ferrous systems

Building a safe mixed-traffic mining system with Rust and Ferrocene

Case study: Kiteshield

Executive summary

Kiteshield is an industrial safety initiative formed in 2022 by two mining and metals companies, Boliden and LKAB, to address critical automation safety challenges in underground mining. Together with tech partners Mobilaris, Combitech, NXP, and Robotec, they are developing a safety system that enables mixed traffic, i.e. automated mobile machines and vehicles operating in the same area as manned vehicles.

The software is built entirely in Rust and compiled using Ferrocene, Ferrous Systems' open source, safety-qualified Rust toolchain, with the intent to create a safe, open source, mixed-traffic mining system certifiable to IEC 61508 (SIL 3).

Customer
Boliden and LKAB
(Mining and metals industry)

Challenge
Enable safe, certifiable mixed traffic in underground mines where automated machines and human-operated vehicles must operate together.

Solution
Kiteshield – an infrastructure-centric safety system written in Rust and compiled with the Ferrocene safety-qualified Rust toolchain.

Result
A certifiable, safety-focused, mixed-traffic mining system meeting IEC 61508 requirements.

The Challenge:
Improving safety at the intersection of people and autonomy

Across the mining industry, automation promises greater productivity and improved working conditions. Yet the transition is challenging. For the foreseeable future, manual vehicles and automated machines must share the same tunnels, ramps, and intersections in underground mines, coexisting in the same space.

Early trials have shown that edge-only solutions—where each vehicle makes independent safety decisions—cannot be proven to be safe. And existing "robot cell" technology, which isolates humans from automated machines, maintains safety but reduces productivity since maintenance, repairs, and manual operations require shutdowns, creating bottlenecks.

The Solution:
Kiteshield - Built on Rust, powered by Ferrocene

In 2022, Boliden and LKAB set an ambitious goal: to create an infrastructure-centric system capable of provably safe mixed traffic, with a clear path to certification. Together with partners Mobilaris, Combitech, NXP, and Robotec, they are tackling this challenge head-on, combining expertise in safety-critical embedded software, real-time positioning, and robotics integration to develop Kiteshield, a system designed to guarantee safe coexistence between man and automated machines.

Kiteshield does not seek to add complexity at the edge. Instead, it moves intelligence into the infrastructure, using ultra-wideband (UWB) technology for precise local ranging and timing and coordinating decisions across embedded devices and backend services. Every software component, from low-level drivers to high-level threat assessment, is written in Rust and compiled with Ferrocene, Ferrous Systems' open source, safety-qualified Rust toolchain.

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Rust was chosen for its memory safety, strong typing, and deterministic performance, all of which reduce the risk of errors that could compromise certification and enable safe operation on resource-constrained hardware. But building high-integrity software requires more than a safe language—it requires a certified toolchain. Ferrocene already comes with a subset of the Rust core library certified by TÜV SÜD for IEC 61508 SIL 2. In the near future, the certification will become available for more safety standards, increase the subset, and include more Rust libraries. Rust and Ferrocene have been central to the project's success, giving the Kiteshield team a reliable, auditable toolchain capable of supporting high-assurance industrial applications.

"We're building Kiteshield to make mixed traffic not just possible, but provably safe. Rust and Ferrocene give us the confidence to scale—from a single junction to an entire mine—without compromising integrity," said Peter Burman, Head of Boliden's Automation Program

Results and outlook

Kiteshield has established a robust platform for mixed-traffic operations, delivering high integrity, strong performance on embedded hardware. Thanks to Ferrocene, Kiteshield plans to extend its certification scope to SIL 3. Looking ahead, the initiative will refine an open standard for mixed-traffic safety, expand OS and tooling support, conduct additional field pilot tests, and explore applications beyond mining.

"Our customers initiated this journey. With Kiteshield as an open standard, the entire industry can mix automation and manual operations safely—not just in mines, but anywhere mobile machines are part of the process," said Peter Burman of Boliden and Johan Enback, Head of LKAB's Automation Program.

The Kiteshield initiative demonstrates how the combination of Rust, a safety-qualified toolchain like Ferrocene, and infrastructure-centric design can transform industrial safety. Together, they enable safer, more efficient operations while paving the way to broader adoption of safety-certified software in high-stakes industries.

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