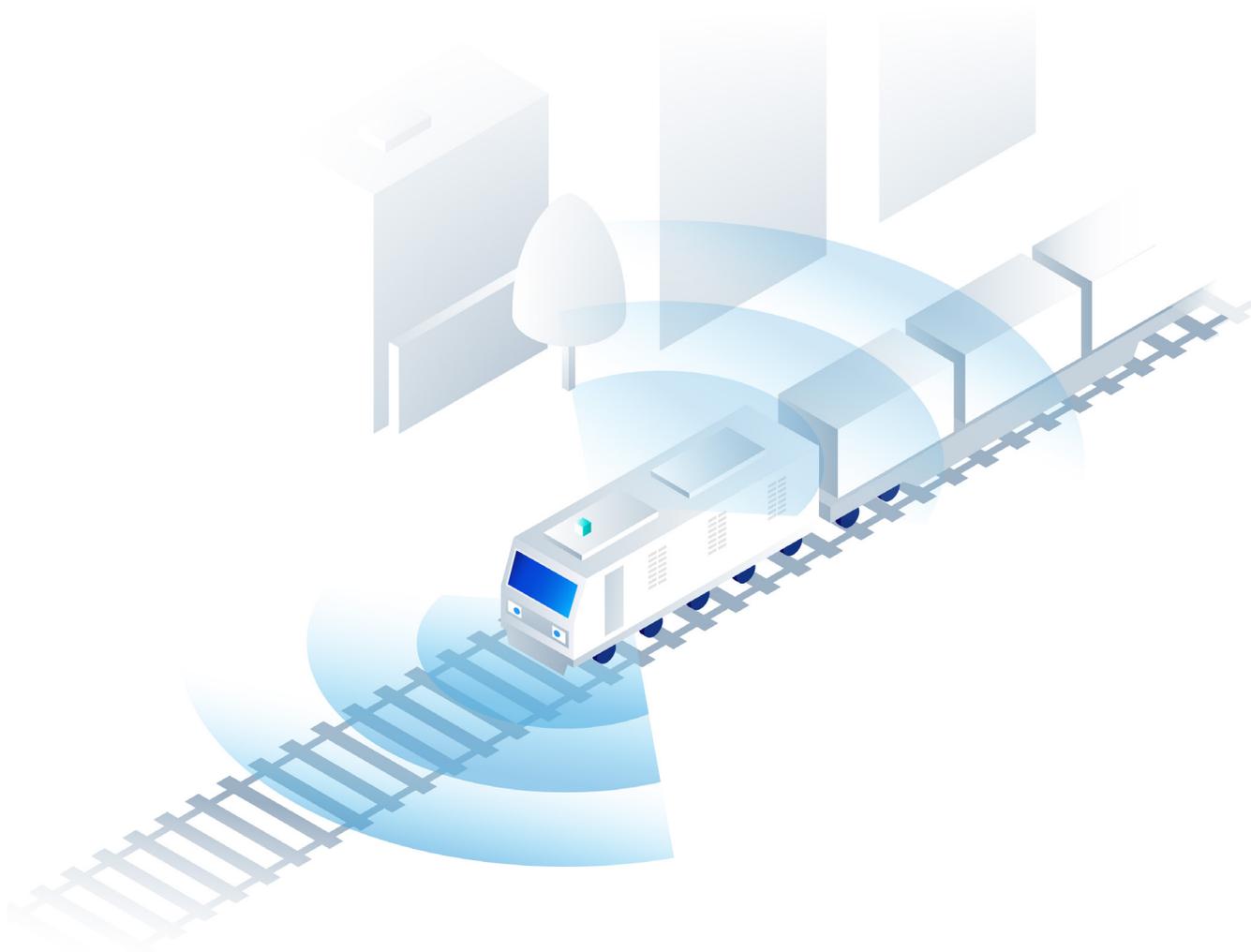# 4Sight™ Lidar for Rail

4Sight™ Lidar for Rail

Safety, efficiency and performance are critical to the rail sector's continued growth. With rail freight movement on an upward trajectory, these pressures will only rise. Implementing perception sensors – such as lidar – that can help identify safety issues, lower risk, improve operations and make rail more competitive, will be critical in the coming years. This is true across the supply chain: Trucking companies, local delivery services and ports are already incorporating lidar technology into their sensor suite to improve safety and efficiency. However, not all lidar systems are created equal, and it's important to understand how these systems work to achieve optimal benefits in the rail industry.

Why Lidar?

Conventional sensors alone, such as cameras and radars, can not meet the complex needs of the rail industry, as they have considerable limitations that can present significant operational challenges. For example, not only are cameras limited to 2D-detection without the ability to provide accurate depth and distance information for long range, but its detection capabilities are often challenged in absence of light (such as at night), in tunnels, and in adverse weather conditions. Meanwhile, radar inherently has low reliability when it comes to detecting stationary objects, and low resolution to enable accurate classification.

Lidar bridges the gap created by cameras and radar, complementing and improving upon existing sensing solutions. Lidar's long range capabilities, ability to provide highly accurate 3D spatial data, and its reliable performance in all lighting and weather conditions makes it a critical sensing modality to add to your sensor suite. Lidar uses lasers to understand where objects exist in 3D space, enabling autonomous systems to safely navigate their surroundings. Unlike cameras and radars, lidar is a deterministic sensor that precisely identifies and locates objects to centimeter-level accuracy and can be used to map out and navigate complex environments, as well as classify objects and provide precise location, velocity, and trajectory information. Lidar is the most reliable perception sensor, with the ability to capture high quality information in the near-range, at distances greater than 250 meters, and across a wide field of view (FOV).

Not All Lidar is Created Equal

Legacy lidar systems have significant limitations, as they were not made to meet the railway industry's complex requirements or support the development and implementation of new features: they do not have the long-range detection or classification capabilities needed to alert a train in time to prevent a trackside incident, nor the agility to switch from one use case to another. In many instances, they also produce an immense amount of extraneous data that can slow the system. Most importantly, because of their mechanical nature, legacy lidar sensors are unable to meet the shock and vibration requirements of the rail industry.

AEye's 4Sight Lidar Addresses Perception Sensor Challenges

AEye's goal is to create a smarter and safer world for all of us. Our **4Sight™ Intelligent Sensing Platform** is a software-defined lidar solution that leverages artificial intelligence to better locate, identify and track objects over time. 4Sight captures better, more precise data, allowing for faster, more accurate, and more reliable perception. This early detection means better decisions can be made—enabling us to deliver precise measurement imaging to ensure safety and performance.

4Sight: Accuracy and Precision

4Sight is designed to ensure that more accurate and precise information is used to drive decisions that improve overall safety, efficiency, and maintenance for the entire railway system:

- Enables faster, more accurate and reliable perception at long range
- Reduces/eliminates false positives
- Performs multiple use cases simultaneously
- Detects small changes or deformations in the assets
- Provides dynamic scan patterns to meet diverse conditions

AEye's 4Sight for Railway Applications

4Sight provides accurate, real time detection generating the most actionable and precise data to support a wide range of railway applications. It boasts the industry's only solid-state, high-performance, adaptive lidar which enables the customization and performance of scanning parameters for every use case:

- Grade crossings
- Asset inspection (track, catenary wires, bridge, and tunnel)
- Collision avoidance
- Vegetation inspection
- Trackside mapping
- Monitoring (platform, passenger flow and construction sites)
- Shunting
- Mapping

How 4Sight Lidar Achieves Application Requirements

Grade Crossings

The United States has over 200,000 grade crossings—the intersections where road and track meet—and were once the rail industry's leading cause of injuries and fatalities. Now, thanks to the implementation of new practices and technologies, the number of fatalities and injuries at grade crossings decreased by roughly 40% from 2001 – 2011 (**Source: Federal Railroad Administration**). However, according to recent data, fatalities at grade crossings increased by 21% from 2020 to 2021 (**Source: National Safety Council**).

In order to ensure and improve safety, researchers and transportation agencies around the world are now deploying fixed mounted lidar sensors at grade crossings for highly accurate object detection—such as identifying pedestrians, stuck vehicles or trapped road users on the track.

In addition, in 2013, the FRA tested a lidar-based system mounted on its research vehicle to perform routine assessments of grade crossings, resulting in the collection of critical data that was used to "improve feature detection algorithms to enhance automated processing" (**Source: Federal Railroad Administration**). The study also revealed that using a lidar-based system drove down the overall cost of these routine inspections, as compared to a ground-based inspection that required trained surveyors.

With safety as the highest priority, AEye's 4Sight lidar sensor is a critical component to any grade crossing application, and can be optimized for any use case: from long range object detection to inspection. 4Sight can achieve the industry's longest small object detection range, mitigating the risk of collision at a grade crossing by triggering warning alarms. And, because 4Sight's software-defined architecture enables flexible integration options, the same lidar sensor can collect the highest quality data whether it's mounted on an active service locomotive, on an inspection car or train, or fixed mounted at a grade crossing.

Asset Inspection

Asset inspection—such as track, catenary wires, bridge, and tunnel—is a critical application for driving improved safety. Not only is monitoring the track and surrounding areas crucial for detecting immediate danger, it's equally important to monitor the vegetation over time, so possible obscurants are dealt with in a timely manner. In order to enable asset inspection for railways, a perception sensor must be able to focus on high-interest areas in the short range, as well as provide high definition scanning to detect small changes or deformations in the assets over time.

4Sight is railway's only sensing solution with triggered performance modes that can adjust range, resolution, field of view, and frame rate, and can be optimized for any application, use case or complex requirement.

A single 4Sight lidar sensor can be used for asset inspection at high speeds, or low-speed passenger monitoring in dynamic environments such as stations, making it the most adaptive and cost-effective sensor solution for rail.

4Sight Unique Features

- Library of optimized performance modes designed for any railway application or use case
- Intelligently identifies Regions of Interest (ROIs) to collect the highest quality data at the required frame rate to match train speed
- Proven solid-state reliability to sustain high shock and vibration in any environment
- Deploys high resolution ROIs for small object detection (200-600 meters)

Unique Rail Mounting Options

- **On active service locomotive**
  For real-time hazard detection and monitoring
- **On inspection cars or revenue trains**
  For mapping and asset survey
- **On station infrastructure**
  For passenger flow and safety monitoring
- **On yard inspection location**
  For railcar monitoring and counting
- **On fixed mount**
  For geo-fenced right-of-way monitoring and security
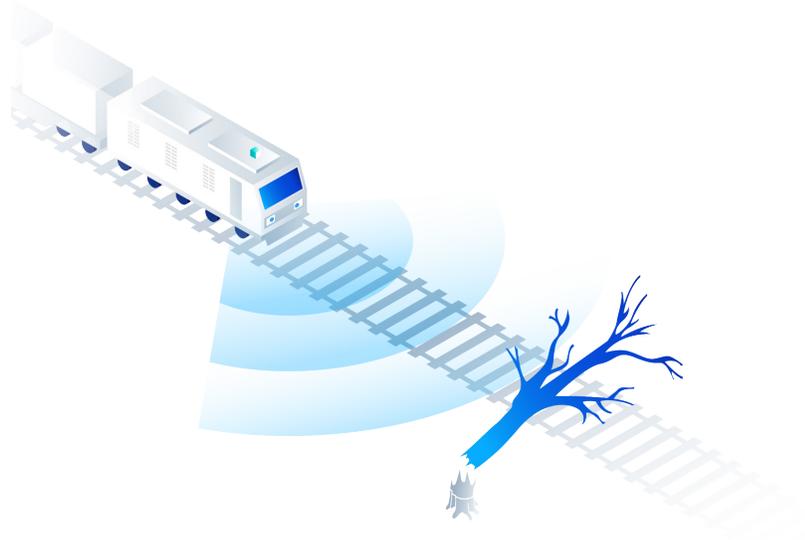
Optimized for Railway

AEye's 4Sight defines the future of railway sensing solutions.

- **Easy to use and deploy** – Easy to operate, low maintenance cost, simple installation, and commissioning.
- **Avoid development uncertainty** – Software-defined lidar sensor optimized for railway application needs.
- **Ultra long-range performance** – The most advanced sensor technology to scale down existing sensing solutions.
- **Flexible integration** – High versatility regarding sensor mounting options.

About AEye

AEye's unique software-defined lidar solution enables advanced driver-assistance, vehicle autonomy, smart infrastructure, logistic, rail and off-highway applications that save lives and propel the future of transportation and mobility. AEye's 4Sight™ Intelligent Sensing Platform, with its adaptive sensor-based operating system, focuses on what matters most: delivering faster, more accurate, and reliable information. AEye's 4Sight™ products, built on this platform, are ideal for dynamic applications which require precise measurement imaging to ensure safety and performance. AEye has a global presence through its offices in Germany, Japan, Korea, and the United States.