5G at the Sandvik underground testmine

A private wireless network enabling mining automation

NOKIA

Early in 2019, Sandvik and Nokia announced a collaboration to deliver Industrial IoT to the mining industry over LTE and 5G Networks.

After having integrated its AutoMine® and OptiMine® solutions with Nokia private 4.9G/LTE technology, Sandvik initiated deployment of a Nokia 5G standalone (SA) private network at its Test Mine in Tampere, Finland.

Sandvik Mining and Rock Solutions' decades-long work in automation has grown to include robust data analytics and process optimization offerings, where connectivity and local computing power are crucial. Applications requiring high capacity and low latency are becoming increasingly important. With a focus on IoT solutions for the mining industry, Sandvik has partnered with Nokia to further develop Sandvik solutions for private 4.9G/LTE and 5G technology.

A private LTE network enables fast, reliable and secure voice, data and video communications in a mining setting, which presents highly challenging deployment conditions. It brings high capacity, low latency and wide coverage mobile broadband to serve mission-critical and business-critical industrial connectivity needs and supports a variety of terminals, sensors and other devices.

The wireless network also enables operation of autonomous vehicles, real-time monitoring of underground and outdoor premises with the intention to keep people and equipment safe, remote diagnostics and predictive maintenance, as well as asset management, control and authentication. The new 5G infrastructure will add even more capabilities to automated mining processes and enable remote machine operations over 4K video links between the deep underground and the surface control center.

The Nokia Digital Automation Cloud (DAC) offers pervasive connectivity in both underground and open pit mines, enabling advanced applications. It has been implemented and tested in the Sandvik Test Mine in Tampere, Finland. The network is used to enhance communications and connectivity at the facility – a real-life mining environment where Sandvik tests, develops and prototypes mining solutions for its customers worldwide.

Photo: Sandvik

Sandvik Mining and Rock Solutions is a global leading supplier of equipment and tools, services and technical solutions for the mining and construction industries. Application areas include rock drilling, rock cutting, loading and hauling, tunneling and quarrying.

Sandvik is headquartered in Sweden. In 2020, sales were approximately 40 billion SEK with about 14,000 employees in continuing operations.

Sandvik is a world leader in mining automation. AutoMine® covers all aspects of automation, from remote and autonomous operation of a single piece of equipment, to multi-machine control and full-fleet automation using automatic mission and traffic control capabilities.

Sandvik's OptiMine® is the most comprehensive solution for optimizing underground hard rock mining production and processes. It integrates all assets and people - including Sandvik and non-Sandvik equipment - delivering descriptive and predictive insights to improve operations.

As a world-leading mining equipment manufacturer, the company is committed to improving mining productivity and profitability.

Sandvik Mining and Rock Solutions products and services provide maximum value in terms of performance, quality, safety, flexibility and – not least – total economy.

Innovation and R&D drive the Sandvik state-of-the-art solutions, which are all backed by application expertise: a worldwide network offering on-site service, training and round-the-clock support.

Business drivers for and customer value of digitalization and automation

Enhanced safety

Removing operators from hazardous environments and improving communication of mine operations, offering real-time insights.

Improved productivity

Solutions eliminating bottlenecks, streamlining operations and offering the fastest automation systems on the market.

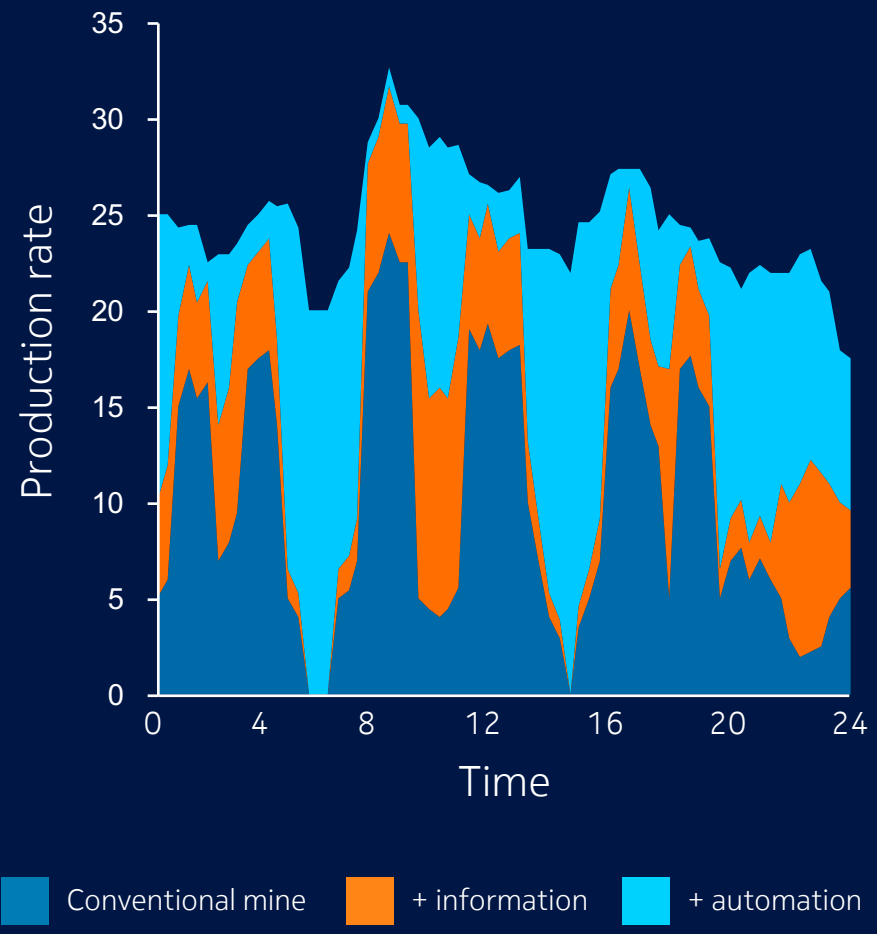
Increased profitability

Solutions increase effective production hours due to less downtime and remote operation, increase transparency and deliver descriptive and predictive insights.

More sustainable operations

Greener operations through improved energy and greenhouse gases efficiency; 5G network consumes less power than legacy operations.

More productivity, lower cost and safer with information and automation



Source: Sandvik Mining and Rock Solutions

Opportunities and challenges of underground mining transformation

The case for innovation in the mining industry has never been more compelling. Driven by the need to reinvent operations, increase safety, and optimize productivity and efficiency, investment in Industry 4.0 solutions has steeply risen over the past years.

The reward of digital transformation can be substantial. Advances in technologies like the industrial internet of things (IIoT), artificial intelligence and virtual reality will enable mining companies to optimize decision making, automate manual processes and eventually replace all manual operations with fully autonomous systems. All while having the capability to see and effectively track people and assets is essential for worker safety.

But to get the best out of these technologies, having high-performing wireless connectivity in the mining areas is essential to the various digital applications they enable. Unfortunately, many mines still rely on legacy networks that weren't created to cater for the demands of ultra-broadband and mission-critical use cases.

Used for a decade by mobile operators worldwide, 4.9G/LTE cellular technology has all the features and characteristics required by the vast majority of business-critical and mission-critical mining applications. The next generation of cellular, 5G, has also started rolling out, and it will support even the most extreme applications.

Over the past few years, these capabilities have also become available for enterprises through industrial-grade private wireless solutions.

To make Industry 4.0 work for mining companies and enable the automation applications that will deliver results for their operation, mining companies need pervasive wireless voice and data connectivity – above and underground.

An industrial-grade private wireless network provides a single infrastructure for fast, reliable and secure data transfer, push-to-talk/push-to-video communications and real-time video transmission in a mining setting that is characterized by highly challenging deployment conditions.

Photo: Sandvik

Especially, underground mining environments with continuously changing networks of tunnels set very specific challenges compared to open-air outdoor sites.

Whereas surface mines have a relatively large space available for infrastructure deployment, the confined space in underground environments introduces extra complexity. The communications network needs to deliver reliable wireless voice and data communication across 'blind' production areas, in narrow drifts and galleries with massive stone walls, to connect miners and machines.

Photos: Sandvik

Sandvik OptiMine® analytics and process optimization

OptiMine® is the most comprehensive solution for analyzing and optimizing underground hard rock mining production and processes.

It integrates all assets and people, including non-Sandvik equipment, delivering descriptive and predictive insights to improve operations.

Sandvik AutoMine® equipment automation and teleoperation systems

AutoMine® is an automation system for autonomous and tele-remote operation of a wide range of Sandvik and non-Sandvik mobile equipment.

In the comfort and safety of a remote control room, operators can simultaneously control and monitor multiple underground or surface machines.

“ Mining digitalization and automation are highly dependent on a predictable communication infrastructure.

We need reliable data and analytics for telemetry, autonomy and optimization. Without a stable, fast and resilient network none of these would be possible.

This is one of the reasons why connectivity is such a big topic for Sandvik. But we are not a networking company, we’re a mining equipment and automation company.

That’s the reason why we are partnering with Nokia.”

Andreas Simoncic,

Automation Business Line Manager, Northern Europe
Sandvik Mining and Rock Solutions

Why Sandvik is implementing 5G

As 5G is just at the beginning of its industrial journey, most of Nokia mining customers are still opting for 4.9G solutions. They know that 5G is around the corner, and that the upgrade will be straightforward. As a matter of fact, more than 85% of digital mining applications can already run on 4.9G today. And, 5G will add even more capabilities, like more bandwidth for (ultra-) high-definition video services and further reduce the latency that is needed for real-time tele-remote control of robots and drones for example.

That's why Sandvik has partnered with Nokia on implementing a private 5G Standalone (SA) network in their Test Mine facility in Tampere, Finland. It will have the capability to ensure and demonstrate that Sandvik's products and systems are compatible with 5G technology and make them ready for roll-out to their customers' mining operations.

Sandvik's 5G standalone network implementation in the Test Mine is in early stages and the plan is to gradually further expand the network. Once the 5G SA network is fully implemented, it will allow the company to showcase an entirely new range of game-changing products and capabilities – with the ability to run several different applications over the network. With 5G, Sandvik will be able to reserve a certain capacity from the bandwidth to specific applications, resulting in predictable performance and improved reliability.

Of course, Rome wasn't built in one day, and there is still some work to be done in 5G standardization. 5G R16 was just finalized in July 2020 and together with R17 it will bring critical machine connectivity features such as ultra-low latency and time-sensitive networking.

These next two releases are critical steps for Industry 4.0 applications, as they will bring significant benefits for private wireless, enabling the bulk of the 15 percent of applications not yet possible today on private 4.9G.

The R18 standard, which is due in 2023, should bring the final piece of the puzzle with massive IoT connectivity – the successor to LTE-M and NB-IoT.

As partnerships and ecosystems are the motor powering innovation and new business opportunities, they are really essential for connectivity players like Nokia when developing solutions.

This is why it's fantastic that Sandvik is taking a global leadership role in developing 5G solutions in mining and is deploying Nokia technology in their Test Mine in Tampere.

For Nokia, it's a real advantage to work with a global leader in mine automation and digitalization.

The combination of the private wireless Nokia Digital Automation Cloud technology with Sandvik's automation solutions is creating a world-class opportunity to deliver unique value to the global mining industry.

> "As we work with our customers to help them leverage technology to digitalize their operations, the introduction of 5G opens the door to new opportunities in robotics, remote and autonomous operations, full-fleet automation, analytics and enhanced safety.
>
> As such, it comprises a breakthrough in the digital transformation of mining."

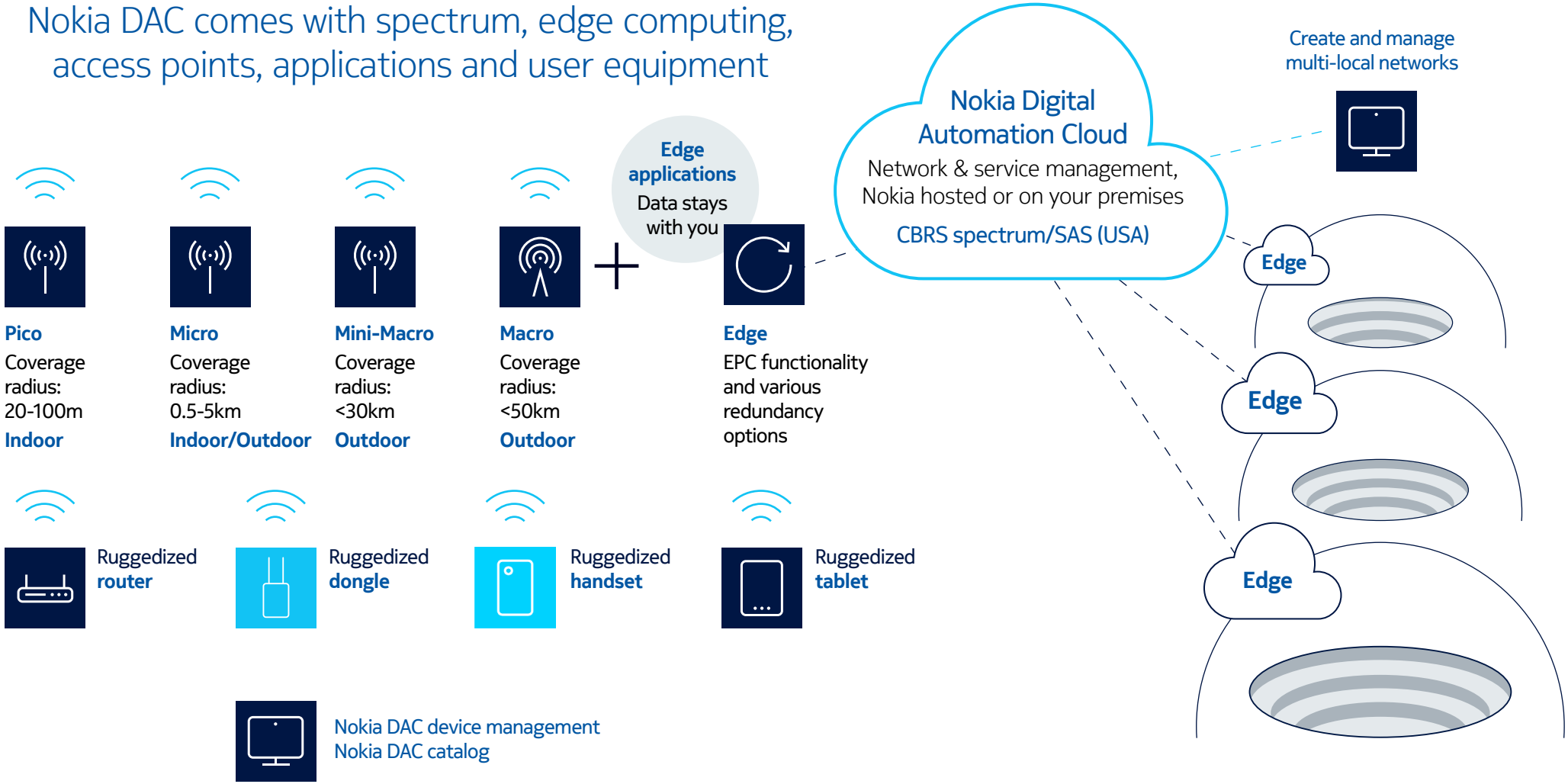
David Hallett, Vice President, Automation, Sandvik

Photo: Sandvik

Nokia Digital Automation Cloud

4.9G and 5G platform for private wireless connectivity and automation

Nokia DAC comes with spectrum, edge computing, access points, applications and user equipment



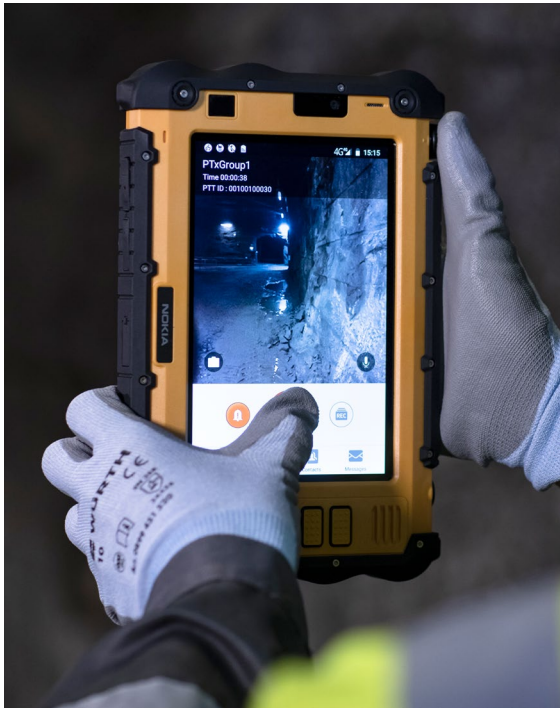
Devices designed for challenging environments

The harsh conditions in which miners operate require a set of resilient, ruggedized devices and handhelds.

Nokia provides a selection of industrial ruggedized devices with hardened enclosure and industrial-graded components that are designed and developed for heavy use in demanding mine environments.

Our device portfolio includes ruggedized workpads, field routers, handhelds and tablets. These devices come in different form-factors, manufactured and certified to address various markets and frequency bands, and cover the needs of customers in 4G, 5G and MulteFire. All devices have been validated and certified with Nokia in-house expertise.

The Nokia DAC platform provides integrated device management with easy-to-use onboarding, scalable to managing thousands of devices.



Private 5G at the Sandvik Test Mine in Tampere

Today, Sandvik's AutoMine® and OptiMine® systems are already running on private wireless Nokia 4.9G network.

To have the capability to ensure and demonstrate that Sandvik's products and systems are also compatible with 5G technology and make them ready for roll-out to their customers' mining operations, the company decided to implement a private 5G Standalone network in their Test Mine.

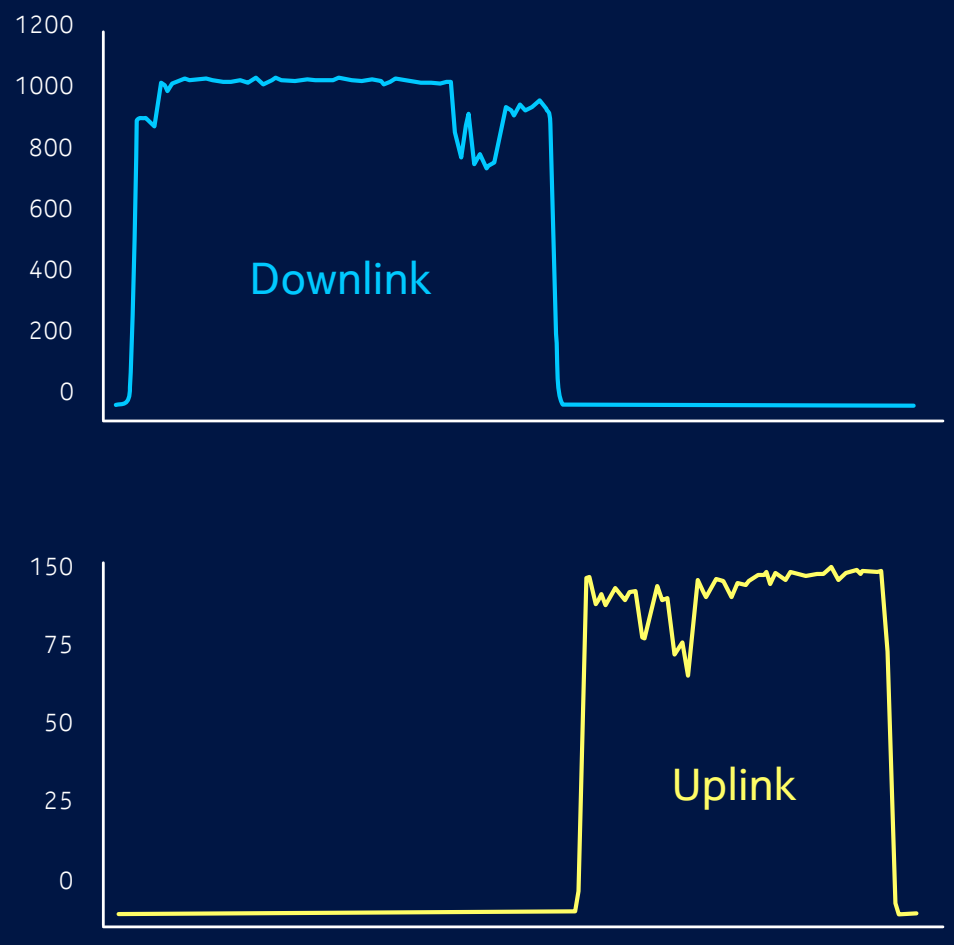
Once the 5G network has been installed, it will allow the company to showcase an entirely new range of game-changing products and capabilities – giving Sandvik the ability to run several different applications over the same network with predictable performance and improved reliability.

The DAC platform enables fast, reliable and secure voice and video communications in a mining setting, which presents highly challenging deployment conditions. Its 5G capability will also be used for automated mining processes, enabling remote machine operations over 4K video links between deep underground and the surface control center.

The configuration at Sandvik includes NG-RAN, connected to the 5G Core and providing 5G NR (new radio) connectivity for user equipment (UE). The 5G spectrum is provided by communication service provider Telia.

Initial results of the 5G project are very promising. Inside the Sandvik Test Mine, we are obtaining downlink speeds of around 1 Gbps and uplink speeds of 140 Mbps. Also, latency is good with a minimum roundtrip time of about 5 milliseconds and an average one of just above 8 milliseconds – which is still expected to improve with the next 5G release.

NR throughput * (Mbps at 100 MHz bandwidth)



* Test environment results from over-the-air testing with iPerf server and client on Mediatek devices

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“ Partnerships and ecosystems are the motor powering innovation and new business opportunities.

Nokia and Sandvik are working together to accelerate the mining industry’s digital transformation journey and to deliver value to our customers worldwide.”

Jochen Apel, Vice President, Digital Industries, Nokia

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At Nokia, we create technology that helps the world act together.

As a B2B technology innovation leader, we are pioneering the future where networks meet cloud to realize the full potential of digital in every industry.

Through networks that sense, think and act, we work with our customers and partners to create the digital services and applications of the future.

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