Achieving more agile, automated mining
Creating safer, more efficient and productive mines

As the world’s economy continues to expand unevenly and technological innovations cause shifting demand for both new and traditional minerals, the mining industry is often under pressure. Not only plagued by demand fluctuations and excessive operational costs, it must also be increasingly attentive to safety and environmental concerns. New digital technologies can help the mining industry to solve these challenges and more, and capture new opportunities.

On the safety front, automation, robotics and remote operations promise to remove workers from the most dangerous and hazardous parts of the mine. Digitally enhanced personal protective equipment (PPE) will monitor workers’ health, and, using geofencing, direct them away from exclusion zones. Internet of Things (IoT) sensing at massive scale will allow every step from the mine to transportation facilities, to be analyzed for under-utilized resources and bottlenecks, as well as their downstream consequences. Sensors, cameras and drones will provide 360° situational awareness for remote operations. Dynamic tracking of machine health and diagnostics will enable predictive maintenance. Machine learning will be used to augment the decision making of personnel from the command center to the mine face. Making these and other innovations possible, however, will first require a whole new network architecture optimized for the mine of the future.

Nokia and mining

At Nokia we are a global leader innovating the technologies at the heart of our connected world. We understand that smart, dynamic communications networks will be the foundation for the digital transformation of society, including our mining sector. The Nokia Bell Labs Future X architecture provides a connected, digital platform that supports and fosters new applications and services for greater productivity and innovation, richer experiences and enhanced quality of life. As a leader in mining communications, we believe that building this dynamic, connected network platform is the best starting point for achieving more agile and automated open pit and underground mining facilities and better managing the safety, performance and decision making of personnel. We call this the Future X architecture for the mine of the future. We are committed to helping mining companies build this smart foundation and, in this way, realize their goals for taking mining to the next level.

For the Top 40 mining companies, labor represents an estimated 32% of operating costs.

PwC, Mine 2018 – tempting times

Developments and principal risks and uncertainties, 2017

1. Source: PwC analysis and Top 40 Annual reports
The digital mining opportunity

Mining companies live in an uncertain and changeable world. Operating at the very end of the supply chain, small shifts in the world economy can cause dramatic changes at the mine or pit face. Innovations in technology can be especially disruptive; suddenly an obscure mineral is essential, while another becomes next-to-worthless. Price fluctuations can turn profitable extraction to dust in a matter of hours or days. Often working in remote and challenging environments, mining companies have to work especially hard to meet stringent environmental requirements, while complying with worker safety regulations. Agility, safety and operational efficiency are, thus, critical to success in the mining sector.

Digital technologies will play a key role in meeting these challenges and opportunities. They will enable continuous improvement in safety, productivity and efficiency by eventually replacing all manual mining operations — exploration, drilling and blasting, digging, loading, hauling, crushing and transportation — with fully autonomous systems. Of course the benefits of automation can be realized in steps. For example, the use of real-time data to enhance fleet management enabled by mobile connectivity can be a precursor to autonomous trucks. But the move to full automation will be assured over time as automated equipment and systems can function 24/7 in a predictable manner, ensuring safety to human workers or machines, and maximizing equipment lifetime. Remote operations will further supplement automation, allowing personnel to monitor automated processes and operate machinery at a distance using virtual telepresence. With augmented reality and low-latency control, remote operators will use 360° situational awareness to troubleshoot automated processes and remotely operate them, if required. Artificial intelligence (AI) and machine learning will augment decision making, providing predictive alerts, isolating causes and suggesting possible courses of action. Data collected from a vast multitude of sensors below and above ground will allow miners to optimize operations across mine.

“Those (mining companies) that do embrace this (digital mine) ideal stand to see more than productivity benefits (typically 10 to 20 percent).”

Deloitte, “Tracking the trends 2018: The top 10 issues shaping mining in the year ahead”
pit, rail and port by gaining near-real-time visibility and identifying potential bottlenecks at every step of the process. Leveraging advances in augmented human and machine intelligence, miners will dynamically track assets and deploy them on demand, perform predictive maintenance on equipment and deliver just-in-time productivity (i.e., tonnage on demand) with extraordinarily high efficiency. Sensors at a conveyor belt can now be part of a more complete IoT deployment that is combined with analytics to deliver overall process automation.

Along with automated and remote operations, which will remove workers from hazardous activities, the mine of the future will support digital PPE to enable tracking of personnel location, alertness and health parameters (accounting for any privacy concerns that may arise). Digital PPE may also be used in a geofencing application to enforce virtual exclusion zones, regulating unauthorized access to areas where there is a danger of falling objects, moving machinery, chemical spills or fallen electrical cables.

All of this can only be enabled with a mission-critical network that supports robust wireless coverage based, not on Wi-Fi, but rather on the more mobile 4G/LTE (evolving to 5G tomorrow). Paired with high-performance optical fiber connectivity, this mission-critical network platform will provide access for sensors, machines and humans, even at very remote command centers. It should also be architected with a multi-access edge cloud for low-latency control and operational resiliency, and a converged cloud hosting network and service automation engines, augmented cognition systems and integrated remote operations management platforms. We call this mission-critical communications platform the Future X architecture for mining.

“Convergence of information technology (IT) and operational technology (OT) can further enable automation and digitization—allowing work to be moved to locations which can support a more diverse and inclusive workforce. Similarly, more mature cybersecurity programs can help address the potential threats introduced by exponential technologies.”

Deloitte
The Future X architecture for mining

The Nokia Bell Labs Future X architecture for mining provides an intelligent, dynamic communications and cloud-based platform as its foundation. This smart network will interconnect all of the individual systems, processes and activities, and provide integrated analytics, machine learning and digital support for innovative new applications and services.

At the deepest level of the Future X architecture lies dedicated universal broadband connectivity, both wireless and wired, making every kind of communication and information exchange possible. Built with a dynamic mesh fabric around a high-performing IP/optical core, it uses LTE today (and 5G tomorrow) to connect with mobile and static sensors, heavy equipment, self-driving vehicles and connected workers, all securely and with the highest reliability.

Cloud technology is essential to the Future X architecture, ensuring the flexibility, scalability and universal availability of both data and intelligence. Placed throughout the network fabric, local and distributed edge clouds ensure the ultra-low latencies required...
Cloud-native, software-defined networks dynamically allocate capacity when and wherever it’s needed — whether to support massive digital twin files, augmented reality or mine site video consultations.

Built into the Future X architecture are data processing capabilities and analytics, including machine learning and AI systems. These ensure that, out of the ocean of data about assets, processes, environment and workers, relevant and actionable insights can enable greater efficiencies and productivity. Analytics, sensor and device management, digital operations and machine learning provide open, digital value platforms that can be harnessed by any kind of mining application.

At Nokia, we believe the Future X architecture will help mining companies to make their mines safer and highly automated. It will help them adjust to market fluctuations and financial impacts that could cause expansion or contraction of mine activities. The ability of the Future X architecture to easily, reliably and rapidly change scale, support operations and adapt to new sensors will positively impact the internal rate of return of the mine. With it, mines will be able to achieve new levels of safety, productivity and efficiency and respond more quickly to the opportunities of an increasingly demand-centric world.

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Use cases for the digital mining operation

Private LTE for mines
Autonomy to telepresence and remote control over LTE are enablers for efficient and safe operations during the lifetime of a mine’s operation. Due to the range limitations of Wi-Fi, mines typically need in the range of 100–200 trailer-mounted access points (APs) to serve an area that can be covered by less than 10 LTE macro cells. Because any loss of connectivity usually triggers autonomous vehicles to stop, the reliability of handoffs between APs needs to be high, as with LTE. LTE also supports narrowband IoT (NB-IoT) traffic typically used by sensors that require short packet access and extended battery life (up to 10 years) and legacy mission-critical features such as Push-to-Talk, broadcast, and pre-emption, typical of TETRA or Project 25 networks currently in use.

Mine communications continuously change throughout the life of the mine. LTE with machine learning and AI can be utilized in a greenfield situation, and then scaled and applied during the entire mine lifecycle: from inception (small portable exploration LTE networks), to construction (worker camp communications), to commissioning and then production (permanent facilities) and even through to decommissioning. Long-lived wireless technologies such as LTE are more consistent, modular and durable systems that can reduce vendor maintenance, labor costs and equipment replacement; thus the TCO of the mine is reduced over its lifetime.

Managing sensors and devices
Massive sensing is key to the future mine. However, that raises the issue of how to manage the plethora of devices. This includes IoT sensors that provide machine health and diagnostics, position reporting, and process monitoring and control. Add to this growing list digital PPE, smart tools, communication devices, cameras and drones, all of which connect to the wireless network remotely, yet need to be managed centrally. This is triggering a new need for a platform that handles every aspect of the lifecycle of machine-to-machine (M2M) and IoT connections – data collection, event processing, device management, data contextualization, data analytics, end-to-end security and applications enablement – for any device, any protocol and across any application.

Video surveillance
Video surveillance is key for monitoring critical assets and ensuring the safety of personnel and equipment. A typical mining operation has multiple, high-quality closed-circuit television (CCTV) systems generating many multicast IP video streams. This requires a cost-effective and reliable high-capacity communications network able to handle traffic of several Mb/s per camera and thousands of multicast streams. Video analytics can automatically call out anomalies in captured behavior, alerting safety and security personnel in real time.

Predictive maintenance and operations intelligence
The maintenance and repair of mining equipment, ore haulers and railway rolling stock, track components and depots pose challenges in planning the use of repair equipment and teams. Predictive maintenance applications, leveraging IoT asset management and advanced data analytics, are designed to improve on today’s preventive and conditions-based maintenance. They promise to reduce costs, increase asset utilization, enhance safety, and minimize delays and revenue loss. Advanced analytics can also break down data silos, correlating data from IoT sensors, environmental information and historical trends to provide operations intelligence, solve specific operational and maintenance pain points, and optimize asset lifecycles.
Customer case story:

South American mining operation realizes productivity gains from enhanced mobility and converged communications infrastructure

Lacking coverage, capacity, mobility and reliability on their existing “in pit” wireless systems, a multibillion dollar mining corporation turned to Nokia to help evolve their network and take their South American open pit operation to new levels of efficiency and productivity.

Facing a loss of productivity on their autonomous truck fleet and bottlenecks in their rail corridor, the operation was unable to expand their operation reliably. Leveraging LTE and a powerful, cloud-native LTE Evolved Packet Core alongside robust management systems, the operation was able to expand their operation. They improved coverage, reliability and performance with the replacement of Wi-Fi access points with LTE macro and small cell base transceiver stations.

The operation improved production optimization and increased tonnage while also experiencing enhanced safety and overall efficiency and effectiveness from their newly converged voice and data networks.
As a leader in mining communications, we believe that the Future X architecture is the best starting point for achieving more agile mining processes with greater use of sensors, automation and machine learning. Nokia is well placed to support mining companies with the most complete portfolio of products and services to support your mining automation.

Bell Labs Consulting will help you with planning for the future and understanding the business case benefits of new technologies using a structured methodology for establishing quantifiable outcomes for your mining operations. Nokia also contributes its professional services to help you leverage your technology platforms while accelerating your transformation and mitigating risk.

networks.nokia.com/industries/mining
About Nokia
We create the technology to connect the world. Powered by the research and innovation of Nokia Bell Labs, we serve communications service providers, governments, large enterprises and consumers, with the industry’s most complete, end-to-end portfolio of products, services and licensing.

From the enabling infrastructure for 5G and the Internet of Things, to emerging applications in virtual reality and digital health, we are shaping the future of technology to transform the human experience.

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