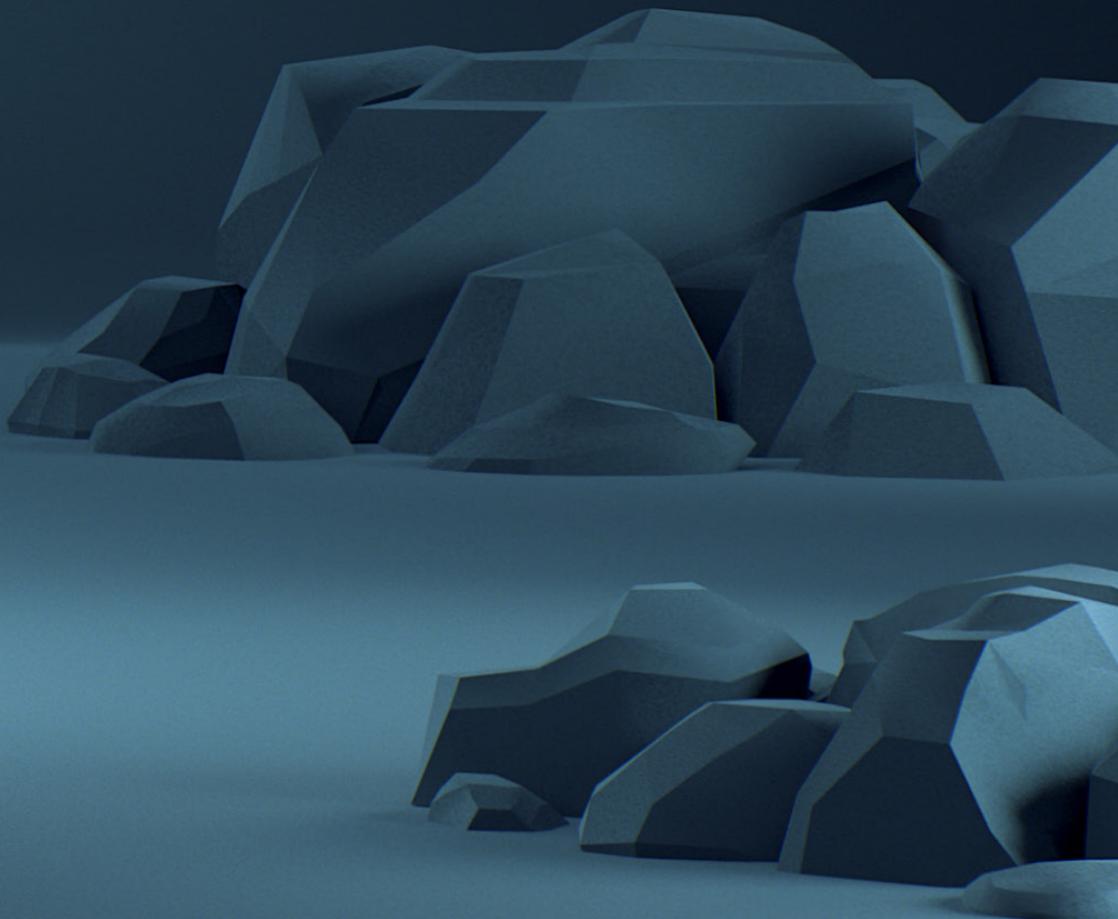


LinkOA: Open Autonomy

OEM-agnostic automation platform for surface mining operations



Automation without limits

For too long, mining companies have been locked into proprietary automation that limits flexibility and potential. LinkOA changes that.

As a scalable, OEM-agnostic automation platform, it enables any machine to work together seamlessly, regardless of make or model. By retrofitting existing equipment, LinkOA unlocks efficiency, control, and the freedom to scale without restrictions.

It's time to break free!



Modular and scalable

LinkOA is designed to integrate seamlessly into mining operations, providing a modular approach that allows mines to adopt only the needed applications. This flexibility ensures that operations can scale automation over time, incorporating new technologies as requirements evolve.

Unlike traditional automation systems, LinkOA supports manual, teleremote, and fully autonomous haulage, enabling a smooth and gradual transition to increased automation. Whether enhancing existing fleets or implementing new autonomous solutions, LinkOA provides the flexibility and scalability to meet operational demands.



Main benefits

OEM-agnostic

Automate any machine, regardless of make or model, and manage them as a unified fleet.

Productivity

Reduce downtime, optimize fleet efficiency, and enhance operational control with intelligent automation.

Retrofittability

Upgrade existing equipment with automation kits, eliminating the need for new machine investments.

Safety

Remove personnel from high-risk environments, improving safety and reducing exposure to hazards.

Scalability

Expand automation at your own pace, adding modules as operations grow and technology advances.

Future-ready

LinkOA adapts to emerging and future energy sources for seamless adoption.

LinkOA for Drills

Autonomous drilling, safe and simple

Operators gain the tools they need to optimize their drill fleet with LinkOA for Drills, leveraging advanced automation and digitalization for a more productive and accurate operation, while ensuring real-time awareness through intuitive dashboards.

Its interface delivers critical information for both day-to-day tactical decisions and long-term strategic planning, ensuring continuous optimization of drilling operations.



With actionable insights and live data, users can respond faster and make more informed decisions, improving efficiency and overall fleet performance.



LinkOA for Blasting

Safety first, efficiency always

LinkOA for Blasting enables teleoperated, Semi-Autonomous, and fully autonomous navigation of blast vehicles, including blast factory and stemming trucks.

Designed for seamless integration, it works with various third-party payload providers to automate the deployment of blast mediums and initiation systems, ensuring precision and efficiency in blasting operations.



LinkOA for Blasting gives users the ability to control blast trucks via TeleOp, Autonomous and Semi-Autonomous options when conducting multiple hole drilling/grid missions.

Coordinated drilling and blasting

Synchronize Drilling and Blasting Operations

Potential integration of blasthole characteristic data such as seam and geology aspects of each hole allow dynamic blast charging and detonation timings during the blast cycle.

By dynamically tailoring the blast process based on actual, "As-Drilled" hole data, blast processes can achieve higher efficiency and increased fragmentation. The resulting benefits ultimately include less impact on excavators, crushers, grinders, and even more efficient haulage.

LinkOA for Haulage

Safety, productivity and freedom

LinkOA for Haulage automates new or existing fleet assets, regardless of make or model, giving mines the flexibility to operate without being locked into a single vehicle provider.



+ Improved safety, reduced damage

Increase safety by removing operators from harm's way. Reduce damage by precision control and improved driving characteristics.

+ Increased equipment utilization

Eliminate the need to stop equipment for breaks and shift changes to increase the utilization of each vehicle.

+ Increased productivity

Machine control on vehicles squeezes productivity gains from various sources including more efficient spotting, driving behaviors, and real-time information flows.

+ Reduced cost per ton

By controlling multiple vehicles in a single control room, and managing vehicle operations in a consistent manner, mine operations can realize a significant reduction in labor, fuel and maintenance costs.

+ Better asset management

Autonomous haulage allows for programmable operation of vehicles within OEM operating parameters. By better tracking and controlling vehicle operations within prescribed limits, asset life can be extended, including areas such as tires, brakes, and other components.

+ Mine plan optimization and mine design

Regulations imposed for human operations restrict flexibility in mine design. By removing humans from the mine, operators have increased freedom to alter mine designs in areas such as road widths or wall heights which can greatly reduce overburden removal costs.



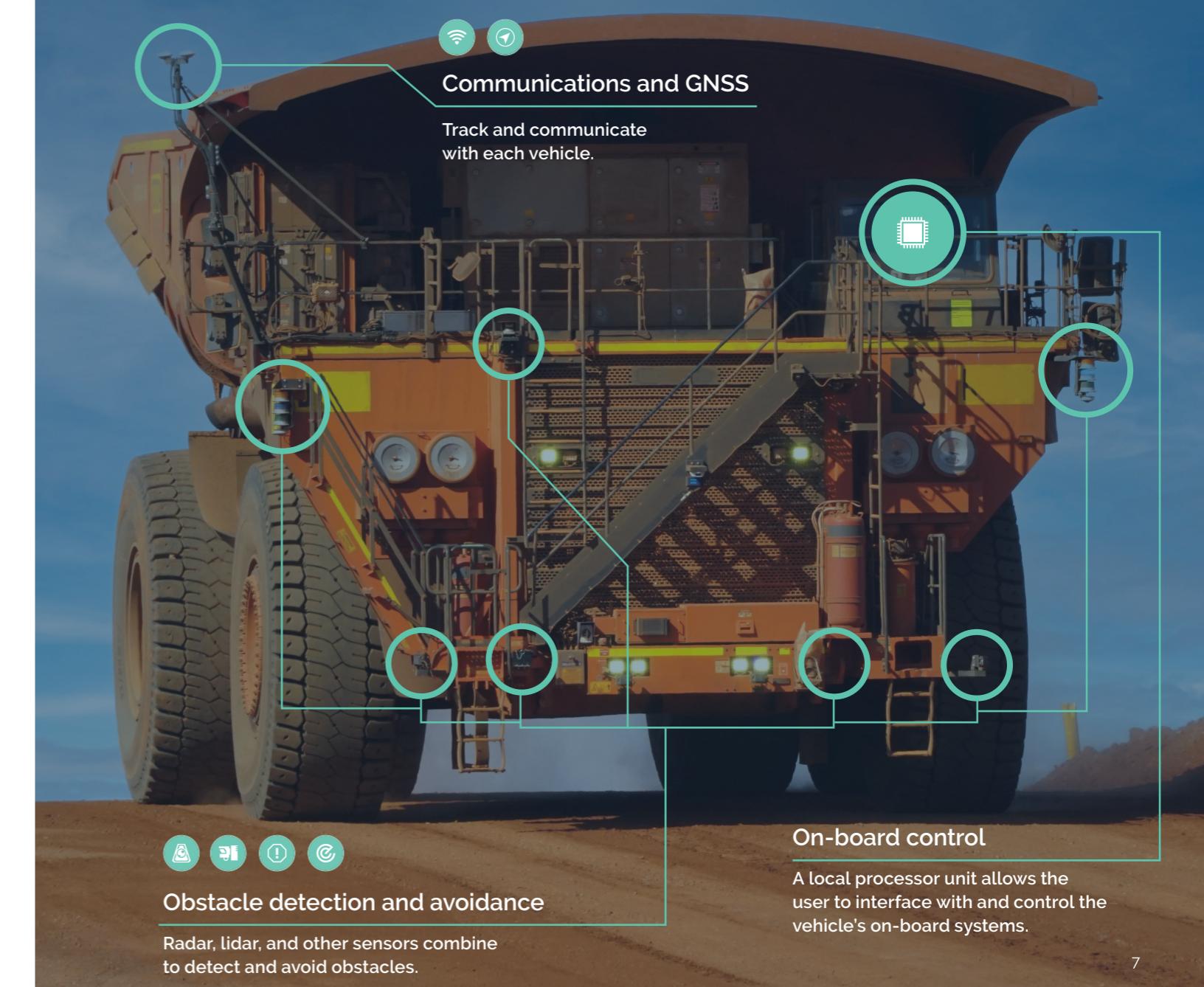
OEM-agnostic / Retrofittable

Automate your existing fleet

Epiroc retrofits existing haul trucks and equipment to run on the LinkOA platform, offering a practical and scalable path to automation. Instead of replacing entire fleets, operators can retrofit or replace vehicles as needed, basing purchase decisions on performance, not OEM system dependence.

At the core of this transformation are two key components: the Vehicle Automation Kit (VAK) and the Drive-By-Wire (DBW) system. The VAK equips trucks with GPS, radar, lidar, and additional sensors that enable obstacle detection and full situational awareness. The DBW system electronically controls steering, braking, and throttle, allowing the truck to drive without human input in the cab.

This Open Autonomy approach gives mines the flexibility to automate older and mixed fleets, extend the life of existing assets, and maintain legacy FMS and infrastructure—without costly, large-scale replacements or upgrades.

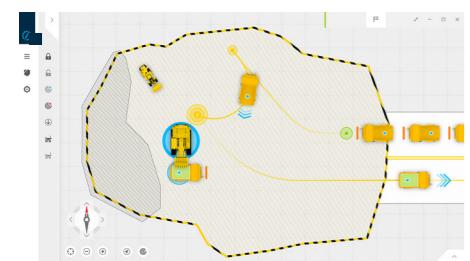


LinkOA for Staffed Vehicles

Safety in motion, always connected

Safety and situational awareness are critical in mixed-fleet mining environments where autonomous and staffed vehicles operate together. LinkOA for Staffed Vehicles enhances safety by providing real-time tracking and proximity monitoring for all mobile assets on-site, ensuring seamless coordination between staffed and autonomous equipment.

Staffed Vehicle locator clients



All manually operated vehicles inside the designated Autonomous Operating Zone (AOZ) are fitted with a Locator Client. These devices provide the vehicle's location to LinkOA at all times and enable safe interaction between manned and unmanned vehicles.

Each Locator Client provides a visual display to the manned operator and interaction with LinkOA using one of three LinkOA In-Cab Clients.

Aware clients (Basic)

- Display a map
- Vehicle motion
- Vehicle paths
- Vehicle lock
- Shape locking
- Regional stop

Interactive clients

All Basic Client functionality plus:

- Ability to modify shapes in LinkOA independent of the control room
- Modifying road grades

Loader Interactive Client

All Basic Client functionality plus:

- Enables loader operator to set spot points and kick and call vehicles.

Supported Vehicle Types	Locator Type	Product Name	Client Features
Locators for Light Vehicles (LV)	Aware	LV Aware	Base Features
	Interactive	LV Interactive	Base + Mapping
Locators for Heavy Duty Vehicle (HDV)	Aware	HDV Aware	Base Features
	Interactive	HDV Interactive	Base + Mapping
Locators for Loaders (used for loading autonomous vehicles)	Interactive	Loader Interactive	Base + Mapping + Loader

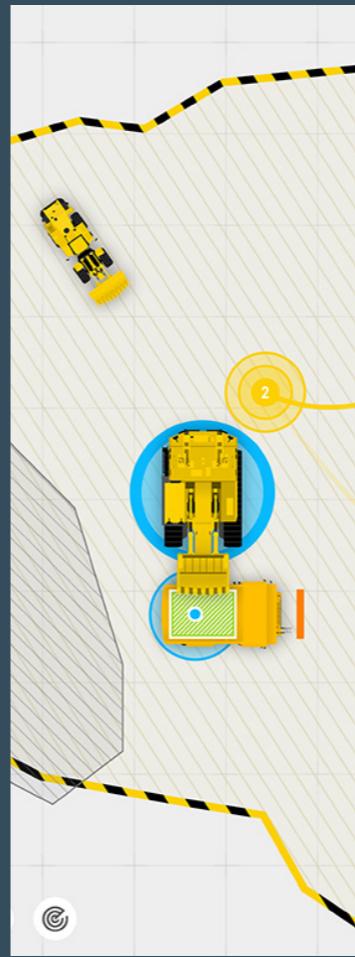
Recommended Application (Recommended Locator by Vehicle Type)	Base Clients		Base + Mapping Clients		Loader Clients
	LV Aware	HDV Aware	LV Interactive	HDV Interactive	
Excavator/Shovel/Wheel Loader (loading AHS)					✓
Excavator/Shovel/Wheel Loader (locator only)		✓			
Dozers (In Load/Dumps Zones)				✓	
Dozers (other)	✓				
Motor Grader	✓				
Water Cart	✓				
Service Trucks	✓				
LVs (Supervisor & Mappers)			✓		
LVs (other)	✓				

LinkOA for TeleRemote and Semi-Autonomous applications

LinkOA enables remote and semi-autonomous mining equipment operation, enhancing safety, efficiency, and precision while reducing operator exposure to hazardous environments. By integrating intelligent control systems, LinkOA allows operators to manage equipment remotely, automate repetitive tasks, and gradually transition toward full autonomy.

Through advanced path control, automated steering, and autonomous navigation, LinkOA optimizes fleet coordination and reduces reliance on continuous operator input. Operators can remotely guide equipment along predefined routes, set operational boundaries, and enable vehicles to autonomously reach destination points before resuming manual or teleoperated control.

These capabilities are integrated across multiple applications, enhancing key mining processes:



LinkOA for Dozers

Improves road maintenance and grading with semi-autonomous blade control and remote operation, ensuring precise material movement and reduced operator fatigue.

LinkOA for Loaders

Enhances truck spotting, queueing, and dispatching, improving cycle times, fleet coordination, and loading efficiency.

LinkOA for Excavators

Optimizes digging, loading, and material handling with remote operation and automated positioning, increasing accuracy and reducing downtime.

With LinkOA, mines can increase productivity, improve safety, and streamline operations by seamlessly integrating teleoperation and automation into their existing workflows.

LinkOA command and control software

Manage all aspects of a mine's basic operation

LinkOA is designed with modules that support multiple operations within the mine. As mines automate various operational stages over time, LinkOA allows seamless integration between each module, resulting in a fully-integrated autonomous mine spanning across all major operations.

LinkOA allows the user to command and control all autonomous vehicles in a mine as well as track all manned vehicles at the mine. This keeps all vehicles safe and on task.

LinkOA has user friendly vehicle icons with interactive and customizable maps to give the user an overarching view of the mine.

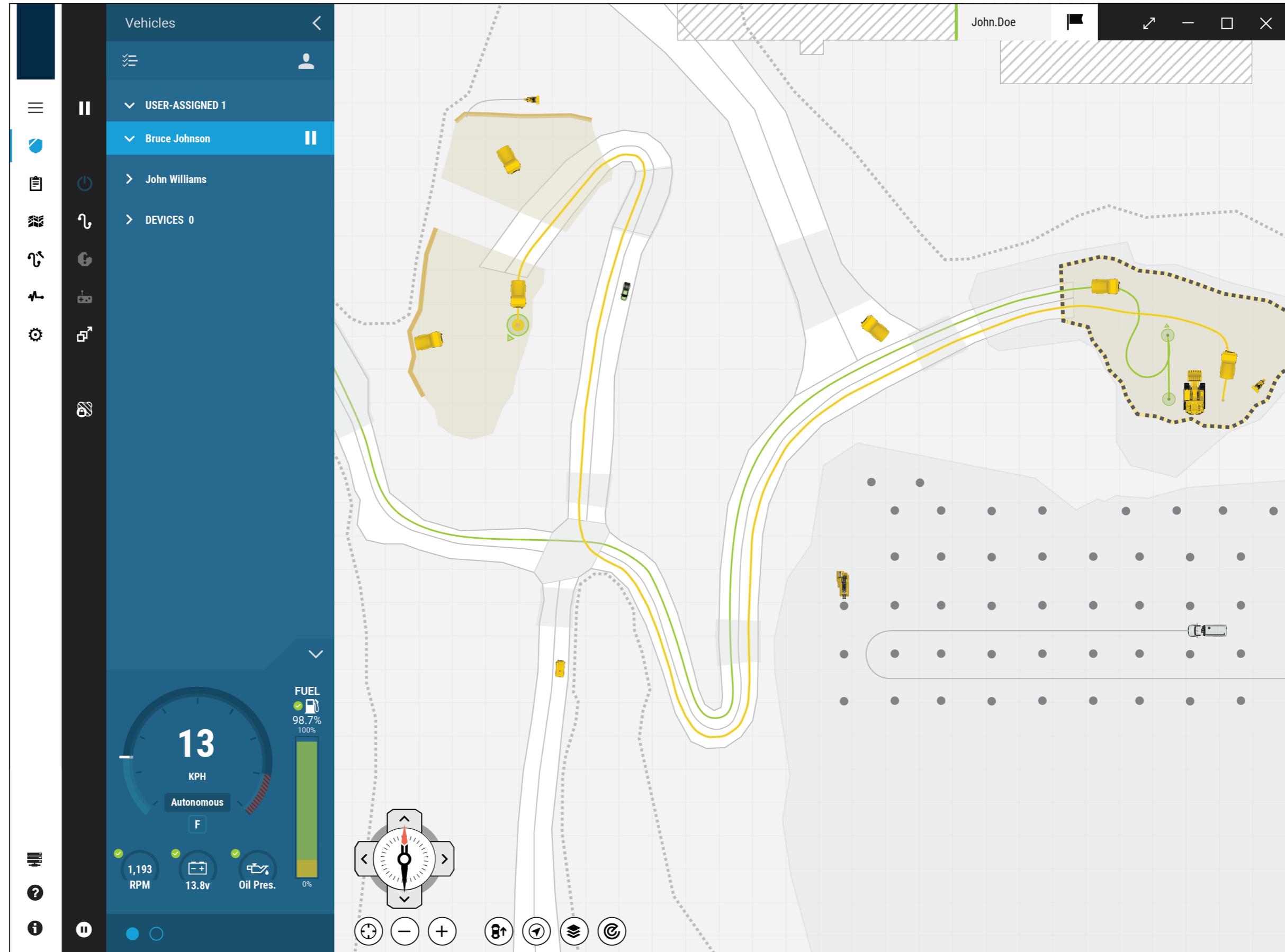
With LinkOA, the operator has complete understanding of where all vehicles are at any given time and what's being done.

The map includes roads, load zones, dumping areas and other custom locations, each with rules, properties and protocols set up according to user preferences.

Each vehicle is also interactive and provides telemetry back to LinkOA that is displayed in a gauge panel.

LinkOA uses the following to simplify the veritable complexity of a mine's operation:

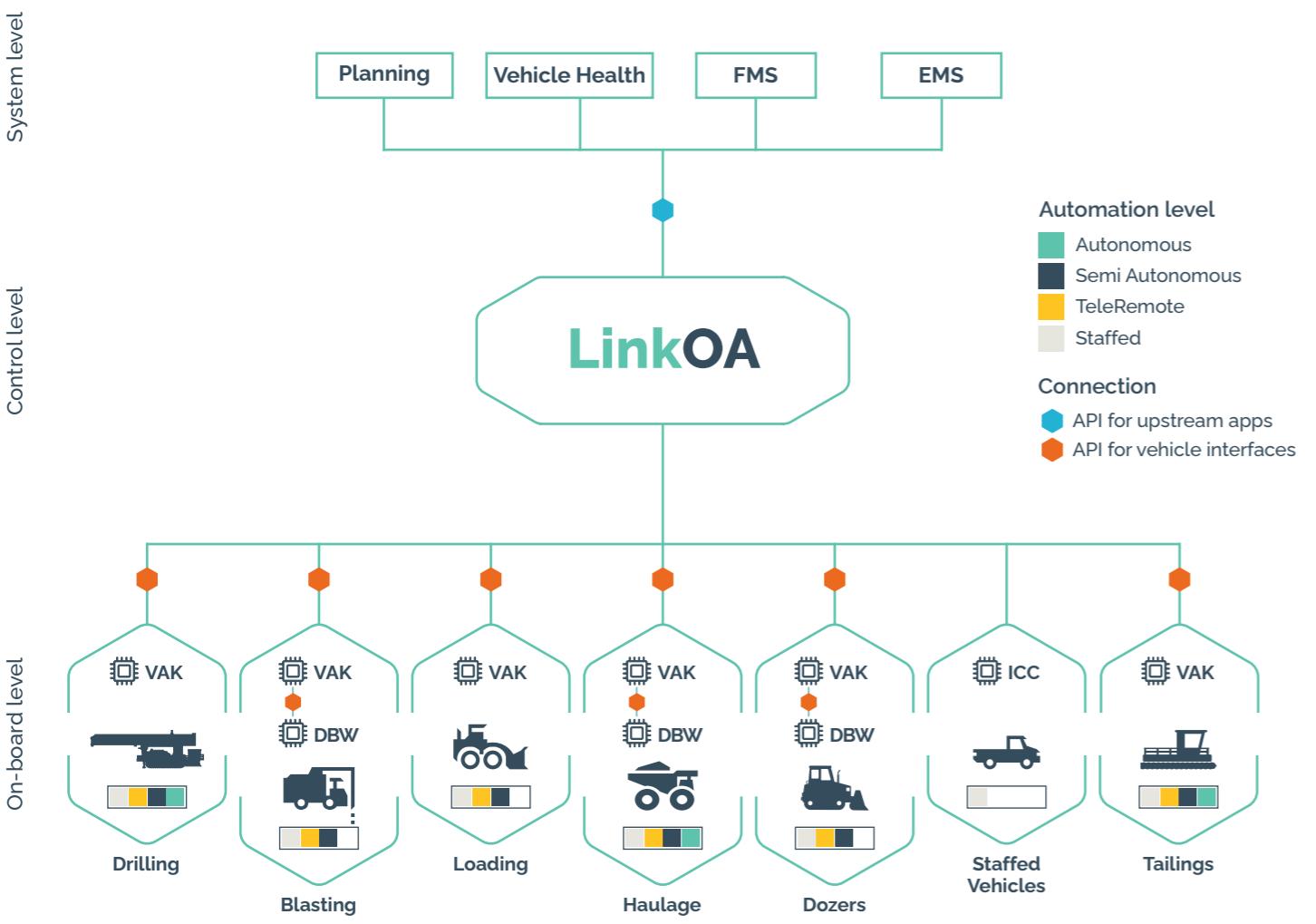
-  Algorithms for load, dump and driving operations
-  Enforcing road rules and safety regulations
-  Manage safe interactions with manned vehicles
-  Manage and coordinate traffic flow including Interactions (Choreography)
-  Control with other autonomous operations (TeleOp, Drills, Blasting, etc.)
-  Data and reporting
-  Exception handling



LinkOA System Architecture

Epiroc's flagship software, LinkOA, is the central intelligence of autonomous mining operations, seamlessly integrating with a mine's existing infrastructure. Designed for flexibility, it connects with any system-level controller and can function as a Fleet Management System (FMS) when required.

LinkOA coordinates vehicle movement through Traffic Management System (TMS) applications, ensuring efficient routing, collision avoidance, and optimized fleet performance. It tracks all vehicles in real time, providing situational awareness to staffed equipment via the In-Cab Client (ICC) while controlling autonomous vehicles through the Vehicle Automation Kit (VAK) and Drive-By-Wire (DBW) interface. This unified architecture allows staffed and autonomous machines to operate safely together, minimizing disruptions and maximizing productivity.



By enabling precise fleet coordination and intelligent automation, LinkOA enhances efficiency, safety, and decision-making, giving mines greater control over their entire fleet.



Automation with a proven track record



TeleRemote

1,957,347	639,902	17%
Total hours	Increased hours	
<i>This equals to 223 years</i>	<i>This equals to 73 years</i>	<i>Increase in average utilization</i>

Autonomous

138 Autonomous drills (In production operation)	35 Sites with Autonomous operations	50 Automated haul trucks	3.5 Million kilometers driven autonomously	188 Million tons hauled autonomously	650,000 Autonomous cycles completed	680,000 Hours without injury or fatality
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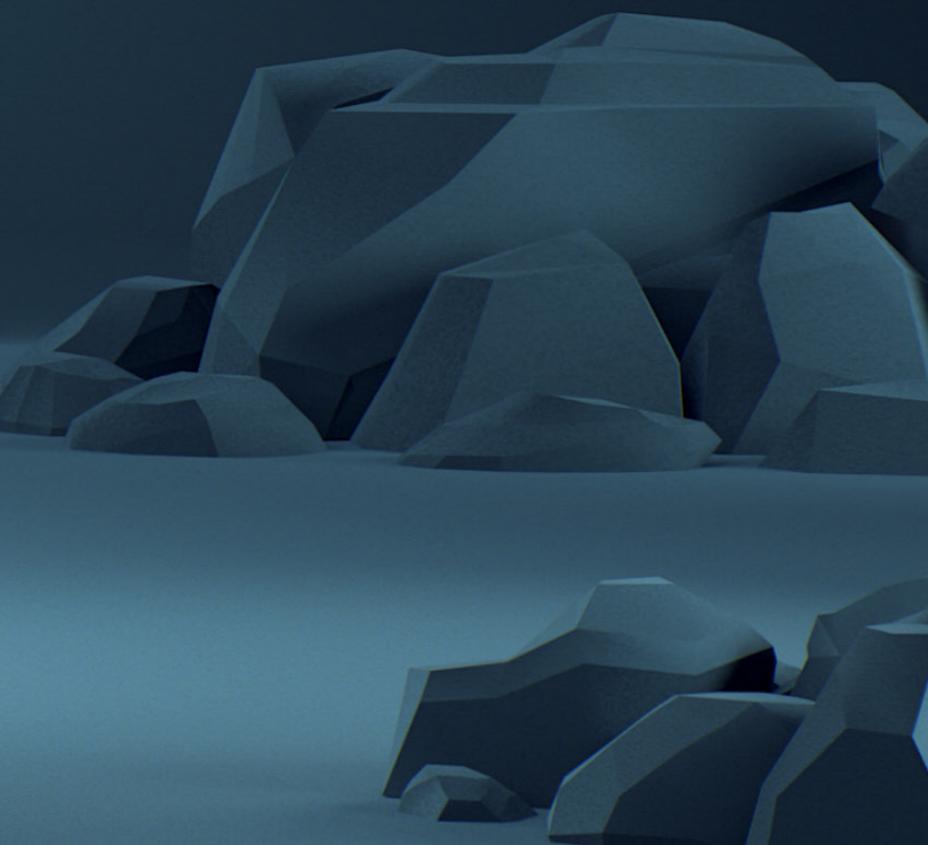
AutoDrill

21,175,402 Increased meters drilled	22% Increase in penetration rate	5,518,788 Meters of avoided overdrill	137,970 Hours saved drilling	60% Increase in spatial accuracy	85% Increase in depth accuracy	69,776,402 Meters drilled autonomously
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LinkOA
Open Autonomy



Scan and go to epiroc.com for more information



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Performance unites us, innovation inspires us, and commitment drives us to keep moving forward. Count on Epiroc to deliver the solutions you need to succeed today and the technology to lead tomorrow.

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