Business Brief

Railways Solutions
Smart Cities & Transportation

Smart Train Collision Avoidance System for Railway Operators

Railway Operators Can Enhance Safety While Reducing Costs with Real-Time Accident Prevention Awareness

Benefits of train collision avoidance systems (TCAS) include:

- **Enhanced train driver safety**
  TCAS helps prevent head- on, rear-end, and side-on collisions, and helps improve safety of trackside maintenance workers and vehicles.
- **Increased rail network usage and volume**
  Less infrastructure and rail car damage means more cargo can be shipped on existing lines.
- **Improved on-time operational performance**
  Less downtime for repairs and unscheduled maintenance helps improve fleet availability.
- **Improved train speed monitoring and control**
  Predictiveand automated alerts help train drivers react faster to hazardous situations and maintain positive train control.

Overview

The global rail market is rapidly growing. Densely populated cities seek more efficient transportation strategies. Plus, cities are trying to respond to population growth, safety concerns, and shrinking operating budgets. Meanwhile, constraints to existing rail networks exist. Accommodating next-gen passenger and shipping demands are challenging. New, innovative railway operations approaches are needed.

As rail networks expand, governments face increased pressure to elevate safety measures to protect citizens and the environment from train collisions. Train collisions and related accidents create additional burdens for railway operators working within tight operational budgets. Collisions endanger citizens, train drivers, maintenance workers, passengers and can disrupt the global supply chain's flow of goods. Supply chain disruptions can also create significant economic damage to an increasingly fragile global system.

Cities are taking advantage of new technologies, such as advanced sensors and cameras and Artificial Intelligence (AI), to access real-time analytics and predictive insights. Intel-powered railway solutions combine integrated hardware and software to consolidate different use case applications at the edge of networks. When rail operators use existing in-vehicle computers and accelerators, Intel-based solutions digitally connect railcars and operators to help create a safer, more efficient, and convenient railway fleet.

Safety Challenges

The rapid expansion of global railways is driving the need for better safety systems to help prevent train collisions and ensure safe railways and continuous railway operations. Train collisions fall into three different categories; head-on collisions, rear-end collisions, and side collisions. All three collision types present challenges for railway operators to identify, detect, and respond to hazardous situations with trains in motion.

Collisions and disruptions can be expensive. Replacement costs to railway equipment, and railcars coupled with the loss of human life, loss of goods, or delays in supply chain operations are complex challenges to overcome. While traditional collision avoidance systems like visual sight, and track signaling technologies exist, new technology innovations are available that can help increase the safety of rail networks.

Solution

Intel and its global ecosystem of partners have developed a Train Collision Avoidance System (TCAS) solution. This safety system for trains and wayside maintenance vehicles offers advanced obstacle monitoring and detection of rail tracks and surrounding environments for potentially hazardous situations. Using a combination of sensors, like Artificial Intelligence (AI) and advanced software processing, the system can help accurately detect obstacles, alert train drivers and maintenance vehicle operators, and perform automated corrective actions.

This Intel-based system helps increase safety by creating better spatial awareness forward, to the side, and behind the train. TCAS can be used for mainline and urban rail networks, on trains of all types, and in all weather conditions. The solution is designed to prevent collisions by warning drivers of potential danger and providing an automated means to respond to hazardous situations.

How the TCAS Solution Works

Train Collision Avoidance Systems collect and analyze data. This data is used to help understand their surrounding environment and trigger safety-based actions. TCAS integrates various sensors with processing software and actuators to help detect railway obstructions and conditions. Train mounted sensors send raw data to an onboard computing unit. Software processes and classifies the data, helping it to measure and position objects

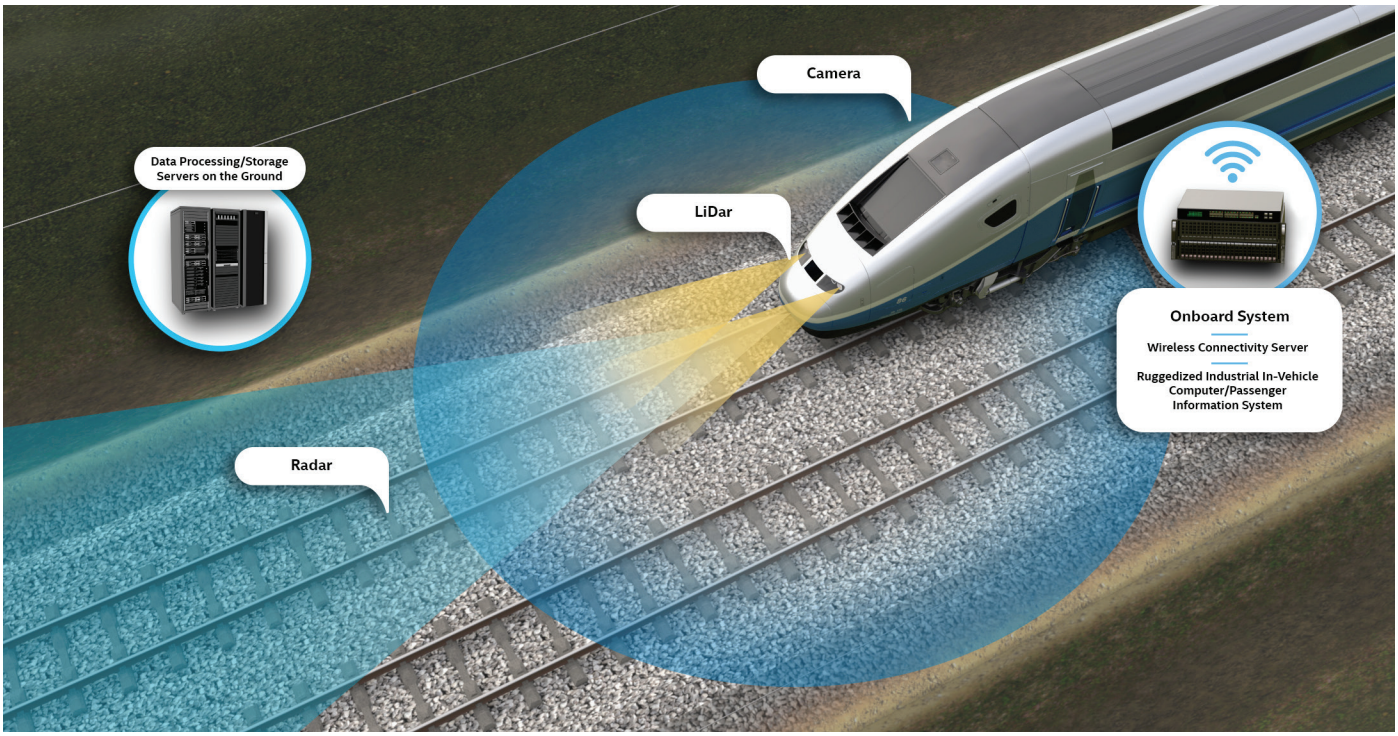

Figure 1. TCAS Overview

TCAS Deployment Scenarios

The benefits of TCAS are clear:

- Enhanced safety for citizens, train operators, and maintenance staff
- Reduction in collisions and their costly aftermaths
- Reduced strain on railway operating budgets

This system uses Intel's end-to-end expertise in processors, and compute technologies to enable solutions for some of the world's most pressing challenges. TCAS is flexible and designed for deployments with two railway operator scenarios: 1. the train-mounted collision avoidance system and 2. Maintenance-of-Way (MoW) wayside solution.

Maintenance-of-Way (MoW) Wayside Solution

For maintenance vehicles repairing or working trackside, the train-mounted solution collaborates with connected maintenance vehicles to help avoid a collision. The train-mounted system shares train location reports with the wayside vehicle and assesses the risk of a real-time crash. Automatically generated alerts help the train driver and wayside vehicle operator avoid collisions. This system also detects, records, and stores unsafe in-cabin behavior and road conditions for video-based intelligence.

New Apps Help Support Collision Avoidance

Innovations across railway ecosystems, such as mobile phone applications, increase safety for both railway employees and citizens.

Maintenance Worker Protection Mobile App

This smartphone application uses track location information for railway track workers and sends user alerts about approaching trains. The smartphone app creates a simple, easy-to-use way for railway operators to add a layer of worker protection to their safety portfolio.

Road Vehicle Protection

This smartphone application generates alerts and helps prevent train-to-person and train-to vehicle collisions at ungated, level train crossings. The app "recognizes" trains in the surrounding area and sends alerts about possible collisions.

Intel Architecture Powers Real-Time Collision Avoidance Solutions

Intel-based TCAS solutions offer many advantages for rail operators beyond the immediate safety benefits. Railway operators attempting to use data collected with their network of sensors frequently discover the data is challenging to access due to siloed or difficult-to-retrieve data. Sensor and camera suppliers may also create proprietary information bottlenecks, further exacerbating the problem. A lack of nodes bridging the endpoint-to-cloud divide might make it difficult to obtain end-to-end insights and achieve full system potential.

The TCAS solution overcomes these challenges by processing data at the edge of a train's network. Rail operators receive real-time information. The onboard diagnostic host server in the train collects data from sensors and cameras, reducing the amount of data sent to the cloud. Edge processing helps keep the network operational and minimizes latency issues. Intel-based systems are easy to upgrade and compatible when rail operators use Intel-based components and software. Thanks to the increased efficiency provided by these new technologies, TCAS helps rail companies achieve higher returns on rail car and infrastructure investment.

Figure 2. Train Collision Avoidance System –Maintenance-of-Way (MoW) Wayside solution

The TCAS uses Intel-based architecture. Intel collaborates with railway industry partners so that all Intel-based solutions can deploy at scale as shown in Fig 3.
The train-mounted architecture includes data collection modules such as sensors and visual imaging cameras to capture the train's current operating environment. In the Data Processing Layer, collected data is ingested using sensor drivers and interfaces to the edge compute system for further analysis and sensor fusion. Sensor fusion is the step to combine sensor inputs resulting in object classification or determination of vehicle speed or direction of travel, for example. The result of analysis and sensor fusion helps create the 3D map of potential obstacles surrounding the train. In the Diagnosis Layer, this intelligence is passed to the onboard diagnostics host server enabling coordination with actuators or ground-based servers and the onboard display and storage system.

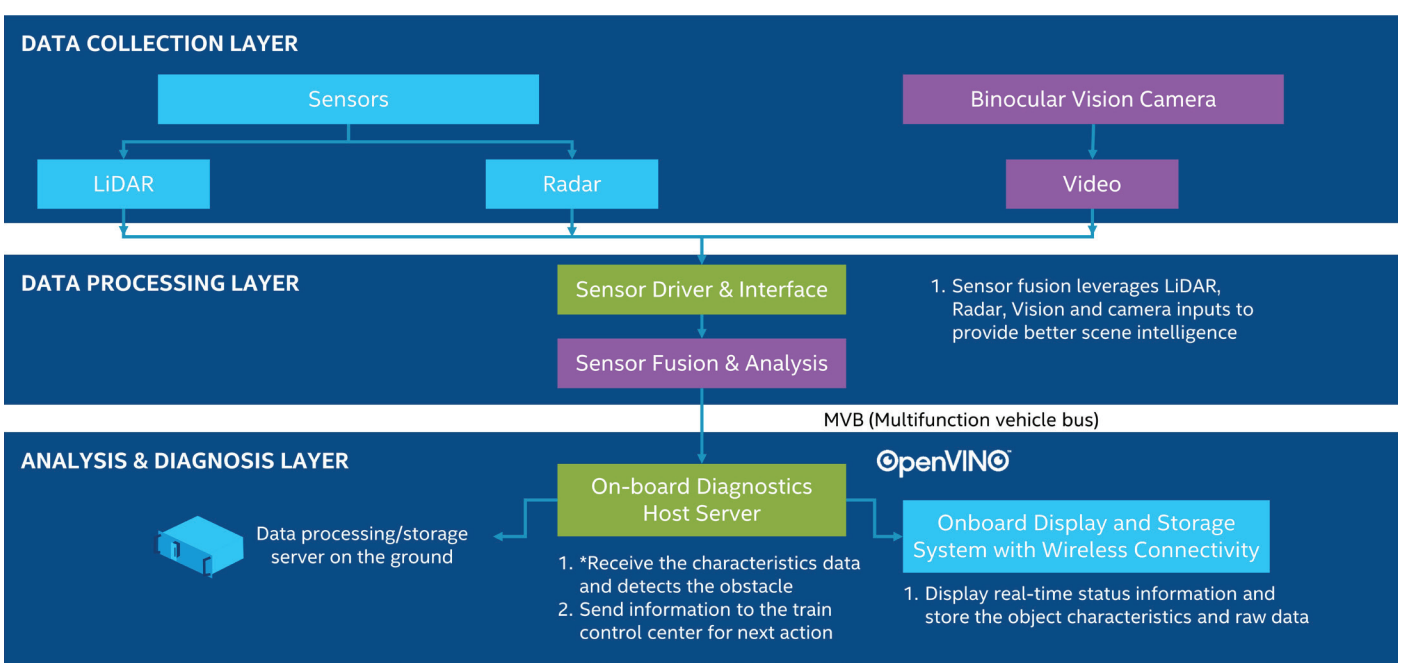

Figure 3. Intel-based Train Collision Avoidance System Architecture

Intel End-to-End Solution Portfolio

Intel's partner ecosystem offers solutions that power the latest workload consolidation technologies, such as containerization and hyper-converged infrastructure. Intel-based devices can perform multiple functions, maximizing the value of each network asset. By using solutions based on industry-standard Intel processors, rail operators can integrate a wide array of devices that work together to provide a holistic view of their network.

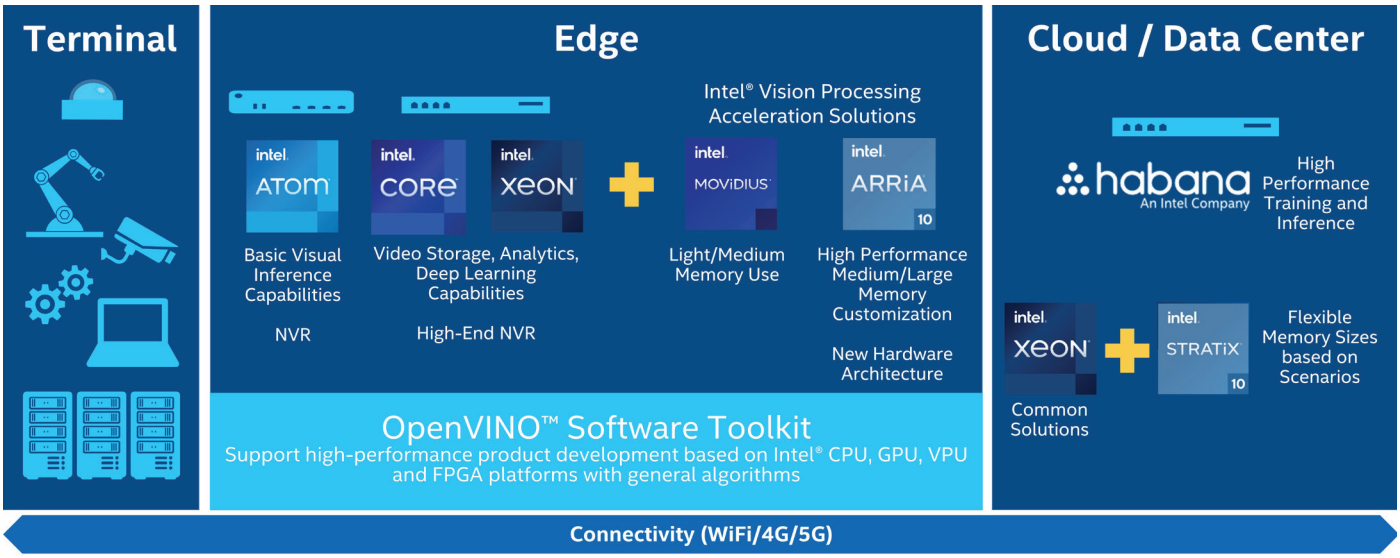

Figure 4. Intel End-to-End Portfolio Solution for Railways

Advances in intelligent rail technology enable operators to manage railways and meet a growing set of challenges. Intel and its ecosystem offer unique components and solutions to deliver the future of smart railway technology. Modern railway operators implementing Intel-based railway solutions across passenger and freight train infrastructure can help enhance safety, operational readiness, and efficiency.

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0622/MS/WS/PDF