developers and their customers, and speeds the delivery of solutions so that rail operators—as well as their passengers—can start realizing the benefits of IoT.

CONCLUSION

The world's railways are ripe for IoT solutions. Improving safety is paramount, but the opportunities for the Internet of Trains run much farther. Operators have the opportunity to drive costs down while using real-time data to elevate the passenger experience through better performance. Among the most prominent challenges are connecting legacy devices and infrastructure and securing networks from malicious intrusion. By working with a partner with proven solutions to the system-level challenges and opportunities that IoT presents, rail operators can rapidly accelerate the implementation of the Internet of Trains.

WIND

Wind River is a global leader in delivering software for the Internet of Things. The company's technology is found in more than 2 billion devices, backed by world-class professional services and customer support. Wind River delivers the software and expertise that enable the innovation and deployment of safe, secure, and reliable intelligent systems.