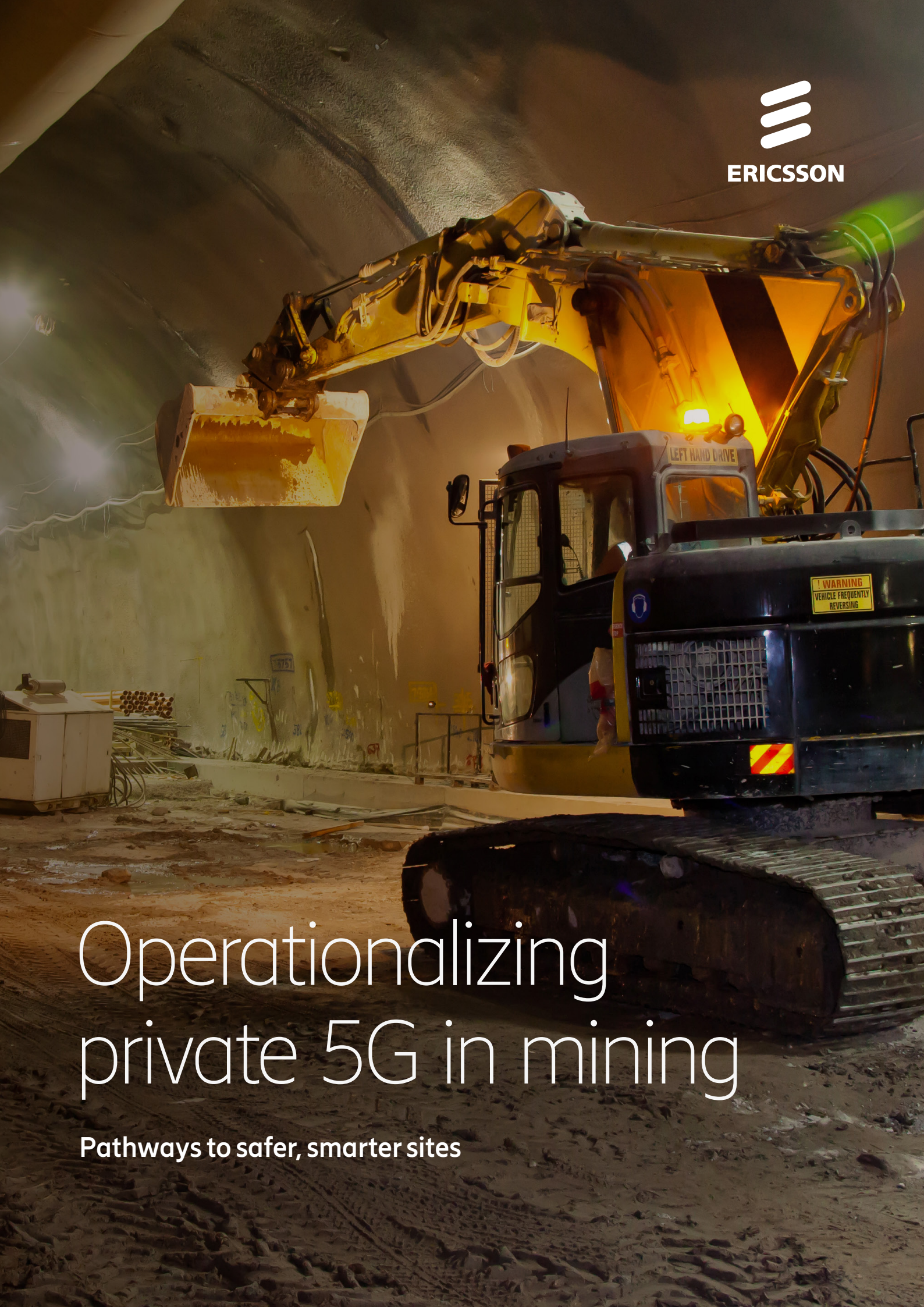
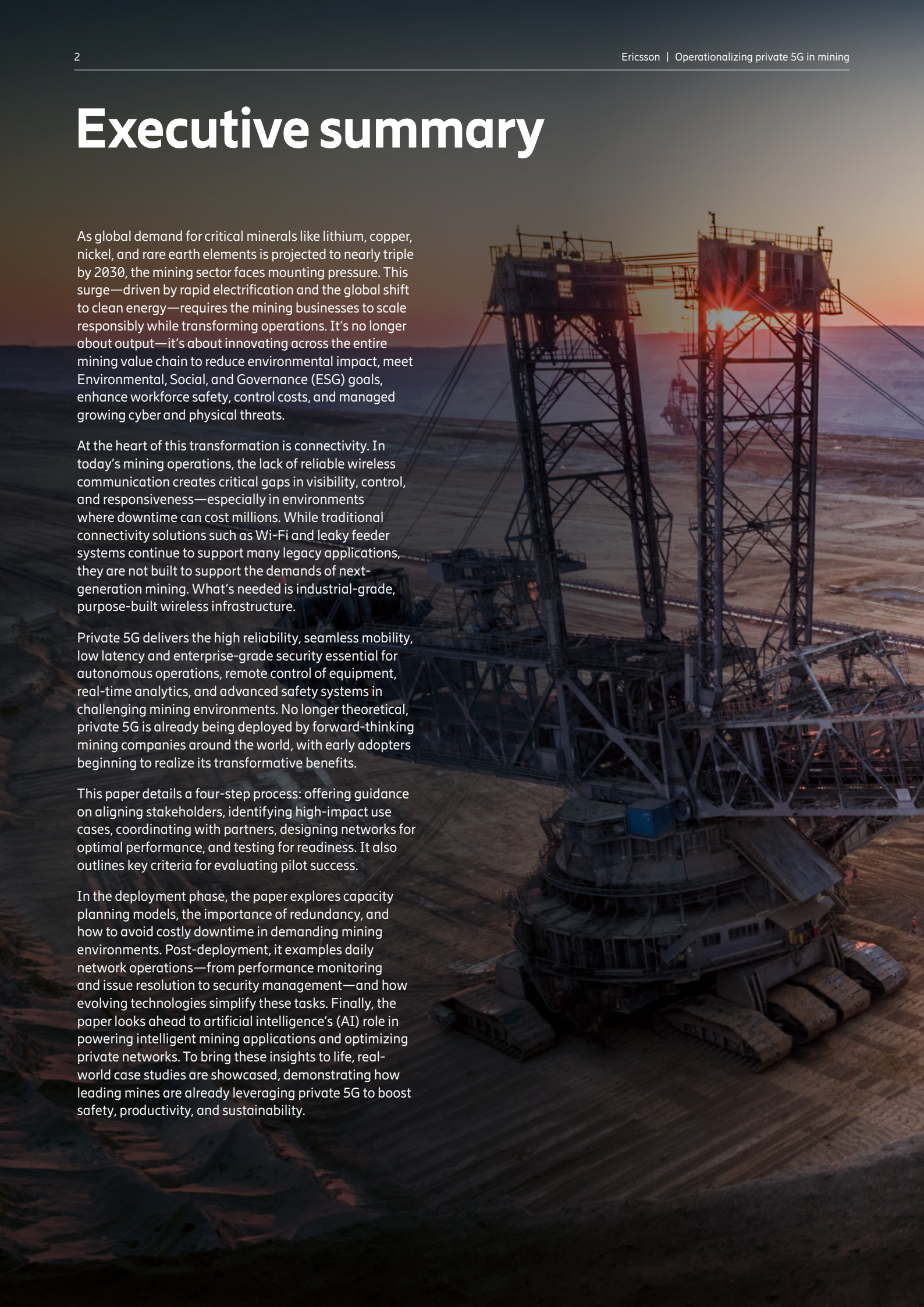


Operationalizing private 5G in mining

Pathways to safer, smarter sites

Executive summary



As global demand for critical minerals like lithium, copper, nickel, and rare earth elements is projected to nearly triple by 2030, the mining sector faces mounting pressure. This surge—driven by rapid electrification and the global shift to clean energy—requires the mining businesses to scale responsibly while transforming operations. It's no longer about output—it's about innovating across the entire mining value chain to reduce environmental impact, meet Environmental, Social, and Governance (ESG) goals, enhance workforce safety, control costs, and managed growing cyber and physical threats.

At the heart of this transformation is connectivity. In today's mining operations, the lack of reliable wireless communication creates critical gaps in visibility, control, and responsiveness—especially in environments where downtime can cost millions. While traditional connectivity solutions such as Wi-Fi and leaky feeder systems continue to support many legacy applications, they are not built to support the demands of next-generation mining. What's needed is industrial-grade, purpose-built wireless infrastructure.

Private 5G delivers the high reliability, seamless mobility, low latency and enterprise-grade security essential for autonomous operations, remote control of equipment, real-time analytics, and advanced safety systems in challenging mining environments. No longer theoretical, private 5G is already being deployed by forward-thinking mining companies around the world, with early adopters beginning to realize its transformative benefits.

This paper details a four-step process: offering guidance on aligning stakeholders, identifying high-impact use cases, coordinating with partners, designing networks for optimal performance, and testing for readiness. It also outlines key criteria for evaluating pilot success.

In the deployment phase, the paper explores capacity planning models, the importance of redundancy, and how to avoid costly downtime in demanding mining environments. Post-deployment, it examples daily network operations—from performance monitoring and issue resolution to security management—and how evolving technologies simplify these tasks. Finally, the paper looks ahead to artificial intelligence's (AI) role in powering intelligent mining applications and optimizing private networks. To bring these insights to life, real-world case studies are showcased, demonstrating how leading mines are already leveraging private 5G to boost safety, productivity, and sustainability.

Mining's foundation for the future

What do mobile devices, modern infrastructure, and interplanetary vehicles have in common?

Despite their differences, each relies on a shared foundation: metals and minerals extracted through mining. Rare earth elements drive the performance of electronics, while copper, steel, and specialized alloys provide the structural and functional materials essential for everything from urban development to space exploration.

Mining's sustainable innovation to meet rising demand

Global demand for key minerals, such as lithium, copper, nickel, and rare earth elements, is expected to nearly triple by 2030 - and quadruple by 2040[1]. This surge, driven by rapid electrification and the clean energy transition, demands not only an increase in production but smarter, more sustainable operations.

Many mines have already embraced digital technologies to boost efficiency and safety. But the challenge now is to scale these innovations across the entire mining chain—reducing environmental impact, enhancing Environmental, Social, and Governance (ESG) performance, protecting workers, managing costs, and mitigating growing cybersecurity threats. At the heart of this transformation is the need for reliable, industrial wireless connectivity—the essential thread enabling real-time data, control and responsiveness.

The challenge: Cracking the connectivity code in harsh mining environments

Yet this is no easy task. Mines operate in some of the world's harshest, most remote environments—deep underground or far offshore—where network infrastructure is sparse or unreliable. Most sites lack robust, dependable connectivity, leading to dangerous gaps in visibility, control and communication, where delays can cost millions or jeopardize safety.

Underground mines present an even tougher challenge; signals must penetrate thick rock layers, navigate narrow tunnels, and coexist with signal-disrupting metal-heavy equipment and vehicles. This lack of reliable wireless connectivity results in serious gaps in operational visibility and control. In an industry where downtime can cost millions, delays in communication, diagnostics, or safety responses can be catastrophic. Traditional wireless systems, like Wi-Fi and leaky feeders, require dense infrastructure and frequent reinstallation as mine layouts evolve, driving up costs, creating logistical challenges, and introducing safety risks. Wi-Fi struggles with interference and limited range, while leaky feeder systems demand extensive hardware and fixed connections.

As mining operations become more advanced, these legacy systems fall short. Emerging use cases-like autonomous vehicles, real-time video analytics, remote operation centres, and AI-driven automation-require far more robust connectivity, including high reliability, low latency, seamless mobility, and enterprise-grade security.

The solution: Private 5G: From pit to peak, high-performance mining connectivity

To meet these evolving needs, mining must move beyond legacy systems to purpose-built, industrial-grade connectivity—private 5G. Specifically designed for complex, high-risk environments, private 5G delivers secure, reliable, high-performing wireless networking that supports advanced automation, AI applications and sustainable innovation—driving mining's transformation for a smarter, safer and more productive future.

[1] BDO Annual Mining Report 2025

Why private 5G is a game-changer for mining

Private 5G is redefining connectivity for mining operations, offering unmatched reliability, mobility, low latency and enterprise-grade security—capabilities critical to safe, efficient, and digitally driven mining operations.

Reliability is fundamental in 24/7 mining environments, where any downtime risks substantial financial losses. Unlike Wi-Fi, which struggles with interference in underground and remote sites, private 5G ensures seamless, high-performance connectivity for autonomous equipment, sensor networks, and emergency systems without the fragility of traditional infrastructure.

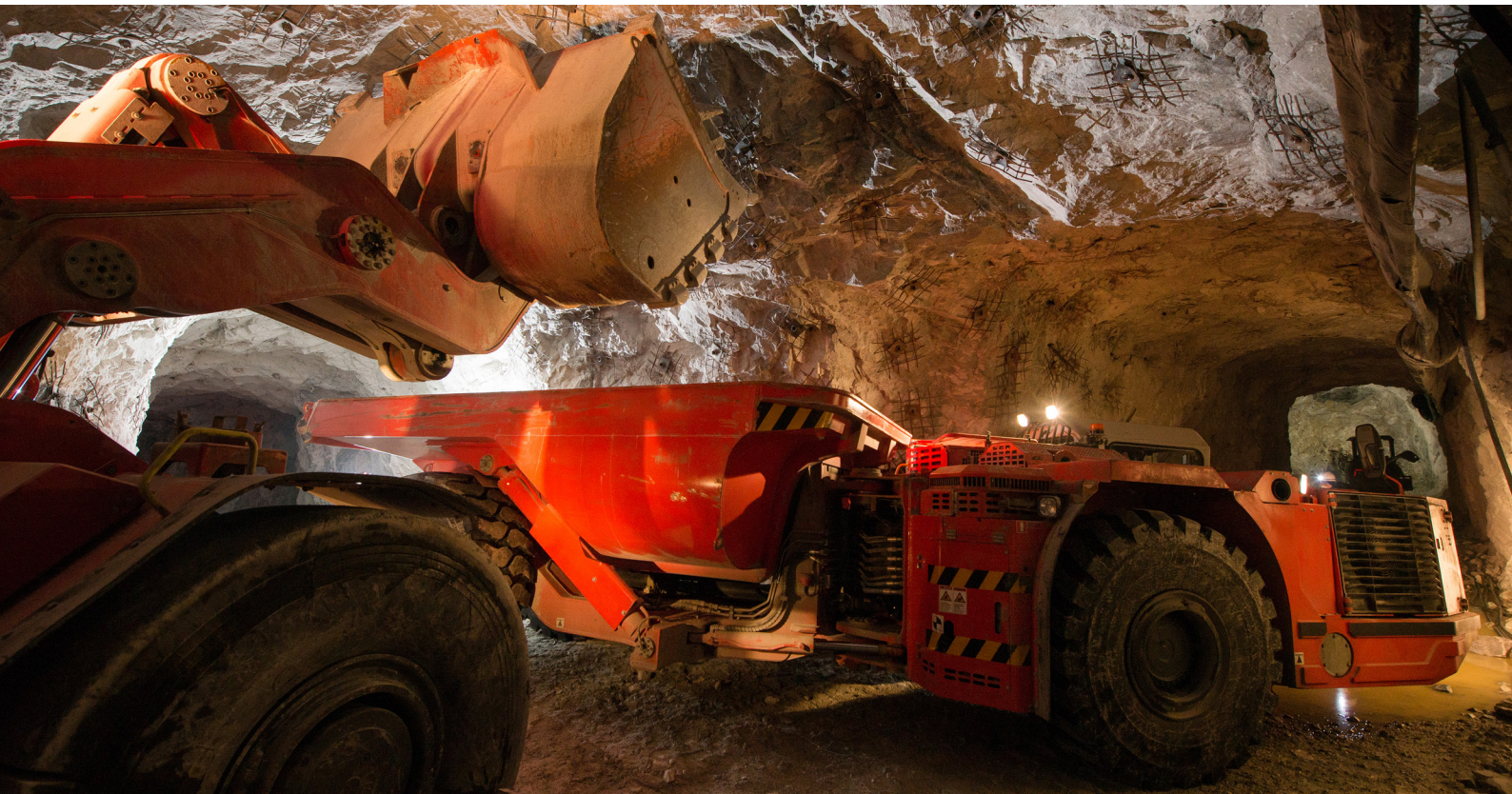
Mobility sets private 5G apart. With fast, uninterrupted connections across the entire sites, including moving vehicles, equipment, and personnel— it enables autonomous haulage, real-time tracking, and remote-control operations without signal drops or handover failures, enhancing safety and site-wide logistics.

Coverage with private 5G, is especially important in large and complex mining environments. Private 5G offers a range of underground radio solutions including micro and "dot" radios, delivering consistent connectivity deep into tunnels with minimal hardware. A single micro radio can cover a range of approximately 500 to 1000 meters , depending on how straight the tunnel is and the complexity of its curves or deviations. In areas with sharp bends or intricate layouts, smaller 'dot' radios can be used to fill in coverage gaps, while open-pit mines benefit from macro radios and clear line-of-sight range. This keeps deployment costs low while eliminating dead zones. Low latency—as low as 10 milliseconds—ensures real-time control for precision tasks like remote drilling or blasting operations, where even millisecond delays can compromise worker safety or equipment integrity. Enterprise-grade security protects sensitive mission-critical data with end-to-end encryption, zero-trust user authentication, and fully on-premises control—vital as operations grow more digital and data-driven.

Additional features further elevate private 5G's value including:

- Session continuity for uninterrupted operation of autonomous vehicles and mobile systems—even during network transitions or in rugged terrain.
- Geo-redundancy with dual controllers for resilience against outages, essential for remote sites with limited on-site IT support.
- Multi-site functionality enabling centralized network management and monitoring across multiple locations, streamlining resources and performance control.

Together, these capabilities position private 5G as a foundational enabler of mining's digital future, connecting machines, people, and processes into a smart, resilient ecosystem. A standout benefit: enabling autonomous operations during post-blast ventilation, potentially boosting production by 25% or more by eliminating idle downtime.



Strategic planning for private 5G success in mining

Cultural readiness and connectivity gaps are driving digital transformation

Private 5G adoption in mining hinges on both cultural and technical readiness. Traditionally reliant on manual, labour-intensive processes that limit efficiency and safety, many mining companies are considering automation as a practical response. Early deployments-such as rugged hand-held devices, real-time monitoring systems, and workforce tracking have proven the value of this transformation, enhancing both operational efficiency and productivity. Yet, as ambitions for advanced automation grow, legacy networks and Wi-Fi solutions frequently fall short in delivering the required scale, reliability, or low latency needed to support more advanced, data-intensive applications. This connectivity gap is a major driver pushing mining companies to explore private 5G as a foundation for their digital evolution.

Cross-functional collaboration and ecosystem partnerships are essential

Once the business case of a private 5G deployment is recognized and gains internal momentum, successful 5G deployment requires close alignment between senior management, IT, and engineering to define scope of implementation, select technology models and engage the right partners. External collaboration is equally critical: Connectivity partners (like Ericsson) deliver the private 5G infrastructure—radio and core networks that enable high-performance, industrial-grade connectivity.

Solution partners (such as Epiroc, Caterpillar, Sandvik and Komatsu) enable automation use cases through connected machinery and platforms.

System integrators bridge technology and operations, ensuring seamless, safe and scalable deployment across complex mining environments.

Spectrum access and regulatory alignment deployment strategy

Securing licensed spectrum is fundamental to reliable, interference-free performance. Countries like the United States, Germany, Australia, Chile and Brazil have established industrial spectrum policies, while others are evolving their frameworks. In the United States, for example, spectrum access is governed by the Citizens Broadband Radio Service (CBRS), which allows companies to access spectrum with various levels of priority and protection. Elsewhere, mining companies can typically obtain access to spectrum through direct licensing or partnerships with telecom providers depending on national regulations and company preferences. Whether through direct licensing or partnerships, dedicated spectrum is a non-negotiable requirement for safe and effective operations.

These technical, organizational, and regulatory factors together shape a successful private 5G rollout—one that drives long-term gains in safety, efficiency, and profitability across mining sites.

Designing and deploying pilot projects to validate private 5G benefits

The pilot phase is a critical step in validating how private 5G transforms mining operations. In many regions, however, as the number of deployments increases, and market adoption grows, mining companies are increasingly moving toward implementing private 5G networks without the need for a pilot phase.

When a pilot is conducted, the focus shifts-not on proving 5G itself, but more on testing high-value use cases under real mining conditions to confirm network performance and operational impact.

A typical pilot includes four key steps:

1

Prioritizing use cases

The first stage in the pilot implementation is identifying the most impactful use cases—balancing foundational applications, like real time monitoring, workforce tracking and asset management, with more advanced scenarios. These could include autonomous vehicles, smart blasting, and remote-controlled machinery. This selection defines the technical and operational demands the pilot must meet.

2

Aligning with technology partners

Once the use cases have been selected, the next step is to establish strong collaboration with connectivity partners (e.g. Ericsson), solution partners (e.g., Caterpillar, Komatsu) and system integrators. This collaboration ensures the network is customized to meet site-specific needs. Key factors optimized during this phase include:

- **Reliability and uptime:** Uninterrupted coverage for remote and underground environments.
- **Seamless coverage:** End-to-end connectivity across all operational zones.
- **Capacity and latency:** Support for data-heavy and time-sensitive applications like autonomous vehicles.

3

Network and use case testing

Mining companies typically designate test sites, either above ground or within controlled sections of their operational mines, for the evaluation and validation of new technologies and equipment. The pilot phase involves two key stages:

- **Dry testing:** Verifies 5G coverage area, bandwidth, latency, and reliability.
- **Use case testing:** Confirms that targeted applications (e.g., remote haul trucks, monitoring systems) operate smoothly under real-world conditions.

4

Monitoring and evaluation

At the conclusion of the pilot phase, a comprehensive evaluation is conducted to assess the success of the 5G network and business & operational objectives. The final evaluation measures technical KPIs and operational success—ensuring the network delivers reliable coverage, low latency, and bandwidth while enabling safe, efficient execution of use cases. Results from this phase inform large-scale rollout plans and define the business value of private 5G.

When thoughtfully designed, the pilot phase lays the foundation for realizing long-term gains in safety, productivity, and efficiency in mining operations.

From pilot to production: Scaling private 5G in mining

Following a successful pilot, the next step is scaling the private 5G network into full production. This requires careful planning to balance the mining company's operational priorities and risk management approach. Companies may opt for a full-scale rollout; others may prefer a phased deployment to mitigate risks, such as downtime and safety impacts. A commonly adopted strategy is to scale one working 'face' at a time to minimize disruption.

Aligning capacity with long-term automation goals

Once deployment areas are identified, a critical early step is defining network capacity to support both current needs and future automation ambitions: Two strategies typically emerge:

- **Full capacity provisioning:** Designs the network upfront for maximum expected demand, especially uplink throughput—supporting future use cases like autonomous vehicles and AI analytics without major upgrades.
- **Incremental provisioning:** Builds for current needs with plans to scale later. While this reduces initial costs, it risks future downtime, higher expansion costs, and delayed adoption of emerging applications.

Clear alignment with the long-term automation strategy helps determine the best approach. Many companies find that once 5G infrastructure is in place, new use cases emerge-making upfront provisioning a smart investment for flexibility and growth.

Coordinated deployment and infrastructure optimization

Once the scaling plan is finalized, close coordination with the mine control team is essential to align deployment with production schedules and avoid disruption. This requires a high level of planning and precision to install the network in selected areas at the right time.

During production deployment, several key infrastructure considerations must be addressed to ensure network performance and reliability. These include:

- **Controller placement:** Above-ground controllers simplify maintenance and provide precise timing signals via GPS antennas, critical for industrial 5G stability.
- **Redundancy design:** Dual fiber paths, overlapping radio coverage, multiple power sources, and battery backups protect against failure or outages.

After physical deployment, fine-tuning ensures the network meets mining-specific demands for cycle time, reliability, latency, and bandwidth.

Workforce engagement and change management

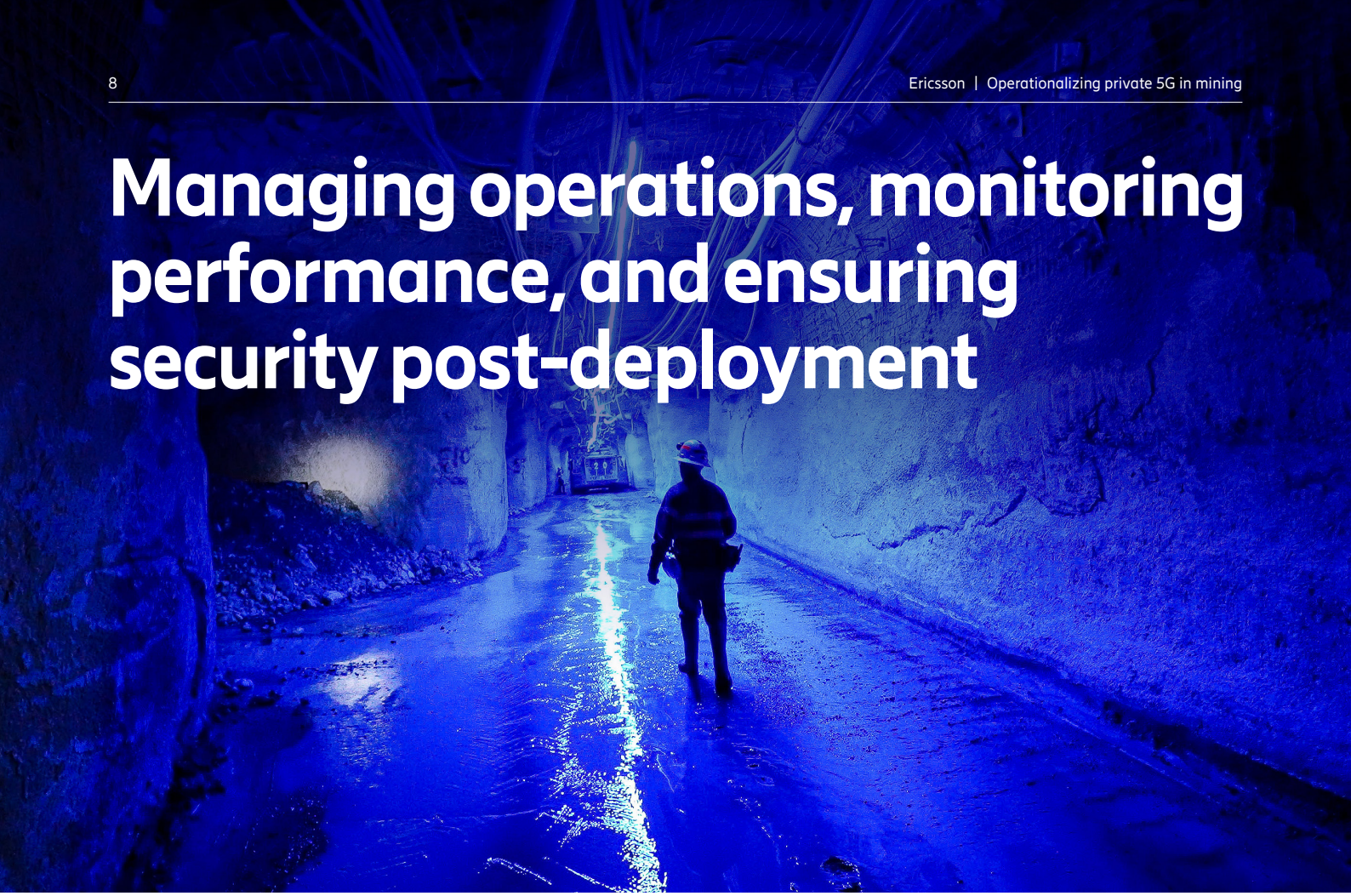
Beyond the technical aspects, equally critical is effective change management to ensure the workforce is prepared for and aligned with the transformation.

With careful planning, robust infrastructure design, and proactive change management, mining companies can unlock the potential and realize the long-term benefits of private 5G in mining, delivering safer, smarter, and more efficient operations at scale.

Key steps include:

- **Leadership communication:** Executives must clearly convey the automation vision—emphasizing safety, efficiency, and opportunity—not workforce reduction.
- **Reskilling and familiarization:** Training supports role transitions and builds confidence in using 5G-enabled systems.
- **Cross-team coordination:** Synchronization among IT, OT, and network teams ensures smooth operations and trusted systems.

Managing operations, monitoring performance, and ensuring security post-deployment



Once the private 5G network is live, maintaining performance, reliability and security becomes the priority. This includes continuous performance monitoring, routine maintenance, system upgrades, and configuration management, all underpinned by a strong cybersecurity framework.

Balancing on-premises control with remote access

Traditionally, mining companies have preferred on-premises infrastructure for maximum control and security. For Private 5G networks, a similar consideration arises around how to manage data and control systems. Two options are available:

- **Fully on-premises management:** Deploy and maintain all network management systems on-premises without any external connectivity. This option offers total control and security but requires expert resources on-site-often challenging in remote locations and can delay critical updates or troubleshooting.
- **Cloud-based/remote management:** Enables faster upgrades, configuration changes, and remote support but raises valid concerns around data sovereignty and cyber risks.

A hybrid approach offers the best of both—keeping core systems on-site while allowing secure, limited remote access for updates and diagnostics, ensuring agility without compromising security.

Skilled support ensures network health and uptime

In terms of day-to-day operational support, mining companies have two primary options: developing in-house capabilities or engaging managed service providers. In either case, it is essential to appoint personnel with strong knowledge of IT and communication systems and certifications to work in mining environments.

A site communications technician (or equivalent) manages day-to-day performance monitoring and troubleshooting. When disruptions occur, they assess 5G network health via dashboards, investigate physical or system-level causes, and escalate unresolved issues to remote experts as needed. This structured process reduces downtime and minimizes on-site interventions.

With this proactive support model and robust cybersecurity in place, mining operations can maintain network reliability, drive continuous production, and enable scalable digital transformation across the mining lifecycle.

Real-world case studies in mining

Newmont transforms operations with private 5G at Cadia Mine

Newmont, the world's largest gold producer, deployed Ericsson Enterprise Private 5G at its Cadia gold-copper operation, Australia's largest underground mine. This milestone marks the first use of private 5G for tele-remote dozing in surface mining. Previously, limited by Wi-Fi's short range and instability, Newmont could support only two machines simultaneously within a 100-meter range. Beyond that, network instability led to frequent disconnections and productivity losses, with troubleshooting and reconnecting consuming up to half of a 12-hour shift.

With private 5G, Newmont today can now connect up to 12 dozers across a 2.5 km zone via a single 5G radio, ensuring stable, high-speed uplinks (up to 175 Mbps). This has improved safety, operational reliability, and productivity. Based on these results, Newmont plans to scale private 5G across 14 global sites, extending to drills, trucks, and graders. now connects its entire fleet of remote-controlled dozers across the 2.5-kilometre-wide tailings construction zone using a single 5G radio.

Encouraged by the performance gains and operational stability provided by private 5G, Newmont plans to expand the technology across 14 mines on four continents. The next phase includes extending 5G connectivity to support drills, trucks, and graders operating both on the surface and underground.

NEXGEN-SIMS proves 5G's value underground at Agnico Eagle's Kittilä Mine

NEXGEN-SIMS, an EU-funded collaboration of technology suppliers and mining operators, aimed to drive innovation in European mining by advancing electrification, automation, and operational safety.

At Agnico Eagle's Kittilä gold mine in Finland, the NEXGEN-SIMS project tested private 5G in underground conditions. Wi-Fi had struggled to meet the demands of multiple autonomous machines and video streams, causing frequent disruptions. Private 5G enabled seamless autonomous loader and haul truck operations, with real-time video monitoring and smooth handovers between cells. The nine-month pilot demonstrated consistent low latency, reliability, and scalability—essential for safe, efficient underground automation.

The pilot demonstration video can be seen here.

Boliden leverages open pit automation at Aitik Mine

Boliden is recognized as one of the world's leading mining companies, operating eight mines across Europe. Among them, Aitik, located in northern Sweden, stands out as the largest open pit mine in Europe. Currently producing 36 million metric tons of ore annually, Aitik is targeting a production increase to 45 million metric tons.

Boliden retrofitted five drill rigs at its Aitik mine in Sweden with autonomous and remote-control capabilities. Existing Wi-Fi networks lacked the performance and scalability to support such operations across the large open pit. Private 5G offers the low-latency, high-bandwidth connectivity needed for future expansion into autonomous haul trucks and complex drilling systems. Automation is delivering tangible benefits, including a projected €2.5M in annual savings and an expected 9,400-ton reduction in CO_2 emissions through improved fuel efficiency and operational flow.

The future of private 5G in mining

As mining operations become increasingly digitized and automated, private 5G is set to become the backbone of the industry's next transformation-one powered by artificial intelligence (AI). This evolution can be viewed through two interrelated lenses: networks for AI and AI within the networks themselves.

Enabling advanced AI mining applications

Private 5G delivers the low latency, high reliability, and bandwidth essential for edge-based AI use cases such as:

- **Predictive maintenance:** Real-time data analysis to forecast equipment failures and minimize downtime.
- **Autonomous haulage:** Safe, efficient operation of driverless trucks, drills, and vehicles requiring uninterrupted connectivity.
- **AI-Guided exploration:** Faster, more accurate mineral discovery using machine learning models.
- **Digital twins:** Live, 3D simulations of mine sites to optimize processes before deployment.

Private 5G ensures these data-intensive systems operate seamlessly across the mine, enabling smarter, faster, and more efficient decision-making.

AI for smarter networks

AI is transforming how networks themselves are managed. In public telecommunications infrastructure, AI is already being used to monitor network health, predict faults, allocate resources dynamically, and enhance security. These same capabilities will be increasingly applied to private 5G networks in mining environments.

AI will also optimize the networks themselves—automating configuration, fault detection, and performance tuning to keep mining operations running smoothly with minimal human oversight. These self-managing capabilities are vital for remote, harsh sites where expert support may be limited.

The convergence of private 5G, AI, and automation paves the way for fully connected, intelligent, and autonomous mining ecosystems—improving safety, productivity, and sustainability.

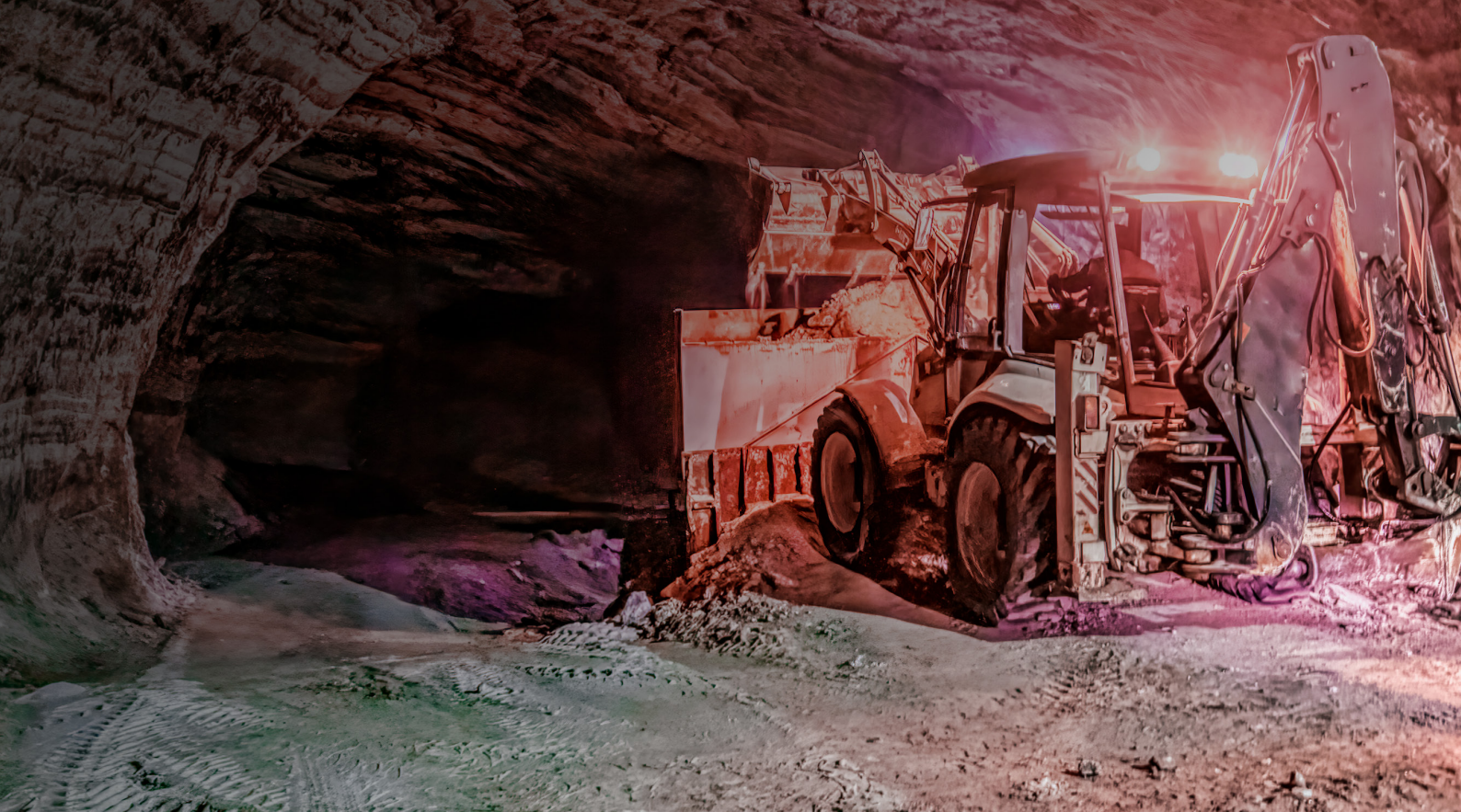
Conclusion

In summary, private 5G networks are rapidly proving their value in transforming mining operations, enabling reliable, low-latency connectivity across vast and remote sites. By supporting real-time automation, autonomous vehicles, wireless smart sensors, advanced analytics, and remote operations, private 5G empowers mining companies to address safety, productivity, and sustainability challenges in ways previously not possible with legacy communication systems.

The shift toward digital-first mining demands infrastructure that not only meets use-case requirements but is also reliable, flexible, secure, and capable of scaling with operational needs. Private 5G provides this foundation, enabling seamless integration with existing and emerging technologies. It offers not only a technological upgrade but a strategic platform that can unlock long-term operational resilience, improved resource utilization, and enhanced decision-making through reliable data flow from every desired corner of the mine.

As mining continues to evolve toward more intelligent, autonomous systems, the adoption of private 5G is no longer a question of "if," but "when." Early adopters are already gaining a competitive edge through enabling new applications, reduced downtime, improved safety, and greater operational efficiency.

Now is the time for mining leaders to move beyond traditional connectivity models and take steps toward building digitally empowered operations. The path to a smarter, safer, and more sustainable mining future begins with the decision to connect intelligently and securely through private 5G.



About Ericsson

Ericsson enables communications service providers and enterprises to capture the full value of connectivity. The company's portfolio spans the following business areas: Networks, Cloud Software and Services, Enterprise Wireless Solutions, Global Communications Platform, and Technologies and New Businesses. It is designed to help our customers go digital, increase efficiency and find new revenue streams. Ericsson's innovation investments have delivered the benefits of mobility and mobile broadband to billions of people globally. Ericsson stock is listed on Nasdaq Stockholm and on Nasdaq New York.

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