Industrial private 5G: Wireless made reliable and secure

Wi-Fi made wireless a reality. Now, private 5G is redefining connectivity to meet industry needs.
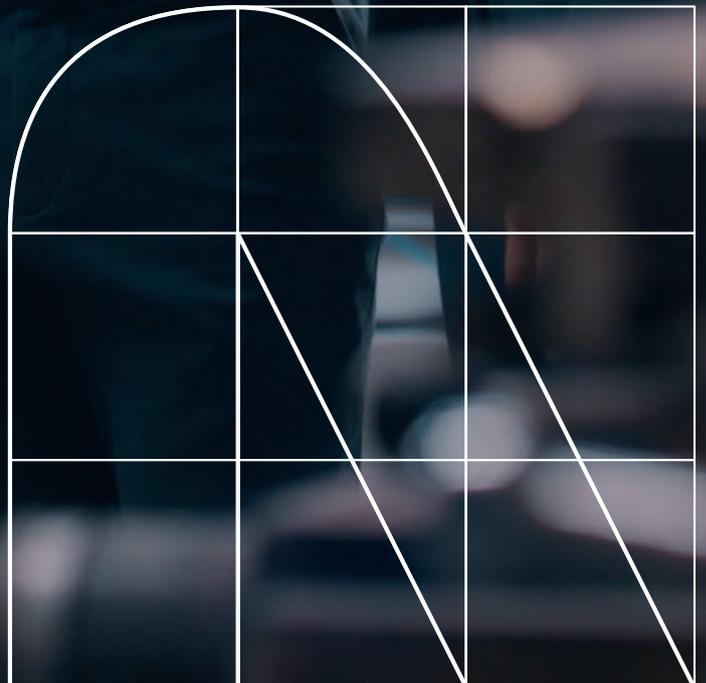
Contents

# Private 5G: An industrial-grade wireless solution

The industrial sector places great emphasis on the reliability of production processes, which is understandable since production is the core function of factories. Despite this, industrial organizations continuously seek ways to enhance these processes, balancing innovation with risk management and reliability.

Over the past 300 years of modern industrialization, a consistent pattern has emerged: new technologies are introduced to solve existing problems or limitations. These technologies are then refined and improved until they are eventually replaced by even better ones. Industries innovate with a clear goal in mind, and this goal is achieved only when all requirements are met and production reliability is ensured.

About 20 years ago, industries migrated from semiproprietary serial protocols to unified Ethernet architectures. This set the stage for reaping the benefits of Industry 4.0. However, this shift also exposed operational technology (OT) to new cyberthreats. It took two decades for IT to mature its solutions and provide OT with the necessary framework to ensure the reliability of production processes.

A similar pattern is evident in wireless communications. Wi-Fi was widely adopted by industrial organizations because equipment could now operate without the constraints of cables. This extended the use of Wi-Fi far beyond its original intent.

Now, another wireless technology has emerged: private 5G. The private implementation of the 5G technology used by mobile operators makes wireless communication considerably more reliable and secure.
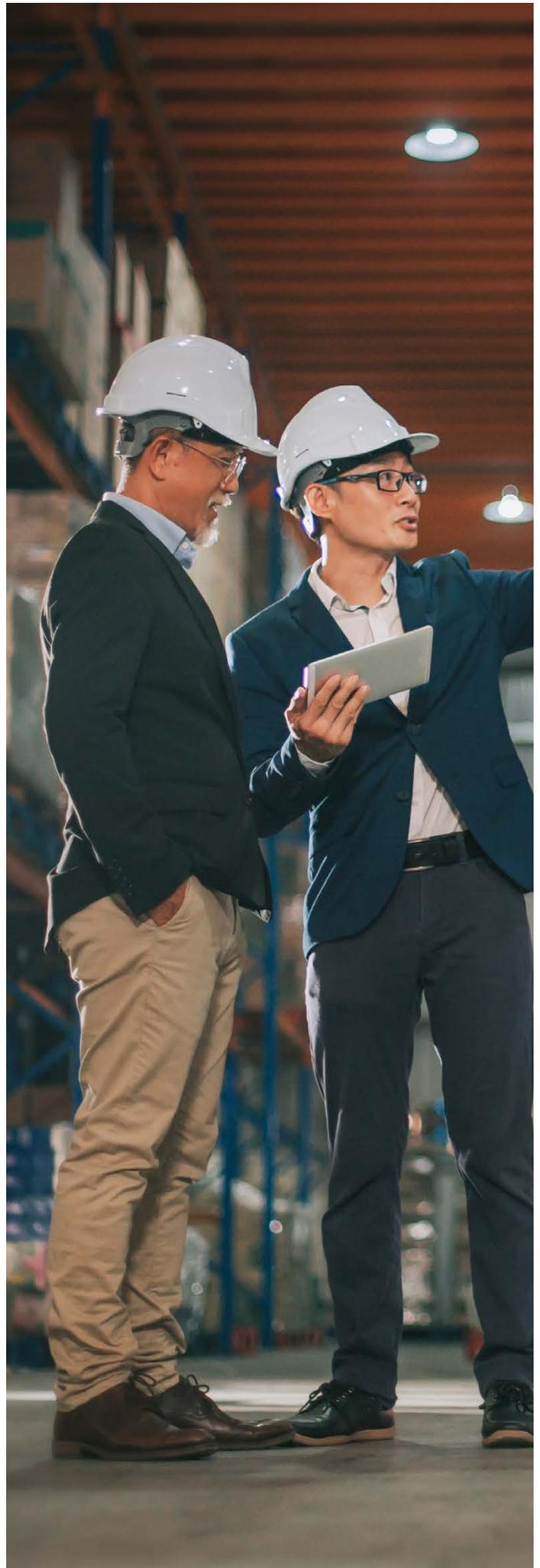
Meeting industrial requirements

Reliability (and, inherently, security) is the first requirement of industrial production. Any technology introduced into a factory serves a singular purpose: to improve the production process in some way. Wi-Fi was introduced to provide wireless connectivity, while private 5G enhances these connections by making them both reliable and secure.

Why private 5G works so well for industrial applications

Dedicated radio spectrum

Private 5G networks use a dedicated, licensed range of radio frequencies (or spectrum) that are exclusively allocated to the user by the local regulator for a specific site.

In contrast, Wi-Fi operates on unlicensed radio frequencies that are freely available to anyone, leading to uncontrolled competition for bandwidth. Even a smartphone can locally contend for this unlicensed spectrum, potentially disrupting communication between other devices and their antennas, and significantly affecting their network connection.

No contention

Private 5G facilitates one-to-one, point-to-point communication between a device and the 5G radio access network (RAN) unit. Devices are managed, with a specific slot allocated for communication with the data network.

Wi-Fi, on the other hand, relies on the traditional Ethernet carrier-sense multiple-access protocol, where devices manage network contention by backing off for a random period of time. This approach limits the predictability of Wi-Fi network behavior, especially in congested environments.

Seamless handover

With private 5G, a device can connect to multiple radio antennas simultaneously. The local RAN seamlessly manages the device handover between antennas as the device moves or the environment radio conditions change.

In contrast, Wi-Fi relies on the device itself to manage these transitions. When the signal to an antenna is lost, the modem must reestablish the connection with another antenna, which often results in poor communication or even a temporary loss of connection.

Reliable reception in any environment

Industrial locations, which are often built with metal and concrete, pose serious challenges to radio communication due to substantial signal absorption and multiple reflections. Furthermore, electric motors and circuits introduce electromagnetic noise that degrades the radio-frequency environment.

Private 5G is less susceptible to these issues, thanks to advanced radio planning and optimization techniques such as beamforming (a signal-processing technique) and MIMO-based connectivity (short for "multiple input, multiple output" — using multiple antennas to improve network speed and capacity). These features enable a more consistent and reliable signal reception.

Moreover, 5G's inherent spectrum optimization allows it to support up to one million devices per square kilometer while consuming only 10% of the energy needed for Wi-Fi in similar scenarios.

Extended coverage

5G naturally excels in covering large open areas, whether it's a campus with multiple buildings, a logistics site, a port or an airport. Once you're connected to the private 5G network, you maintain a seamless connection wherever you go. With control over your own private 5G network, issues such as areas of poor coverage and difficulties connecting become a thing of the past.

Seamless roaming

When a device moves outside the private 5G coverage area, private operators can continue the connectivity — provided the device SIM card (physical or eSIM) allows it. It's like a seamless extension of your corporate network, and something that Wi-Fi simply cannot match.

Security

Wi-Fi connections rely on a simple service set identifier (SSID), username and password to give users access to the wireless environment, subsequently relying on network security to control user access to additional resources. In contrast, private 5G operates on a zero trust model from the outset, leaving no room for traffic to be monitored by or copied to unregistered users.

> **NTT DATA offers secure hybrid roaming solutions that maintain similar levels of connectivity when transitioning to the networks of public mobile network operators.**

Private 5G networks require a combination of the device's International Mobile Equipment Identity (IMEI) and SIM card for any initial network access. When these parameters are not registered in the core 5G configuration, there can be no access.

In addition, because private 5G networks use dedicated frequencies, devices must be configured to operate on these frequencies in order to even "see" the network. This creates an extra physical layer of security.

Less power used

Private 5G networks consume far less energy than Wi-Fi and 4G/LTE. Using the same power output from radio antennas, private 5G can cover a much greater distance than Wi-Fi.

5G radio units feature a technology called beamforming, which dynamically adjusts the coverage area based on the location of connected devices. This ensures the highest quality and speed for each network connection.

Device capacity

Private 5G has a distinct architecture for data ingress, capable of supporting multiple data paths into a local network — unlike Wi-Fi, which is limited to a single data path. Coupled with the ability to support up to one million devices per square kilometer, private 5G fundamentally changes the way environments can be "sensorized."

Easy integration

Just as (VLAN) allow you to segment a cabled network, private 5G lets you slice the 5G network into multiple concurrent logical networks, each with its own quality of service (QoS) or reserved bandwidth configurations. These logical networks can be spread across multiple sites within your organization, providing transparent mobility and virtualizing geographical boundaries.

In contrast to Wi-Fi, where every hotspot functions as a gateway to a single wireless network range, private 5G offers more options for segmentation and dramatically simplifies network management through a single software interface to the 5G core.

Support for industrial communications

Industrial communications have unique requirements. While application-layer protocols often rely on broadcasts, field protocols need reliable connections with low and predictable latency. In automated factories, where synchronized robots and AGVs are commonplace, time-sensitive networks have become a hot topic.

Private 5G is the industrial wireless technology that meets these demands. It effectively introduces a wireless dimension to the entire industrial network, offering speed, reliability and predictability along with strong security.

> **NTT DATA's Private 5G seamlessly extends the capabilities of a cabled network, offering cable-like performance.**

A comprehensive solution

Private 5G checks all the boxes for being a comprehensive industrial wireless solution.

It offers the benefits of modern connectivity without the limitations of a cable and without compromising on any IT or OT requirements. It excels in reliability, security, area coverage, network integration and support for industrial communication, surpassing Wi-Fi in every aspect and offering a real connectivity alternative in scenarios where using cables is already a compromise.

Private 5G at your facility

Wi-Fi is no longer the only wireless network option. Systems integrators like NTT DATA have developed the expertise to install and operate both public and private 5G networks for industrial clients worldwide.

While 5G is often associated with mobile operators, the technology has now been adapted to serve local wireless use cases. This private implementation of 5G integrates seamlessly with industrial IT infrastructure, offering wireless performance far superior to that of Wi-Fi.

> **Early adopters of NTT DATA's Private 5G solutions are already reaping the benefits for their industrial wireless needs. Our solutions meet a growing demand in the industry, and we're dedicated to overcoming the barriers that prevent more organizations from enjoying the same advantages.**

So, why do industrial organizations still use Wi-Fi?

And, given the costs associated with cabling and the challenges posed by harsh industrial settings, why do we still see cables on the factory floor?

Support and service

At NTT DATA, we understand the concerns of our clients who say, "I don't want to deal with the antennas." Our Private 5G offering ranges from supplying the hardware and software (including edge computing), and conducting the installation and commissioning to a full-service package that includes operations, training and operational support.

A significant factor in the perception of private 5G versus Wi-Fi is the sense of control.

Many clients believe they can manage Wi-Fi installation and integration independently, given their in-house IT knowledge. This is only partly accurate, as industrial Wi-Fi implementations require a thorough site study conducted by a service provider with expertise in radio-wave propagation. This is a crucial step to ensure that Wi-Fi meets industrial-grade requirements for reliability, as the technology is often pushed far beyond its original use case and typical home or office environment.

When it comes to 5G, installation invariably demands specialist skills, which means most organizations need to collaborate with service providers who can both install and maintain the technology.

This can be a sensitive issue for OT teams for whom autonomy means reliability. However, choosing a service provider with proven expertise and experience can alleviate any concerns.

Price and total cost of ownership

Private 5G has a reputation for being considerably more expensive than Wi-Fi. This may hold true to some extent, but the costs must be evaluated case by case and compared with the total cost of the Wi-Fi solution, including cabling and the risk of service disruptions.

Although the individual cost of a 5G radio unit may be higher, the overall cost efficiency becomes evident when you consider that fewer units are required.

We have seen installations where 200 Wi-Fi access points were replaced with just seven 5G radio units, providing SLA-guaranteed bandwidth and reliable connectivity. Once you factor in the cost of cabling, the installation costs alone highlight the advantages of private 5G.

When it comes to internal logistics, we have encountered clients whose AGVs went unused due to frequent Wi-Fi connectivity issues. Clearly, the range and reliability of Wi-Fi falls short of the requirements of AGVs and autonomous mobile robots. The full potential of these advanced tools can be realized only with the deployment of a robust and reliable wireless connectivity infrastructure such as private 5G.

Read more: NTT DATA'S Private 5G solutions

A vision for private 5G in the industry

Wireless technology has emerged as a key solution to the complex connectivity challenges of modern industrial environments, with Wi-Fi being the sole wireless connectivity option available for some time. However, industrial demands have pushed Wi-Fi far beyond its original office applications.

Now, there is an alternative.

Private 5G has been adapted to support local private deployments. The technology was chosen because it meets, by design, the strict requirements of industrial applications Its strong security and reliability and predictable quality will encourage widespread adoption and standardization in the industry over the coming years.

More than just extended coverage

As the NTT DATA-delivered LyondellBasell project shows, private 5G is not merely about improving local wireless coverage, reliability and overall capability. It also plays a crucial role in unifying global IT infrastructure and integrating a broader range of services, including push-to-talk, asset tracking and positioning, and personal safety monitoring.

Read more: Showcasing the benefits of private 5G with LyondellBasell

> " Deploying private 5G networks across our manufacturing sites provides critical connectivity that enables our digital solutions, resulting in increased operating efficiency and enhanced safety measures. Working with NTT DATA to install secure and reliable connectivity will underpin our value-enhancement program and empower our global teams with better working environments."

Kathy VanLandingham, Vice President and Chief Information Officer at LyondellBasell

The design of 5G, with its focus on reliability, security and seamless roaming, makes it more than a mere wireless alternative: it introduces a wireless dimension to the corporate network.

Private 5G also offers far more than a local replacement for industrial Wi-Fi. It serves to unify and modernize the corporate network architecture, both wired and wireless, with flawless roaming across all organizational sites. It also enables a transparent network architecture where segmentation is centrally managed by software, extending to each end-device.

The 5G module is not simply a modem for remote connectivity; it functions as a wireless Ethernet port to provide fast and flexible corporate connectivity, across the company, from the office to the factory floor.

Private 5G in practice

Logistics and intralogistics

Private 5G supports AGV operations in and around warehouses, connects tablet applications and barcode scanners, and enables machine vision for operations and safety monitoring.

Communicating wirelessly with autonomous mobile robots that are moving through warehouse stacks at high speed can be a chalenge for Wi-Fi, but isn't for Private 5G, that greatly improves connectivity, enabling supply chain automation.

Transatel, an NTT DATA subsidiary, has announced a 5G IoT solution for the industrial, IT and automotive industries, giving NTT DATA Private 5G clients the benefit of a single SIM serving both their private network needs and enabling global roaming beyond factories and campuses.

Read more: NTT rolls out new 5G IoT service
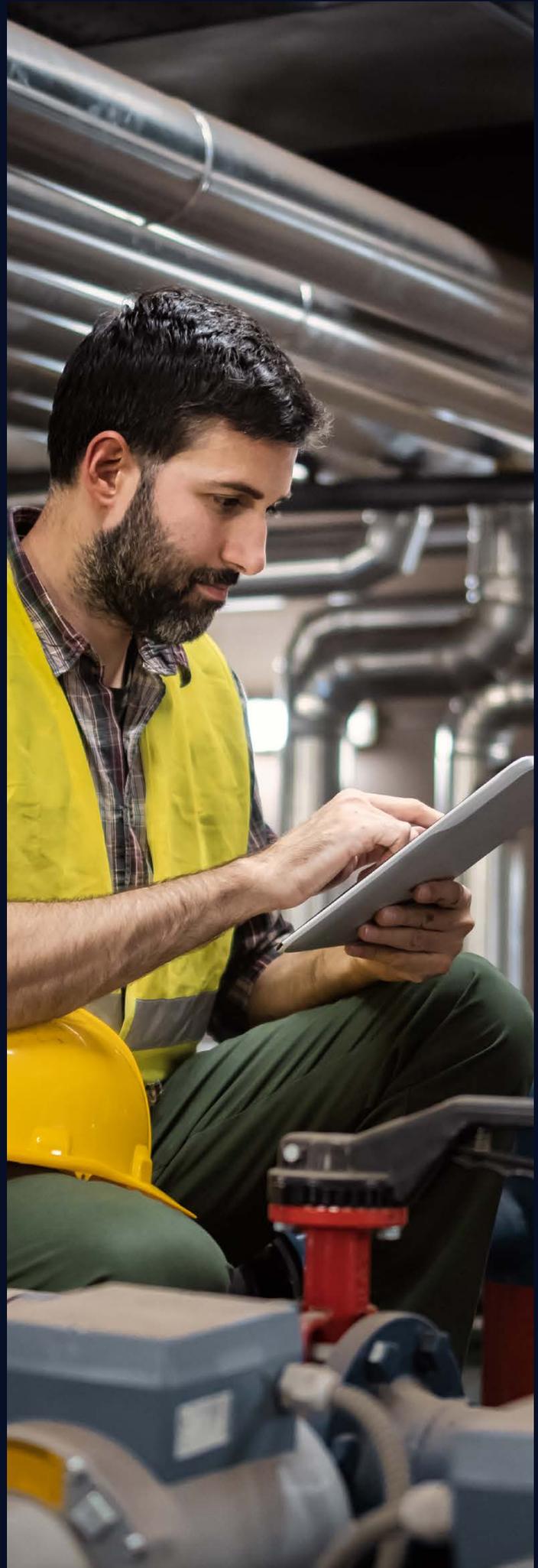
Manufacturing plants

In manufacturing, private 5G's reliable, high-speed connectivity in industrial facilities and across sites enables cable-free operations, asset tracking and positioning, high-speed updates of customized firmware (for example, updating a new car's firmware while it goes through the last stages of the production line), automated parking or storage, and automated site surveillance.

NTT DATA was a partner in developing an Innovation Hub in the training center of the BMW Group plant in Dingolfing, Germany, where projects have included using private 5G for plant connections.

Read more: "Real laboratory" for testing future technologies

We have also worked with LyondellBasell, a leader in the global chemicals industry, to take advantage of the possibilities of private 5G and the critical role the technology plays in providing pervasive, secure and reliable connectivity in their manufacturing facilities.

Airports and seaports

In port operations, private 5G excels in keeping applications on portable PCs and tablets connected anywhere around port facilities, and in enabling AGV operations over large areas. It also enables IoT and fast data-harvesting from planes, as well as push-to-talk for emergency communications.

At Köln Bonn Airport in Germany, we worked with the authorities to find ways of using private 5G connectivity to innovate and improve the efficiency and safety of the airport.

The owner and operator of Germany's largest airport, Fraport AG, wanted a secure, reliable network to cover all 2,500 hectares of Frankfurt Airport. NTT DATA was chosen as their partner to design and build a private 5G network that would connect the technology needed to streamline airport operations.

Read more: Köln Bonn Airport looks to leverage private 5G connectivity to drive innovation

Read more: Private 5G serves as the network base for Fraport AG's future development
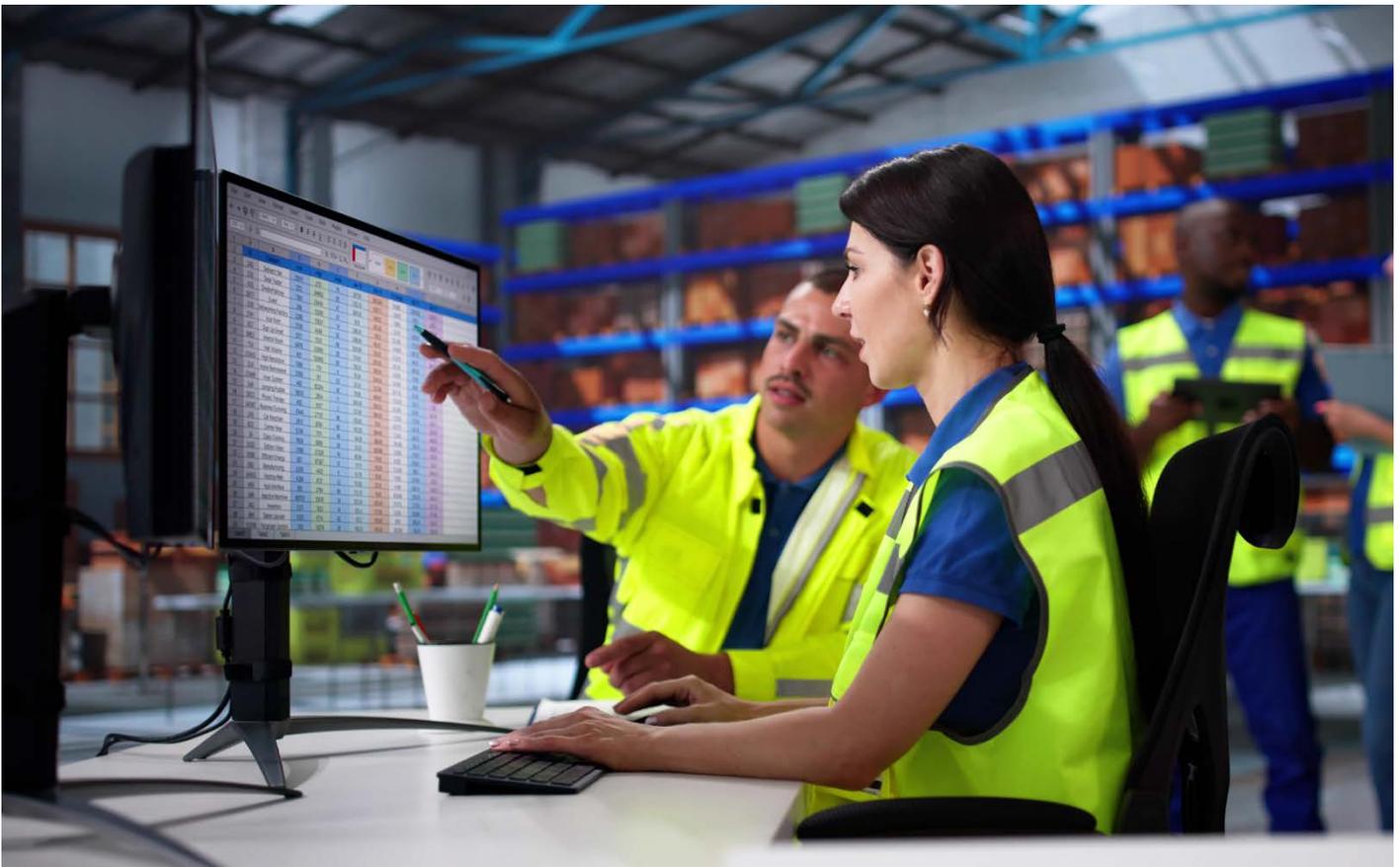
Technical comparison

Here's how NTT DATA's Private 5G solutions outperform other wireless solutions:

Feature	Private 5G	Wi-Fi
Security	Enhanced security features like SIM-based authentication and encryption, even before accessing the network	Limited security, vulnerable to interference and security breaches; relies mostly on network security
Reliability	Private spectrum with consistent coverage and controlled interference	Shared spectrum, susceptible to interference and inconsistent coverage
Latency	Predictable and significantly lower latency	Higher latency with unpredictable contention, especially in environments populated with many devices vying for access
Bandwidth	Managed bandwidth, with QoS, optimized based on user device and application requirements	Limited bandwidth, especially in environments populated with many devices
Coverage	Managed coverage to cover extended areas or complex environments	Limited coverage, especially outdoors or in industrial environments
Control	Centralized control over the whole network infrastructure	Limited local control over network wireless extensions
Cost	Higher individual antenna costs but needs far fewer antennas and much less cabling; predictable operational costs	Lower cost for individual access points but significant hidden cost for initial set-up, maintenance and future updates
Complexity	Deployment requires qualified personnel, but the centralized management and network integration make it simpler to manage	Simpler deployment but more complex changes and infrastructure management
Power consumption	About 100 bits/joule	10–20 bits/joule

About NTT DATA

NTT DATA is a $30+ billion trusted global innovator of digital business and technology services. We serve 75% of the Fortune Global 100 and are committed to helping clients innovate, optimize and transform for long-term success. As a Global Top Employer, we have diverse experts in more than 50 countries and a robust partner ecosystem of established and startup companies. Our services include business and technology consulting, data and artificial intelligence, industry solutions, as well as the development, implementation and management of applications, infrastructure and connectivity. We are also one of the leading providers of digital and AI infrastructure in the world. NTT DATA is part of NTT Group, which invests over $3.6 billion each year in R&D to help organizations and society move confidently and sustainably into the digital future.

Visit us at nttdata.com

NTT DATA