

On Track to the Future

with Smart Railways

intel®





As the world recovers from the pandemic, technology will be a key driver in ensuring progress and adoption of new business models, leading to economic growth. We'll see a ramp up in technology investments.

Sameer Sharma

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Overview

The railway industry experienced unprecedented change in 2020. As rail transport gets back on track post-COVID, governments and rail operators are looking for innovative ways to reopen safely and deliver a reassuring passenger experience. Station safety, security, railway maintenance, and operational efficiency will be crucial in regaining the public's trust. Advancements in Artificial Intelligence (AI), Artificial Intelligence of Things (AIoT) edge computing, and deep learning technologies are enabling railways to automate manual processes, provide touchless experiences, and improve capacity management—while staying in compliance with health and safety protocols.

Many transport venues have already accelerated their adoption of transformative technology to protect public safety—and show passengers it's safe to travel again. Forward-thinking businesses recognize the opportunity to modernize their core technologies in order to meet today's challenges while positioning themselves for future success.

Locomotives, railcars, stations, and other infrastructure are already equipped with hundreds of sensors and cameras that deliver rich data to help railway operators maintain the safety and security of passengers and cargo. Railroads are also utilizing historical data to enable predictive maintenance and anticipate problems before they occur. Machine learning continuously provides insights into operations, inspection, planning, and programming. Operators are leveraging smart technologies to deliver integrated digital experiences to passengers at every turn.

But this is just the beginning. Transformative technology will be key to post-COVID resiliency. Better days are ahead. Intel and its ecosystem are uniquely positioned to offer the components and solutions to power the industry forward.



Challenges

A railway operator's number one priority is ensuring passenger safety. Enhancing operational efficiency and improving the passenger experience are also top-of-mind. Transformative technology makes this balancing act not only possible but exceedingly manageable, as well. Below are examples of other key factors an operator must consider today.

Operational Management and Efficiency

Rail forms an important part of the transport infrastructure in many countries, both for passengers and for freight. As demand increases, the rail industry faces the challenge of how to add capacity. Often, the land and budgets are not available to extend the network, so the industry needs technology solutions that will enable more capacity to be squeezed from the existing infrastructure. Rail trip delays can result from extreme weather, mechanical issues with locomotives and rail cars, track availability and safety issues, crew availability, and more. Rail passengers expect on-time travel experiences, but delays can also lead to financial penalties for infrastructure and rail service operators. With consolidated, end-to-end network solutions, operations across the rail infrastructure can be streamlined, increasing the on-time delivery of services.

Data Security

Cyberattacks on transportation agencies can have a cascading effect because many information technology systems are integrated. Governments and railway executives must implement full-spectrum cyber-security solutions to guard against cyber-threats to passengers, employees, and operating systems. Given the potential for such attacks, officials need to address the impact on freight and critical infrastructure and the foundational information technology (and often the command-and-control systems) underlying the operation of the network. Recovering from an advanced cyberattack could take weeks rather than days.

Railway Safety and Maintenance

Installation, inspection, and maintenance of rails, rail cars, locomotives, and station facilities are typically sub-contacted to qualified track inspectors and railway equipment maintenance companies. Comprehensive systems, signal, and communications systems services are also subject to inspection. Systems of rail signaling and train control differ around the world, with more than 20 signaling systems across the European Union alone, each with unique specifications, philosophies, and national requirements. Because each system is stand-alone and non-interoperable, extensive integration and engineering effort is necessary.



Environmental Impact

Currently, freight moved by rail accounts for only two percent of U.S. greenhouse gas emissions. Increasing the use of railways to move only 10 percent of the freight that currently is transported by the largest trucks would save more than 1.5 billion gallons of fuel per year. This could cause annual greenhouse gas emissions to fall by more than 17 million tons. That's equivalent to removing 3.2 million cars from freeways or planting 400 million trees.¹

An acceleration in the impact of climate change may increase the vulnerability of tracks due to temperature increases that can cause track expansion, with the potential to cause delays or even derailment under extreme conditions. The higher the greenhouse gas

What is a smart space?

Smart spaces incorporate sensing and connectivity between systems. This creates new automation possibilities for railway solution providers to enable innovative use cases for safety, security, passenger experience, and operations.

emissions, the greater the impact on delay-minute costs, which could range between \$35 and \$60 billion under a high emission scenario by 2100. Utilizing sensor technology could greatly lower this number, along with other changes in operational procedures.²



MODERN RAIL DRIVES ECONOMIC DEVELOPMENT

SWITZERLAND

JAPAN

#1 highest quality rail infrastructure for 2019^c

The global railway network spans over 1.3 million route-kilometers worldwide^a

Indian experts believe that rail is 6x as energy efficient & 4x more economical than road^d

Globally, there are 63 FAO (fully automated operation) lines in 42 cities and 19 countries^e

The United States operates the longest railroad network in the world, closely followed by Russia, China, India, Canada, Germany, and France^b

PROJECTED GROWTH

4.3%

annual forecasted global rail market growth rate through 2026^f

177B

average annual total market volume, in €^g

32B

average annual market volume forecast for railway technology in North America through 2023, in €^h

^a Statista, [Railway Networks Worldwide - Track Systems 2016](#).

^b Statista, [Railroad Network of Selected Countries 2016](#).

^c Statista, [Ranking of the most efficient countries in train transport services in 2019](#).

^d The Economic Times, [Why transport infrastructure is most important for country's progress](#).

^e Railway Technology, [Around the world: 1,000km of fully automated metros](#), July 2018.

^f Market Watch, [Rail Market Size is Estimated to Grow with a CAGR of 4.3%](#), May 2021.

^g UNIFE, [World Rail Market Study, forecast 2020 to 2025](#), July 2020.

^h Statista, [Railway Technology - Global Market Volume Forecast 2018](#).

Opportunity

Trends

Railways have been key to innovation and society across civilizations. Rail systems had a major impact on farming, as perishable goods such as dairy products could now be moved longer distances before they were inedible. Opportunities for travel broadened as people could travel farther and more freely. Expanding railways accelerated innovations in communications, timekeeping, supply chain management, and more.

Expanding High-Speed Railways

With distinct advantages over personal transportation by air, road, and sea, today's high-speed trains can travel at speeds between 300-500 kph. High-speed connections exist worldwide, with China leading the way with 35,000 kilometers of high-speed rail connections (and growing). Not only is high-speed often cheaper and faster than planes, especially when including air travel delays and cancellations due to weather and other factors, but high-speed rail can also accommodate more passengers than automobiles. And it's much more environmentally friendly.

Increasing IoT and Autonomous Operations

Artificial Intelligence (AI) is being used to predict rail delays, which will help increase capacity without building new infrastructure. Modern, smart trains can be operated largely by Network Operation Centers (NOC), which help operators to enhance safety and efficiency. The NOC can stop the train, slow it down, or speed it up where needed, helping to reduce the risk of accidents based on human error.

Growing Demand for Rail-Based Freight Transportation

U.S. freight movement is projected to rise to 24.2 billion tons in 2040—an increase of 23 percent. Strategies will have to be put in place to manage the growth in demand from year to year.

Leading Environmental Sustainability

Technology helps smart railways lead in environmental sustainability through automation and near real-time feedback for operators, contributing to reduced emissions and increased efficiency. Governments worldwide are making policy shifts to focus transportation investment on expanding railways and related infrastructure to support safety and control pollution.

Historical use of rails

2630 BCE

The Pyramid of Djoser in Memphis, Egypt was constructed using logs as rails or skids for transporting stones

600 BCE

Diolkos, a 6 to 8.5 km long paved trackway, transported boats across the Isthmus of Corinth in Greece

1504 CE

The Reisszug, which transports goods to Hohensalzburg Castle in Austria, is the oldest operating cable railway

1812 CE

The Middleton Railway in Leeds is the oldest public railway and ran the first commercial steam locomotive

Major Railway Expansion Projects

California

High-Speed Rail Project

800+ miles of railway to transport 5 times more people per hour than highways in rush hour conditions

Europe

Rail 2050 Vision

Proposal to implement automated trains using near real-time communications

Smart Rail Use Cases

Passenger Information

Digital Signage and Connected Kiosks

In railway stations, digital signage and connected kiosks provide a wide variety of benefits to travelers, retailers, staff, and security personnel. Interactive wayfinding improves traffic flow by using Beacon or MSE indoor positioning technology. Intelligent self-service such as self-ticketing and quick payment service provides interactive customer engagement to gain data-driven customer insights as well as quick-service in retail. Near real-time information display can provide passengers with updates for their train and departure track, with boarding pass scanners for quick information access to any departure times, track finders, or walking speeds. Railway operators can drive ancillary revenue by offering sponsorship to partners through advertising on railway station monitors.

Connectivity and Network Communications

5G technology is a step-change in mobile networking for both consumers and industry, offering users faster download speeds, lower latency, and data sharing in near real time. Downloading a 2-gigabyte high-definition movie in less than 20 seconds on a phone is now

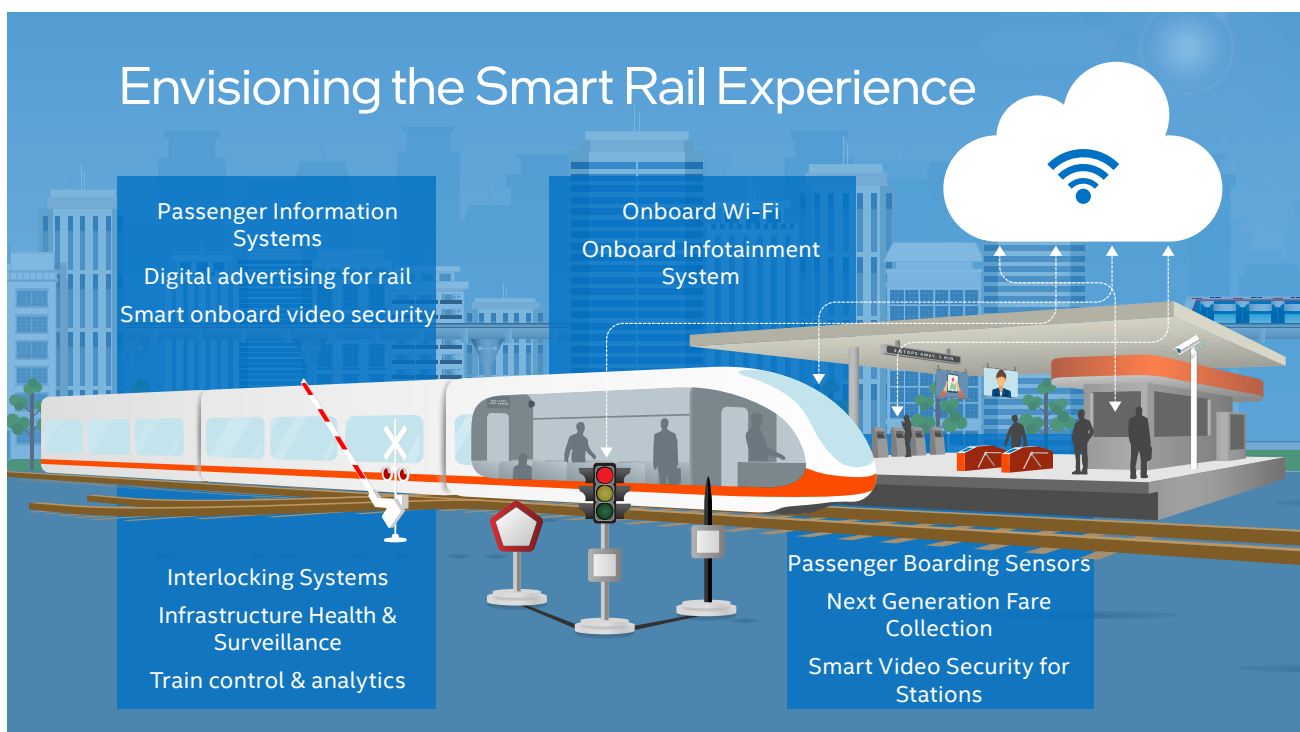
becoming a reality for train station passengers. Railway stations with 5G infrastructure can offer 5G Wi-Fi to passengers through public kiosks.

Onboard Units

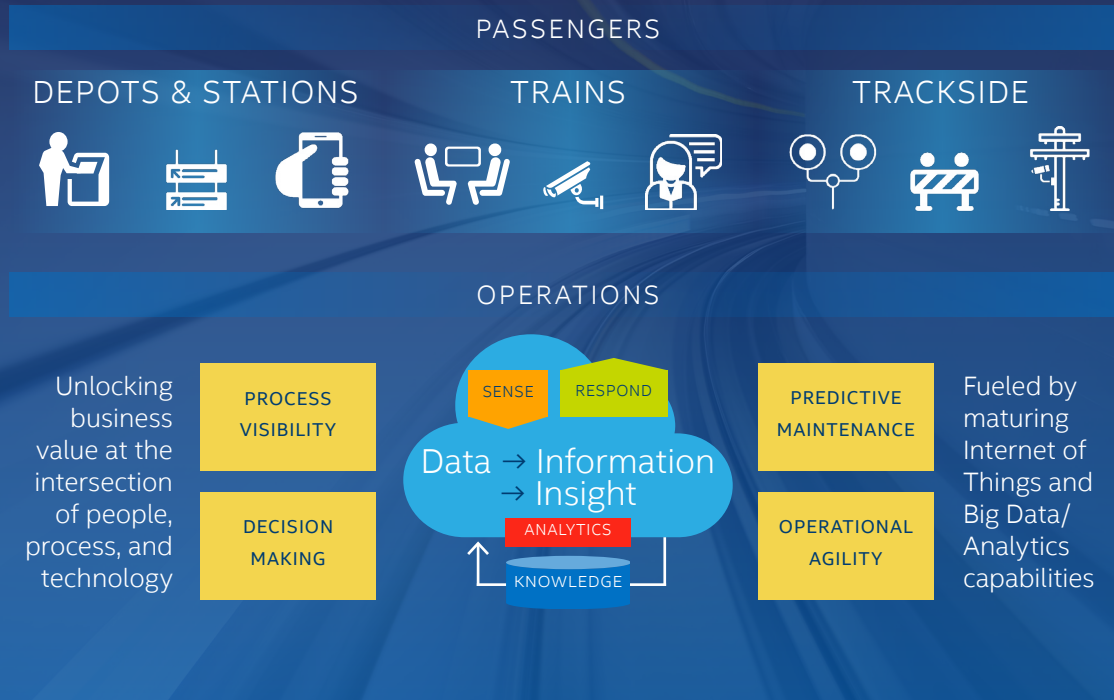
To improve passenger experience, train operators are looking to enhance the reliability and availability of onboard Wi-Fi. Delivering the same level of speed and reliability that passengers expect at home used to be a challenge. Not anymore. Now Wi-Fi connections that are up to 10 times faster.

Infotainment and Advertisement

Digital signage in train stations can shorten queues, optimize people flow and wayfinding, increase labor efficiency, and improve passenger experience. High-performance, environment-sensing display technology allows advertisers, retailers, and station operators to effectively monetize visual communications, engage passengers, and boost commercial revenue. Optimized near real-time displays improve customer experience by providing information and wayfinding support. Modern digital infrastructure at the network helps deliver actionable, data-driven insight and support for applications and experiences.



Smart Rail: How does it work?



Smart Ticketing Automated Fare Collection

Smart ticketing systems using sensor beacons could eventually result in the removal of ticket barriers and signal an end to queues at the ticket machine in metro railway stations. Sensors on station platforms or onboard trains will be able to detect an app on passengers' smartphones as they enter the station or board, automatically charging the correct fare and eliminating overcharges. Metro railway operators will be able to streamline backend billing and revenue management, while better understanding metro train usage behavior through near real-time data.

Access Control

With access control using eGates, passengers can board their train without a ticket or passport and proceed through customs and border control more efficiently. eGates confirm eligibility to enter the train and then accordingly open the eGate door for passengers to board the train.

Vision and Analytics

Security

Vision applications help railways enhance security, measure the flow of people, enable smart parking at stations, and provide automated access control. Railway operators can use optical sensing, thermal detection, alarm systems, and system linkage to protect the perimeter. Track monitoring identifies arriving and departing trains with optical sensing, thermal detection, long range viewing, and panoramic mode. Parking lot security helps protect parking lots and control entrances using optical sensing, and parking guidance. Railway operators can also control traffic and monitor vehicles using optical sensing, suspect car alarm, information issuing, and traffic incident detection. Terminal monitoring allows railway operators to monitor retail sites, passenger behavior, e-passport gates, and luggage systems. Smart security at train stations and onboard trains can use biometric indicators to confirm identity as well as provide alerts in an uncontrolled environment, or for abandoned bag detection. Alerts for any overcrowding incidents with people-counting based on zones can enhance rescue operations during emergencies. Suspicious behaviors such as loitering or sudden crowd gathering are also detectable, as are man-down situations.

Passenger Safety

Smart security functions help enhance passenger safety and reduce public liability. For example, computer vision solutions enable automated and safe platform screen door systems, train door systems on passenger trains, and detect when passengers slip and fall. In addition, these solutions can help locate missing children in a crowd and can detect if children climb onto conveyor belts, fall on escalators or onto trackways, or enter restricted areas. The need for automated quarantine control can also be identified, as well as potential water spills and smoke and fire detection in an open-air environment.

Predictive Maintenance

Predictive maintenance for tracks, locomotives, trains, and equipment is an important safety and efficiency tool for railway operators. It uses near real-time diagnostic data to plan maintenance cycles at an early stage through monitoring and the collection of data, helping railway operators to avoid operational breakdowns or failures. Downtimes and maintenance costs are reduced, while the lifecycle of tracks, locomotives, trains, and equipment increases. Passengers, in turn, benefit from improved reliability of railway operations.

Driver/Operator Distraction Prevention

The natural demands of long-distance trips can leave railway operators fatigued and distracted, creating the potential for increased errors. It can be challenging for railway organizations to monitor sleep patterns, energy levels, and/or behavior of drivers and operators. With the implementation of a computer vision and AI solution, railways can use predictive analytics to detect face and eye signals that may indicate possible distraction and fatigue. These tools can help drivers, operators, and railway leaders increase safety, prevent accidents, and protect assets.

People Counting

Getting from one place to another seems easy enough, right? Not so fast. Operators face numerous challenges on a daily basis: congestion, overcrowding, and crime result in lost revenue and operational inefficiencies for stations (and lead to traveler dissatisfaction). Using deep learning and AI through computer vision, stations can accurately monitor passenger traffic flow for enhanced analytics that aid in station planning and operations decision-making. This includes assigning the right quantity of staff during peak hours and protecting people and assets by detecting threats before they happen.



Luggage Tracking

Lost luggage can be costly and detrimental to the reputation of the company. An operator using computer vision can track passenger luggage and notify other operators if luggage is misplaced, helping to ensure on-time delivery to the correct destination.

Asset Tracking

For safety and efficiency, it's important for railways to know where assets are at all times. With so many different assets constantly on the move, railways face challenges including lost equipment, theft, and delays. Leveraging asset tracking through computer vision can reduce dwell time of stationary locomotives and increase operational efficiency by tracking assets at near real-time to maximize utilization and reduce cost.

Integrated Supervision

Auto-Routing and Scheduling

In railway traffic, it is difficult to meet the high demands of efficiency, safety, and good infrastructure utilization without accurate train information. Especially on track sections in between stations, insufficient information on where exactly the trains are located can lead to poor or ineffective capture and coordination of processes and operations. Tracking systems help railway operators pinpoint the positions of all operating trains at any time by viewing them on a map. These systems help to quickly find and deploy certain trains using near real-time location information. Additionally, these can be combined with status attributes such as delays and planned service work. By automating train routing and scheduling, operators can improve the efficiency, on-time performance, and safety of train trips across a rail network. Auto-routing systems centralize routing decisions and control railroad interlockings and traffic flow.

Detection of Railway Obstructions

The potential for railway transportation accidents can increase at locations where humans and animals cross rail tracks or where mountainside railways are impacted by landslides. Multi-sensor obstacle detection systems used on rail tracks can help railway operators monitor tracks for obstructions and enhance safety. These systems can combine optical look-ahead sensors, light detection and ranging (LIDAR), vibration sensors, and signal filtering to detect a broad range of railway obstructions.

Wayside Condition Monitoring

Condition monitoring of wheels, bearings, axles, train load, and other components can help identify potential problems before failures happen. Data from optical, acoustic, and thermal sensors can be combined into a holistic view of individual component measurement and then compared to trends from fleet-wide metrics. This enables rapid identification of condition monitoring faults to help railway operators address potential issues faster.

Communications between Train Station and Train Control Room

Getting passengers safely through train stations, onboard their train, and to their destination can typically involve challenges for customers and railway operators alike. Using a 5G network, train stations and train control rooms can communicate nearly instantaneously to improve decision-making, operational efficiency, and incident response time.



Technology Summary

Simplify the path to smarter railways with end-to-end solutions based on Intel technology. Intel powers every segment of the smart, connected world from the device to the network to the cloud to insights. Intel technologies and its vast set of ecosystem partners and solutions create a more vibrant, extensible, and sustainable way for railways to implement intelligent strategies. Additionally, Intel helps protect connected systems from the inside out with a foundation of security technologies designed to harden and protect the entire device stack against a wide range of attacks. In addition to technology, Intel contributes to the development and adoption of many standards which support Intel business objectives. These include standards which address global environment issues and best practices for corporate governance and business operation as well as product safety. Intel participates in hundreds of standards bodies and industry groups worldwide and has played a significant role in bringing about globally adopted standards such as Ethernet, USB, and Wi-Fi. Whether you look to the future of cloud computing, IoT, cybersecurity technology, autonomous systems or AI, standards are the common tool to bring new innovations to global mass-markets. For decades, Intel has been at the forefront of technology research, innovation, and development ranging from advanced compute, storage, and networking technologies that power many of the world's data centers to advanced innovations and

designs for emerging technologies and platforms such as autonomous driving vehicles and 5G communications. At every step, Intel takes a deeply integrated approach with technology to provide a strong set of compatible solutions, platforms, products, technology innovations, and architectures to complement one of the world's most dynamic set of ecosystem partners.

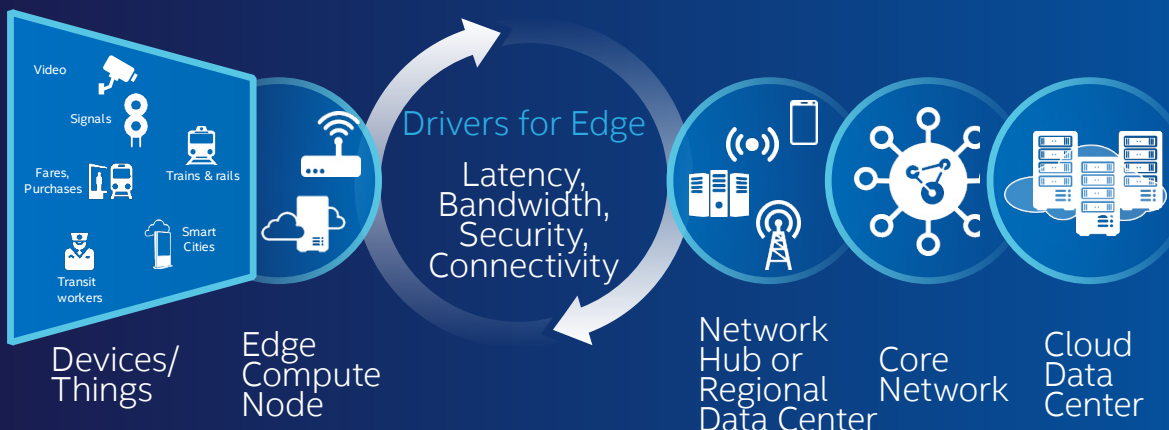
Intel® Compute Technologies

As railways connect more infrastructure to the cloud, they're seeing a greater need to place high-performance compute at (or near) the edge to perform predictive analytics and AI using data from sensors, cameras, and other sources. This reduces latency, improves near real-time responses, and relieves demand on network bandwidth for performance-hungry tasks like vision. Solutions based on Intel platforms deliver high performance at the edge. Railways can use Intel platforms with specialized technologies to consolidate multiple systems into one while leaving enough room to add new functionalities as needed. Intel is helping IoT innovations get to market faster, reducing solution complexity, and defining how to derive actionable intelligence more quickly and securely. Intel® Compute Technologies are hardened to support today's IoT scenarios for railways. The Intel® IoT Platform breaks down barriers to IoT adoption by offering a defined,

Intel: the end-to-end solution for smart rail

45% of all data that IoT devices create will ultimately be stored, processed, analyzed, and acted upon at the edge of a network.

Source: IDC



repeatable foundation for how devices will connect and deliver trusted data to the cloud. It allows original equipment manufacturers (OEMs), systems integrators (SIs), and vertical industries to develop and deploy solutions using building blocks on the Intel® IoT Platform. Intel is deeply integrated and committed to the research and design of advanced computing for data centers running intelligent transportation applications using new and emerging technologies, such as 5G, AI, and advanced IoT sensors and data collection technologies. Intel architecture helps smart railway systems scale through a wide range of product offerings. Intel Atom®, Intel® Core™, and Intel® Xeon® processors each support a wide range of performance points with a common set of code.

Intel® Networking Technologies

Intel is a leader in driving network transformation and enabling edge compute that's needed to bring 5G to life. Intel is transforming purpose-built networks to become more agile, flexible, and scalable with Software Defined Networking (SDN) and Network Function Virtualization (NFV)—setting the stage for 5G. For Intel's communications service provider customers, the work is already underway as they lay the foundation for 5G and transform their communications infrastructure to SDN. This enables more seamlessly connected, powerful, and intelligent 5G-ready networks in comparison to previous networks that were hardware-based. Leading service providers around the globe have made incredible progress in advancing SDN and NFV with solutions across the core network. With move to the 5G, Intel is transforming the fundamental economics of service providers and enterprise. Intel powered networks are AI ready, with the compute power to handle networking, cloud, and AI workloads. Transformed networks with powerful computing resources at the edge enable operators and cloud providers to intelligently deliver highly personalized services for railways today and in the 5G future. Networking is key to connecting devices to the cloud and making them smart or autonomous. A variety of network technologies are used in railways, such as Ethernet, which connects sensors and edge devices, Wi-Fi, and wireless networks to provide connectivity without cables, and cellular connections for edge computing and cloud services. Intel provides solutions to support each of these needs.

- **Intel® 10/40GbE** reduces expenses, increases throughput, and increases flexibility by using Ethernet interfaces instead of dedicated SAN networks. This reduces the number of switch ports, decreases cabling, and lowers power for data centers, which helps reduce costs.

- **Single-Root Input/Output Virtualization (SR-IOV)** is a multi-instance host interface that lets a single physical PCI Express device be shared on a virtual environment. This allows the direct assignment and isolation of the PCI Express device in resources for improved manageability and performance.
- **Orchestration Ready Network (ORN)** is a trusted-scalable-flat network originating and terminating in the Intel server itself. ORN provides for spinning up and spinning down of networks on demand, like a VM Network Function Virtualization (NFV). As railways move toward software defined networks, network functions can be virtualized, rather than hardware based. This speeds up network management and the change cycle. NFV performance is enhanced through Intel® QuickAssist Technology (Intel® QAT), which accelerates bulk encryption, public key cryptography, and compression.
- **Open Network Edge Services Software (OpenNESS) Toolkit** offers cloud and IoT developers an easy-to-use toolkit to develop and deploy applications at the network edge or on-premises edge locations. By abstracting out complex networking technology, OpenNESS exposes standards-based APIs from 3GPP and ETSI Multi-access Edge Computing (MEC) industry group to application developers. Using this software toolkit, applications can steer data traffic intended for the edge at 5G latencies.

Intel® Artificial Intelligence

Intel has the industry's most comprehensive suite of hardware and software technologies that deliver broad capabilities and support diverse approaches for AI—including today's AI applications and more complex AI tasks in the future. Intel's AI portfolio helps customers enable AI model development and deployment at any scale from massive clouds to tiny edge devices, and everything in between. Intel is leading the next wave of AI with [new products](#) designed to accelerate AI system development and deployment from cloud to edge.

Intel® Movidius™ Vision Processing Unit (VPU)

Intel® Movidius™ VPUs enable demanding computer vision and edge AI workloads with efficiency. By coupling highly parallel programmable compute with workload-specific hardware acceleration in a unique architecture that minimizes data movement, Movidius VPUs achieve a balance of power efficiency and compute performance. VPU technology enables intelligent cameras, edge servers, and AI appliances with deep neural network and computer vision-based applications.

Additional technologies supporting AI include:

- **Intel® Xeon® Scalable processors:** powerfully designed to handle the broadest range of AI workloads including deep learning.
- **Intel® FPGA:** Near real-time, programmable acceleration for deep learning inference workloads.
- **Intel® Vision Accelerator Design products:** Based on Intel® Movidius™ VPUs and Intel® Arria® 10 FPGAs, the Intel® Vision Accelerator Design products provide powerful, deep, neural network inference for fast, accurate video analytics to meet the demands of computer vision applications at the edge and to enable solution providers and their customers to take advantage of a wide spectrum of video analytics-based use cases.

Computer Vision with Intel® Distribution of OpenVINO™ Toolkit

The **Intel® Distribution of OpenVINO™** Toolkit is a comprehensive toolkit for quickly developing multiplatform applications and solutions that emulate human vision. Based on Convolutional Neural Networks (CNNs), the toolkit extends Computer Vision workloads across Intel hardware, maximizing performance. Railways can accelerate and deploy CNNs on Intel platforms with the Intel® Deep Learning Deployment Toolkit that's available in the OpenVINO™ toolkit and as a stand-alone download. Together with the new **Intel® DevCloud for the Edge**, OpenVINO addresses a key pain point for developers—allowing them to try, prototype, and test AI solutions on a broad range of Intel processors before they buy hardware.

The OpenVINO™ toolkit:

- Enables CNN-based deep learning inference on the edge.
- Supports heterogeneous execution across computer vision accelerators—CPU, GPU, **Intel® Movidius™ Neural Compute Stick**, and FPGA—using a common API.
- Speeds time to market via a library of functions and preoptimized kernels.
- Enables development and optimization.

Intel® Edge Insights Architecture

Intel® Edge Insights Architecture enables greater control and gives businesses the power to understand data and take action to streamline operations and reduce

cost. The software collects various types of data and analyzes it at the edge, incorporates AI analysis, and then publishes the insights to local applications or the cloud. It's simple to modify and customize for a variety of applications.

With advancements in machine learning and data analytics, industrial systems are undergoing a fast-paced digital transformation, driven by a massive volume of machine-generated data. Intel® Edge Insights Architecture makes it easy to adapt, extend, and scale. Intel-provided middleware handles sensor integration, time series, video capture, and AI inference.

The Intel® Edge Insights Architecture helps manufacturers across industries improve quality, work smarter, and extract insight from their processes.

Gleaning insights from deep learning and computer vision, Intel® Edge Insights Architecture accelerates the development and deployment of AI models at the edge by leveraging the Intel® Distribution of OpenVINO™ toolkit.

Intel® Edge Software Hub

The Intel® Edge Software Hub is making it easier to optimize edge solutions, including computer vision and deep learning applications for Intel® architecture. Just set your objectives and ramp up quickly—much less prework is needed. Choose the architecture type, then select Intel, third-party, or open-source software. Use containers and run multiple workloads on a single converged edge system, managing the data flow between sensors and applications. Whether building from scratch or customizing an implementation, Intel® Edge Software Hub accelerates business development.

The Intel® Edge Software Hub makes it easy for developers to benefit from edge-to-cloud workflow integration, too. The Intel® Distribution of OpenVINO™ toolkit and marquee cloud service provider (CSP) offerings allow developers to extend their cloud applications to seamlessly develop and deploy solutions at the edge.

Intel® Storage Technologies

The rapid and exponentially increasing rate of data growth is creating enormous needs in data storage technologies, particularly for railways. Intel research and innovation are leading the way with advanced technologies for data centers including:

- **Intel® Optane™ SSDs:** SSDs based on 3D XPoint and Apache Pass technologies is a simple, stackable, and transistor-less design that will create fast, nonvolatile storage memory with low latency to unleash a

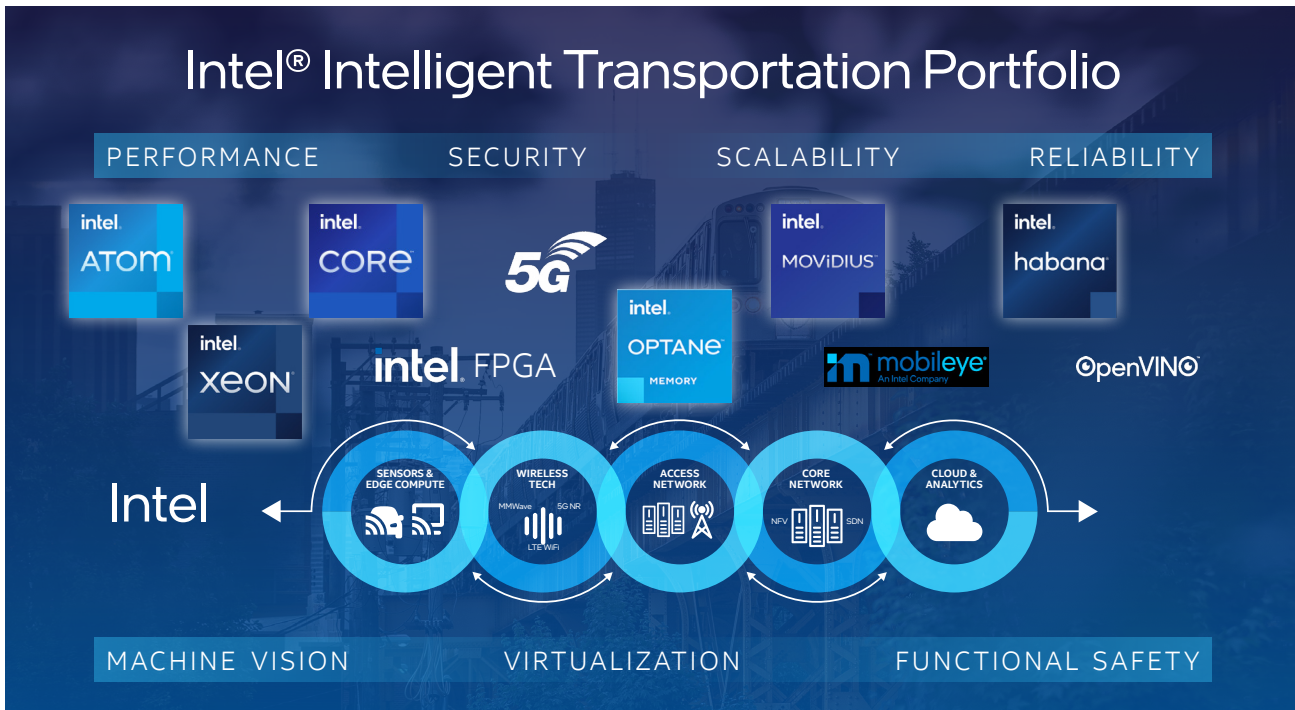
processor's true potential and improve service capabilities.

- **Intel® ISA-L:** Libraries that can be used with Ceph to provide erasure coding to minimize disk space usage while reducing the latency/penalty imposed by calculations and data manipulation. This results in faster and more efficient deduplication and compression for storage when combined with Intel® Advanced Vector Extensions (Intel® AVX) with ISA-L.
- **Intel® 3D NAND SSDs with Non-Volatile Memory Express (NVMe):** This technology outperforms SATA SSDs, running demanding workloads simultaneously while lowering costs and increasing system utilization for greater responsiveness.
- **Intel® Advanced Encryption Standard New Instructions (Intel® AES-NI):** This technology allows for efficient encryption/decryption operations on data traveling to/from storage with a minimum impact on performance.

Intel-Based Visual Solutions: Digital Signage and Interactive Kiosks

To improve travel experiences, railways are deploying Internet of Things (IoT) nodes to impart value-added services and collect data that will deliver insights. Railways are replacing outdated infrastructure, such as static signage, with digital signage and kiosks. These solutions provide valuable services—such as wayfinding, transit routes, emergency alerts, and free Wi-Fi. In addition, digital signs and kiosks can pay for themselves through advertising, giving brands an attention-grabbing way to reach consumers in high-traffic locations.

Intel delivers engaging, effective digital signage experiences with turnkey solutions that speed development and reduce maintenance needs. When digital signage and kiosks are installed in crowded locations, it can be difficult and expensive for railway and station repair crews to dismantle or repair them. Remote management allows network operators to maximize uptime while reducing operating costs.



With Intel® Active Management Technology (Intel® AMT), network operators can remotely manage indoor and outdoor kiosks, both out of band and in band, and maintain a large network of kiosks. This includes managing and updating content remotely, in near real time, with tightly integrated Intel or third-party content management software. Network operators can remotely diagnose issues and reboot the operating system, even if the media player in the sign or kiosk has gone down. Energy-saving features allow network operators to turn off displays during low-traffic-flow periods, such as nighttime. Protecting data and devices is critical when it comes to deploying indoor and outdoor kiosks. Security technologies in Intel® Core™ vPro™ processors help protect kiosks, data, and content with Intel® Trusted Execution Technology, whitelisting, encryption, secure payments, and other features. These industry-leading Intel security technologies help prevent unauthorized copying, duplication, dissemination, or playback. Through an integrated, modular architecture for digital signage and kiosks, Intel brings together multiple workloads on one platform, along with technologies that attract advertisers. This helps network operators, railways, and stations boost their return on investment. Digital signage and kiosks powered by Intel technologies can support demanding workloads for one-on-one engagement, including 4K displays and gesture recognition, while delivering near-real-time audience analytics. Railways can monitor air quality, sound, and other environmental data with enhanced sensor integration. With Intel-based kiosks and digital signs for railways, system integrators can streamline the development and deployment of feature-rich, scalable solutions that provide unprecedented levels of performance, reliability, standardization, remote manageability, accountability, and security. As a result, railways can improve traveler experiences and support tourism, while network operators maximize their returns.

Railway Benefits of Visual Solutions: Digital Signage and Interactive Kiosks



Public Safety

Digital signage and kiosks can display near real-time public safety messages to warn travelers about evacuations, toxic gases, or other emergencies within a particular area. Travelers can also use kiosks to make emergency calls. Railway station officials can use kiosk cameras to analyze vehicular and pedestrian traffic for improving railway station road safety for traveler departures and arrivals.



Passenger Experience

Interactive platforms provide valuable near real-time information to travelers including 3D wayfinding within the railway station, event details, points of interest, and multi-modal transit information. Travelers can also connect directly to station officials and talk to a live person on the screen.



Connectivity

In many railway stations where lower-cost broadband internet infrastructure is under-developed or unavailable, free public Wi-Fi provided by kiosks helps stations bridge the digital divide. Kiosks can also provide VoIP phone calling or accommodate a small cell to enhance cellular coverage for service providers where coverage is weak.



Efficiency

As a screen hub in a railway station, kiosks can be a data center on the edge of a dispersed network—with edge computing, virtual servers, and data storage running locally. Data can be aggregated from a variety of IoT nodes nearby via wireless connection, and then analyzed before sending insights or relevant data to the cloud for analysis.

Customer Spotlights on Railway Solutions

Switzerland Rhaetian Railway

Advantech Passengera

Challenge: The Glacier Express and Bernina Express, run by the Rhaetian Railway (RhB), services Alpine tourist destinations. Limited mobile signal coverage along the route prevented passengers from accessing the Internet on their devices. RhB desired a solution that allowed passengers to use their smartphones and tablets to view specially produced video and audio content—describing scenery and points of interest—presented in sync with the train's location, as determined by a Global Positioning System (GPS). Such a solution would greatly enhance the passenger experience, with the added benefit of generating passenger demographic data.

Solution: The Passengera platform, hosted on railway-compliant Advantech onboard servers powered by Intel technologies, with advanced antenna system, delivers uninterrupted Wi-Fi infotainment and enables new business and marketing opportunities. The solution enables passengers to log in through a web-based app on their devices to access the Internet and GPS-synchronized content over an onboard Wi-Fi network, which is integrated into Advantech servers. Passengers receive pop-up information on their mobile devices, notifying them when GPS-synchronized content matches their current location. It allows developing new communication channels with passengers with the AI Travel Assistant integrated, which extend passengers' reach also pre- and after- journey. In addition, the Passengera solution provides near real-time information on screens, including arrival times and location-specific promotional content. The solution also provides RhB with revenue-producing opportunities through in-app marketing of souvenirs and other items to passengers. Future opportunities include enabling passengers to order meals and beverages served directly to customers in their seats, through the Passengera platform.

Results: The Passengera solution on the Glacier Express and Bernina Express trains demonstrated value within its first months of service by providing passenger demographic data for developing targeted promotions and increasing viewership with high-quality content. RhB has achieved higher opt-in rates, deeper passenger engagement, and increased customer satisfaction with the solution. The passenger preferences and information generated by the Passengera solution equips RhB with data to enhance the passenger experience and to market new products and services. The convergence of improved passenger services, near real-time generation of personal data, and the introduction of revenue-generating opportunities makes the Passengera solution a critical component of RhB's marketing efforts.



Platform Solution

Wabtec Corporation: Asset Track and Status Download Application

The Asset Tracking and Status Download (ATSD) is a web- and mobile-friendly application that provides railroad operators with locomotive and train health information in real time. As onboard software, it is typically hosted on an Intel processor card or gateway and then securely and accurately collects data from the locomotive control system, the locomotive data recording system-video (LDRS-V+), and other sensory devices. ATSD remotely reports them in real time via a user-friendly dashboard.



ATSD combines data from several onboard systems to provide intelligence and insights to operators and decision-makers. By establishing a secure communication with the various onboard devices and collecting data to be analyzed and processed in real time, ATSD enables railroad managers, dispatch, mechanical, operational, and best practices teams to gain more visibility and enhance decision making.

Key capabilities:

- Connectivity – Remote access to the locomotive to provide near-real-time data from the locomotive control system, event recorder system and other on-board systems and sensors.
- Device Management – Near-real-time connected device information, status, and ability to update the configuration via over the air software updates.
- Data Insights – Reporting of locomotive snapshot data and analytics of data parameters to provide alerts and information for insightful decision making and workflow.

Key benefits:

- Remote download of data – Ability to download locomotive control system data, data recording system data, images, and videos, saving operational teams a significant amount of time from the traditional approach of waiting for physical access to the trains.
- Status Alerts – Real-time information about locomotive status and condition gives operational teams insights into train location and condition that help drive workflows and actions, thereby eliminating waste and inefficiencies.
- Dispatch – Real-time information about locomotive position, direction, and speed gives customer care teams insights into service-level agreements and customer commitments and hence provides valuable information for better customer experience.
- Operational – Visibility of locomotive performance and benchmarking gives the operational team actionable insights that help increase consistency and efficiency.

For more information: [Website](#)

Platform Solution

DFI INC.

Artificial Intelligence of Things (AIoT) edge computers help railways operate in a safer, smarter, and more efficient manner by reducing tedious and repetitive tasks—while providing a better passenger experience. This added computing power is necessary to handle issues such as real-time track intrusion detection, driverless operation, passenger flow, and pantograph monitoring. The computer also needs to meet relevant certifications and standards and have sufficient input/output (I/O) to communicate with various peripherals.

RC300-CS is an in-vehicle system with comprehensive functions used for real-time information analysis from various sensors and cameras. The computer generates useful information for peripheral systems, drivers, and passengers alike. All the designs are meant to meet the demands required for a rail-based in-vehicle system with high integration of all kinds of configurations. RC300-CS has rich I/O such as 4 x 802.3af PoE at 15W in RJ-45 for IP cameras, M12 X-coded connectors for sensors, 8-bit DI and 8-bit DO with 2KV isolation for alarm and relevant devices, up to 4 x RS232/422/485, 4 x USB3.0, 2 x USB2.0 ports, mini-PCIe slots to install CAN bus, LTE, 5G-NR, Wi-Fi, and GNSS modules. With the wide-temperature and wide-voltage support, system integration also becomes easier. RC300-CS operates fanless in extreme hot and cold weather conditions. It's vibration- and shock-resistant to protect critical components in case of impact.

Due to the high reliability and adaptability of RC300-CS, it can shorten the introduction time of track applications, and operators and system integrators will encounter fewer difficulties with system integration and maintenance. The high scalability of RC300-CS also allows for quick integration with peripheral equipment, making deployment more flexible. The implementation of AI means that human resources can be more focused on train service, vehicle control, and cabin safety.

For more information: [Website](#)



Solutions for Railways

Intel® IoT Market Ready Solutions

Intel® IoT Market Ready Solutions program is designed to help members of our broad ecosystem of partners strengthen their delivery of solutions through unique support and scaling opportunities. These solutions give railway authorities scalable, repeatable, end-to-end solutions. That means less time, cost, and risk. These solutions are made up of sensors, edge hardware, software, cloud, and analytics from across the IoT ecosystem. By choosing Intel IoT Market Ready Solutions, railway authorities get scalable, repeatable solutions designed to solve key challenges in vision technology, mobility, traffic management, and more. Intel has already vetted these solutions, so railway authorities can move forward with the assurance of intelligent connectivity, exceptional performance, and easy manageability.

Intel® IoT RFP Ready Kits

Intel® IoT RFP Ready Kits are focused technology offerings that solve a class of market problems, have been deployed and tested in the field, and provide bundled hardware, software, and support. The technology is scalable and designed to grow

with customer requirements, enabling accelerated development and time to market.

Intel® IoT Solutions Alliance

Railway authorities can also find optimized solutions through the Intel IoT Solutions Alliance, one of the world's most trusted ecosystems for hardware, software, systems, and services. The Intel IoT Solutions Alliance helps providers deliver first-in-market IoT solutions. A global ecosystem of more than 800 industry leaders, the Alliance offers its members unique access to Intel technology, expertise, and go-to-market support. By accelerating the design and deployment of intelligent devices and analytics, technology providers can win greater market share. With more than 6,000 solutions, from hardware and software to systems and services, Intel helps fulfill nearly every requirement in a range of markets. Early access to Intel road maps and design support enables Alliance members to stay ahead of the competition, as well as reduce risk and development costs.

Station Solution

Acer Intelligent Transportation E-Ticketing System

The Acer e-Ticketing System can be applied to metro rail transit, light rapid transit, and bus rapid transit. Passengers, who use stored value cards, can be quickly charged through the gate at stations and the eGate validator will deduct fare from the contactless card automatically. The e-ticketing system can greatly improve the quality of intelligent traffic and transport efficiency by automating the entire ticketing management process for a railway station.

Key capabilities:

- Complete e-ticketing system supports multiple methods of payment and multi-issuers' transaction in one device.
- Support multi-group transfer discount based on parameter settings.
- Support multiple fare deduction modes, group ticket and periodical ticket application.
- Flexible design for support of local business rules.

For more information: [Website](#)



Station Solution

Cisco/Davra Connected Mass Transit

The Cisco/Davra Mass Transit Solution (MTS) is a dynamic ETA system that responds to changing variables to keep riders informed of schedule changes and arrival times. Information is shared on digital signage at all bus and train stations and on the transit vehicles themselves. In addition to the ETAs, the configuration supports a passenger announcement (PA) system to bus or train depots and stations throughout the city.



Cisco, Davra Networks, and Intel have formed a strong partnership to bring together different pieces of the value chain to enable business outcomes for mass transit. Davra brings the software element, the analytics algorithms; Intel brings the compute engine that is running the Cisco ruggedized gateway routers. Because the data-driven IoT system requires interoperability, integration, and connectivity between disparate hardware and software components, as well as the transit system assets (from trains and buses to legacy infrastructure), the multiplayer ecosystem collaboration is critical to developing and piloting the Smart City solution. The rich data and two-way communication system can also inform related MTS initiatives such as predictive maintenance, increased monitoring of environments for security and safety, and near real-time display of alerts and notifications. Near real-time diagnostics gives the maintenance staff a window on train or bus operations and thresholds, and replacements can be installed proactively to prevent major service failures.

Key benefits:

- Improve customer service by keeping riders informed of schedule changes and arrival times.
- Share information on digital signage on transit vehicles and at bus and train stations.
- Improve transit operations by gathering data for proactive diagnostics and maintenance.
- Enhance cross-system monitoring to increase security, safety, and efficiency.

For more information: [Datasheet](#) • [Solution](#) • [Website](#)



Station Solution

22 Miles Interactive Wayfinding Kiosk

Powered by Intel® NUCs, the 22Miles Interactive Wayfinding Kiosk is a powerful digital signage solution that improves the wayfinding experience by helping end-users navigate busy, complex transportation hubs and buildings. The solution features interactive, near real-time navigation, mapping, and information, all easily managed from the 22Miles Publisher Pro CMS. 22 Miles is flexible, multi-function cross-platform software solution providing railway stations with 3D Wayfinding, 4K Video Walls, mobile indoor positioning, dynamic signage and more, powered by Intel® NUCs. The interactive wayfinding and digital signage software can be embedded into a variety of devices like kiosks and video walls.



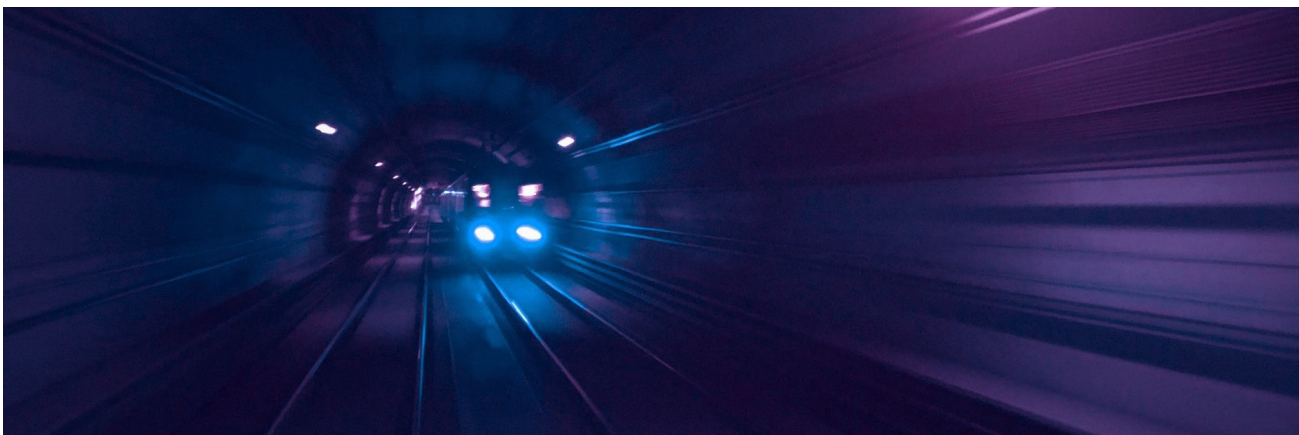
Key capabilities:

- Provide wayfinding with near real-time, turn-by-turn mobile wayfinding experience.
- Enable dynamic map pop ups.
- Deliver quick information access combined with boarding pass scanners.
- Offer travelers a self-service kiosk.
- Provide dynamic content updates based on click behavior analytics.
- Utilize modular kiosk design to maximum space and foot traffic.

Key benefits:

- Inform and engage travelers with dynamic proximity-based pop-up messaging, augmented reality content, and 3D map views.
- Improve the wayfinding experience by using smart pathway algorithms with automatic destination routing, unique construction pathway rerouting, and ADA compliance.
- Simplify signage management through a centralized content management system that wirelessly updates kiosks within minutes and supports third-party schedules and promotions.

For more information: [Case Studies](#) • [Solution](#) • [Website](#)



Station Solution

LG-MRI BoldVu® Signage and LG-MRI Wayfinding Kiosks

LG-MRI BoldVu® Signage and LG-MRI Wayfinding Kiosks are an effective way to enhance railway traveler experience while achieving greater environmental and economic sustainability. Designed with Intel® RealSense™ technology, LG-MRI BoldVu® Signage and LG-MRI Wayfinding Kiosks can integrate multiple connected devices to deliver a public kiosk solution in railway stations. The displays provide unparalleled luminance and visual clarity in the most challenging and unforgiving indoor and outdoor environments.



Key capabilities:

- Provides 3500 nit luminance, high contrast, and a wide viewing angle.
- Guarantees ten years of operation in the end-use environment without image degradation.
- Outdoor ready with an IP56 design, weatherproof, filter-less, and thermal management system.
- Vandal protected, including laminated, ballistic-resistant vandal glass, and anti-tamper locks.
- Self-monitoring and control of over 150 operating parameters.
- Integrator-friendly: house cool and power peripheral devices inside the display chassis.
- Multiple sizes & options: 55", 75", 86" sizes, single or double-sided, touchscreen option, custom mounts, and fascia.
- Turnkey availability: can be completely integrated in factory for plug-and-play deployments.

Key benefits:

- Integrate and communicate with smart lighting, traffic cameras, and parking meters.
- Communication center using real-world user-interfaces for two-way calling, public connectivity, citywide alerts, and concierge information, including points-of-interest and interactive wayfinding.
- Revenue opportunity based on locations with large volumes of pedestrian and vehicular traffic can prove attractive to media buyer looking to make advertising impressions.
- Data and analytics - using connected sensors, cameras, traffic counters, Wi-Fi beacons, and other IoT devices, smart city kiosks can gather data for invaluable insights.
- Ad content always looks as intended on a Bold Vu® LCD display—a core advantage for big brands and advertisers.

For more information: [Website](#)

Station Solution

ZIVELO Endless Aisle

The ZIVELO Endless Aisle solution helps capture revenue at the point of inspiration by providing railway retail customers with in-store access to the entire inventory. Powered by Intel and paired with purpose-specific software, this digital kiosk solution delivers a complete, inviting, and empowering user experience for customers to discover, explore, and order products.



Key capabilities:

- Bring intelligent self-service to retail spaces, connecting through either Wi-Fi, Ethernet, Bluetooth, 3G, or 4G.
- Kiosks compute from Dell OptiPlex 3040* PCs built on Intel® Core™ i5 processors.
- Retail end customers place orders on the kiosk via Honeywell Vuquest 3320g barcode scanner and Magtek Sureswipe 21040145 magnetic card reader.
- Transaction information is sent to the store operator's preferred cloud and analytics can be performed at the edge in near real-time.
- Through high-volume Intel® SSDs, store operators can choose to store the information either on the local device or in the cloud.

For more information: [Solution](#)

Platform Solution

Gorilla Intelligent Video Analytics Recorder

Gorilla Technology's Gorilla Intelligent Video Analytics Recorder (IVAR) solution powered by BCDVideo utilizes groundbreaking near real-time intelligent video analytics to extract business and operational insights across all facilities to a single dashboard, enabling users to improve facility security and business operations. Interactive wayfinding and digital signage software can be embedded into a variety of devices, including kiosks and video walls.



Key capabilities:

- Intelligent Video Analytics (IVA) for people counting, occupancy detection, direction detection, line crossing detection and vehicle loitering detection.
- Gorilla FVS can help track and route people to the correct railway gate, departure track, or other locations.

For more information: [Solution](#) • [Website](#)

Platform Solution

iOmniscient IQ Roads

iOmniscient is a technology leader and pioneer in video analytics, having recently expanded their expertise to include AI-based multi-sensory analytics. The iOmniscient IQ Roads solution is a comprehensive AI-based intelligent traffic management system.

iOmniscient's IQ Roads solution works through virtually any camera to capture and analyze live video feeds for fast responses that can increase the likelihood of positive outcomes. Powered by Intel processors, data is analyzed at the Edge in an edge device (located near the cameras for optimal processing), at a centralized location, and remotely.

Key Capabilities:

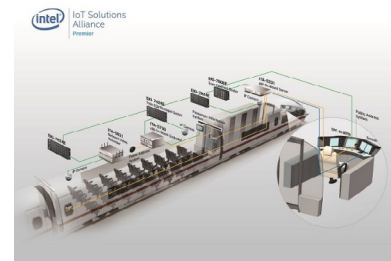
- Decrease data processing with iOmniscient's Nuisance Alarm Minimization System (NAMS) module that removes noise from video streams
- Detect traffic infringements with various features, like speed detection, intrusion of bike/bus lane alerts, red light violations, and jaywalking.
- Reduce response time of emergency responders and traffic officers by over 80%1 with iOmniscient's Automated Response System (optional add-on)

For more information: [Website](#)

Platform Solution

Advantech Rolling Stock Systems

Advantech ITA-5000 Series features in-vehicle technology to provide information to passengers and security monitoring capability to railway operators. The Passenger Information System delivers arrival and departure information, entertainment content, public address, and emergency announcements to travelers. The Vehicle Monitoring System helps railway operators track and monitor train cars, with a panel PC for control. The system helps improve security and safety of passengers. Advantech Rolling Stock solutions are EN 50155 compliant with M12 connectors



For more information: [Website](#)

Platform Solution

Advantech Passengera

Passengers expect Wi-Fi and internet with a stable connection and fast broadband. Advantech, together with eco-partner Passengera, co-created a solution that is meeting the needs of train operators and their clients. Thanks to an on-board Infotainment platform designed by Passengera, based on the Advantech Industrial Computer (with EN50155 norm), passengers can enjoy various options of content to choose from, railway operators can measure clients' activities, and both can rely on a stable connection during the trip.

For more information: [Website](#)

Platform Solution

ADLINK Railway Focused Systems

ADLINK is a leading provider of building blocks and intelligent platforms for edge computing. ADLINK's Rugged by Design CompactPCI, computer-on-modules, industrial-grade system, and panel computer product portfolio has been specifically selected for onboard TCMS/ATO/PIS/DMI and wayside CTC/RBC/TSRS railway solutions. ADLINK's exceptional flexibility in design and manufacturing has been utilized by top train control and rail signaling providers worldwide.



Key capabilities:

- ADLINK's AI-enable Video Analytics Platform powered by Intel is an AI-ready, EN50155-certified solution for near real-time video and graphics analysis applications including railroad hazard and intrusion detection, trackside equipment fault detection and train station video surveillance
- The ADLINK Driver Machine Interface Touch Panel Computer is EN 50155-certified and designed specifically for onboard deployments as a HMI unit for driver's desks and control panels of trail monitoring, railway diagnostics, passenger information and communications systems.
- The ADLINK High Performance Extreme Rugged Computer provides a VITA 75-compliant, highly compact, rugged intelligent computing platform in an IP67-rated enclosure for track monitoring systems that help railway operators monitor settlement and twist of railroad tracks.
- The Locomotive Data Recorder powered by Intel primarily focuses on vital railway applications including train operation safety and driver performance monitoring, post-incident investigation with support up to three 3G/4G LTE/WLAN/GNSS communication modules.
- ADLINK's Communication Control Unit is a high-performance, fanless onboard communication gateway providing passenger Wi-Fi, train diagnostics and telemetry functions with support of numerous ruggedized input/output (I/O) interfaces and up to six wireless communication modules.
- The ADLINK's extensive CompactPCI board and system solutions provide an industry-leading, field-proven, and cost-effective portfolio enabling a broad range of rail singling applications for both onboard and wayside deployments including TCMS, ATO, CTC, RBC and TSRS

For more information: [Website](#)

Platform Solution

Cisco Connected Rail

Cisco Connected Rail helps rail companies achieve safety, mobility, and efficiency objectives. The solution is a set of validated reference architectures, design documentation, and implementation guides co-created with global rail industry stakeholders. Cisco Connected Rail is built on existing architecture—there's no set starting point. The solution delivers an end-to-end architectural framework, including trains, tracksides, and stations. Designed with Intel technology and other proven and well-established, standards-based technologies, the Cisco Connected Rail solution includes expert guidance to deploy solutions that lay the groundwork for expert deployment, significantly reducing installation risk, cost, and deployment time.



Key capabilities:

- Connected Train includes an onboard high-speed, wired, and wireless IP network.
- Connected Trackside replaces multiple older, proprietary railway networks with a Cisco Unified MPLS Mobile Transport (UMMT) network.
- Connected Station integrates multiple in-station networks and retail communication systems into a single, standards-based IP network.

Key benefits:

- Lower operating expenses and simplify maintenance by consolidating multiple single purpose applications into one converged, open-standards IP network.
- Enhance passenger and employee safety with improved monitoring, automated compliance measures, and other automated systems.
- Deploy new services with high-speed, train-to-trackside wireless infrastructure.
- Generate additional revenue with greater advertising capabilities, increased ridership, and more station and trackside businesses.

For more information: [Solution](#) • [Video](#) • [Website](#)

Platform Solution

Nexcom Railways Solutions

Nexcom Railways Solutions are compact, rugged, and entry-level railway computers for harsh railway related applications. Because of the compact design, these computers are easy to be located without compromising its features. With adopting lock concepts, LAN, power-in and audio, the Nexcom Railways Solutions are designed against vibration and shock impact. An advanced GPS receiver supports GPS/Glonass/QZSS/Galileo/Beidou and an optional dead reckoning module is also available. Thanks to a mini-PCIe socket, the solutions are perfectly suited for wireless applications, such as WLAN and WWAN data and voice transmission. With an external SIM socket, it allows users to access the SIM card conveniently. A 12VDC output can be provided for external display with easy power wire arrangement. The solutions are suitable for passenger information systems, automatic fare collections, and digital radio data/voice transmission applications.



For more information: [Solution](#)

Platform Solution

Kontron: LoRa™ Connected Devices

Connecting and operationalizing sensors across locomotives is expensive and adds unneeded fuel cost through weight. Train operations require a solution that can enable wireless asset management while overcoming the limitations of cloud-only solutions for monitoring in near real-time. LoRa™ wireless technology is a breakthrough allowing easy installation of multiple new connected devices, even in moving environments like trains, to offer new services to customers, for asset management, preventive maintenance operations optimization, and finally driving to lower cost of ownership and better customer experience. The LoRa Networking Platform from Intel and Kontron enables secure train-to-ground station communication, providing reliable transmission across LoRa-connected devices and directly on trains. LoRaWAN® is a wireless network that allows the train operators to connect to sensors along the train without the need of cables, reducing implementation and maintenance costs but also weight and fuel. This platform compliments the Kontron TRACe portfolio of Intel-based railway certified computers, enabling a single gateway to cover connected devices inside a while double-length high-speed train.

Key benefits:

- Drives lower cost of ownership by solving complex logistic services in the field of asset management and energy conservation.
- Allows for better customer experience through consistent passenger updates and security improvements.

For more information: [Data Sheet](#) • [Solution](#)

Platform Solution

LinkTronix Video Inspection Solution for Catenary Power Supply Safety

The LinkTronix Video Inspection Solution includes advanced technology cameras mounted on train roofs to drive near real-time monitoring of train operation status, improving maintenance efficiency, and reducing risk rate.

The solution collects image by industrial camera, analyzes data by video servers installed in the train, and provides operators with near real-time monitoring of train operations.



For more information: [Website](#)

Platform Solution

Moxa's Smart and Connected Mobility

Moxa's onboard networking and computing solutions help enable smooth train operations with enhanced safety and improved experiences for passengers. Network solutions with enhanced reliability help devices to connect, communicate, and collaborate with systems, processes, and people. Moxa's edge-to-cloud connectivity solutions are the foundation for creating more reliable networks.

The Moxa Smart and Connected Mobility Solution is a scenario-based solution that drives alignment between onboard, trackside, and station-based train systems. The onboard system includes wired and wireless devices, computing equipment, and I/O controllers that monitor passenger experience and report data to the control center. Moxa devices are embedded on the train and installed along the trackside. The programmable trackside network collects and reports real time data of track and train conditions, which can be remotely monitored or accessed.

Key capabilities:

- Increase communication reliability via self-healing technology that enables faster fault recovery and intelligent Ethernet redundancy.
- Enable seamless connectivity with standardized Ethernet switches, programmable controllers, and Automatic Carriage Connection configuration.
- Improve customer experience with onboard Wi-Fi that supports secure client access, high-speed data rates, travel updates, and automatic climate and lighting controls.

For more information: [Website](#)



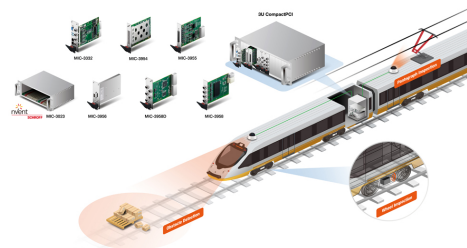
Platform Solution

Advantech CompactPCI for Stable Power Supply and Train Driving Safety

Advantech's modular 3U standard CompactPCI products are a robust solution with excellent performance, optimized heat dissipation, flexible configuration, easy expansion, and easy maintenance.

High-speed railways run on electricity, and the pantograph is the apparatus mounted on the roof of trains that collects power from overhead cables and transfers power to the trains. Pantographs contain multiple components making safety inspection and monitoring complex. With Advantech's CompactPCI series products that have industrial grade reliability and high performance, pantograph monitoring systems have been successfully developed and implemented in many cities in southern China, and has become a standard solution for providing stable power supply and driving safety on trains.

For more information: [Website](#)



Partner Solutions for Railways

Solution	Partner	Use Case
Secure OS Transit	Intelligent Security Systems	Safety
Arbor Machine Vision Controller FPC-9002-P6	Arbor	Safety
Vecow IVH-9204MX ICY	Vecow	Multiple
Advantech Automatic Fare Collection (AFC) Systems	Advantech	Passenger Experience
Advantech Fanless Railway Box PC ARS-2620	Advantech	Multiple
Advantech wayside controller ITA-2231	Advantech	Safety
Advantech All-in-One Self-Service Kiosks	Advantech	Passenger Experience
Advantech AI Incident Detection System – mic 7700	Advantech	Safety
Infotainment System	Advantech	Passenger Experience
Train to Ground Communication	Advantech	Multiple
Automatic Train Operation	Advantech	Predictive Maintenance
Railway Signaling and Interlocking System	Advantech	Safety
Integrated Supervisory Control System	Advantech	Safety
AI Surveillance	Advantech	Safety
Automated Fare Collection	Advantech	Passenger Experience
Passenger Information Display System & Closed Circuit Television	Advantech	Passenger Experience
Acer Intelligent transportation e-Ticketing System	Acer	Passenger Experience
Moxa smart and connected mobility V2406A Series	Moxa	Passenger Experience
AdLink Panel Computer DMI-1210	Adlink	Safety
AdLink AVA-5500 Series: AI-enabled Video Analytics Platform	Adlink	All Video Analytics
ADlink DCS-211 Rackmount Data Collection System	Adlink	Multiple
Ultra-compact IoT Platform: MXE-210 Series	Adlink	Multiple Safety
3U CompactPCI blade cPCI-3630	Adlink	Multiple
High Performance Extreme Rugged Computer: HPERC-KBL-MC	Adlink	Multiple Predictive Maintenance
iBase Passenger Information System (PIS)	iBase	Passenger Experience
Kontron LoRa Connected Devices on High Speed Trains	Kontron	Predictive Maintenance
Eurotech BoltGATE 20-25	Eurotech	Multiple
Eurotech BoltGATE 20-31	Eurotech	Multiple
Nexcom ATC 8110/8110-F	Nexcom	All
Nexcom nROK 1020	Nexcom	All
Linktronix Video Inspection for Catenary Power Supply Safety	Linktronix	Multiple
Smart Parking Lot	Portwell	Multiple
Locomotive Control Stand	Portwell	
Transportation Network management	Portwell	Multiple
Railway Management	Portwell	Predictive Maintenance
Fleet management	Portwell	Multiple
In Bus Infotainment Business	Portwell	Passenger Experience
Vehicle Monitoring System	Portwell	Multiple
Remote Monitoring and Asset Management	Portwell	Safety
Locomotive Data Recorder	Portwell	Predictive maintenance
Bus Broadcast System	Portwell	
Trash hauler Fleet Management	Portwell	
Fleet Preventive Maintenance	Portwell	Predictive Maintenance
Fleet Dispatch & Tracking management	Portwell	

Solution	Partner	Use Case
Commercial EV Fleet Management	Portwell	
In Bus Commuter Trail Infotainment System	Portwell	
Taxi Telematics System	Portwell	
Forklift Weight Scale System	Portwell	
Electronic Toll Collection System (ETC)	Portwell	
Generic Box Computer TRACEeB40xTR	Kontron	Multiple
Network Video Recorder (NVR) TRACEe-V40x-TR	Kontron	Safety
Train Control & Communications TRACEe-RM40x-TR	Kontron	Communication Multiple Train control
Multipurpose Fanless Edge Computer TRACEeB104TR/IV	Kontron	Multiple
Edge Data Processing Gateway SR-TRACEe-G40x	Kontron	Communication Gateway
Nexcom Fleet Solution	Nexcom	General Fleet
Genetec Fleet Solution		Bus General Fleet
Rubicon Waste Management Solution	OnLogic	Geo Spatial Utilities
Parsons Snow Plow	OnLogic	Utilities
Vnomics Fleet Solution	Advantech	General Fleet
Trek-60	Advantech	Bus Cargo Monitoring Cargo Vans Data Logging General Fleet Geo Spatial Heavy Duty Vehicles Police Utilities
GPC Wound Care		Cargo Monitoring
EvoTRAC-1901	Kontron	Data Logging General Fleet Heavy Duty Vehicles
Panasonic Bus Transport System	Nexcom	Bus
INDRA Nauta	Congatec	Bus
LivNSense ViCAS	Nexcom	Heavy Duty Vehicles
Advantech Cold Chain Solution	Advantech	General Fleet
ADLINK AVA-3510 AI Fleet In-Vehicle PC	ADLINK	General Fleet
Harman Passenger Bus	Advantech	Bus
IEI In-Vehicle Inventory Security	IEI	Cargo Monitoring
Viso.ai Vehicle Monitoring Solution		General Fleet
Everfocus Fleet Telematics Solution	AAEON	Bus General Fleet
Nexcom VTC 7251-7C4	Nexcom	General Fleet
Nexcom ATC-8010	Nexcom	General Fleet Police
Nexcom VTC 1021-C2K	Nexcom	Bus
Nexcom VTC 6220-BK	Nexcom	Bus Utilities
Nexcom VTC 6221	Nexcom	Bus
Nexcom VTC 7251-7C4	Nexcom	Bus
Nexcom ATC 3200	Nexcom	Heavy Duty Vehicles
Nexcom ATC 8110	Nexcom	Heavy Duty Vehicles Police
Nexcom VMC 2020	Nexcom	Heavy Duty Vehicles Utilities
Nexcom VTC 1911-IPK	Nexcom	Utilities
Nexcom VTC 7252-7C4IP	Nexcom	Heavy Duty Vehicles Utilities

Solution	Partner	Use Case
Nexcom VTC 7251-7C4	Nexcom	Police
Nexcom VTC 6222-C4S	Nexcom	Bus Police
Nexcom VMC 3020	Nexcom	Heavy Duty Vehicles
Nexcom VMC 4020	Nexcom	Heavy Duty Vehicles
Nexcom VTC 1910	Nexcom	General Fleet
Nexcom VMC 220/2020	Nexcom	General Fleet
Nexcom VTC 1021-BK	Nexcom	Cargo Monitoring Heavy Duty Vehicles
Nexcom VTC 1020	Nexcom	Cargo Monitoring Cargo Vans
NEXCOM VMC 1100	Nexcom	Heavy Duty Vehicles
Nexcom VTC 7250-7C8	Nexcom	Bus
Nexcom nROK 6222-AC4S	Nexcom	Bus
Nexcom bROK 7251-7C4	Nexcom	Bus
DFI VC300-CS	DFI	Utilities
DFI VC70B-KU	DFI	Bus
DFI VP101	DFI	Cargo Monitoring
DFI VC230-AL	DFI	Police
DFI SNT101-AL	DFI	Police



For more information: [Website](#)

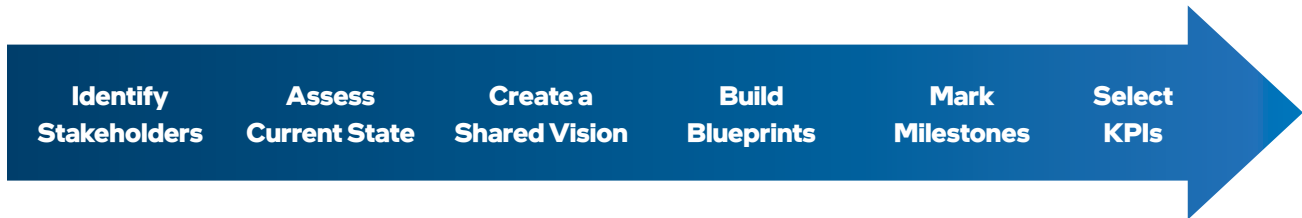
Getting Started

Leading railway organizations through strategic innovation and transformation is a continual journey. Many railroad management teams plan their intelligent initiatives across three action areas to:

1. Transform data into new insights in how their railway works with intelligence from edge to cloud.
2. Leverage proven intelligent railway solutions to support stakeholder goals.
3. Consolidate systems at the edge for greater efficiency and value.

Initially, leaders should examine which services may have the most impactful outcomes. Stakeholder identification, participation, and clear priorities are essential foundation points for building a plan. Leveraging experience working with many governments and railway authorities worldwide, Intel is bringing together the right stakeholder organizations and companies to deliver building blocks that railway leaders can use to create and implement an appropriate plan.

Here are the major steps to enable the railway transformation journey:



Identify Stakeholders

Identify who the major stakeholders in any digital transformation project might be. Depending on the project, this could include government representatives, members of the railway management team, employee representatives, concessionaires, railway IT team, railway security team, and passenger advocates.

Assess Current State

Determine where your railway is now, using the same key performance indicators you will use to quantify success. What works? What needs work? How can you improve satisfaction, security, safety, and success for all stakeholders?

Create a Shared Vision

Establish your ultimate outcomes, expressed in terms of stakeholder benefits. The vision should not be expressed solely as technical achievements but also as experiential improvements that technology can make possible. It is essential to build that vision with stakeholder involvement to achieve better and more diverse suggestions, consensus, and commitment.

Build Blueprints

Develop a priority list and “blueprints” for the most important projects in your technical modernization plan. Possibilities include master plans for:

- Better utilization of current railway and station space and/or the addition of new space.
- Modernization of the current technical infrastructure (communications and computing resources).
- Data collection.
- Improvements to all interacting railway systems.

Mark Milestones

Identify waypoints at which you measure progress, share lessons learned, discuss course corrections, and strengthen stakeholder commitment to your shared vision.

Select KPIs

Decide on key performance indicators that quantify success and align with your vision.

Exploring Financing and Partnerships

Implementing a comprehensive digitization vision requires committed funding. It is a critical component that should be thoughtfully planned. Innovative funding and financing alternatives can accelerate your projects. Exploring multiple funding sources such as regional economic development; state and federal agency funding for transportation, public safety, environment; and private developer and industry partnerships are a few examples of broadening sources. Developing partnerships to embrace industry knowledge, best practices, plus key solutions and technologies, provides insight from planning to implementation. Defining and executing a digitization strategy is neither straightforward nor without risks—but the benefits can be significant. Intel believes a successful railway transformation requires certain key components: the right level of stakeholder participation, clear priorities, and methodical planning of technology infrastructure.

Read what others read

Here are some top publications for the railway sector:

- [InnoTrans Report](#)
- [Rail Magazine](#)
- [International Railway Journal](#)
- [Railway-News](#)
- [Railway Age](#)
- [Global Railway Review](#)

Connect with Peers

Consider joining these railway associations to help develop relationships:

[The Association of American Railroads](#)

[National Railroad Construction and Maintenance Association](#)

[UNIFE - Union of the European Railways Industries](#)

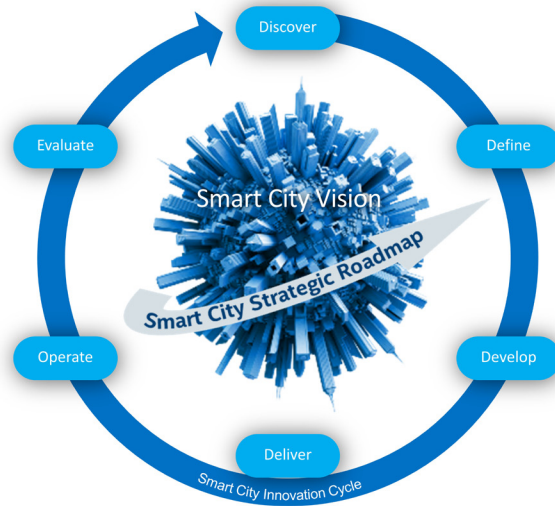
Endnotes

1 [AAR Greenhouse gases CHALLENGES Competition](#)

2 [SCIENCE DIRECT CHALLENGES Environment](#)



Let's explore the possibilities together



Learn more about Smart Rail at [Intel.com](https://www.intel.com)

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THINK BIG

...not just smarter, but better cities

START SMALL

Get going with projects and opportunities

MOVE FAST

Learn, adjust, iterate

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