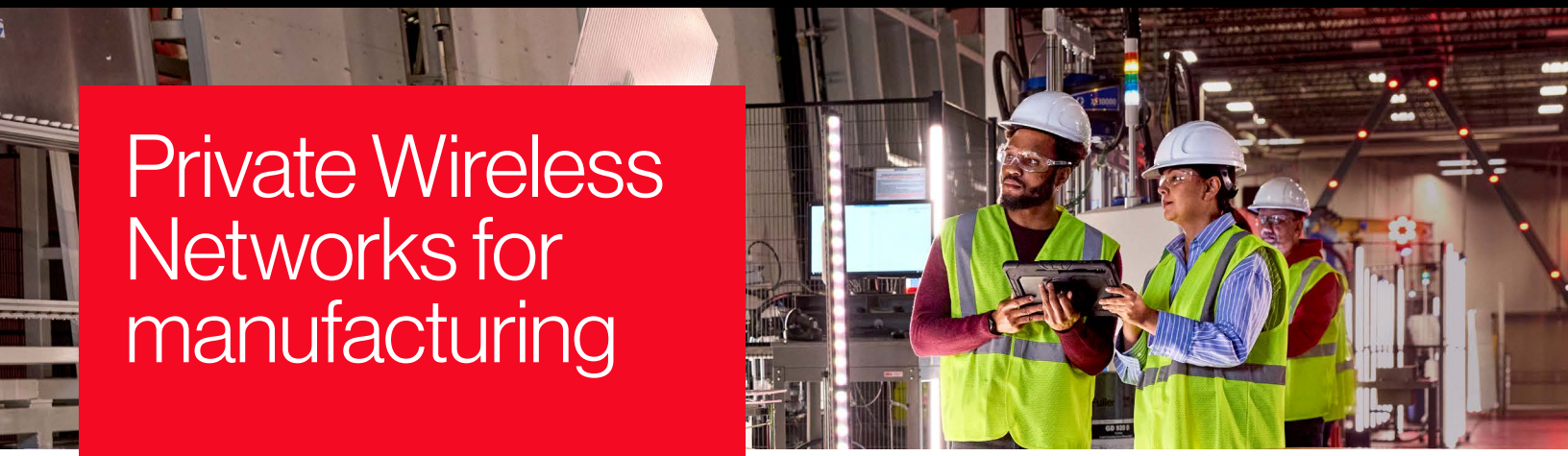


Private Wireless Networks for manufacturing

Executive summary

The manufacturing industry is profoundly transforming, driven by Industry 4.0 technologies such as IoT, robotics, AI and automation. Reliable and secure connectivity is critical to enabling these advancements, making private wireless networks a compelling solution.

This document explores the benefits, use cases and deployment strategies of private wireless networks tailored for a manufacturing environment. There is a strong demand for automation, real-time decision-making and operational efficiency, and telecommunication companies like Verizon are expected to have a unique role in helping shape the future of the manufacturing Industry.

Private wireless networks empower the manufacturing industry by fostering innovation and enhancing operational efficiency. While the initial setup may be challenging to understand, the long-term benefits outweigh the costs, positioning manufacturing for a bright future defined by precision and agility.

By investing in private wireless networks, manufacturers can enhance productivity, reduce costs and maintain a competitive edge in an increasingly digital world.

Private Wireless Networks

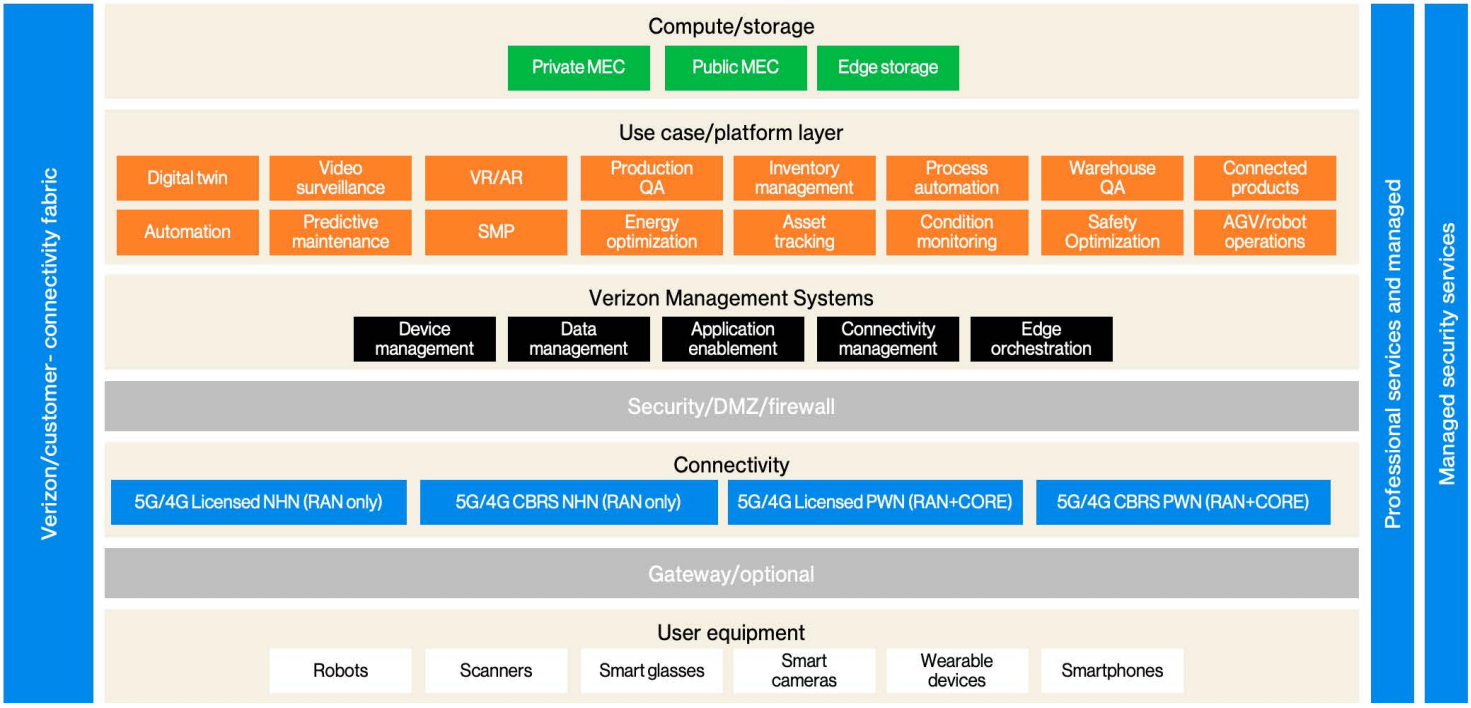
Introduction

As manufacturers embrace digitalization, the demand for high-performance, secure and customizable connectivity solutions has never been greater. Private wireless networks—built on cellular technologies such as LTE or 5G—offer the ability to address these needs while ensuring operational reliability and data sovereignty.

Unlike public networks, private wireless networks provide tailored coverage, capacity and control, making them ideal for modern manufacturing challenges. It uses cellular technologies like LTE (4G) or 5G to enable seamless communication between devices, machines and systems within a manufacturing facility.

verizon business

Here is a visually engaging architecture for a private wireless network tailored to the manufacturing industry using the Purdue model.[1]



Why Private Wireless Networks?

A Verizon Private Wireless Network ensures minimal interference and consistent performance, which is crucial for time-sensitive manufacturing applications such as robotic coordination and real-time quality control. Data transmitted over a private wireless network remains within the factory's boundaries, significantly reducing the risk of cyber threats and ensuring compliance with stringent industry regulations.

Manufacturers can design private wireless networks to meet their specific needs, such as prioritizing bandwidth for critical operations or expanding coverage in challenging environments like large factory floors. These networks can easily scale to accommodate new devices and use cases as manufacturing facilities grow and evolve. Private wireless networks for the manufacturing industry integrate Operational Technology (OT) and Information Technology (IT) systems seamlessly.

A Verizon Private Wireless Network provides connectivity for mobile devices with centralized control, real-time insights, analytics and visibility into the entire network through a rich, customer-facing web portal.

Overall this architecture ensures seamless integration between operational and enterprise technologies while prioritizing security, reliability and scalability to meet the demands of modern manufacturing environments.

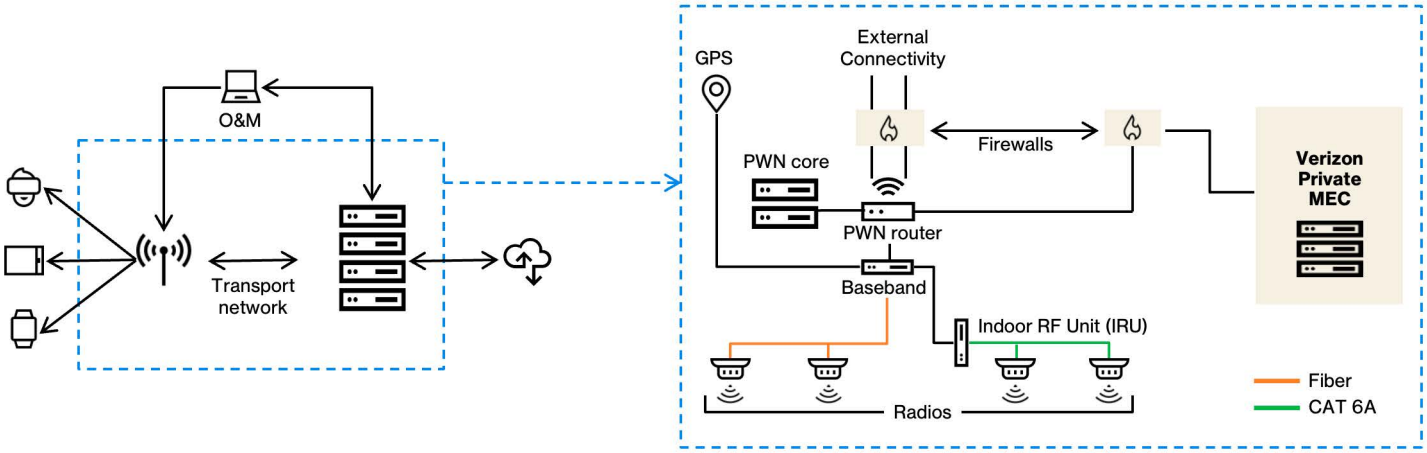
Key characteristics of a private wireless network:

- **Dedicated infrastructure:** Owned or leased exclusively by the manufacturing company, operates on licensed or unlicensed spectrum.
- **High performance:** Provides ultra-reliable low-latency communication and can handle massive device connectivity with high throughput and minimal interference.
- **Enhanced security:** Supports data privacy as information remains within the facility. Offers better control over access and network policies compared to public networks or Wi-Fi.
- **Customizable network features:** Configurable to meet specific operational and production needs.

Private Wireless Networks reference architecture

Before we dive into the reference architecture, it is important to understand the components of a private wireless network:

- **Core network:** The control system that manages devices, user authentication and data flow within the network.
- **Radio Access Network (RAN):** The wireless infrastructure (base stations, small cells) that provides connectivity to devices.
- **Edge computing integration:** Colocates local data processing with wireless connectivity for real-time applications.
- **User Equipment (UE):** Devices like IoT sensors, industrial robots, augmented reality (AR) tools and handheld devices connected to the network.

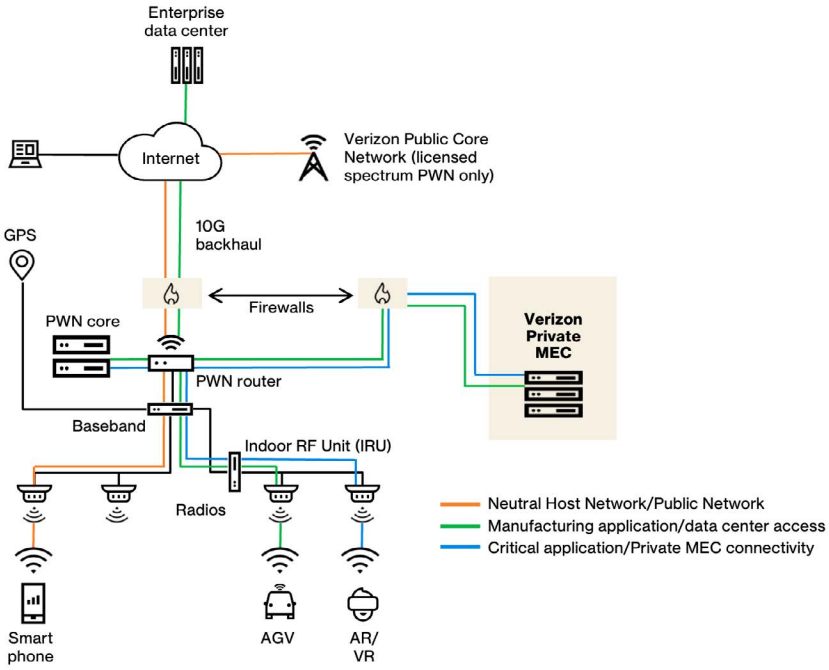


Network requirements analysis

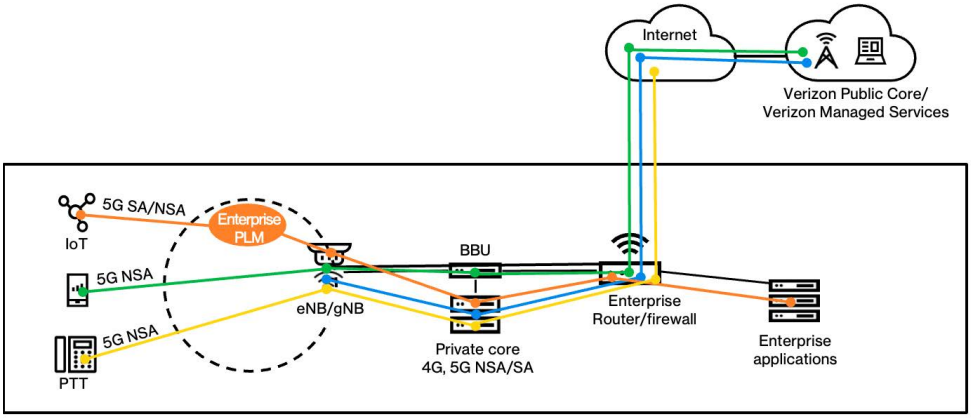
Designing and implementing private wireless networks for the manufacturing industry requires careful consideration of various technical, operational and strategic factors to ensure reliable performance, scalability and security. The design is fully customized based on the needs of the enterprise:

- **Connectivity needs:** Number and types of devices (e.g., IoT sensors, robotics, AR/VR systems). Required bandwidth and throughput per device/application
- **Performance criteria:** Low latency for real-time applications. High availability and reliability for critical operations
- **Coverage area:** Size and layout of the facility (indoor, outdoor, multi-site)
- **Wireless standards:** Choose between LTE, 5G based on performance needs
- **Spectrum:** Licensed, unlicensed or shared spectrum
- **Integration with existing networks:** Ensure seamless interoperability with legacy systems
- **Data protection:** Encryption for data in transit and at rest
- **Access control:** Role-based access, multi-factor authentication (MFA), SIM-based verification and secure device onboarding
- **Network segmentation:** Isolate critical systems (e.g., production line controls) from less sensitive systems

High-level private wireless network reference architecture



High-level data flow



- **Enterprise user** – Enterprise specific SIM, No monthly plan, Coverage within enterprise facility, Data only service (OTT Voice / PTT capable)
- **Operations & Management** – Verizon Network Operations Center
- **PTT/Internet Apps**
- **Any Verizon user** – Verizon SI, Monthly Verizon plan, Coverage within enterprise facility and Verizon 4G/5G network, Voice support through Verizon IMS

- **Data generation:** IoT devices and machines generate data in the OT zone.
- **Processing**: Data is aggregated and analyzed at the Enterprise Level in Verizon Private MEC.
- **Storage and decision-making:** Processed data is sent to the IT zone for storage, enterprise analysis and actionable insights.
- **Feedback loop:** Commands from the IT zone are sent back to the OT zone to optimize operations.

Two Critical Private Wireless Network Use Cases for Manufacturing

Use case 1

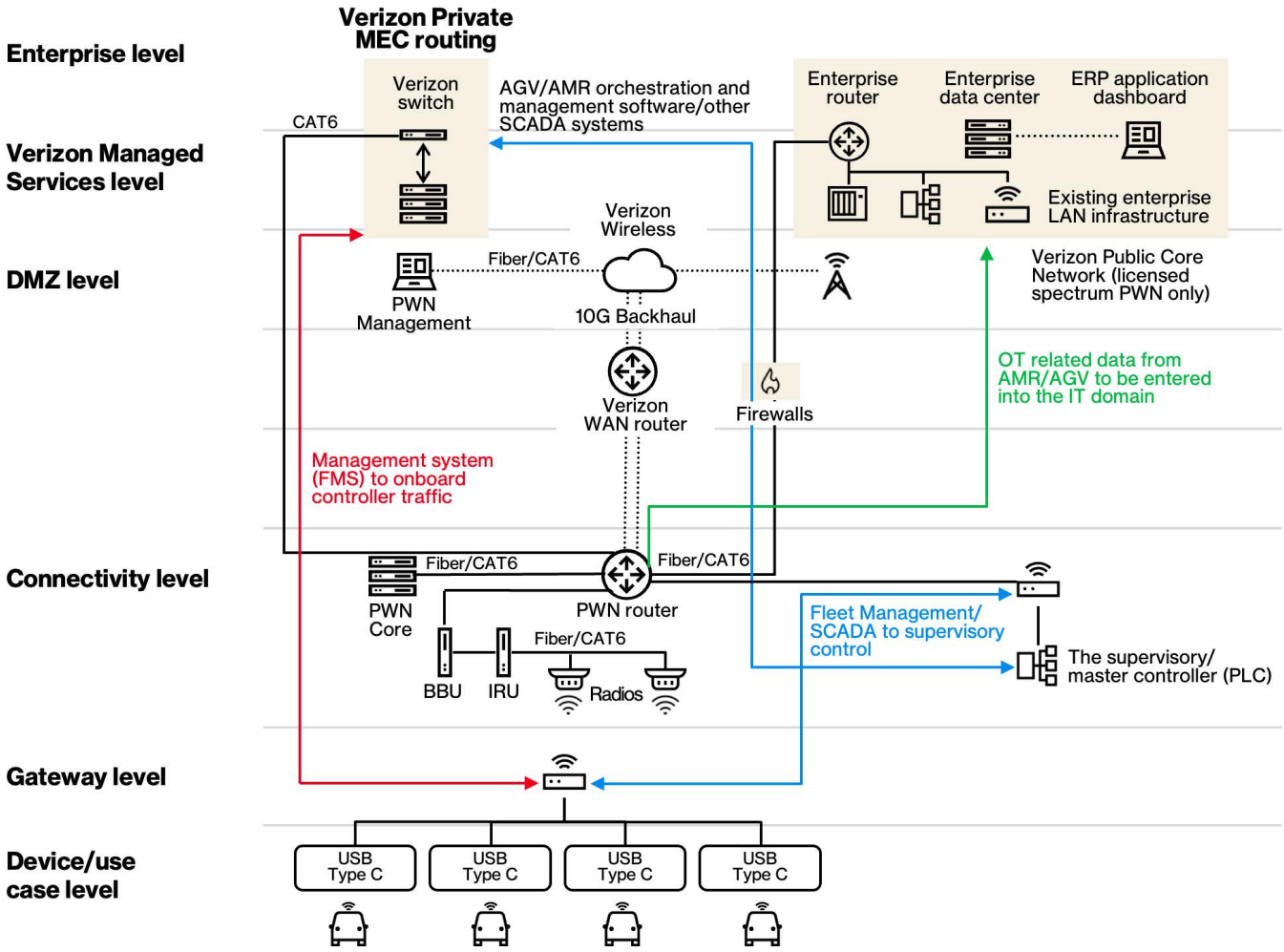
Industrial Automation – Robots: AGV/AMR

The demand for robots in manufacturing and warehousing facilities is increasing exponentially. In the manufacturing industry, robots are primarily used to automate repetitive tasks like assembly, material handling, picking and placing parts, packaging and quality inspection, significantly increasing production efficiency, reducing errors and improving overall product quality while minimizing human involvement in hazardous operations; streamlining the manufacturing process from raw materials to finished products.

Benefits of using private wireless networks with robots in manufacturing

The Ultra-fast, low latency wireless connectivity offered by 5G means that AMRs can be utilized almost anywhere inside of a warehouse. Private Networks not only add reliability of service and mobility but also help enable automation of processes like product inspection, packaging etc. 5G enhances warehouse automation due to its capacity to support million connections within a given area. Sensors can communicate the exact location of faulty equipment so that it can be repaired. Robotics and Artificial Intelligence capabilities also benefit from the combination of private 5G and edge computing.

The AGV/AMR market is expected to reach $9.1 billion by 2030. The mobile robot market is expected to reach $22 billion by 2030. The AGV/AMR market is expected to grow at a CAGR of 12% from 2024 to 2030.[2]



Use case 2

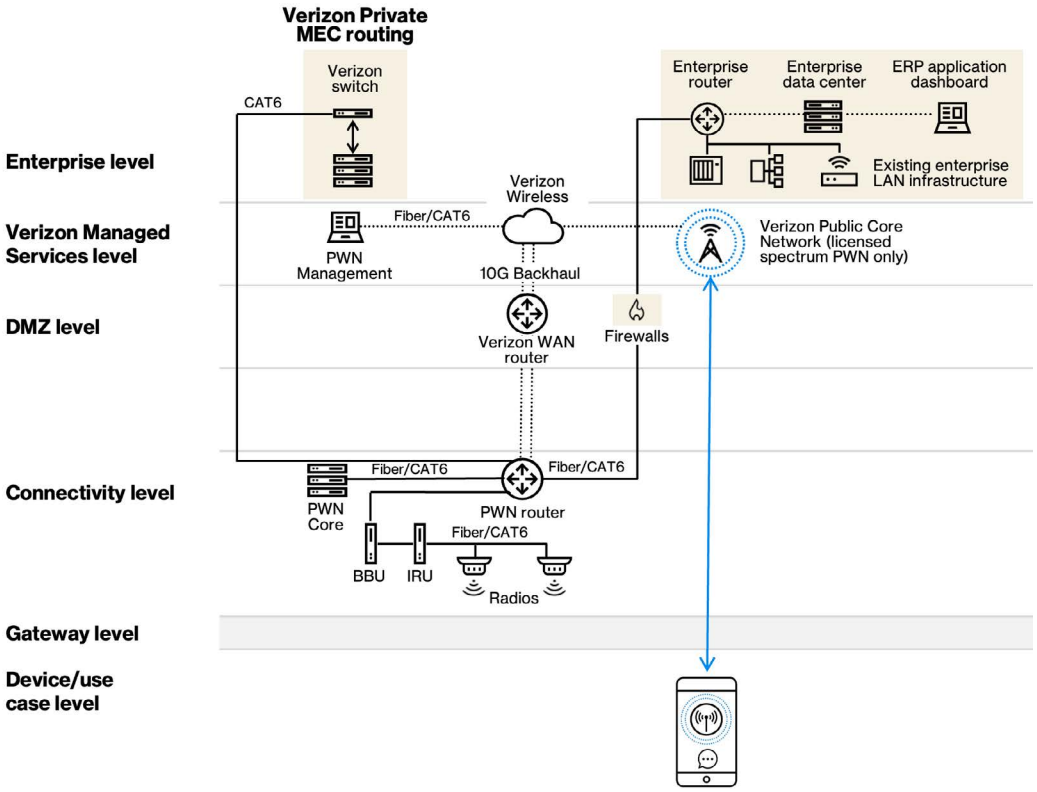
Industrial Scanner

Industrial scanners play a pivotal role in the manufacturing industry, streamlining operations, enhancing visibility and improving productivity. Scanners are an essential tool in modern manufacturing, facilitating real-time data collection and management across the production lifecycle.

They improve operational efficiency, ensure accuracy and enable smarter, data-driven decision-making. Their versatility makes them an indispensable asset in achieving Industry 4.0 objectives.

Key use cases of private wireless networks with industrial scanners in manufacturing:

- **Large and complex facilities:** Private 5G scalability enables extensive scanning for larger warehouses, manufacturing plants or distribution centers.
- **Enhanced worker productivity:** Highly-reliable connectivity in challenging environments like areas with potential interference from machinery or metal structures.
- **Customized network configuration:** Companies can tailor network settings to suit their specific scanning requirements, including signal strength and roaming capabilities.
- **Improved security:** Private networks are isolated from Wi-Fi providing a more secure environment for sensitive data transmitted by the scanners.



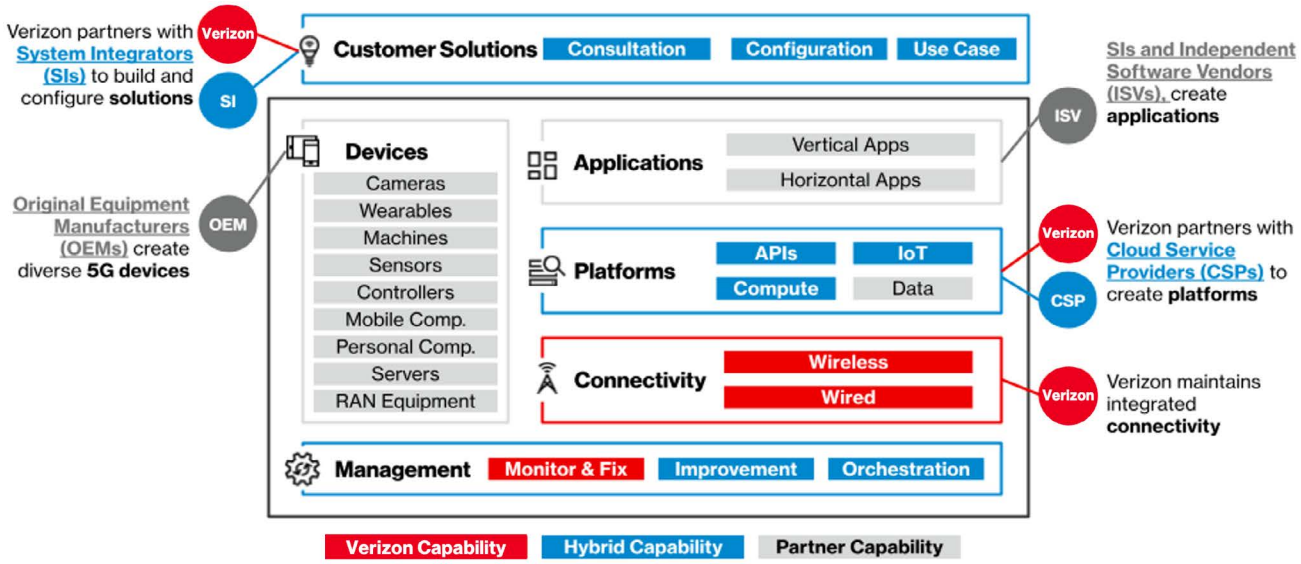
Verizon private wireless network/edge partner ecosystem

Verizon has established relationships with a range of technology partners and integration providers to integrate 5G Edge technologies with existing infrastructure, creating a robust ecosystem that accelerates digital transformation for businesses. It is through these initiatives that Verizon and our ecosystem partners are able to position 5G Edge technology as a catalyst for innovation, enhancing operational efficiencies, enabling new business models and supporting adoption across industries.

The Verizon ecosystem consists of the following partners who provide consultation, application, device integration and end to end integration to enable use cases and outcomes for our Manufacturing customers. Exhibit 1 provides details of how these partners interact to provide the best application of our robust Private Network and Edge network:

1. **System Integrators:** Our SI partners leverage our 5G assets to provide an array of functions including ideation, consultation and creation of bespoke solutions for our Manufacturing customers.
2. **Software Vendors/ISVs:** Solutions are available for use in Manufacturing settings that integrate VZ 5G edge assets on our partners' software or platforms.
3. **Device Manufacturers:** We have many devices certified for use on our "macro" network and validated for private network deployments in the United States through multiple device OEMs.
4. **Edge Cloud Service Providers (CSP):** Our partnerships with CSPs enable us to bring computing and application closer to the devices through on-prem servers.

Exhibit 1: Block representation of how our partners work across the tech stack to enable manufacturing outcomes.



Our Partners can leverage our Private Network and Private Edge capabilities to enable use cases for our manufacturing customers across the following domains and applications:

1. **Enhanced Communications/PTX:** Operations Logistics, Connected Workforce, Remote Maintenance Supervision, Manufacturing Floor Communication, Security and Surveillance
2. **OT Security:** Industrial Systems Access Control, OT Vulnerability Management, Operational Process Data integrity, Safety Control & Compliance
3. **Asset Management/Location Service:** Asset & Inventory Management, Connected Devices, Connected Toolset, Geofencing for Safety & Security, Production Tools Calibration Management
4. **IoT and Analytics:** Smart Manufacturing, Predictive Maintenance, Robotics
5. **Edge AI:** Automated Product Quality Inspection, Visual Predictive Maintenance, Assembly Line Optimization, Workplace Safety

While our private and edge networks are built to support multiple use cases for our Manufacturing customers, there are a few of them that we have activated through key ecosystem partnerships and exist in our portfolio today.

Exhibit 2: Key partners and solutions enabled for manufacturing

Partner type	Use case/(s)	Description
System integrator	Consulting, Worker safety, Operational improvement, Worker training and planning	Provide advisory and use case consulting, design solutions based on site surveys, deploy or implement solutions with Verizon 5G Private Network and Edge, and run network operations and automation.
	Consulting, Asset Management	
	Consulting, AGV/AMR	
	Robotics, Worker safety, Warehousing, Quality Assurance	
	Worker safety, Quality Assurance	
ISVs	Smart Manufacturing	Centralized interface between shopfloor OT and IT enabling more efficient, secure data collection for quicker decisions, productivity improvements, actionable insights.
OEMs	Connected Workforce - PTX	Next generation comms for frontline workers, certified for safety in hazardous environments, enabling increased productivity with enhanced collaboration capabilities.
	Smart Manufacturing - 5G Industrial PC	Enabling manufacturing control and production mgmt to drive enterprise-wide compliance, quality, efficiency through 5G connectivity to the automation system via the industrial PC, Manufacturing Execution System (MES) and Asset Performance Management (APM).
	Smart Manufacturing - Industrial Routers	Provides industrial mission-critical connectivity in operations environments where Wi-Fi based solutions are falling short.
	Connected Asset Management	Connected devices for frontline workers in logistics, warehouses improving productivity and employee satisfaction. OT/IT platform for industrial control, automation, insights, asset management.
	Connected Toolsets	5G connected industrial toolsets for the future of smart connected assembly improving productivity, freedom, quality where wired lacks flexibility and Wi-Fi lacks adequate coverage, reliability.
	Connected Rugged Portable Devices	Rugged and reliable 5G connected mobile devices (scanners, handhelds, computers, smartphones) built to increase efficiency, productivity and enhance customer services across a range of industries.
	IoT & Analytics - Edge Gateways	Industrial Edge Gateways for IoT, secure data collection, connectivity, edge analytics (CPU) across legacy and modern enabling insight, analytics, operational efficiency, intelligent automation.
	IoT & Analytics	Industrial router/gateway enabling connectivity across private/public 5G. Allows transmission of industrial communication protocol data (including safety) and edge compute capability via containers.
Edge CSPs	Low latency applications	Private Edge enables manufacturing applications that help increase efficiency through near real time insights and analytic.

Example of how an ecosystem partner enables a specific outcome for our customers:

Connected devices

A well-known device maker provides an extensive portfolio of ruggedized industrial smartphone and tablet devices for manufacturing, operations and logistics applications, such as scanning for inventory management, push-to-talk, augmented reality and quality inspection.

Resources

Verizon has the ability to enable multiple solutions through our partners as well as the ability for developers to integrate our services into their products through our APIs. The following link details our capabilities, use cases and case studies for manufacturing focused customers:

A. Manufacturing Webpage

B. Private MEC Webpage

C. 5G Edge Developer Portal

Conclusion

According to a recent survey manufacturing is estimated to generate petabytes (PB) of data every year, more than other industries.[3]

As decision-making processes have become increasingly complex due to the increase in digital transformation, manufacturers have to utilize information more efficiently, using smart technology to address problems that could not previously be anticipated. Verizon Business has the proven expertise and experience to deliver digital transformation combined with the appropriate network strategy. Verizon can enable your organization to realize true enterprise intelligence by enabling secure and reliable network connectivity along with our Edge capabilities. Verizon Business experts will work with your team to create an effective network strategy and execute against it to ensure your organization has a solid network foundation to accommodate existing and future needs. This would include the ability to leverage private cellular technologies such as 4G/5G, Edge and Neutral Host Networks to operate more efficiently and innovate more effectively.

Credits

Author

Taru Jain – Associate Director, 5GA Solution Architect

Contributors

Eric McClanahan – Sr. Director, 5GA Solution Architect

Ravi Annadanam – Distinguish Architect, 5GA Solution Architect

Preeti Singh – Associate Director, 5GA Business Development

Thomas Fuerst – Sr. Manager, Product Marketing

Moose Moussa – Sr. Director, Sols Architect

Gregory Welch – DA, 5GA Business Development

Zhenjun Zhu – DA, 5GA Business Development

George Michael Weller – Associate Director, Business Strategy

1. The Purdue Enterprise Reference Architecture sciencedirect.com/science/article/pii/S1474667017485326
2. https://www.industryarc.com/Research/agv-amr-market-research-800477
3. retrocausal.ai/blog/manufacturing-industry-trends/

verizon business