

The Siemens logo is displayed in a bold, teal, sans-serif font. It is positioned in the upper left corner of the image, within a white rectangular box. The background of the entire image is a high-angle photograph of a freight train in a desert environment. The train consists of two orange and black locomotives followed by several black tanker cars. The train is traveling along a set of tracks that cut through a dry, hilly landscape with sparse green and yellow vegetation. The hills in the background are eroded and have a similar color palette to the foreground. The lighting suggests it's daytime, with shadows cast across the terrain.

SIEMENS

Ingenuity for life

Trainguard Sentinel

Scalable | Tailored | Cost-optimized

Railway solutions for Industrial, Mining, and Freight.



Control, centralize, and automate

Mobility is one of the key success factors in the globalized economy. Efficient inter-city, state, and country transport increases competitiveness. Siemens rail signaling solutions for industrial, mining, and freight help to control, centralize, and automate your freight movement. Siemens Trainguard Sentinel enables smooth operations for heavy loads.

Today's key railway challenges

Transporting raw materials and finished goods efficiently is the need of today's globalized business. Industrial, mining, and freight operators face four major issues, the biggest of which being incidents such as derailment, collision, or loss of train integrity. Another worry is concentrated around unreliable

systems with high maintenance costs. Additional challenges are the inefficiency and limited expansion flexibility of adapted systems; and finally, high procurement and operational costs for new solutions. Siemens Trainguard Sentinel solutions are tailored to facing these optimally.



Safety

Collision prevention: Integration within an operational control center network and access to train brakes provide built-in safety.

Derailment avoidance: Object controllers ensure the remote locking of point machines.

Line speed enforcement: Ensuring suitable line speed with brake interface modules eliminates the most frequent rail accidents caused by human error. The system allows a level of flexibility for drivers to both make up on lost time and reach their destination safely.

Train separation alert: Monitoring train integrity at all times immediately identifies unwanted train separation.

Railroad worker protection: Possible programming of the system to operate at lower speed reduces accident risks and enables work completion without losing operational efficiency.



Reliability

On-time performance: Train control avoids time delays by guiding the operator to safely accelerate or decelerate where and when required.

Speed forecast: The system is able to predict the speed a full minute in advance, giving drivers sufficient notice for the required braking effort. This reduces the chances of derailments.



Efficiency & flexibility

Braking algorithm: With all parameters of the freight train, the system calculates and optimizes braking for more fuel efficiency.

Process automation: In the area of automation, Siemens Trainguard Sentinel helps to optimize train control processes and business operations to reduce costs by minimizing inefficiencies and eliminating failures.

Scalable: Cost flexibility is ensured, as the system can be implemented in several phases. Gradual upgrades lead to the full spectrum of benefits.

Interoperable: The system adapts to all communication networks with data capability (TETRA, GSM-R, LTE, 3G/3.5G/4G/4.5G, VHF/UHF, etc.).



Cost savings

Low initial costs: Lower capital expenditure (CAPEX) is realized with this competitively priced solution. It can be easily expanded, helping to reduce initial procurement costs.

Lower operational costs: Lower operational expenditure (OPEX) is realized as a result of minimized installed equipment, reduced required maintenance, automation, and more efficiency in power consumption.





A scalable solution, tailored to your needs

Operators need to move their goods with the most efficient and safe mode of transportation. While road is suitable for moving small goods, rail has proven to be the best choice for transporting goods in bulk and on a regular basis.

Siemens Trainguard Sentinel offers a best-in-class and cost-optimized train control solution. The system is scalable in size and scope, assuring highest operator benefits at lowest invest.

We offer our customers three scalable building blocks

3. Automate

Process enhancement
Automate your business to maximize results

2. Centralize

Integrated interlockings and Operation Control Center
Centralize your control and increase efficiency

1. Control

On-board Unit
Control your trains and improve operations



Control your trains and improve operations

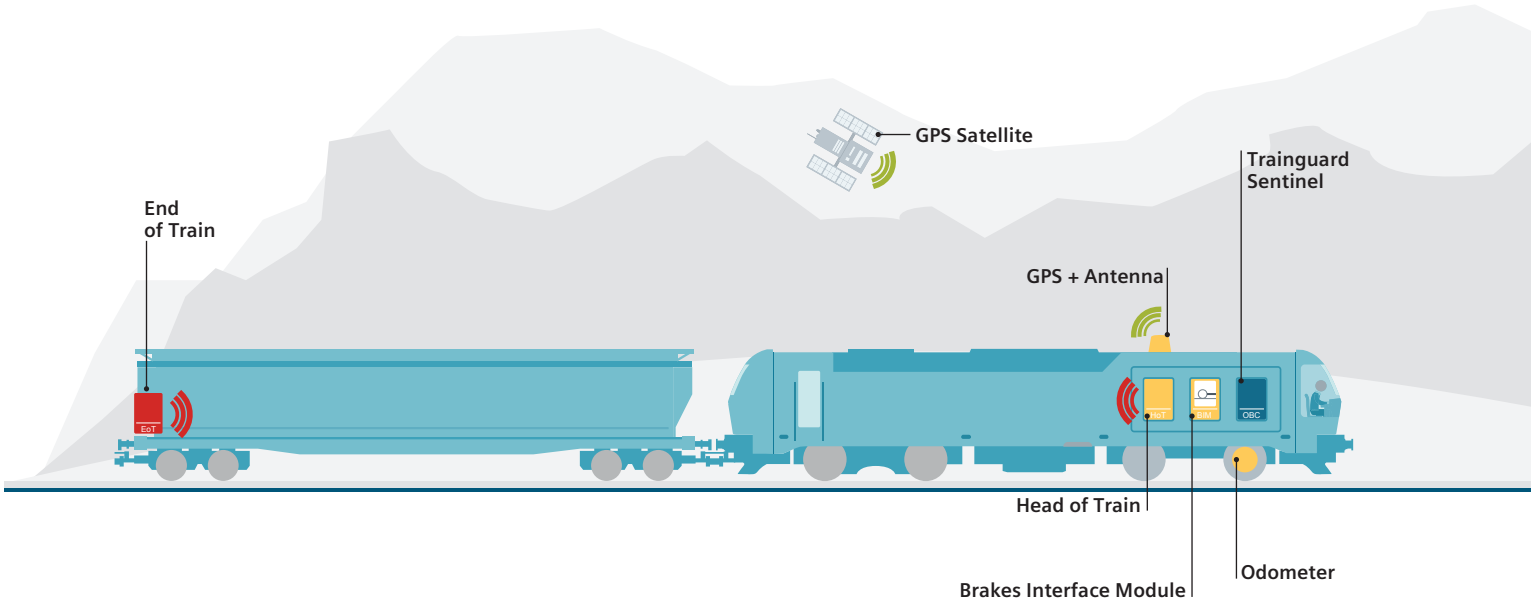
On-board Unit

The gateway to Trainguard Sentinel is a stand-alone solution that includes an on-board system, the On-board Unit (OBU). It delivers speed monitoring, a time-optimized speed profile, and the estimation of fuel consumption.

Trainguard Sentinel includes the On-board Unit GPS Positioning and an odometer sensor to determine location. The system can be expanded with optional brake interfaces and train integrity monitoring using head-of-train and end-of-train devices. It also uses wireless communication for voice and data.

Trainguard Sentinel can be bought at a low cost to benefit immediately from speeding prevention. It regulates speed, logs driver's actions, and monitors the position of the train in areas with GPS signals. Thanks to the use of speed sensors, the position can be monitored at the end of the trip by checking the log, even for areas without GPS coverage.

Control with stand-alone solution



Additional benefits

- Speed monitoring to prevent derailments
- Optional brakes interface
- Optional train integrity monitoring
- Estimation of fuel consumption
- Predefined optimal speed profiles to optimize energy consumption

Centralize your control and increase efficiency

Integrated interlockings and Operation Control Center

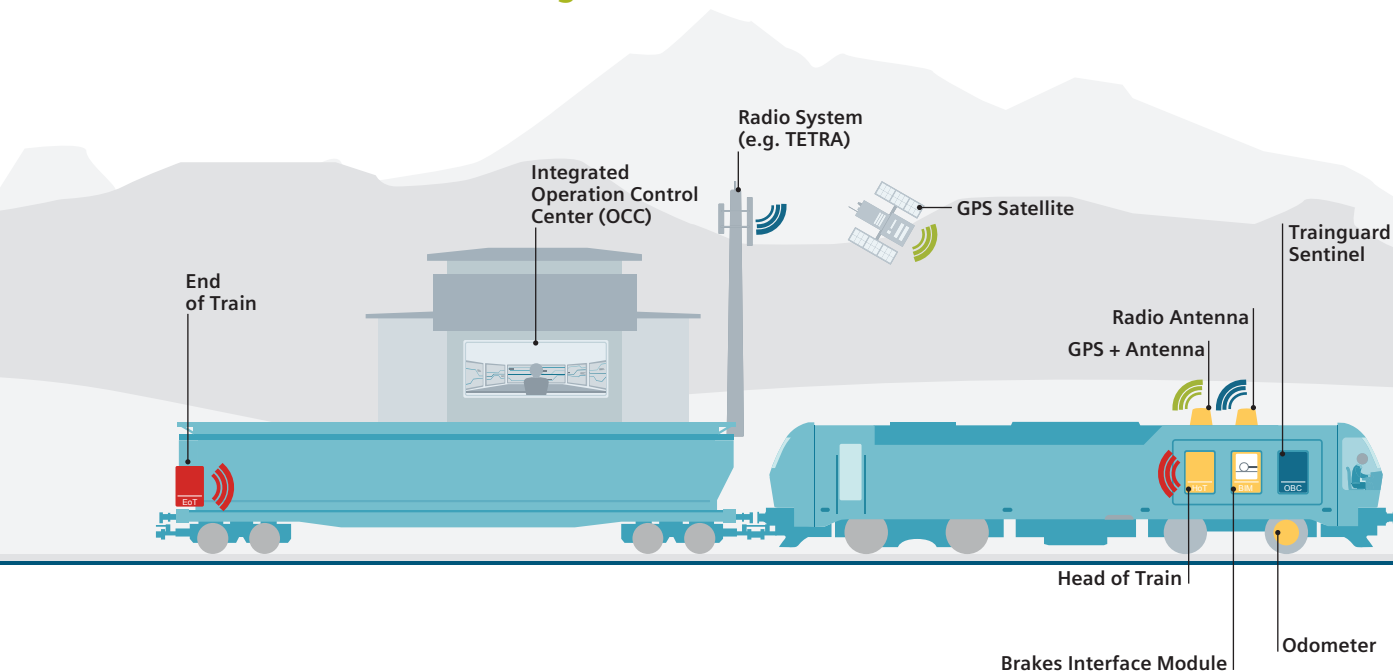
In addition to all the features of the stand-alone solution, the integration of the Operation Control Center (OCC) allows movement authority, temporary speed restrictions, and transparent train position and data.

This integration also allows the update and release of locked areas in case of communications failure. It utilizes a double confirmation process that intervenes between the driver and the OCC operator. Locking of areas or definition of reduced speed areas for track work is also possible.

Trainguard Sentinel options can be adapted to existing interlockings or serve as a Siemens solution for wayside products. This solution can include SIL4 electronic interlockings, point machine detection, speed monitoring, hot-box/axle detectors, derailment detectors, or track vacancy devices such as axle counters or track circuits. It may also integrate wayside signals and road crossings.

Trainguard Sentinel can interface the existing wayside systems or provide new wayside solutions to enhance the safety and operation of the trains.

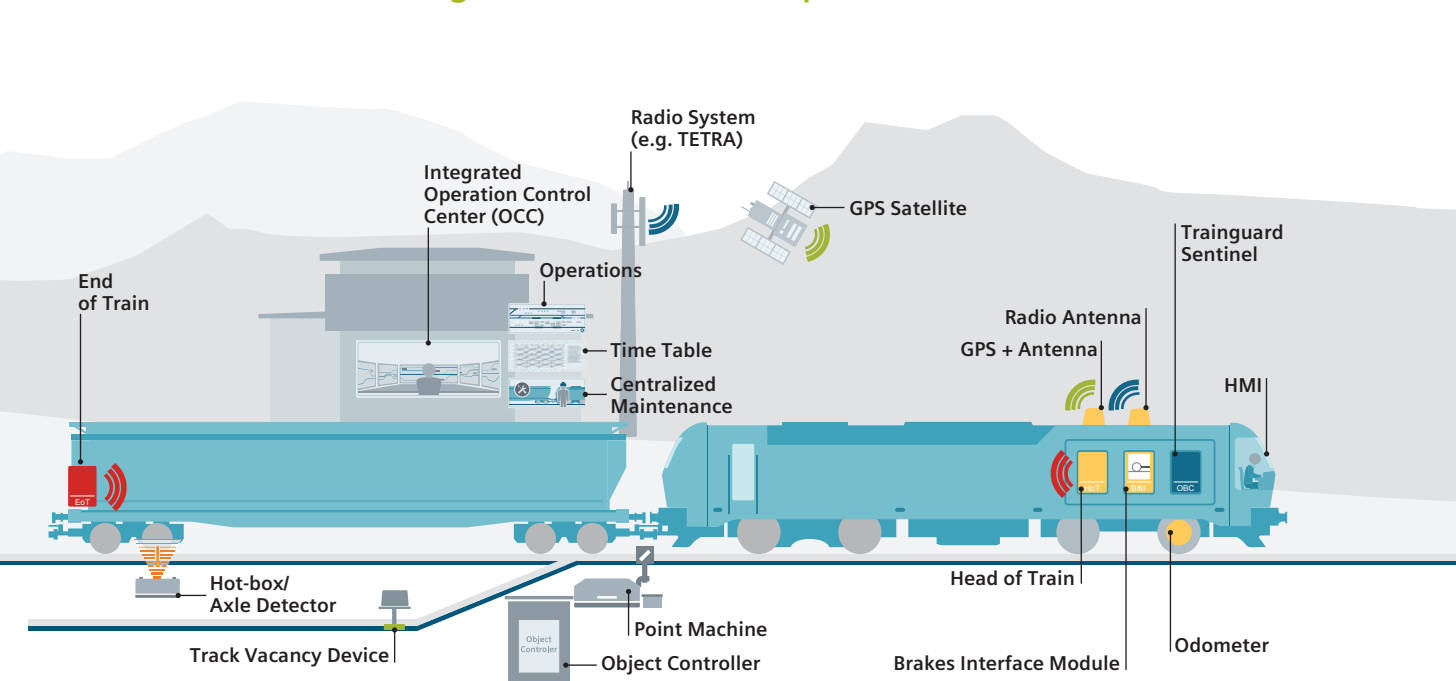
Control with the OCC integrated solution



Additional benefits

- Increase of safety thanks to the use of track warrants (movements authorities management)
- Possibility of establishing/removing temporary speed restrictions
- Train position and train data shown in OCC

Control with the OCC integrated solution and options



Additional benefits

- Safety level increased through interlocking functions, e.g. point machine position detection
- Hot-box/axle detection system
- Derailment detection system

Automate your business to maximize results

Process enhancement

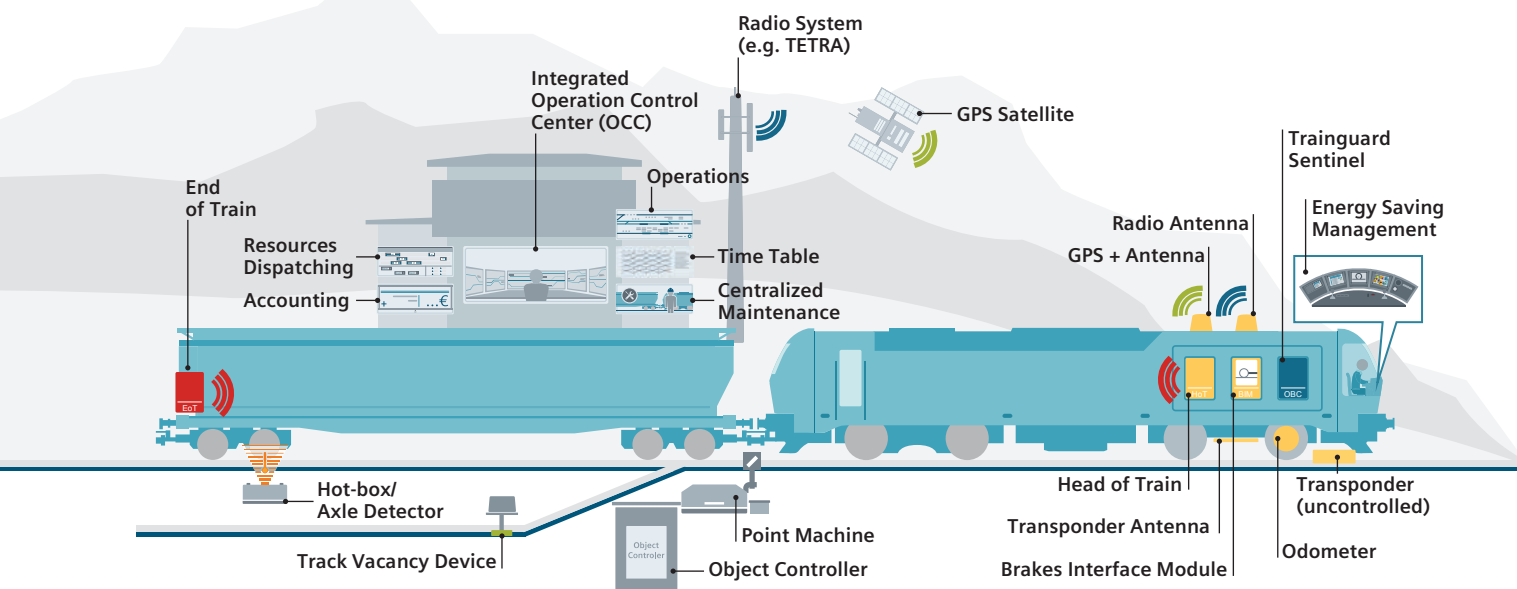
Trainguard Sentinel offers scalable upgrades to continuously maximize business results. In the area of automation, Siemens Trainguard Sentinel helps to optimize not only train control processes but also further business operations to reduce costs, minimizing inefficiencies and eliminating failures.

Trainguard Sentinel can also be configured for tunnels and underground operations.

The optional operations management solution allows the integration of train control into the production and logistics chain of the operator.

This solution improves management of both the fleet and staff. The OCC also offers the option to monitor and enhance the logistics, fleet, finance, and operations functions of the operator.

Accelerate with automation



Additional benefits

- Advanced energy saving management
- Management of fleet and crew
- Customized integration into operation, production, and logistic chains



Panama Canal Railway Company

The challenge

The Panama Canal is a legendary achievement in engineering and global freight transport. Today, it has almost been forgotten that long before the canal was built, a railroad was constructed: In 1855, a single track train connected the Atlantic and Pacific Oceans for the first time. Through decades of change, the train kept on running. In 2014, the Panama Canal Railway Company (PCRC) handled over a hundred thousand containers, while commuter and tourism passenger service complemented the container moves.

The evolution of PCRC continues with Siemens. The original Gen I system had more than seven years of revenue service. The main goal was to further optimize fuel consumption, make train handling more uniform, and help prevent accidents.

The solution

So far, the PCRC has operated on 70 mph passenger and 60 mph freight trains. The proposed solution was a conversion to a 60 mph passenger and 55 mph freight train speed. The implemented material included 136 lbs of welded rail, concrete ties on granite ballast, four remote-controlled mainline switch machines, CTC Class switches (all solar powered), and three hot-box detectors. Enabled by the Siemens Trainguard Sentinel solution, the people of PCRC can now focus even more on what they do best.

The benefits

On the 47.6-mile track with mundane day-to-day operation, which is susceptible to lapses in concentration, Siemens Trainguard Sentinel provides real-time and positional feedback immediately when mistakes are made. The new system improves situational awareness and operation decisions, especially in inclement weather and poor visibility. It provides assurances that all crews operate under the same rules and oversight, slowing down the speed merchants and making drivers more consistent.

In addition to a very good acceptance by train crews, the results after three years speak for themselves:

- Tens of thousands of track warrants executed
- Hundreds of penalty brake applications
- No overruns of authority limits by any equipped train

With Siemens, the legacy of the PCRC continues.





Tasmania Railway

The challenge

The economy of Tasmania, the island state south of Australia, largely depends on its railway. The narrow-gauge lines are operated by TasRail, transporting various commodities such as cement or coal as well as containers. While passenger service ceased decades ago, freight trains are crucial for connecting the mining and forestry operations on the west coast and in the northwest.

Until January 2015, the signaling system was still paper-based and required considerable human interaction, making it vulnerable to human error and a relatively high number of safe-working breaches.

The solution

TasRail decided to implement Advanced Network Train Control System (ANCS) using Siemens Trainguard Sentinel. The GPS-based system is supported by a digital data radio network that ensures significant additional safeguards for both rail movements and track maintenance activities. It provides improved visibility of network occupation, combined with alarming of potential occupation or breaches in speed.

The system operates across the entire network, representing the largest-ever change to rail freight operations in Tasmania.

The benefits

Siemens Trainguard Sentinel enables TasRail to deliver efficient and competitive freight solutions:

- Reduced risk of errors, collisions, and safe-working breaches with a fully automated system, providing train controllers with a convenient working environment
- Improved speed compliance with alerts for driver and train controller; recording of speed and location data
- Enhanced management and monitoring of work by streaming the transmission and authorization of network access authorities
- Increased productive track access time, enabling efficient infrastructure maintenance and upgrades as well as fuel savings
- Operational efficiency thanks to improved freight movements and reliability
- Possibility to introduce “track and trace” data for customers

The Tasmania railway now boasts one of the most innovative train control systems in Australia.

Mozambique- Nacala Rail Corridor

The challenge

Mozambique's untapped reserves of coal are among the world's largest. By 2020, production could reach 100 million tons per year. But the country was torn by civil war and still lacks a reliable infrastructure to profit from its natural richness.

In 2013, Siemens was selected to be part of a major project known as the Nacala Corridor. The goal was to build up the infrastructure from the mining town of Moatize to the port in Nacala. At 912 km, it is East Africa's longest rail stretch for freight traffic, running across Mozambique and Malawi.

The solution

The client Vale's ambition was to increase the transport capacity of freight from pit to port. Siemens was commissioned to provide the solution for the single-line railway, which includes three line branches. The technical solution was based on proven hardware and software platforms, customized to fulfill the demanding requirements of mining railway applications and the tropical climate. Siemens provided the Trainguard Sentinel Positive Train Control (PTC) system, train integrity monitoring, Westrace-type solid-state interlockings, a telecommunication system based on a microwave network, a Tetra system for track-to-train data transmission, and the operations control center in Nacala.

The benefits

The system enhances safety, reliability, and capacity of the coal transportation, permitting more frequent trains. At the start, 92 locomotives and 2,328 railcars will be in service, transporting some 18 million tons of coal per year to Nacala.

The automated system calculates the optimum speed and headway between trains based on the line data. This enables the railway operators to increase network capacities by minimizing headway and ensuring energy-efficient operation.

The train control is the brain of the system and enables track warrants from route requests and work-between authorities. Further functionalities are temporary speed restrictions, maintenance-of-way authority, track bulletins, or text messages. The system facilitates event logging and playback, fault tolerance via disk mirroring as well as automatic and manual route setting. Crew and train consist data, dispatcher handover, and hours of service can be conveniently managed.

Siemens' contribution boosts the coal industry as an engine of economic growth in Mozambique.



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