The Intelligent Edge Stack and What it Means for Industrial Enterprises

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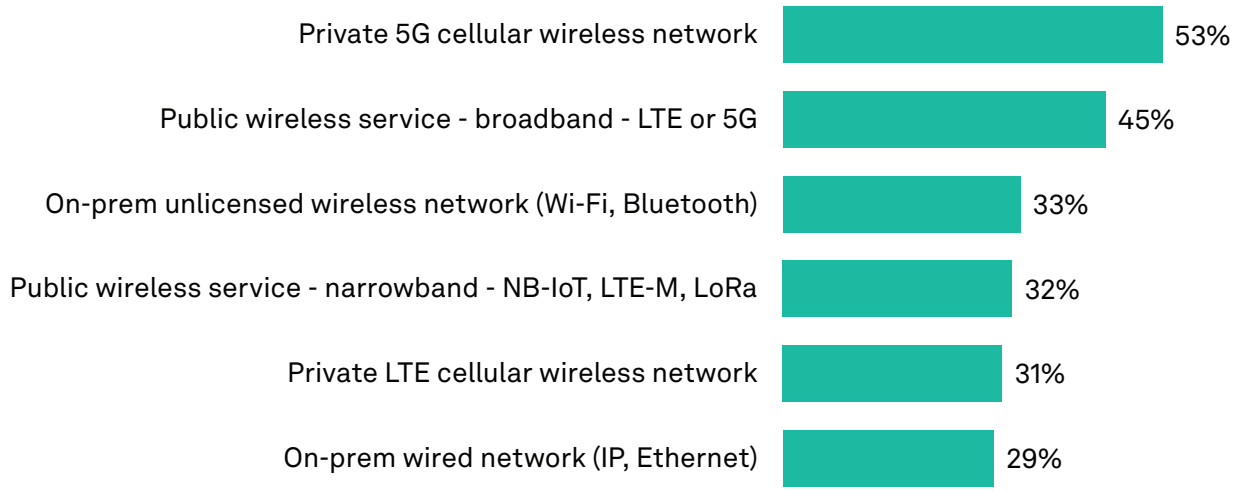
Introduction

A new stack of digital infrastructure including private 4G/5G, edge computing, containers/Kubernetes (K8s) and AI will lay the proper foundation for the next decade of industrial enterprise digital transformation. The disruption caused by the pandemic, supply chain issues and increased competition has led CIOs to prioritize digital transformation initiatives that converge and integrate operational technology and information technology (OT/IT) domains.

Most foundational technologies for digital transformation are production-ready today, and their adoption need not disrupt existing investments and workflows. Private 4G/5G wireless deployments are increasingly gaining mindshare, and their adoption is accelerated by spectrum availability. A good example of this is the Citizens Broadband Radio Service (CBRS), which enables dynamic spectrum sharing specifically designed to enable private cellular networks in the U.S. (see Figure 1). Integration and managed services can be vital to success given ecosystem complexity, internal skills gaps and the ability and experience of partners to bring vertical process knowledge, proven solution blueprints and risk-sharing business models.

Figure 1: Enterprise Demand for Private Wireless to Support IoT Workloads Is Increasing



Q: Which of the following overarching connectivity approaches do you plan to use within your organization to support IoT workloads? Select all that apply.

Base: All respondents (n=354)

Source: 451 Research's Voice of the Enterprise: Internet of Things, Workloads & Key Projects 2021

The Take

A new stack of digital infrastructure that includes private 4G/5G networks, edge computing, containers/K8s, AI and managed services has set the stage for the next decade of industrial enterprise digital transformation. Never have these technologies come together in a way that is accessible and manageable for private enterprise. LTE/5G, software-defined wide-area networking, AI and edge computing create a technological foundation to support mission-critical performance, security and quality of experience with mobility and ready support for the most complex edge workloads. Adopting these technologies can be minimally disruptive as well, overlaying and augmenting existing systems for quicker ROI. They also feature management capabilities that rely on modern application architectures and automation targeted at an enterprise IT/OT audience.

A major factor easing the way for adoption of 5G networking by enterprises is the growing availability of dedicated, lightly licensed spectrum globally, such as CBRS in the U.S., which until recently had been a scarce and expensive resource for enterprises to secure for private cellular deployments. The private 5G wireless market is both a greenfield and brownfield opportunity awaiting the arrival of 5G-enabled devices beyond smartphones and tablets, such as cameras, modems, wearable devices, medical equipment and point-of-sale terminals. A broader ecosystem of capable devices will accelerate interest in the technology and fuel growth, but early movers aren't waiting for 5G to fully materialize; instead, they are getting started with LTE and will transition to 5G when the time is right.

Enterprise leaders should consider best practices when designing digital initiatives that include private 4G/5G wireless/edge. This will help ensure a smoother introduction of the technology and make it easier for all stakeholders to determine clear KPI targets without unnecessary disruption in initial phases. Managing private wireless networks is complex and not yet on par with Wi-Fi for self-service management of mission-critical workloads, although areas such as self-organization and automation are improving. Private wireless deployments by early adopters will often require or benefit from direct guidance and support from expert practitioners with a track record of success at the intersection of private cellular, edge computing, digital transformation and software-defined networking.

Example Use Cases/Best Practices

The intelligent edge stack of private 4G/5G, edge compute, containers/K8s and AI/ML is important to unlock the value of real-time data processing at the edge, and to support ultra-low-latency and mission-critical applications designed with cloud-native technologies to unlock the power of distributed infrastructure including the enterprise edge. Ultra-low-latency performance is table stakes for acting on data at the edge to support cyber-physical systems, immersive media experiences or to reduce the overall amount of data that must be processed in centralized datacenters. These systems are state of the art for network performance, availability, security, mobility and self-service. The critical building blocks are sourced from global ecosystems and standards and are, therefore, on an accelerated path to scale and cost-effectiveness. A typical path of private 4G/5G networking involves designing an initial deployment with 4G, which can get an enterprise started as the 5G ecosystem matures in areas such as standards, user equipment availability and cost.

Industrial enterprises often have a common set of network and edge platform requirements that are then customized to meet specific requirements for use cases, integrated software, performance, security, governance and the like.

Use Case No. 1: Chemical Processing Plant – Reliable Wireless and Edge Computing

The first case study is a continuous chemical processing plant with operations spanning 1 million square feet. Monitoring and maintenance task recording processes were manual: Plant inspectors and workers drove around the facility taking measurements and recording them onto clipboards using pen and paper. This process was both cumbersome and prone to record-keeping errors, so the desire was to digitize the manual process. In addition, the large number of vehicles at the facility combined with a few reckless operators created several personal safety incidents. Wireless coverage was a long-standing challenge due to the remoteness of the facility and the lack of consistent Wi-Fi coverage.

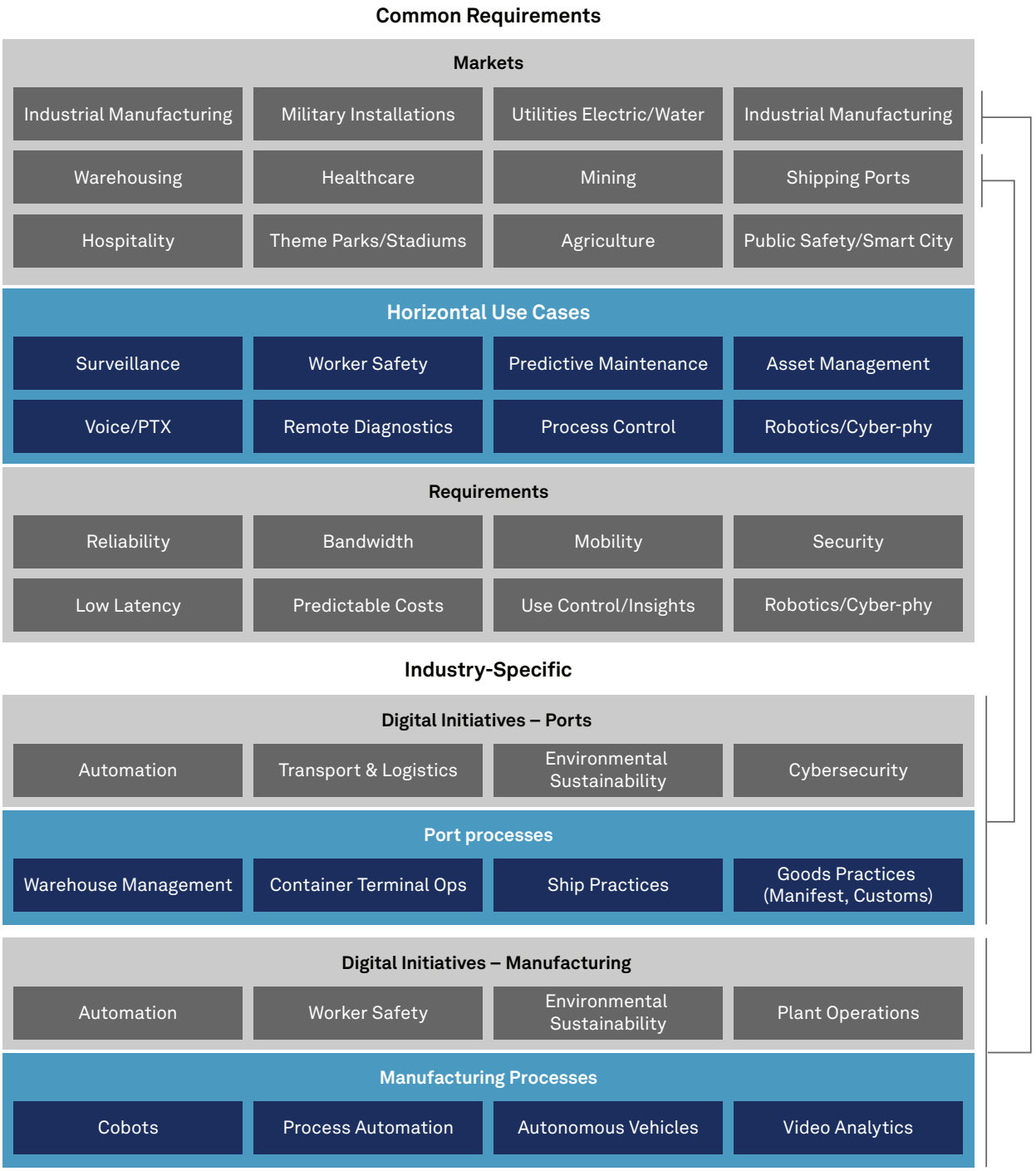
- **Initial use cases:** Improve worker communications, add in-vehicle cameras for location tracking and logging violations, digitize inspection and daily maintenance record keeping.
- **Solution:** With limited disruption to operations, the facility deployed a private network of LTE coverage using CBRS spectrum. With LTE, workers can use CBRS ruggedized devices for voice and video connectivity. CBRS devices mounted to plant vehicle dashboards provide real-time tracking using edge computing and AI for incident alerting. The project included the deployment of local edge computing running AI for plant applications served from local “micro” edge computing facilities.
- **Benefits:** High-quality network coverage and performance allowed inspection and recording processes to be digitized, saving time and reducing errors. The plant achieved network coverage with private LTE, which offered higher-quality, stronger security and lower cost than Wi-Fi, which struggles to meet outdoor coverage requirements. In-vehicle tracking motivates safer driving behaviors and digitally records unsafe situations that require remediation or additional worker training.
- **Phase 2 use cases under consideration:** Using augmented and virtual reality (AR/VR) applications for worker assistance and remote support operations, based on use of a combination of edge computing for application hosting, private wireless connectivity and Microsoft HoloLens heads-up display.

Use Case No. 2: Aluminum/Copper Manufacturing Plant – Industry 4.0 Transformation

Consider an aluminum and copper processing plant with critical infrastructure such as annealing furnaces, material separating equipment, cranes and industrial scales. The challenge in this type of environment is to deliver high-quality, secure connectivity for monitoring complex manufacturing machinery and connecting workers. This use case is a real-world example of OT/IT convergence and integration.

- **Initial use cases:** Equipment monitoring and control of real-time operating parameters including speed and temperature, power draw/voltage, weight measurements and indoor position/location.
- **Solution:** With limited disruption, the facility deployed a private network of LTE using unlicensed spectrum (i.e., spectrum that is free for anyone to use). Industrial machine programmable logic controllers (PLCs) are integrated with private wireless, supporting standardized industrial IoT protocols.
- **Benefits:** High-quality network coverage and performance allowed for a single network deployment to support several mission-critical connected machinery operations. The plant achieved network coverage with private LTE, which offered higher quality, stronger security and lower cost compared to Wi-Fi.
- **Phase 2 use cases under consideration:** AR/VR applications for worker assistance and remote support operations.

Figure 2: Common Requirements and Vertical Specific Uses of Private Wireless/Edge



Source: 451 Research

Best Practices

When starting a digital transformation project where some of the technology is new to the enterprise, the role and counsel of a trusted systems integration and services partner is valuable. The experience and technical acumen of these strategic partners can offload complexity from the enterprise. Working with proven, trusted partners is a foundation for success by early adopters. Partners can provide relevant architecture blueprints, pre-integrated and validated systems, and the capability to "run" these systems on behalf of the enterprise, with a wide variety of risk-sharing and consumption models set up to maximize impact and minimize corporate risk. Some additional considerations to keep in mind:

- **Start with a use case or limited set of related use cases that will add immediate value to the organization and help demonstrate immediate results.** Identifying potential use cases is a strategic initiative requiring participation from across enterprise functions including IT staff, operations staff, office of the chief technology or digital officer, sales and marketing, and product management. Ensure the use case includes key performance indicators to track the project's success and help identify stack and architecture requirements, as well as consumption and risk-sharing models.
- **Make efforts to understand economics up front.** This includes acquisition model and cost of expansion, hardware and software upgrades, and ongoing support and maintenance to quantify total cost of ownership over the life of the project. Acquisition options for private wireless networking include building and managing the private stack, acquiring it as a service via a trusted partner, and hybrid models that use the best parts of both.
- **Understand the impact of any potential disruption to existing processes and investments.** In some cases, private wireless combined with edge computing will become a substitute for mature and proven systems such as existing wired and wireless networks, embedded computing, PLC/manufacturing execution systems and air-gapped operational technology (OT) systems. Minimizing disruption with a well-established plan will lead to success. It is also important to be empathetic toward legacy technology stakeholders.
- **Consider how new technology platforms should work with and preserve investments in the legacy technology stack or provide strong enough ROI to incentivize rapid transition.** A typical pattern is proof of concept, deploy at one location, revisit/improve, scale, learn/improve, repeat.
- **Remember that solutions scale will drive down costs over time.** Investments that combine private wireless, edge computing and AI are the same as any new information and communications technology: Initially, costs and complexity will be high relative to established technology. Maturation and scale quickly drive down costs and complexity.

In terms of who ultimately "owns" the private 5G edge network, it will be a combination of stakeholders either led by OT leadership or, increasingly, by IT with direct input from and participation of OT. These systems are real-world examples of the potential of and need for well-executed OT/IT convergence.

Conclusion

The intelligent edge stack built with private 4G/5G will be critical to enhance the productivity of workers and machines while helping reduce the cost of legacy networks at industrial enterprises. Accelerating demand for these capabilities is driven by the need to digitize operational processes and requires high-quality connectivity, application awareness, self-service and support of low-latency operations.

The potential ROI will be highest in industry verticals that can benefit from improving the efficiency of processes and require a large coverage area, a high number of things to communicate with, and a low-latency and highly available wireless network. Enterprises modernizing processes will have an increased need to support the next generation of enterprise assets and experiences, including AR/VR and autonomous robotics and vehicles. We believe that the next generation of industrial enterprise market leaders will be decided by those that can put these platforms to work to accelerate their own digital transformation.

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