White paper

Smart manufacturing with private 5G & edge as a service

How edge computing and private 5G accelerate digital transformation in manufacturing

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Digital transformation is delivering change and opportunity to organizations the world over – including as part of the move to Industry 4.0, bringing rapid changes to technology, industries and processes amid increasing interconnectivity and smart automation.

Add to this the rise of hybrid working, virtual and augmented reality (VR and AR), IoT, AI and edge computing – all of which also require new security approaches – and the digital journey becomes as complex as it is exciting.

Organizations may, however, lack the technology or infrastructure to meet their evolving business requirements. Unreliable and insecure past wireless technologies cannot fully support mission-critical, real-time functionality such as edge computing, but 5G technology has cleared these hurdles, leading to demand across industries for private 5G networks.

According to NTT's 2022–23 Global Network Report, more than 80% of organizations are embracing the adoption of new enabling technologies, of which cloud-based network management, AIOps and private 5G are the top three investment priorities for the next two years.

A localized private instance of a 5G network can support enterprise-level applications, quality-of-service policies and security requirements with reliable performance in real time. Its high-bandwidth, low-latency connections provide stability for mission-critical applications and can make manufacturing processes more effective while boosting productivity.

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Edge computing refers to the processing of data with applications at or near the edge of a network in a range of devices, and a key advantage is its ability to work with 5G by:

- Allowing applications to process data on the edge near the source
- Delivering dependable, real-time analytics and machine-learning capabilities
- Easily deploying and enabling mission-critical applications to process data securely on-premises
- Providing observability and governance with cloud-centric infrastructure

A combined platform approach – a private 5G network with edge computing – can also improve efficiency, allowing users to use multiple devices and applications seamlessly.

Expertise on demand to overcome complexity

However, because private 5G can be complex to set up and manage, NTT's Private 5G delivers the features enabled by this technology in a fully managed, enterprise-friendly turnkey package directly to organizations.

We connect our clients' on-site teams and devices seamlessly from the edge to the cloud, giving them the speed, control, security and coverage they need to transform their customer and employee experience.

Our managed services provide a single point of support to integrate private 5G with existing enterprise networks, industrial IoT infrastructure, and edge and cloud computing resources. We're the first to offer a full stack of network and service options, with a range of fully tested mobile devices, to meet the challenge of making private 5G perform optimally in any environment.

Organizations also have to control data sovereignty, ownership and location, and our private 5G can ensure that all customer traffic remains on-premises. Essentially, this extends the enterprise local-area network (LAN) with private 5G technology to place data control in the hands of the IT department.

So, our Private 5G – which forms part of our overall Edge as a Service offering – is delivered as a managed, packaged solution that contains all the device and application integration services an organization needs to be up and running rapidly, coupled with our managed services to provide continual support.

A powerful partnership now includes private 5G too

The partnership between NTT and Cisco has served our clients well for more than 30 years with full-stack technology solutions and services. As one of Cisco's largest partners globally, we have many large mutual customers that have invested heavily in the Cisco ecosystem – everything from their network architecture to hardware and firewalls.

Much of this technology can be enhanced when these customers adopt private 5G as part of their LAN. We see private 5G very much as a LAN extension, not a separate part of their networks – and therefore there is tight integration with pre-existing Cisco networking.

Therefore, we have worked together again to bring to market the technology and value-added services that enterprise customers need to deploy private 5G and achieve better business outcomes, particularly in the automotive, logistics, healthcare, retail and government sectors.

Our end-to-end Private 5G powers Cisco Private 5G. This enables our mutual customers to seamlessly integrate private 5G into their pre-existing network infrastructure for secure, reliable connectivity that can help them achieve Industry 4.0 capabilities.

This is backed up by NTT's managed services, including Edge as a Service, which help our customers make the most of their private 5G connection and take advantage of the connectivity between devices at the edge.

Compelling demand for private 5G

It is clear that private 5G holds much promise for organizations in several industries.

In 2022, Cisco's Strategic Execution Office ran a study on private 5G in collaboration with Deloitte, titled "Vertical use cases offer development", to examine use cases that illustrate the main applications of private 5G and the differentiation it delivers.

Through primary and secondary research, the study analyzed 72 use cases across 12 industries based on publicly available research and interviews with their own 5G experts and sector leaders. Of these use cases, 24 were categorized as having high industry demand and high private 5G applicability.

The most compelling demand for private 5G was observed in the manufacturing, logistics and government industries – which is also where NTT's Private 5G and Edge as a Service have found the most traction.

The success of edge computing in an industry like manufacturing is closely linked to private 5G, in particular for applications needing high-performance computing and secure, reliable connectivity.

Use cases of private 5G

The research found four common themes across the use cases that were studied:

1. **Enabling hybrid connectivity:** It is easy to separate or reconfigure multisensor access networks and stable private 5G connectivity.
2. **Activation and policy setup for varied sensor profiles:** There is a standardized and accelerated approach to activating legacy systems and devices and new devices with private 5G through templated provisioning, policies and security profiles.
3. **Advanced intelligence with private 5G and the edge-computing stack:** Deploying unified network and edge appliances leads to significantly increased sensor–edge data transfer, edge inferencing and real-time actuation.
4. **Integrated app and infrastructure to enable business outcomes:** The preintegration of data flows between sensors, applications and the network supports business outcomes in multiple scenarios.

From themes to applications

In NTT's experience, these themes have translated into five main application areas:

1. **Group wireless communications (push to talk):** Private 5G can connect workers and teams across locations through group calling and instantaneous messaging combined with real-time location tracking.
2. **A connected workforce:** AR and VR supported by private 5G enable self-assist (training and guidance, real-time data sharing and finding contextual information), work-assist (instructions and checklists) and remote-assist (such as taking part in expert sessions for training) capabilities.
3. **Autonomous guided vehicles:** Portable robots can transport materials across industrial sites, with private 5G making real-time connectivity and control possible.
4. **Computer vision:** Automatic video surveillance, inspection and guidance – such as detecting product flaws by video – is faster and more efficient on a private 5G network.
5. **Connected devices (PCs, tablets, handhelds):** Mobile devices remain reliably and securely connected to the enterprise network throughout a work shift without relying on Wi-Fi of portable hot spots.

Drilling down into industries

The Cisco study also identified industry-specific IT needs:

Manufacturing: There is a need for a rationalized, layered, accumulated variety of access networks (over 10- to 15-year upgrade cycles) and simplified network management. Solutions should enable reliable time synchronization of sensor data streams for better application decisioning.

Logistics: Complex, interference-prone facility layouts must not prevent the provision of reliable device connectivity. Networks should solve the varying time-sensitivity thresholds needed by different applications.

Government: For mission-critical applications, there is a need to provide mobile connectivity platforms in remote locations for field deployments. For infrastructure-led deployments, there must be a step-function increase in support for device types and for bring-your-own-device environments.

How will private 5G make a difference?

In manufacturing, logistics and government (the three industries found to have the most compelling demand for private 5G), Deloitte provided examples of use cases linked to specific functions enabled by private 5G:

Offer	Manufacturing	Logistics	Government
Asset traceability	**Factory asset intelligence:** Traceability from parts to product, with increased sensor enablement across manufacturing, assembly and testing sites	**Supply-chain transparency:** Precision asset tracking and the enablement of automated guided vehicles and autonomous mobile robots at warehouses and distribution centers	
Enterprise campus mobility networks			**Search-and-rescue operations:** Response personnel and devices enabled by turnkey connectivity for an improved emergency response
Asset monitoring and operations control	**Dynamic factory scheduling:** Closed-loop control and safety applications enabled by real-time actuation, sensor fusion and dynamic process schedules	**Smart warehousing:** Productivity and cost optimization, more automation, and better work-floor safety and compliance in warehouses by using autonomous devices	
Remote diagnostic and technical collaboration		**Fleet tracking and analytics:** Managing vehicle status, safety, compliance, use and fuel efficiency through real-time data streams and analytics	**First-responder solutions:** Advance, time-sensitive actioning capabilities enabled by field personnel unifying and sharing data feeds to mobilize precise responses

Source: "Vertical use cases offer development", 2022 Cisco study

Private 5G on the production line

The study looked at how private 5G can be used to optimize the assets and processes found on manufacturing, assembly and testing sites, and in warehouses and storage facilities.

Manufacturers trace assets throughout their lifecycle – from parts to product – as they move through their facilities. This is achieved through location and event data and other telemetry that flow from a range of sensors and factory systems.

Private 5G now brings new levels of speed and precision to asset tracking, system monitoring and real-time schedule and process optimization.

Why do factories need private 5G?

Using private 5G in manufacturing facilities helps to avoid Wi-Fi access-point proliferation and blind spots that make it harder to track assets.

It also makes it possible for asset-based sensors to achieve indoor positioning accuracy of less than one meter.

Reconfiguring connectivity between devices and the network becomes simpler when a manufacturer is changing or creating new production lines, while there are also benefits in terms of the timing synchronization of sensor data feeds.

Making the business case for private 5G in manufacturing

Network and connectivity

What manufacturers want:
A significant reduction in capital and operational expenditure from a simplified network (limited to operational expenditure with an as-as-service model) with fewer overhaul needs, as well as a unified network to enable the data meshes needed to converge IT and operational technology (OT) applications.

What private 5G supports:
Unified, reliable connectivity for devices and sensors.

Tracking

What manufacturers want:
The continual tracking of assets (with precise locations), using asset-based sensors to send asset-positioning data and other telemetry to control systems.

What private 5G supports:
Continual tracking of asset movements and events.

Systems reconfiguration

What manufacturers want:
An easy way to dynamically reconfigure factory networks and systems in short intervals to support mass customization or personalization (where production output could be as low as one unit).

What private 5G supports:
The dynamic, wire-free reconfiguration of manufacturing lines.

Asset positioning

What manufacturers want:
Precise positioning for assets that need precision control with ultra-low latency, including mobile assets such as automated guided vehicles. Exact and continually available positioning information supports operational forecasts, reduces time lost in locating assets and enables closed-loop decision-making.

What private 5G supports:
More accurate asset-positioning data.

Application support

What manufacturers want:
For safety and closed-loop applications, an end-to-end (sensor–app–sensor) round-trip time of less than 20 milliseconds (with an air-interface latency of less than 10 milliseconds). This will allow them to migrate workloads incrementally from open- to closed-loop functions.

What private 5G supports:
Low-latency actuation for mission-critical applications.

Private 5G and the bottom line

The study summarized the estimated impact of these business outcomes on manufacturers' cost structures as follows:

Business outcome	Wages	Purchases	Utilities	Other
Unified, reliable connectivity for sensors	Low	Not applicable	Medium	High
Continual tracking of asset movements and events	Medium	High	Low	Medium
Support for the dynamic reconfiguration of manufacturing lines	High	Not applicable	Low	High
Improvements in asset-positioning accuracy	High	High	Low	High
Enabling low-latency actuation for mission-critical applications	High	Not applicable	Medium	HIgh
Expected aggregate impact on cost heads	-6% to -8%	-0.5% to -1%	-5% to -8%	-6% to -8%

Source: "Vertical use cases offer development", 2022 Cisco study

5 ways private 5G enables business outcomes in manufacturing

In summary, this is how the study makes the case for manufacturers to invest in private 5G and edge computing:

1. **Rationalizing radio networks to gain the interoperability and data fusion needed for digital transformation**

   The challenge: Manufacturers run multiple access networks on their sites, which are limiting in terms of management and for automation use cases that need IT and OT convergence and a unified data platform (voice, data, video, IoT). Disparate networks limit digital transformation efforts and the ability to standardize connectivity across sites.

   How private 5G can help: Private 5G offers a secure LAN extension with low latency, high bandwidth and more reliability to connect mobile devices for mission-critical applications and use cases with quality-of-service classes specified by the organization's own IT group. Manufacturers are also increasingly comfortable outsourcing their network management.

   The outcome: Manufacturers expect a significant reduction in capital and operational expenditure from a simplified network (limited to operational expenditure with the as-a-service model) while limiting overhaul needs. A unified network is also expected to enable the data meshes needed to converge IT and OT applications.

2. **Allowing the continual tracking of assets by overcoming air shadows and blind spots caused by Wi-Fi access points**

   The challenge: Manufacturers have largely relied on remote sensing of asset movements (using radio-frequency identification tags and scanning at specific points to detect asset movements and Wi-Fi scanning of assets in enabled coverage areas). However, this is seen as limiting and they want to enable continuous asset tracking (with precise locations) using asset-based sensors.

   How private 5G can help: In manufacturing settings, private 5G services higher device density with far less radio equipment compared with Wi-Fi but with reliable unchanging connectivity performance as the device density increases (with a specific focus on mission-critical applications). It also solves other limitations of Wi-Fi deployments with, for example, unprotected spectrum, near-instantaneous handoffs between radio units and predictable coverage despite layout changes.

   The outcome: In automotive assembly, for instance, 90% of tools are electric, of which 70%–80% are connected to the wired network. These tools have largely become wireless (power and network), but the sector faces limitations as set out above to enable them for "true wireless" operation. With continuous asset tracking powered by private 5G, manufacturers can monitor asset movements, collect reliable and continual telemetry from assets, perform root-cause analysis and failure-pattern detection, and optimize their material flows.

3. Simplifying the time needed to reconfigure sensor connectivity when changing or setting up new manufacturing lines

The challenge: It can take months or even longer – and be extremely expensive – for manufacturers to set up new production lines or reconfigure existing ones because connectivity profiles for all connected devices and systems need to be reconfigured. They are increasingly looking to switch wired to wireless connections to allow fast and simple reconfiguration of sensor connections and the synchronization of timing mechanisms.

How private 5G can help: Private 5G is viewed as a drop-in replacement for wired connections (at the minimum for backhauling traffic from wired systems). There are 5G-based equivalents being developed for wired protocols, and private 5G can support the autodiscoverability of devices at scale and apply automatic or templated configurations to activate reconfigured networks and devices.

The outcome: Manufacturers can accommodate mass customization or personalization (where production output could be as low as one unit), which requires factory networks and systems to be dynamically reconfigured in short intervals. And, once they have dynamically reconfigurable production lines, they can pursue further automation by using AI and machine learning for real-time process improvements and line reorganization.

4. Improving asset-positioning accuracy

The challenge: Manufacturers have been accustomed to limited asset-positioning accuracy from current positioning technologies, with intermittent tracking failures and low spatial resolution. However, to enable increased shop-floor automation and real-time workloads, they need reliable asset positioning with higher precision.

How private 5G can help: Private 5G (depending on the frequency band) can support positioning accuracy from sub-meter to 10cm (with the potential to get to 1cm). It uses additional location-specific measures to increase location precision. Manufacturers can support different applications with differing accuracy requirements and latency thresholds.

The outcome: Enabling higher precision in asset positioning opens the door to the increased automation of workloads. Additionally, reliable asset tracking at low latency drives significant workforce time savings in locating assets to assemble.

5. Enabling low-latency actuation for mission-critical applications

The challenge: To expand their level of automation, manufacturers want network solutions that drastically reduce delays between instruction and reaction. The latency requirements for autonomous use cases in manufacturing can range from 5 to 15 milliseconds, with jitter of less than 100 microseconds.

How private 5G can help: Private 5G supports guaranteed low-latency data transmission over a wireless interface, delivering time-synchronized data over long distances on the factory floor, and transmitting traffic with differentiated guaranteed quality of service.

The outcome: Manufacturers can move from the current "automation pyramid" model (which classifies the IT layers of industrial automated production plants) to an "autonomous pyramid" model with unified, intelligent connectivity and the ability to respond to changing market and business conditions in real time. Wireless networks can be extended to enable closed-loop applications at scale.

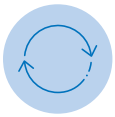
> **"Software-defined infrastructure is growing at 13% year-on-year.** Software provides commercial and operational flexibility, while allowing for orchestrated and automated approaches to managing these environments."
>
> NTT Network Insights Report

Take the next step for your organization

Making the most of IoT and the trend towards automation and autonomous factories depends on fast and secure low-latency networks with continuous, reliable connectivity – and every connection needs to be secured to protect data and intellectual property.

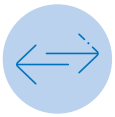
In this context, many organizations are discovering how the pairing of private 5G and edge computing (especially when bought as a service) can power their Industry 4.0 transformation.

We help our clients to make the improvements they need without significant upfront investment, effort or risk to their existing operations:



A full turnkey service

Our unique delivery and management model is delivered as a single point of control and can be used as you want, with minimal risk. Our coverage-based pricing model is predictable and budget-friendly.



Connected and integrated across your organization

Private 5G as a service fits into enterprise environments, including legacy systems, with no need for LAN overlays or rearchitected security policies.

Uniquely global

Your private 5G is ready to deploy anywhere you need it, with simple global device management and our full support network on standby.

Secure, robust, and business-ready

Get only the functionality that you need, nothing more. It's secure by design, including network-level embedded security and compliance.

Future-proof

Our network is designed to meet enterprise coverage and reliability demands, and is easily upgraded to grow with your organization. We invest in research and development so you can rely on a modern, secure and constantly evolving network.

How we manage our private 5G partnerships with manufacturers that are on a journey of digital transformation

1. We assess your key connectivity requirements and the limitations of your existing technology portfolio.
2. We identify 5G use cases and solutions in close collaboration with all relevant people in your organization.
3. Next, we find the best 5G implementation model for your organization, with critical success measures.
4. We adapt your connectivity strategy to your evolving digital transformation goals and the latest developments in 5G to maximize your return on investment.

Get in touch

To make the most of a private 5G network that is purpose-built for your organization, contact us now for a network assessment and more information.

Download our brochure on 5G network partnerships for manufacturers.

For more information on Cisco, contact Gurpreet Ubhi, Senior Director. Solutions, on gubhi@cisco.com.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