ON TRACK TO THE FUTURE
With Smart Railways
As railway networks get busier and busier, Intel and its ecosystem are moving the future of smart railways forward. Our solutions help railway operators achieve safety, mobility, and efficiency objectives, from trains to tracksides to stations.

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

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

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

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

### PROJECTED GROWTH

- 2.6% annual forecasted world rail market growth rate through 2021
- 145B 2021 world rail market volume forecast, in €
- 32B average annual market volume forecast for railway technology in North America through 2023, in €

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**Notes:**

- b Statista, Railroad Network of Selected Countries 2016.
- c Statista, Global Efficiency of Railroad Services 2018.
- 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.
Growing demand in urban mobility and freight transportation is driving the need for innovative approaches to railway operations. The global rail market is expected to continue its path of steady growth, with the highest growth rate in urban transit. At the same time, rail traffic volume has increased 84 percent since 1981, without a corresponding increase in the size of the railroad network. This rapid expansion coupled with limited network puts significant strain on railway operators looking to accommodate the next generation of passenger and shipping demands.

Governments around the world are setting new goals for improving mass railway transportation to accelerate the delivery of goods, alleviate congestion, and increase sustainability. In fact, Global transport emissions could peak in the 2030s unless railways are “aggressively” expanded, according to the International Energy Agency (IEA). Advancements in smart rail technology enable operators to meet these goals and actively improve railway operation and management.

Today’s locomotives, railcars, stations, and other infrastructure are equipped with hundreds of sensors and cameras that can deliver crucial information to help railway operators maintain the safety and security of passengers and cargo. If this data can be properly utilized, it can go beyond providing passive safety to improve operations and gain efficiencies across the rail network.

Railroads are also utilizing historical big data resources to enable predictive maintenance and apply machine learning to solve problems in unprecedented ways. Operators are leveraging smart technologies to deliver integrated digital experiences such as driver-machine interfaces and infotainment to drive positive experiences and efficiencies for drivers and passengers.

One example of change is related to the concept of Transportation 4.0—the idea of a multimodal transportation global future, where different forms of transportation are integrated. Transportation 4.0 looks at new ways to streamline services for travelers and simplify the provisioning of services for operators. For example, imagine buying one ticket to get on a train, to an airport and plane, and straight to a hotel—where your luggage will be waiting for you. The aim is to make travel experiences more efficient, safer, greener, and with less disturbance while optimizing journey times and minimizing costs for travelers.

However, there are challenges to implementing a truly smart railway network of the future. It can be difficult to maintain rail network uptime with near real-time access. Without adequate nodes to bridge the divide between endpoint and cloud, it can be challenging to unlock the end-to-end visibility needed to drive insights across the railway network. And rail decision makers are facing the perennial challenge of gaining a competitive edge against other modes of transportation.

Smart railways offer transportation leaders the opportunity to modernize their core technology and transportation infrastructure and establish a new and better foundation that will meet today’s growing demands for mobility and the movement of goods. Intel and its ecosystem are uniquely positioned to offer components and solutions to deliver the future of smart railway technology. These solutions help railway operators achieve safety, mobility, and efficiency objectives, from trains to tracksides to stations.

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1. Arthur D. Little & UITP, Future of Urban Mobility Study.
3. Sunday Train: Data shows high speed rail is a big part of global decarbonization (and part of the Green New Deal), February 10, 2019
Railways have been key to innovation and society across civilizations. Railways 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 further and more freely. Expanding railways accelerated innovations in communications, timekeeping, supply chain management, and more.

### Historical Use of Rails

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2630 BCE</td>
<td>The Pyramid of Djoser in Memphis, Egypt was constructed using logs as rails or skids for transporting stones</td>
</tr>
<tr>
<td>600 BCE</td>
<td>Diolkos, a 6 to 8.5 km long paved trackway, transported boats across the Isthmus of Corinth in Greece</td>
</tr>
<tr>
<td>1504 CE</td>
<td>The Reisszug, which transports goods to Hohensalzburg Castle in Austria, is the oldest operating cable railway</td>
</tr>
<tr>
<td>1812 CE</td>
<td>The Middleton Railway in Leeds is the oldest public railway and ran the first commercial steam locomotive</td>
</tr>
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### Major Railway Expansion Projects

- **EUROPE**
  - **Rail 2050 Vision**
    - Proposal to implement automated trains using near real-time communications

- **CALIFORNIA**
  - **High-Speed Rail Project**
    - 800+ miles of railway to transport 5 times more people per hour than highways in rush hour conditions

- **CHINA**
  - **Vision 2030**
    - For expanding high speed trains, safety, track modernization, locomotives, signaling systems, and heavy haul systems

- **INDIA**
  - **Vision 2030**
    - For high speed rail network to continue expanding to 38,000 kilometers by 2025

### Sources

- a California High-Speed Rail Authority
- b European Rail Research Advisory Council Rail 2050 Vision
- c Railway Age, Glass Half-Full? Or Half-Empty? Mar 2020
- d Economic Times, View: The Mega Restructuring of Indian Railways to achieve ‘Vision 2030,’ Jan 2020
Expanding High-Speed Railways

With distinct advantages over personal transportation by air, road, 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.

Increasing IoT and Autonomous Operations

An estimated $30 billion will be spent in the next 12 years in IoT projects in the rail sector.\(^5\) 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. An estimated 106,290 autonomous train units will be in operation by 2030 (up from 60,078 in 2018), which represents a CAGR of 4.87 percent during that time span.\(^6\)

Growing Demand for Rail-Based Freight Transportation

U.S. freight movement is projected to rise from 19.7 billion tons in 2020 to 24.2 tons in 2040—an increase of 23 percent over 20 years. Strategies will have to be put in place to manage the growth in demand from year to year.

Leading Environmental Sustainability

Today, the railway sector carries 8 percent of the world’s passengers and 7 percent of global freight transport and only uses 2 percent of total transport energy demand,\(^7\) making it one of the most energy efficient modes of travel. 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.

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\(^5\) Top five trends that will shape the global rail industry in 2019

\(^6\) Autonomous Train Market by Level of Automation, Global Information, Inc, 2018 (Paid research report)

Globally, the railway sector faces a complex set of challenges that vary by railway system, region, and country. As railway systems grow and connect with each other, integrating different railway systems often means addressing differences in gauge widths, energy and fuel systems (diesel, electric, electromagnetic), trackside and on-board control-command and signaling systems, rolling stock specifications, noise level standards, accessibility needs, and safety in railway tunnels. Governments and railway operators are also looking for new and innovative ways to address challenges in environmental impact, passenger experience, railway station public safety, railway safety and maintenance, data security, and operational management and efficiency.

Railroads are physical barriers for animals who can no longer move within and between their usual habitats. Increase in collisions with trains, and the disturbance of human presence also alters their natural environments. As species continue to disappear at an alarming rate, this continues to be an issue.

Increasing Competition

Railways compete with both air travel for moving passengers and with the trucking industry for moving freight—with trucking winning the freight race so far. However, one of the key advantages that weigh in heavily on rail’s favor is the sustainability factor. Currently, freight moved by rail accounts for only 2 percent of U.S. greenhouse gas emissions. Increases in greenhouse gases in the coming years pose a real threat to the stability of our planet. 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 the equivalent to removing 3.2 million cars from freeways or planting 400 million trees.

Passenger Experience

The railway passenger experience starts with trip planning and ticket or pass purchase, extends to the arrival at the railway terminal, and baggage check-in. Once onboard and rolling, the on-train part of the journey holds the power to make or break passenger opinion. After the train has reached its destination, the customer off-boards, collects their luggage, and exits the terminal to catch transportation to their destination. Any glitch along the way can compromise passenger willingness to rely on rail as one of their transportation options, which can potentially impact the railway’s reputation. Passenger experience challenges can include difficulty with online train schedules, over-crowded terminals without adequate food or retail concessions, no in-terminal or on-board Internet connection, or delays while riding the train.

Railway Station Public Safety

In the US, 90 percent of railway stations are completely unmanned. This scenario is also true throughout the world. The lack of situational awareness and the inability to share important, timely information with passengers increases risk of accidents, injuries, litigation, and potential damage to railway reputation. Protecting passenger and railway property from theft or damage is also more difficult. In the case of emergencies, risk is hard to access. It also makes it difficult to study passenger movement patterns and make the most of opportunities for space or concession rental.

Railway Safety and Maintenance

Installation, inspection, and maintenance of rails, rail cars, locomotives, and station facilities are typically sub-contracted to qualified track inspectors and railway equipment maintenance companies. Comprehensive systems, signal and communications systems services are also subject to inspection and

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8 Rail-Interoperability & Safety, Mobility and Transport, European Commission
9 The Environmental Literacy Council – Rail Transportation
10 "Demand for Freight Transportation Will Rise
11 Security: Derailing Terrorists," by Mark Hosenbali
services. Globally, rail accidents are down, thanks in part to increased safety regulations and the growing use of IoT and other technologies that help to prevent accidents before they happen, such as using ultrasound to detect physical anomalies that threaten track integrity.12

Consistency in safety is a key issue in rail transport. Systems of rail signaling and train control differs around the world, with more than 20 signaling systems across the European Union alone, each with unique specifications, philosophies, and national requirements. Trains must be equipped with at least one system but sometimes more, just to be able to run safely within that one country. Because each system is stand-alone and non-interoperable, extensive integration and engineering effort is necessary. This drives up total delivery costs up for cross-border traffic, restricts competition, and hampers competitiveness.13

Data Security
Cyberattacks on transportation agencies can have a cascading effect because many information technology systems are integrated. Experts project that cyber-crime will cost the world $6 trillion a year by 2021.14 Governments and railway executives must implement full-spectrum cyber-security solutions to guard against cyber-threats to passengers, employees, and operating systems.

A 2018 cyberattack on the Colorado Department of Transportation caused disruptions in every functional unit. A disgruntled employee leveraged administrator credentials, which were still active after termination, to infiltrate the transcontinental railway system’s core switches.15 Leaked information included contact information for employees, customers, and responders.16 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.

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 delivery of on-time services.17

Environmental Impact
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 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.18

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12 High-speed non-contact ultrasound system for rail track integrity evaluation
13 Digitalization of Control Command and Signaling (CCS) and migration to ERTMS
14 Annual Cybercrime Costs to Double to $6 Trillion by 2021 by Tara Seals, Infosecurity Magazine
15 Former Employee of Transcontinental Railroad Company Found Guilty of Damaging Ex-Employer’s Computer Network, United States Department of Justice, The United States Attorney’s Office District of Minnesota, October 2017
17 Intel is Powering the World’s Intelligent Railways
18 Impacts of climate change on operation of the US rail network by Paul Chinowsky, Sahil Gulatic, James Neumann, Jeremy Martinich; ScienceDirect, Volume 75, March 2019, pp. 183-191
Connected transportation systems use disruptive technologies such as the Internet of Things (IoT), 5G, cloud, and artificial intelligence (AI) to develop and deliver efficient and cost-effective systems unlike anything seen before.

Smart railway solutions include the orchestration of Internet Technology (IT) and Operational Technology (OT) systems across the rail journey, from the station, to the on-board experience, and to railway operations. This allows rail transportation systems to both increase revenue and decrease operating costs through enhanced operational performance for high-speed passenger service, urban metro and light rails, and freight service, including an enhanced passenger experience, energy efficiency, and safety improvements.

Smart railway technologies provide the opportunity to increase profits by optimizing available data from all aspects of railway operation including terminal security and readiness, train status, increased retail sales from terminal-side shopping opportunities, or on-train purchases. Railway operators can also increase productivity by using a system-wide approach to gather near real-time information that can be used to improve decision-making. Additionally, railways can improve partner and passenger satisfaction by delivering people and goods safely, securely, efficiently, and on-time.

Rail must be able to compete on speed of transit, convenience of terminals, reliability, and price or it risks losing out to aviation. The use of Smart Rail technology can help to make that happen. Digital security and optical sensor systems—and other types of sensors (e.g., acoustic, heat vibration, or chemical)—can be integrated with existing databases and analytics to vastly improve security and public safety for customers and workers. Passenger, railway personnel, and railway assets can be safeguarded using optical sensing with real-time analytics capabilities, which lead to better on-the-spot or over-time strategic decisions about how operations flow smoothly, efficiently, and safely.
Intel is powering a revolution in digital transformations for railways across networking and communications, applications, data management, compute, analytics, and security. By using gateway, Edge, and IoT solutions, railways can improve passenger experience, operator efficiency, and equipment safety and performance.

Intel supports and enables the digital transformation of the railway industry while providing the technology foundation for the future. We help transportation and government leaders plot a course for modernizing their rail infrastructure and adopting new technologies so that they can optimize rail performance while also improving the passenger experience.
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 can visually relieve the directional frustration of travelers. Using Beacon or MSE indoor positioning technology for a real-time turn-by-turn mobile wayfinding experience. 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 partners through impactful advertising opportunities on railway station facility’s screens.

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 WiFi to passengers through public kiosks.

Onboard Units
To improve passenger experience, train operators are looking to improve the reliability and availability of onboard WiFi for passengers. However, bringing onboard WiFi up to the same level passengers expect at home, plus commercial issues and the difficulties of large-scale infrastructure upgrades, can be difficult to achieve. Super-fast onboard broadband powered by 5G technology offers passengers WiFi connections that are up to 10 times faster.

Infotainment and Advertisement
Digital signage in train stations can shorten queues, optimize people flow and wayfinding, improve 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 Edge helps deliver actionable, data-driven insight and support for applications and experiences.
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 biometric egates, passengers can board their train without a ticket or passport. With a simple glance at a high-resolution face capture camera at the egate, the passenger’s face is recognized biometrically in a matter of few seconds. The image can be securely sent to customs and border control for traveler verification, which then carries out a matching process with the stored digital facial token captured at the initial immigration process. In a few seconds, the system reconciles the passenger with the train, recognizes the passenger as eligible to enter that train, and then accordingly opens the egate door for the passenger 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 license plate recognition, optical sensing, and parking guidance. Railway operators can also control traffic and monitor vehicles using optical sensing, license plate recognition, 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 about people of interest, or suspects in a crowd 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. Trollies that have been left where they shouldn’t be as well as suspicious behaviors such as loitering, sudden crowd gathering, or man-down problems are also detectable.

Passenger Safety

Smart security functions can also help enhance passenger safety and reduce public liability. For example, computer vision solutions can 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 increase. 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 track 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 in a train station can create challenges for customers and train station stakeholders on a daily basis. Congestion, overcrowding, and the potential for crime can result in lost revenue and operational inefficiencies for stations and 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 spiked times, and protecting people and assets by detecting threats before they happen.

Luggage Tracking

A constant challenge for traveling passengers is how their luggage is handled. When they arrive at their destination to learn that their luggage has been lost, and they can’t enjoy their trip; If the luggage of a passenger traveling for business was transferred to the wrong connecting train, this can be costly and detrimental to the reputation of the company. An operator using computer vision can track passengers’ 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 their assets are at all times. With so many different assets constantly on the move, railways face challenges including delays, lost equipment, theft, and errors. Leveraging asset tracking through computer vision can reduce dwell time of stationary locomotives and increase operational efficiency, and can track all of a railway systems’ 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. Operators can keep track of trains' locations across the territory.

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 the 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 WiFi. 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 can reduce latency, improve near real-time responses, and relieve 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, 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, autonomous vehicles, 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 the move to 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, WiFi 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 VMNetwork 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. The broadest in breadth and depth in the industry.

**Intel® Movidius™ Myriad™ Vision Processing Unit (VPU)**

Intel's next-generation Intel® Movidius™ VPU is designed for Edge media, computer vision, and inference applications. The technology incorporates unique, highly efficient architectural advances that are expected to deliver leading performance—more than 10 times the inference performance as the previous generation—with up to six times the power efficiency of competitor processors.

Additional technologies supporting AI include:

- **Intel® 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® 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 is 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 erasurecoding 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.

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**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 WiFi. 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**

**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.

**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.

**Connectivity**
In many railway stations where lower-cost broadband internet infrastructure is under-developed or unavailable, free public WiFi 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 exhaustive analysis.
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 WiFi 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 WiFi 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, Passengera solution provides near real-time information on screens, including arrival times and destination type 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 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 viewship 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.
**UK: NETWORK RAIL**

**Cisco Connected Rail with Davra**

**Challenge:** Network Rail needed to increase UK rail system capacity to accommodate increased public demand. Existing rail telecom infrastructure could not accommodate the transformation program required to improve network safety and reduce downtime.

**Solution:** Cisco Connected Rail with Davra defined a meta-model framework for designing and architecting a carrier-grade network and IP-based command and control system.

**Technologies:** Cisco switches, Cisco UCS, mobile and Edge platforms powered by Intel Atom® to Intel® Core™ to Intel® Xeon® processors.

**Results:** Reduced operational costs by more than 20 percent, reduced capital expenses by 21 percent over multiple supervisory control and data acquisition (SCADA) networks, and provided wireless access for 1.3 billion trips per year.
SOLUTIONS FOR RAILWAYS

Intel® Market Ready Solutions

The 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 gate 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
**STA T I O N  S O L U T I O N**

**Cisco/Davra Connected Mass Transit**

The Cisco/Davra Mass Transit Solution 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. Security cameras at stations allow data sharing with police and contribute to a more secure environment for travelers.

**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.
- Guarantee 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, 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 WiFi, 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:
- Data analytics and data correlation for railway station security, government agencies, and customs/border control.
- Video analytics can detect abnormal behavior and alert security teams.
- Gorilla FVS can help track and route people to the correct railway gate, departure track, or other locations.

For more information: Solution  • Website
PLATFOR M SOLUTION

iOmniscient IQ Smart City

iOmniscient delivers AI-based, multisensory, smart optical sensing analytics powered by Intel® Architecture. The solution consists of a set of modular technology building blocks that can be combined in nearly unlimited ways to provide unique multi-sensory solutions for railway operations. The technology is a unique hybrid of Heuristic, Neural Network, and Deep Learning algorithms to achieve fast and accurate results with minimal computing infrastructure. iOmniscient helps railways to improve operational efficiency, enhance individual productivity, and provide immediate tangible returns on investment.

Key capabilities:

- Security: Detection of abandoned or suspected luggage left in a crowd, detection of fights.
- Operations: Queue management, automated check-in, automated quarantine control, parking management, people counting, movement monitoring, access control and staff identification, and detection of asset destruction or manipulation.
- Safety: Detection of travellers slipping and falling to mitigate liability, find lost children even without having an image of them, and help prevent railway hazards by detecting objects left on train tracks.
- Efficiency: AI-based Nuisance Alarm Minimization System (NAMS) helps eliminate false alarms while still maintaining detection accuracy, while smart compression allows high bandwidth video to be sent over low bandwidth networks.

For more information: Website

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PLATFOR M 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 optical sensing system records events to help enhance security and safety of passengers. Advantech Rolling Stock solutions are EN 50155 compliant with M12 connectors.

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 track 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 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 signaling applications for both onboard and wayside deployments including TCMS, ATO, CTC, RBC and TSRS.

For more information: [Website](#)

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**PLATFORM SOLUTION**

**Advantech Passengera**

Passengers would like to use WiFi and Internet in the train with stable connection and fast broadband. Advantech together with eco-partner Passengera co-created a solution that is meeting needs of both—train operators and their clients. Thanks to an on-board Infotainment platform designed by Passengera, based on the Advantech Industrial Computer (with EN50155 norm), it’s becoming possible. Passengers can enjoy various options of content to choose from, railway operators can measure clients’ activities, and both can rely on stable internet connection during the train trip.

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

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**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/Gloness/QZSS/Galileo/Beidou and 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
Wabtec Corporation: GE Transportation EdgeLINC™ and GE GoLINC™ Platforms

The GE EdgeLINC is a comprehensive Industrial IoT platform that represents the future of device management, Edge analytics, and application enablement. It is designed for constantly moving rail assets, using a combination of Edge-level computing and streaming analytics to maximize rail operator investments in industrial IoT systems.

The GE GoLINC Platform is an industry-tested network, communication, and application management platform for the railroad environment. It is a mobile data center that provides robust processing, wireless communication, networking, video and data storage. The GoLINC Platform interfaces with both locomotive and third-party systems to make data available and features onboard wireless capability for easier data transfer.

The GE EdgeLINC and GoLINC™ platforms enable railway operators to connect and monitor railroad assets, maximize train performance, reduce delays, and improve efficiencies. Together, these solutions provide near real-time defect monitoring, video analytics, notifications, locomotive health status, performance, and proactive maintenance.

Key capabilities:
- Streaming analytics on a mobile edge platform.
- Seamless scalability and industrial IoT lifecycle management.
- A secure, safe, and efficient solution whether assets are at rest or in transit at high speeds.
- Unparalleled platform flexibility with an open, vendor-agnostic architecture.
- An ecosystem designed for growth.

Key benefits:
- Remotely monitor device status and health and perform over-the-air device configuration, firmware updates, and consolidated data offloading.
- Perform efficient system management including new device enrollment and remote configuration updates.
- Create and edit rules using graphical and intuitive rules editor or execute standard ruleset from the rules library built specifically for the rail industry.
- Process data in near real-time using SAS® Event Stream Processing (ESP) Engine at the Edge and at the back office.
- Enable rapid development of business applications that deliver intelligence and insights.
- Utilize the portfolio of EdgeLINC powered applications that deliver operational, mechanical, and situational analytics for improved business performance and business savings.

For more information: Website
PLATFORwM SOLLUTION

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

PLATFORwM SOLLUTION

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.

PLATFORwM SOLLUTION

Moxa's Smart and Connected Mobility
Traveling long distance in a train without any entertainment could be the least desirable option for a passenger, but it may be costly to pay for the premium access for mobility. Certified with IRIS Rev. 0.3 system, Moxa provides a wide array of rail-proven products and experiences that help onboard passengers and staff stay connected and satisfied with their networking experience and time-efficiency during their train travels, all safely under monitoring of an IP Camera.

For more information: Solution
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

Within the complex structure of your railway identity, who the major stakeholders in any digital transformation project would be. Depending on the project, this can 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
- Railfan & Railroad Magazine
- 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
- International Association of Railway Operations Research
- UNIFE - Union of the European Railways Industries
Learn more about Smart Rail at Intel.com

Intel technologies features, and benefits depend on system configuration and may require enabled hardware, software, or service activation. Performance varies depending on system configuration. No computer system can be absolutely secure. Check with your system manufacturer or retailer to learn more at intel.com

Test document performance of components on a particular test, in specific systems. Differences in hardware, software, or configuration will affect actual performance. Consult other sources of information to evaluate performance as you consider your purchase. For more complete information about performance and benchmark results, visit intel.com/performance.

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October 2020
THINK BIG
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