HEXAGON

White paper

Enhancing railway safety and security with LiDAR-based technology

Introduction

As rail networks become more complex and urbanized, and even move toward autonomous (driverless) transportation networks, ensuring the safety and security of passengers, personnel and infrastructure has never been more critical. Railway safety involves the detection and mitigation of hazards in both operational and public access areas such as platforms, tracks, tunnels and depots. Human errors, unauthorized access and overlooked objects contribute to service disruptions and, more critically, accidents.

However, traditional monitoring tools, such as CCTV and infrared sensors, are often limited in performance under adverse conditions. And conventional detection technologies face challenges such as low-light performance, occlusion and false positives.

The adoption of 3D LiDAR technology addresses these challenges by providing robust, all-weather and high-resolution sensing capabilities that support real-time decision-making. LiDAR enables transformative solutions for real-time, high-precision object detection and situational awareness in railway settings. LiDAR-based systems significantly enhance railway safety through intelligent monitoring, environmental adaptability and seamless integration into automated control systems.

LiDAR: Why it's important for railways

LiDAR is a remote sensing technology that emits laser pulses and measures the time for the reflected signals to return to generate a 3D point cloud of an environment.

This spatial data enables:

- High-precision object detection (centimeter-level accuracy)
- Real-time movement tracking
- Environmental mapping, even in visually obstructed conditions

Its strengths over traditional technologies include:

- Operation in total darkness or poor lighting
- Resistance to adverse weather such as rain, fog and snow
- Capability to monitor complex geometries like curves and elevation changes

Risk scenarios and safety challenges in railway environments

Railways operate in open, dynamic and highly trafficked environments. Several high-risk situations and threats challenge the performance of traditional safety systems:

Unauthorized intrusions

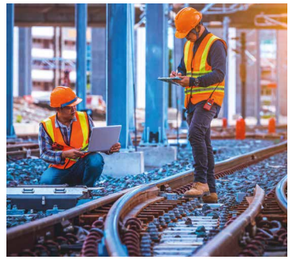
- Trespassing in restricted track areas
- Children or animals in operational zones control
- Vandalism or self-harm attempts

Objects on tracks

- Luggage, tools, debris
- Fallen branches or vehicles at crossings

Passenger behavior at platforms

- Standing too close to edges
- Accidental falls
- Overcrowding during peak hours



Maintenance and worker safety

- Personnel in unsafe zones
- Lack of visibility during maintenance

Environmental conditions

- Poor weather
- Challenging lighting conditions (darkness, glare)
- Visual blind spots

Infrastructure limitations

- Incomplete camera coverage
- False positives from environmental noise

HxGN dC3 LidarVision

HxGN dC3 LidarVision, part of the HxGN dC3 physical security portfolio, is an advanced 3D surveillance software solution based on volumetric detection technology. It uses modern 3D LiDAR sensors to visualize threats in a digital representation of reality – a digital twin.

It addresses the above risks through its core capabilities:

- Real-time 3D object detection
- Volumetric analysis for size-based intrusion detection
- Object-on-track monitoring
- Loitering and proximity alerts
- Worker protection zones
- Zone-based logic and redundancy features
- Integration with control systems via APIs and command interfaces
- Support for simulation-based planning and BIM modeling

HxGN dC3 LidarVision combines operational resilience with technological innovation, making it a strategic asset for railway safety.

Bridging reality and innovation: This LiDAR-generated 3D twin mirrors the real-world scene, highlighting a designated track-bed zone that triggers alarms if breached. The system also identifies a nearby individual as a person of interest, showcasing advanced detection and monitoring capabilities.

Advanced system capabilities for long-term reliability and future-proof automation

HxGN dC3 LidarVision enables accurate and reliable protection of train platforms and tunnel entrances, where traditional surveillance technologies fall short.

These capabilities ensure long-term reliability and readiness for future automation:

| System design

An effective LiDAR-based railway safety system using HxGN dC3 LidarVision includes:

- Redundant sensor layout
- Zone-based detection logic
- Sensor-agnostic architecture
- Standardized integration interfaces

| Integration with railway control and automation

HxGN dC3 LidarVision and all detection data can be integrated with central control and automation systems to trigger:

- Train slowdowns or stops
- Alarm systems and video feeds
- Time-synced event recording
- Semi or fully autonomous train systems

| Future readiness and upgradability

Ongoing developments of HxGN dC3 LidarVision include:

- Time-aware clustering
- Enhanced diagnostics and health monitoring
- Obstruction and packet loss detection

| Scalability and simulation-driven deployment

HxGN dC3 LidarVision supports deployment planning through simulation tools that use:

- BIM data
- Scenario testing
- Optimal sensor layout validation

HxGN dC3 LidarVision vs. traditional surveillance technology systems

When it comes to securing critical perimeters for railway operations, choosing the right technology is essential. The table below once again highlights the key differences at a glance, showcasing how LiDAR-based technology offers a modern, more effective approach to perimeter security compared to conventional methods.

Feature	Traditional systems	HxGN dC3 LidarVision
Visibility in darkness	Limited	**Full functionality**
Weather resistance	Variable	**High reliability**
Object classification	Low spatial precision	**High precision**
False alarm rate	Moderate to high	**Low**
Environmental awareness	2D	**Full 3D map**
Automation readiness	Manual dependent	**Automation compatible**

| Explore HxGN dC3 LidarVision

Hexagon is the global leader in precision technologies at any scale. Our digital twins, robotics and AI solutions are transforming the industries that shape our reality.

Hexagon's Safety, Infrastructure & Geospatial division improves the resilience and sustainability of the world's critical services and infrastructure. Our solutions turn complex data about people, places and assets into meaningful information and capabilities for better, faster decision-making in public safety, defense, transportation, government and physical security.

Hexagon (Nasdaq Stockholm: HEXA B) has approximately 24,800 employees in 50 countries and net sales of approximately 5.4bn EUR. Learn more at hexagon.com and follow us @HexagonAB.