

# Enabling Smart Manufacturing With Private 5G

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## Overview

The tremendous amount of data that can be transmitted and processed today has paved the way for smart manufacturing. Using Industrial Internet of Things (IIoT) technology, the factory floor can achieve real-time monitoring and control, resulting in improved efficiency, a bigger return on investment (ROI), and the ability to offer cost-effective customization for a competitive advantage.

To build truly automated, intelligent, and robust industrial applications, communication capabilities must meet a set of stringent requirements. Boasting unprecedented speeds, 5G networks check all the boxes. Moreover, private 5G offers extensive capabilities, making it ideal for building reliable connectivity in manufacturing applications.

A private 5G network architecture not only grants smart manufacturing the benefits of a 5G cellular network—like high bandwidth, low latency, and extensive IIoT capabilities—but also ensures interference-free operation with allocated network frequencies. As a result, private 5G networks improve stability and security by allowing the secure storage of data privately, rather than on a shared public network.

This white paper examines the shift towards wireless networks in manufacturing, the benefits of private 5G in smart manufacturing, the challenges of implementing private 5G in industrial settings, and how new solutions address these challenges.

## Going Forward, Going Wireless

Each year, the manufacturing industry experiences a rise in wireless data transmissions as it embraces Industry 4.0 and lighthouse factories. In fact, “going wireless” is the buzz right now in the automation industry.

In key regions promoting smart manufacturing, local governments have already allocated specific frequencies for 5G private networks. These regions include the U.S. (n48), Germany (n77), Australia (n77), Japan (n79), South Korea (n79), and Taiwan (n79). The frequencies are reserved for specific regions to avoid wireless instability caused by interference from public networks. Additionally, the frequencies of telecom providers are leveraged for private 5G networks in certain regions, like China.

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Moxa is a leading provider of edge connectivity, industrial computing, and network infrastructure solutions for enabling connectivity for the Industrial Internet of Things. With 35 years of industry experience, Moxa has connected more than 82 million devices worldwide and has a distribution and service network that reaches customers in more than 80 countries. Moxa delivers lasting business value by empowering industry with reliable networks and sincere service for industrial communications infrastructures. Information about Moxa’s solutions is available at [www.moxa.com](http://www.moxa.com).

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According to the [Private 5G Network Market Size, Share & Trends Analysis Report \(2023\)](#), the private 5G network market will grow from USD 2 billion in 2023 to USD 36 billion by 2030, achieving a compound annual growth rate (CAGR) of 51%. These projections show a positive outlook and substantial market potential for private networks, justifying increased investment.

Leading global electronic device brands and manufacturers worldwide are already developing their own 5G-specific equipment, such as central units (CUs), distributed units (DUs), and radio units (RUs), as part of the Open Radio Access Network (ORAN) framework. The market’s recognition of the extensive applications of 5G and the development of its architecture are driving this trend. And, one of the primary applications is private 5G.

## The Transformative Benefits for Industries

Private 5G networks greatly enhance the security and stability requirements of smart manufacturing. They offer exclusive frequencies for stable signal performance, free from public frequency interference. Additionally, they create a customized network environment that ensures optimal connectivity and security in specific areas. The major benefit lies in storing all data on-site, rather than on a potentially compromised public network. For example, hackers could intercept data transmitted over a public network or infiltrate a vulnerable network and gain unauthorized access to sensitive data.

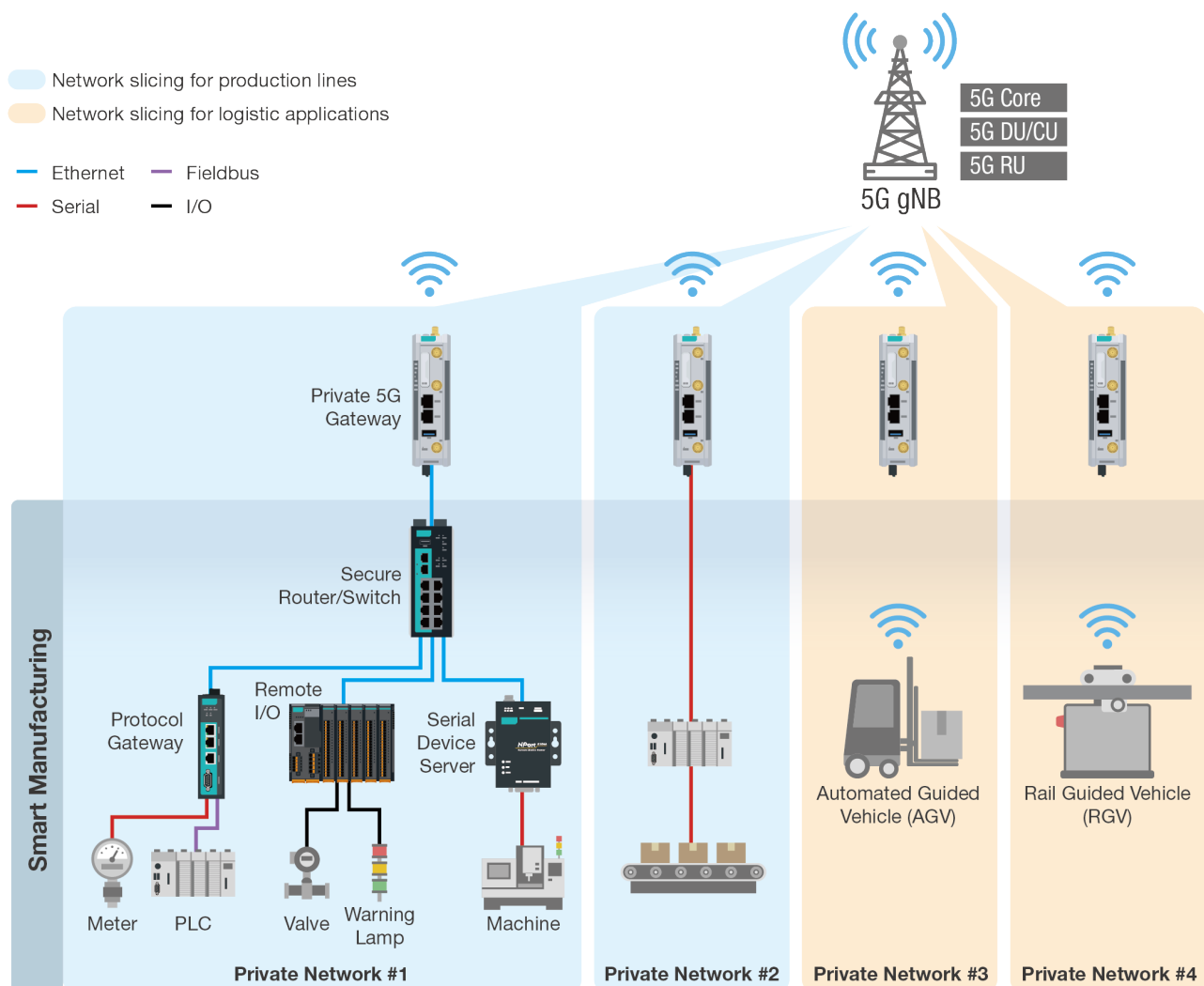


Figure 1. Private 5G networks in smart manufacturing applications

Some current private 5G applications in smart manufacturing include fixed-point programmable logic controllers (PLC) and mobile transportation carriers, such as automated guided vehicles (AGVs), automated mobile robots (AMRs), and rail-guided vehicles (RGVs).

Many industrial 5G gateways available in the market tend to highlight their compatibility with various interfaces, most often resulting in more intricate equipment designs and larger dimensions. However, this focus fails to consider the demand from manufacturing customers for energy-efficient compact 5G devices.

## Navigating the Pain Points

Reconciling IT and OT priorities is the primary challenge in deploying a private 5G network for smart manufacturing. IT and OT often clash as they prioritize top security and high availability, respectively. In OT systems, for example, they prioritize production capacity and occupational safety over cybersecurity. The impact of strict cybersecurity measures on production line operations can cause a decline in production capacity, something manufacturers cannot afford. Therefore, conducting an on-site analysis is crucial for obtaining detailed insights into manufacturing processes, OT network architecture, and production line assets. It involves recognizing customers' genuine needs regarding OT and converting them into a language IT can comprehend, aiming for an intelligent system that blends efficiency and security.

However, understanding the differences between OT and IT is only the first step. Industrial private 5G implementation also requires overcoming challenges such as infrastructure deployment, device and endpoint management, and system integration.

1. **Infrastructure deployment:** To use private 5G, integrators must construct the infrastructure, including 5G gateways, base stations, 5G core networks, and multi-access edge computing (MEC). These devices are expensive and demand skilled professionals for deployment because of their technical complexity. Because of the unique nature of each 5G deployment, custom configurations are necessary for every site and cannot be replicated effortlessly.
2. **Device and endpoint management:** It's challenging to handle multiple devices and endpoints in a private 5G network. Managing all 5G devices often requires customized software for tasks such as authentication, firmware updates, status monitoring, and viewing past messages.
3. **Integration with existing systems:** The communication protocols of industrial equipment typically function at Layer 2, while 5G architecture operates at Layer 3 and higher with IP capabilities. As a result, IT professionals face the challenge of enabling 5G communication to support Layer 2 packet pass-through.

## Moxa Solutions

For building 5G networks and implementing OT/IT convergence projects, system operators want efficient solutions that minimize pain points and lower deployment costs.

Factory engineers can use Moxa's extensive line of serial communication products to connect a variety of field devices when integrating diverse OT devices. Moxa has dedicated years to specializing in establishing industrial communications for OT equipment, such as terminal PLCs, meters, and sensors, using a wide range of protocol gateways, remote I/Os, and serial converters. With their private 5G cellular gateways, Moxa facilitates the seamless integration and transmission of data from OT devices to 5G networks in the new 5G era.

### Compact and Energy-efficient

Moxa's CCG-1500 Series private 5G cellular gateways deliver powerful performance in a compact design, measuring only 100 x 125 x 35 mm. Featuring customizable network settings and built-in redundancy with automatic SIM card switching, the CCG-1500 Series ensures outstanding field performance and stable network connectivity. Moreover, these private 5G cellular gateways have low power consumption (averaging 8 W), which improves battery life, allows fewer power inputs, and reduces maintenance and operating costs. Remote deployments require these specific features to prioritize power efficiency.

### IIoT Compatibility and Performance

Designed as both a media and a protocol converter, the CCG-1500 Series is ideal for IIoT applications. It has conversion capabilities for 5G-to-Ethernet and 5G-to-serial streamline OT (Ethernet and serial) for private 5G data transmissions, supporting both public and private networks. Dual-SIM redundancy offers industrial-grade reliability for uninterrupted connectivity. Wide temperature models are available for extended temperature applications. To ensure consistent 5G performance in wide-temperature environments, all CCG-1500 Series models are subjected to rigorous testing in a specialized testing chamber.

### Ethernet Frame Tunneling With Layer 2 Data Packets

Moxa's private 5G solutions enable Ethernet frame tunneling services, allowing Layer 2 data packets to be transmitted over the 5G network as end-to-end (E2E) communication between two or more terminal devices. Seamless E2E communication enables secure transmission of data packets from the central control to end devices over a private 5G network, saving time and resources that would otherwise be spent managing devices on-site.

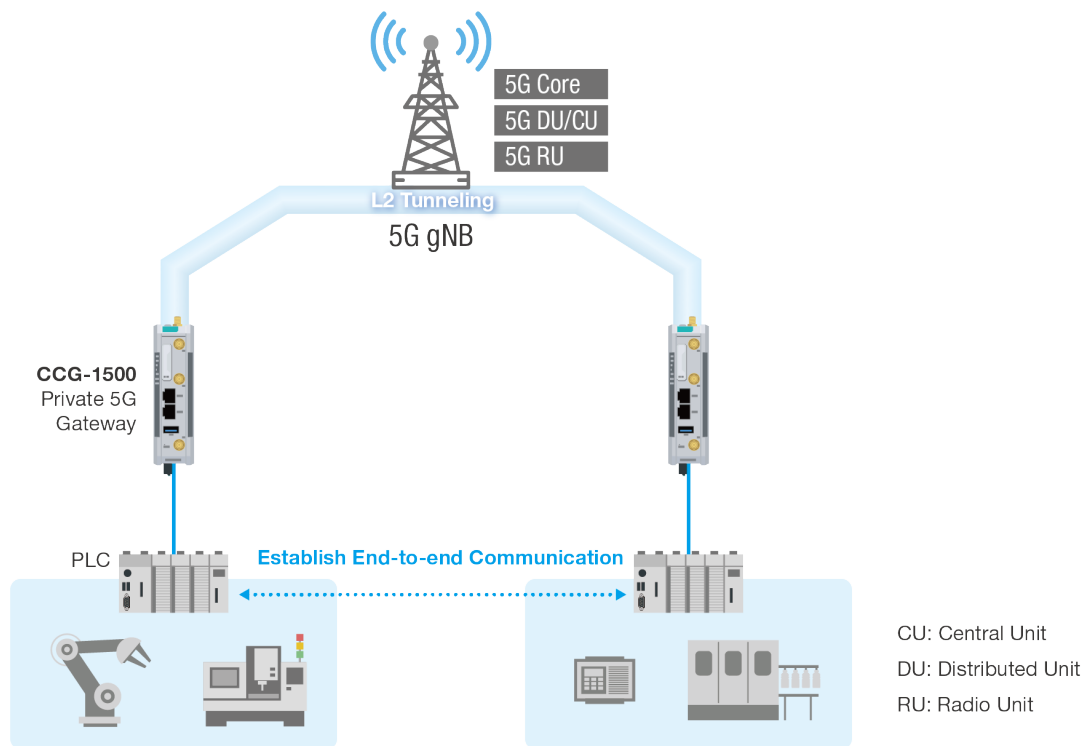


Figure 2. Layer 2 tunneling for end-to-end communication over a private 5G network

## Accessories to Boost Performance

Moxa conducted proof-of-concept tests with customers before releasing the CCG-1500 Series and discovered that factories frequently neglect signal interference from operational equipment or metal partitions during their private 5G infrastructure deployment. Overlooking this can cause poor signal quality, attenuation, and increased expenses because of the deployment of additional radio units (RUs) for signal upkeep.

To maximize the performance of the CCG-1500 Series private cellular 5G gateways, Moxa offers an additional accessory: the LNA-1000 Series low-noise amplifiers (LNA) strengthen reception quality and support 5G cellular bands.

## Network Oversight and Management Software

Constant monitoring and maintenance are necessary for optimal performance of a private 5G network. With Moxa's Device Lifecycle Management (DLM) software, trained IT and OT operators can easily manage devices. DLM supports the OMA LwM2M protocol, allowing administrators to monitor the network in a control room and quickly identify potential issues. Users can use DLM to effortlessly perform various network management tasks, including secure software updates, network monitoring, log access, troubleshooting, and more.

## On-site Troubleshooting Tool

Moxa has developed a packet logging diagnostic tool called "Diagnostic Partner" that interfaces with chip manufacturers' proprietary network packet analysis software. This tool enables on-site personnel to quickly capture the content of packet communications between user equipment (UE) and radio units (RUs), facilitating quick troubleshooting of network anomalies through parsing software. This provides crucial support for customers' on-site network maintenance and problem resolution efforts.

## Summary

As smart manufacturing advances towards Industry 4.0, private 5G networks play an increasingly pivotal role. Moxa's valuable contributions to problem-solving and reliable solutions make them a crucial player in shaping the future of connectivity in smart manufacturing.

Private 5G not only enables wireless connectivity but also paves the way for a smarter, more agile, and secure industrial ecosystem. Private 5G aligns seamlessly with the specific requirements of smart manufacturing applications, thanks to its dedicated network frequencies, improved stability, and secure local data storage.

Moxa, with its comprehensive suite of products and decades of expertise, addresses the 5G migration challenges by offering compact and energy-efficient solutions like the CCG-1500 Series of private 5G gateways. Furthermore, Moxa shows its dedication to the industrial sector by incorporating features like Ethernet frame tunneling, low-noise amplifier accessories, and network oversight and management software into their reliable and customized 5G solutions.

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