

Private Cellular Networks: Spectrum, Architecture and Use Cases



One of the most exciting growth areas in wireless communication is private cellular networks (PCNs). Systems integrators, solution providers, industries, and public sector organizations around the world are exploring the benefits and use cases made possible by this technology.

In this white paper, we'll outline some of the key factors driving the adoption of private cellular networks and explain how these networks offer secure, reliable connectivity, enabled by technology such as [Anterix](#) and [Citizens Broadband Radio Service \(CBRS\)](#).

What Are Private Cellular Networks?

A private cellular network uses cellular access points, sometimes called small cells, to form a dedicated wireless network that can cover tens of thousands of square feet — a smaller scale version of a public cellular network. When public cellular and Wi-Fi networks aren't available due to coverage limitations or aren't working well because of capacity issues, data-driven operations and critical services can suffer interruptions or a decline in the quality of service.

There are three common scenarios where public cellular or Wi-Fi are less than ideal:

- Coverage limitations don't allow service to the site in question
- Data transmission is slow due to high network traffic levels
- Security measures are inadequate for the particular application, industry or use case

To overcome this challenge, organizations are increasingly looking at the option of private cellular to meet their business connectivity needs.

Advantages of Private Cellular Networks

Enterprises across a range of industries are developing private networks to solve problems of unreliable connectivity and provide bandwidth in uncrowded spectrum. Dedicated equipment used in private cellular deployments increases device and data capacity and also has the advantage of built-in controls not possible in public networks.

Compared to public cellular or Wi-Fi networks, private cellular networks offer several advantages:

- **Dedicated spectrum:** This methodology guarantees consistent communication, particularly during emergencies, by avoiding public network congestion.
- **Privacy:** In a private cellular network, data never leaves the enterprise network. This is especially important for highly regulated industries, such as healthcare or finance.
- **Security:** SIM-based authentication, encryption, and firewall segmentation significantly reduce cybersecurity risks by utilizing a unique identifier for all devices and ensuring they are properly authenticated — providing tight control over the devices allowed on the network.
- **Flexibility:** Private cellular networks can be customized to meet an organization's unique application needs.
- **Coverage:** In a private network, coverage is better than Wi-Fi from a RAN/access point. And because the network can be deployed locally or within a building, it provides better coverage than a public network.
- **Capacity:** Private cellular networks can use either dedicated or shared spectrum, allowing organizations to tailor their infrastructure density based on their specific needs.
- **Control and customization:** Organizations like utilities can prioritize critical data traffic and tailor network coverage to their specific operational needs.

- **Lower latency:** Private cellular supports deterministic latency — the ability to set a fixed length of time for the transfer of data, which can be crucial for use cases that require devices to be tightly synchronized.
- **Resiliency:** With private cellular, users can deploy additional small cells for increased resiliency and uptime. If desired, they can also allow fallback to public cellular using the same cellular device.
- **Mobility:** In contrast with Wi-Fi, with private cellular mobility the hand-over between private cellular small cells is seamless and comparable to that of public cellular.
- **Reduced cost:** While the cost of an individual small cell used in a private cellular network is higher than an enterprise-grade access point, fewer small cells are needed to provide the same coverage as many Wi-Fi access points. With private cellular infrastructure, the cost for running cables, power and the maintenance of a larger number of nodes is significantly lower. For this reason, most operators realize cost savings in private cellular networks over public networks.

Private Cellular vs. Wi-Fi

While the underlying concepts and architecture of cellular and Wi-Fi networks are similar, the experience of using these two wireless technologies is quite different. Let's consider a few of the key differences in performance and security.

Cellular networks use radio frequencies that provide excellent coverage over a large surface area. The signals can penetrate walls or buildings that may block a Wi-Fi signal. And while Wi-Fi networks also use radio waves, their access points are designed for the short-range coverage commonly seen in homes or offices.

Even when comparing the latest Wi-Fi 7 to private cellular connectivity, private networks offer improved quality of service and better coverage. These capabilities are very important for many data-intensive use cases. Private cellular provides:

- Reliable, high-speed connections to transmit ongoing streams of data from multiple IoT devices.
- More control over roaming mobile devices to deliver uninterrupted handoffs between access point radios.
- Secure, scalable networks that limit access to whitelisted devices, even in locations that are far away from centralized IT.

The growth of 5G is leading many organizations to consider 5G for their private networks in order to future-proof. With 5G becoming ubiquitous, upgrading to the next generation is an excellent strategy. But with 4G LTE expected to be in service until at least the end of this decade, the long-term future of 4G LTE for private cellular is also viable.

The Anterix 900 MHz Spectrum for Utilities and Critical Infrastructure

Anterix provides utilities with access to its proprietary 900 MHz broadband spectrum (Band 8 and Band 106), uniquely suited for expansive and remote utility service territories. The propagation characteristics of this lower-band spectrum enable utilities to achieve extensive coverage efficiently, reducing both deployment times and capital expenditures.

Anterix spectrum solutions like [Digi IX30-0EG4](#) and [Digi IX25](#) also enable utilities to migrate from legacy narrowband or land mobile radio (LMR) systems to a unified broadband platform, simplifying communications infrastructure. This reduces both operational complexity and the costs associated with maintaining multiple separate networks.

Enhanced Reliability through Multi-Network Integration

Anterix collaborates closely with technology providers such as Digi to deliver multi-network connectivity solutions. [Digi cellular routers](#) complement Anterix's spectrum by providing robust, industrial-grade connectivity designed for harsh, mission-critical environments typical of utilities. These routers support multiple network frequencies, including Anterix's bands, CBRS, and global LTE/5G, ensuring seamless connectivity and network redundancy.

Moreover, Digi's innovative multi-carrier technology ensures continuous connectivity by dynamically switching between available networks. This capability is especially critical in maintaining uninterrupted communications for mobile field teams and essential operational assets, effectively mitigating downtime risks.

Critical Applications Supported by Anterix Private LTE

When utilities leverage Anterix's PLTE solutions in combination with multi-network capabilities, they unlock several strategic benefits:

- **Rapid deployment and transition:** Seamlessly transitioning legacy systems to modern LTE infrastructure without service disruptions.
- **Field operation continuity:** Maintaining connectivity for mobile teams operating beyond traditional network coverage.
- **Automatic failover:** Ensuring continuous operation even during network outages by automatically switching to secondary networks.
- **Comprehensive security management:** Actively managing network security through integrated platforms and continuous updates.

Anterix's Active Ecosystem

Anterix is fostering a vibrant ecosystem through its Active Ecosystem program, which includes over 125 technology innovators. These partnerships accelerate the deployment and effectiveness of private wireless broadband solutions tailored specifically for the utility industry. This collaborative approach ensures rapid innovation, interoperability, and comprehensive support, helping utilities swiftly realize the benefits of modernized, resilient communications infrastructure.

A Future-Proof Approach

Anterix's continued investment in enhancing its private wireless broadband capabilities reflects its commitment to supporting the utility industry's modernization goals. By integrating robust PLTE infrastructure, utilities are better prepared to handle increased electrification demands, adapt to extreme weather, and respond proactively to cybersecurity threats.

Anterix's petition to the Federal Communications Commission (FCC) for supporting a 5 MHz channel underscores its ongoing dedication to expanding broadband capabilities and further strengthening the utility industry's communication infrastructure.

Building Resilient Communication Networks with Anterix

As the energy landscape evolves, utilities must remain agile, secure, and reliable. Anterix's PLTE solutions provide an essential foundation for utilities to achieve enhanced resilience and performance, positioning them well for future growth and stability.

Discover how Anterix and its partners are reshaping the utility communications landscape and paving the way for a smarter, more resilient grid.

The CBRS 3.5 GHz Spectrum for a Range of Use Cases

In the U.S., [Citizens Broadband Radio Service \(CBRS\)](#) has become a popular topic in the telecommunications space. In the U.S., CBRS is a spectrum of radio frequencies that are suitable for deploying both 4G LTE and 5G networks.

CBRS uses radio frequencies from 3.5 GHz to 3.7 GHz. In the past, CBRS, which is also known as LTE band 48, was only accessible to the U.S. federal government, fixed satellite services, and Department of Defense. But as of 2019, the "innovation band" became partially available for commercial use. In the U.S., the FCC implemented a shared spectrum model for CBRS, with access managed across three groups:

- **Tier 1** — reserved for incumbent users, primarily the U.S. Navy and satellite ground stations
- **Tier 2** — available for enterprise users with priority access licenses (PALs)
- **Tier 3** — open to general authorized users (GAA) at no cost

Industry observers have said that “CBRS will put enormous wireless networking power into the hands of organizations.” With private cellular networks, enterprises will be able to extend or even replace the public networks that lack the performance and reliability needed for today’s advanced wireless use cases. Organizations that depend on high-speed wireless connectivity are particularly eager to take advantage of the CBRS frequency bands to build their own private cellular networks.

Private Cellular Network Providers

Enterprises can lease dedicated frequencies to support their private networks, for example by working directly with Anterix, or by leasing Tier-2 CBRS licenses from companies that own a PAL.

Tip: Digi experts can help organizations to identify the right solution and private spectrum based on their use case. And [Digi Professional Services](#) offers expertise in planning and deploying private networks to ensure the most seamless and cost-effective process.

Building a Private Cellular Network

Organizations have a number of options when planning to build and deploy a private network. Each organization needs to weigh the associated costs against its specific business needs. Depending on the approach, costs for a cellular network can include:

- Construction materials and labor for underlying infrastructure (including private cellular base stations)

- The network infrastructure (fiber, wired or wireless)
- Purchasing and installing small cell radios
- Monthly charges for cellular services, depending on the spectrum used

The total cost depends on a variety of factors, but the biggest differentiator is the spectrum your network will use: Licensed spectrum, shared spectrum or unlicensed spectrum.

Licensed spectrum: To set up a reliable private cellular network, organizations can choose to rent a dedicated part of the spectrum owned by a mobile network operator like AT&T or Verizon, or an entity with an FCC license that has spectrum available for private networks, such as Anterix. Every country has unique laws that dictate how bands within the licensed spectrum can be used.

Shared spectrum: Private cellular networks can use Tier 2 or Tier 3 CBRS shared spectrum. While a dedicated band can deliver better performance, shared spectrum offers an affordable way to access the benefits of private cellular when cost management is a critical consideration.

Unlicensed spectrum: A private cellular network can be set up in an unlicensed band such as UNII-3, which is also used for Wi-Fi networks. While this can be cheaper than other options, unlicensed spectrum offers less-than-ideal performance due to higher volumes of traffic.



Private/Public Hybrid Networks

In some cases, it is prudent to maintain legacy public networks alongside private cellular networks. It allows for the broadest array of use cases. With a hybrid strategy, an organization can optimize the blend of capacity, coverage, capabilities and cost that a private/public hybrid network delivers.

There are three key benefits of a private/public hybrid network:

- **Mobility** — The ability to use the private network where available, and fall back to the public network where it isn't
- **Reliability** — The ability to fall back to the public network if the private network goes down
- **Increased rollout speed** — The ability to use an available public network first, while the private network is being built

Setting up the Core Network

Designing the core network architecture for a private cellular deployment includes setting up the LTE Evolved Packet Core (EPC). The core network is made up of multiple nodes and is designed with your organization's mobility, security, authentication and traffic management needs in mind. The EPC connects to both external networks and on-site base stations (called evolved NodeBs or eNBs), which serve as the central source of the private cellular signal.

Installing Cellular Access Points

You will also need to install and connect cellular access points to provide sufficient coverage for the specific site and use case. 4G LTE and 5G cellular routers offer significantly wider coverage than



Wi-Fi access points, which makes them ideal for many industrial and commercial applications. When selecting routers, look for:

- Fully integrated [cellular solutions](#) with intelligent backup connectivity
- Features that simplify deployment and management at scale
- Robust device security and edge computing capabilities

Organizations using the CBRS spectrum also need to implement a Spectrum Access System (SAS) to assign frequency channels to CBRS access points.



Primary Industries Adopting Private Cellular

Industries are deploying an increasing number of network-connected devices in both the commercial and consumer spaces. As the IoT continues to grow, private cellular can support large volumes of data from thousands of IoT devices in network deployments.

Private cellular can connect IoT sensors, cameras, autonomous equipment and infrastructure management systems on one network, unhindered by the limitations of a public network. As machine learning, as machine learning (ML) and artificial intelligence (AI) become even more prevalent, private cellular networks will provide the bandwidth these data-intensive programs require.

Private Cellular Deployments and Use Case Scenarios

The industries and use cases that can benefit from the security and reliability of private cellular networks are very broad. In general, private networks fit into two large categories.

Critical Mass of Devices in Defined Area

The first category is where there is a large collection of assets sufficient to create a “critical mass” that justifies the cost of putting up a network in a defined area. This could be a city, a municipality, a university campus, a medical campus, manufacturing facility, construction site, distribution center, seaport, airport, or corporate campus.

Remote Areas without Public Cellular Coverage

The other large category of use cases involves remote areas that have limited cellular coverage. These include oil and gas facilities, mines, electric, gas and water utilities, large-scale farming operations and communities such as villages and Tribal Nations where private cellular can be a valuable tool in helping to close the “digital divide” for underserved communities.

Defined Area Use Cases:

- ✓ Cities and municipalities
- ✓ Colleges and universities
- ✓ Medical campuses
- ✓ Manufacturing facilities
- ✓ Construction sites
- ✓ Distribution centers/warehouses
- ✓ Seaports and airports
- ✓ Corporate campuses
- ✓ Retail shopping malls

Remote Limited Coverage Use Cases:

- ✓ Oil and gas fields
- ✓ Mines
- ✓ Gas and electric utilities
- ✓ Water/wastewater sites
- ✓ Agricultural operations
- ✓ Villages
- ✓ Tribal Nations



The following use cases illustrate the benefits and use cases attracting some industries that have shown the greatest interest in private cellular.

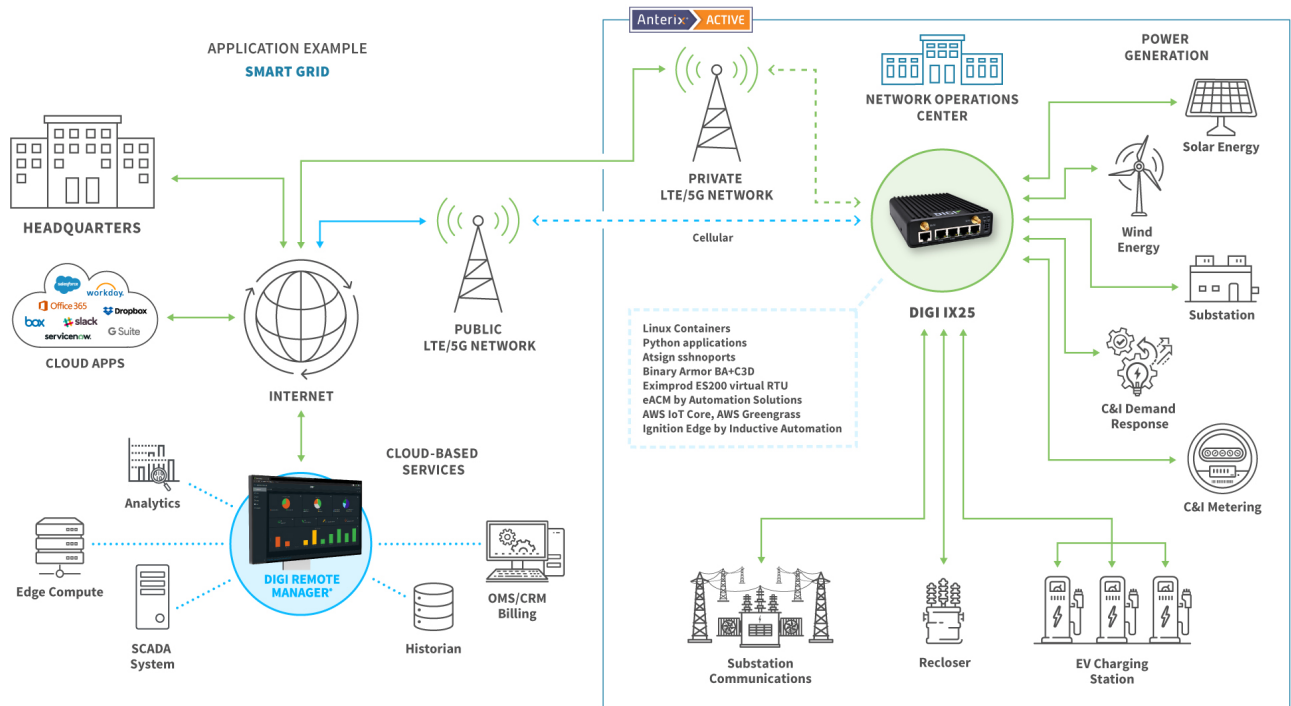
Electric Utilities: Anterix

There is perhaps no industry better positioned to benefit from private cellular networks than the utility industry. Utilities require reliable, secure and resilient networks to connect a wide array of IoT devices, including sensors, smart meters, voltage regulators and more. Because a private cellular network is owned by the electric utility, it can be 100 percent dedicated to connecting data-intensive IoT devices. This grid modernization decision means better bandwidth prioritization for everything from energy analytics to improved cybersecurity.

Private networks built on the Anterix 900 MHz spectrum add resilience and minimize utility downtime in ways that mobile carriers cannot. And because electric utilities face strict regulations, they cannot afford to risk fines from lengthy service outages. Private cellular networks provide superior performance, reliability and security — they can also significantly reduce costs.

Benefits of Private Cellular for Utilities:

- ✓ Improved security
- ✓ Better control and quality of service (QoS)
- ✓ Lower operating cost (eliminates carrier costs)
- ✓ Better geographical coverage
- ✓ Lower risk from service interruptions due to natural disasters
- ✓ Funding available through rate payers and public grid modernization funds



Public and private cellular within an electric utility smart grid



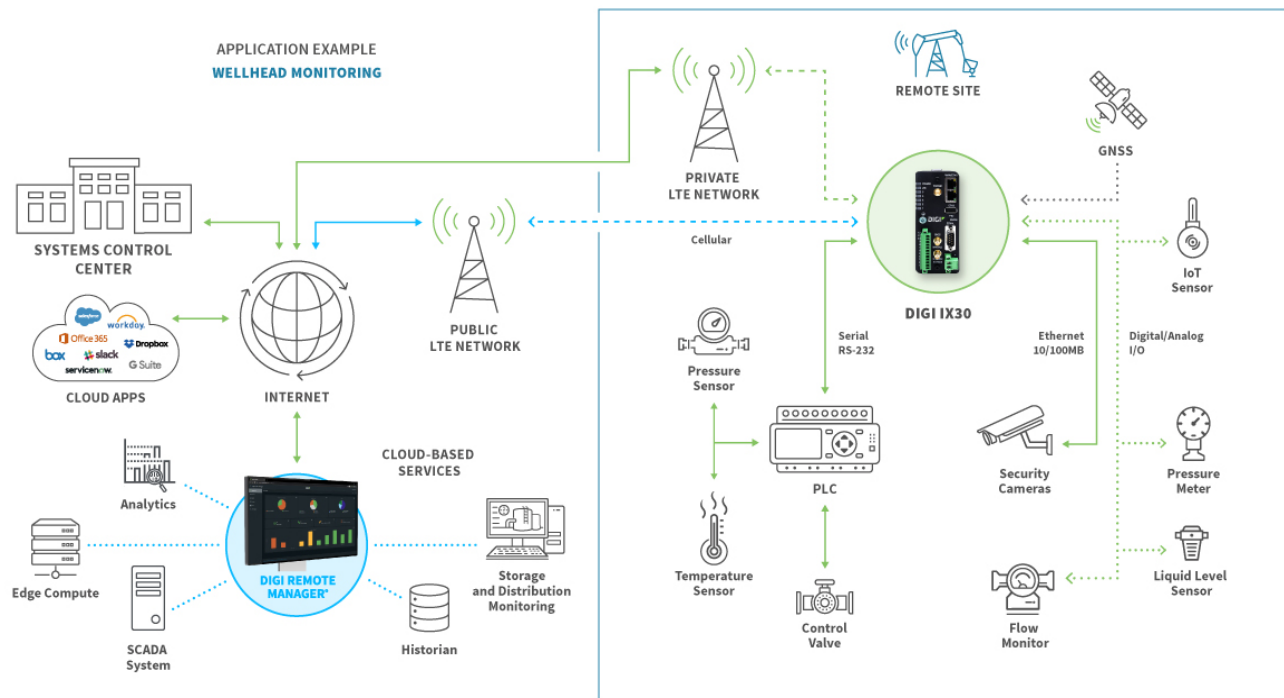
Oil, Gas and Distribution: Anterix and CBRS

Oil and gas operations are large and complex, covering huge areas. They also utilize a patchwork of different network technologies across upstream, midstream and downstream applications, each with its own challenges in managing connectivity and troubleshooting of remote equipment. That's where private cellular networks can help — simplifying networking infrastructure while improving reliability and quality of service.

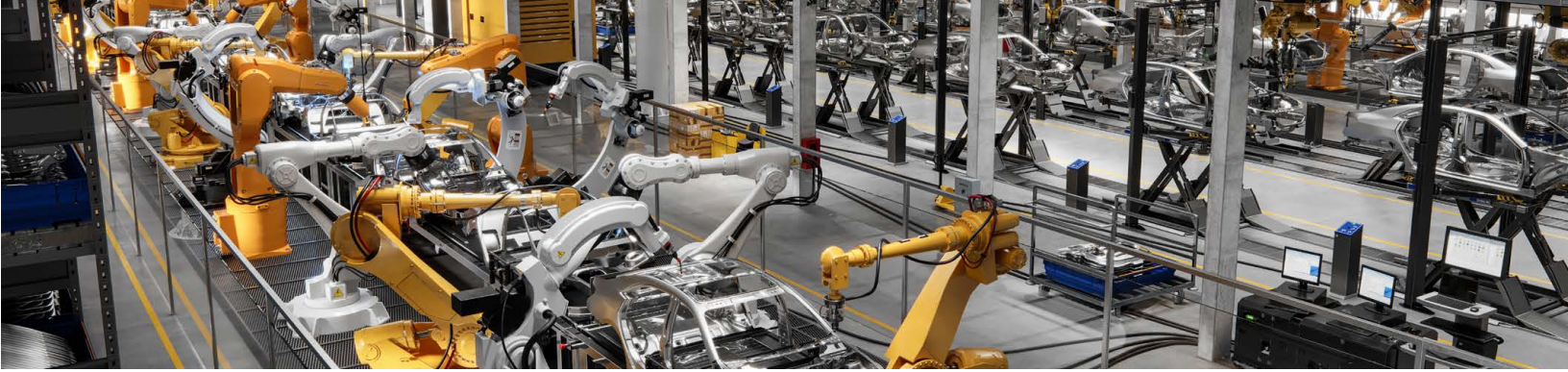
Oil and gas operations that use private networks can support large numbers of IIoT devices that include everything from air quality sensors to remote inspection drones. Anterix solutions are particularly suitable for pipeline monitoring, as they can offer cost-effective PLTE coverage across wide geographic areas. In contrast, the upstream and downstream segments are generally best served by CBRS solutions.

Uses of Private Networks in Oil and Gas:

- ✓ Wellhead monitoring (pumpjack, downhole pressure, gas flow metering)
- ✓ SCADA communications
- ✓ Tank battery monitoring (for oil or wastewater tanks)
- ✓ Chemical tanks, pump monitoring
- ✓ Field vehicle communications for work sheds and drill sites
- ✓ Gas detection
- ✓ Video surveillance



Wellhead monitoring using private and public cellular



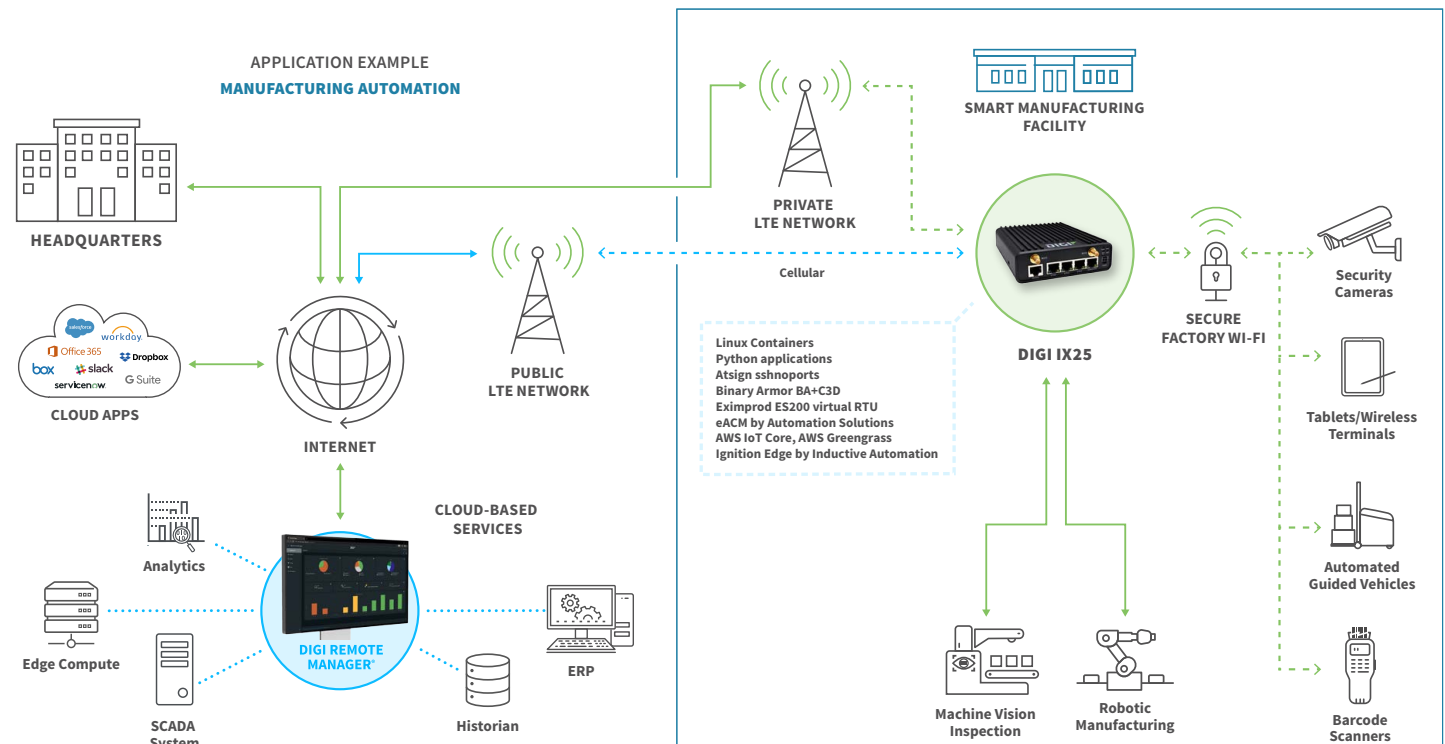
Manufacturing: CBRS

With the push to Industry 4.0 in manufacturing, private cellular networks based on CBRS provide dedicated connectivity for everything from remote diagnostics and automated inspections to enabling remote assistance services using advanced digital communications. In manufacturing, the demand for real-time data, predictive models and other data-intensive applications means the reliance on mobile carrier options is costly. The flexible, dependable, high-bandwidth connectivity provided by private networks is an increasingly attractive choice.

While digital transformation is crucial, public cellular networks are challenged to provide the service level and reliability needed for mission-critical operations in this data-intensive industry. Private cellular networks have built-in encryption, making them more secure. With 5G, operations enjoy high data speeds, low latency, very high reliability and robust device density.

Benefits of Private Cellular in Manufacturing:

- ✓ Lower cost than Wi-Fi and/or cable, especially in new plants where wireline service has not yet been installed
- ✓ More flexibility, enabling factory floor agility
- ✓ More secure with SIM-based security
- ✓ Better quality of service (QoS)
- ✓ Better facility coverage than Wi-Fi with less infrastructure



Public and private cellular deployed in a manufacturing environment



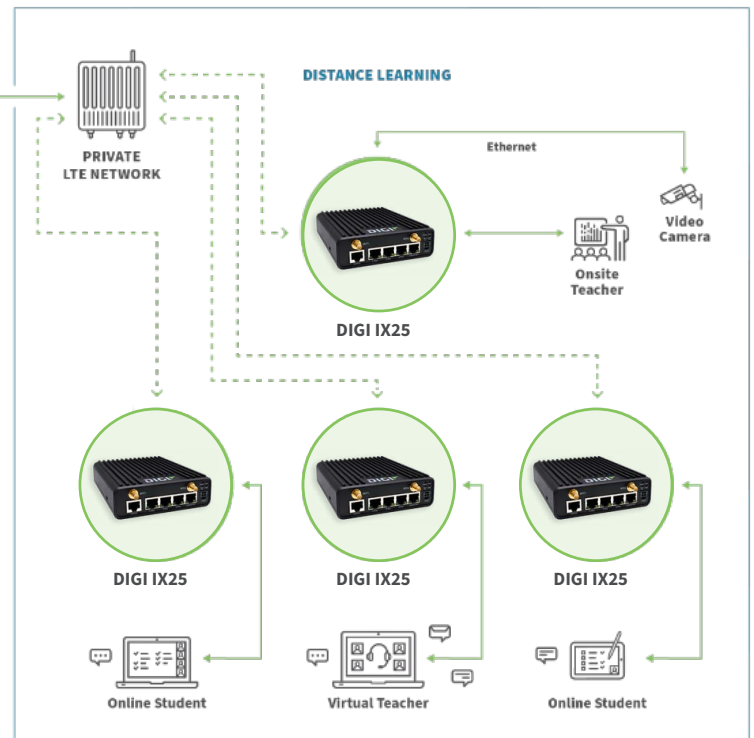
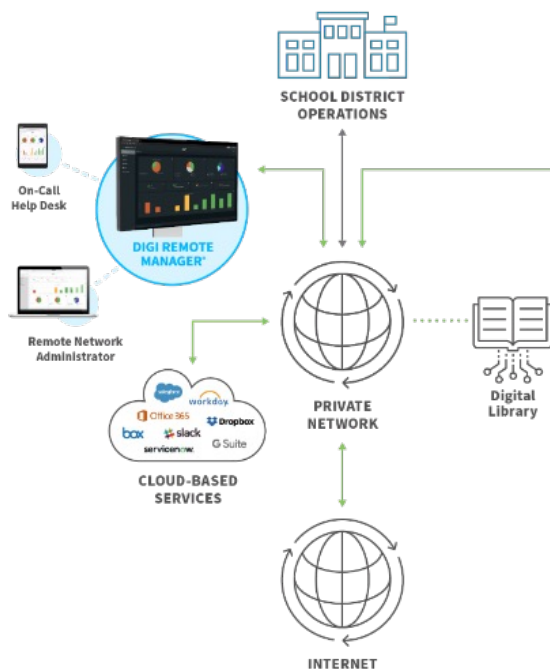
Municipalities and Educational Institutions: CBRS

When you think of the term "smart city," you probably think about surveillance cameras, smart streetlights, EV charging and public Wi-Fi hotspots. However, any city or municipality that wants to provide new, innovative services to the public can become a smart city with the help of private cellular networks. And with 5G, private networks can unlock enormous IoT potential to transform the way a city interacts with its citizens and vice versa.

Educational institutions, hotels, apartments and other campuses are like tiny cities, which means the same opportunities for smart technologies apply. At-home connectivity, too, is crucial for student learning as became evident amid the pandemic.

Private Networking Use Cases in Smart Cities and Education:

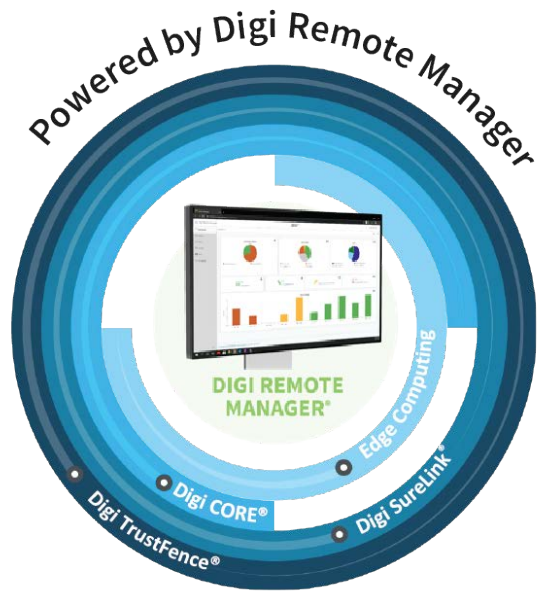
- ✓ Distance learning
- ✓ College or university campus networking
- ✓ Traffic and public safety
- ✓ Networking of Tribal Nation properties for Digital Divide initiatives



Distance learning supported with private cellular

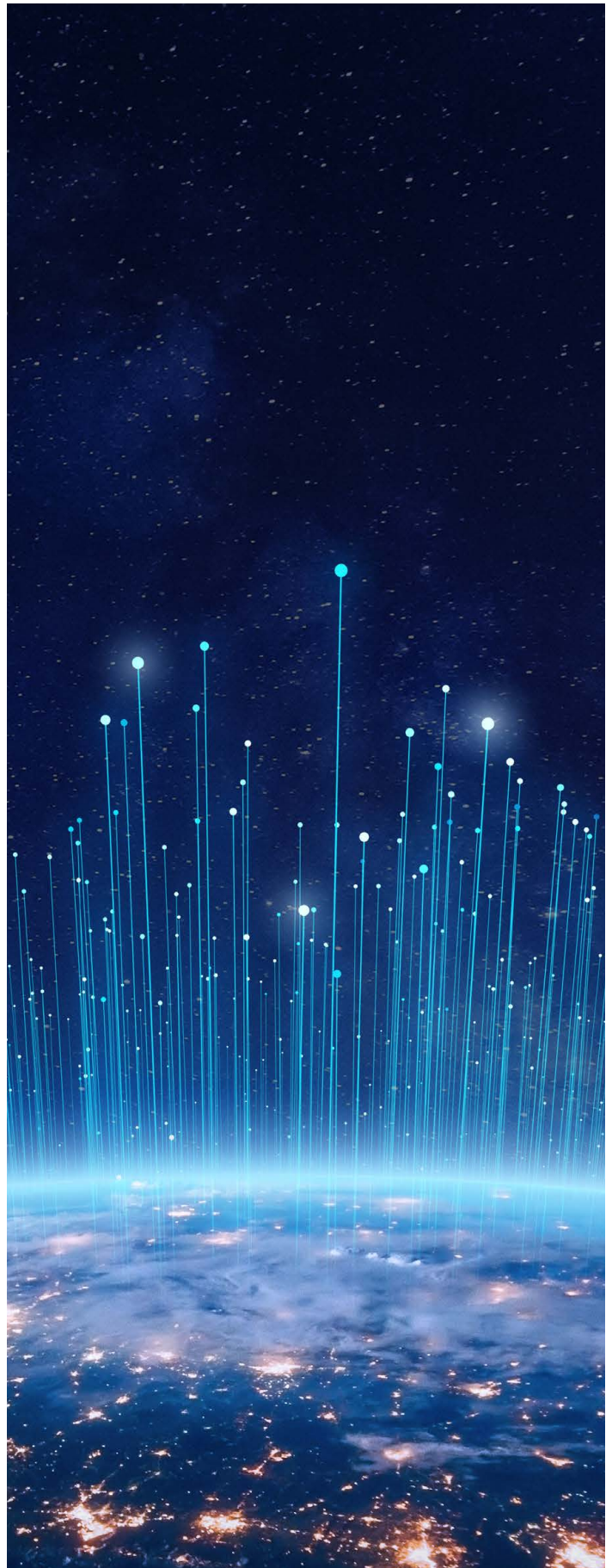
Your Go-To Partner for Private Cellular Edge Connectivity

Private cellular networks are seeing increasing adoption for a wide range of connectivity needs, across commercial and industrial spaces, smart cities and remote areas. Whether your organization or municipality uses a licensed cellular network or chooses to set up your own network on a shared band, you can expect to save money and gain increased reliability and security over public networks.



As you explore how to build your own private cellular network, Digi has the solutions and expertise to simplify your journey. For example, many [Digi cellular router solutions](#) include support for the CBRS and Anterix licensed spectrums.

Whether you need highly secure, reliable 4G LTE and 5G cellular routers or need to plan an entire private cellular device network, our teams can help you navigate all the options based on your business requirements and determine the best fit. What's more, Digi solutions are integrated with [Digi Remote Manager](#), the command center for configuration, visibility and management of wireless networks.





Why Digi?

Digi is a complete IoT solutions provider, supporting every aspect of your project, from mission-critical communications equipment to design and deployment services to get your application designed, installed, tested, and functioning securely, reliably and at peak performance.

Digi builds its products for high reliability, high performance, security, scalability, and versatility so customers can expect extended service life, quickly adapt to evolving system requirements, and adopt future technologies as they emerge. Digi embedded modules, routers, gateways, and infrastructure management solutions support the latest connected applications across verticals, from the enterprise to transportation, energy, industrial and smart cities use cases.

Our solutions enable connectivity to standards-based and proprietary equipment, devices, and sensors, and ensure reliable communications over virtually every form of wireless or wired systems. Our integrated remote management platform helps accelerate deployment and provide optimal security using highly efficient network operations for mission-critical functions such as mass

configuration and firmware updates, as well as system-wide monitoring with dashboards, alarms, and performance metrics.

Company Background

- Digi has been connecting the “Internet of Things” — devices, vehicles, equipment and assets – since 1985
- Digi is publicly traded on the NASDAQ stock exchange: DGII
- Headquartered in the Twin Cities of Minnesota, Digi employs over 800 people globally, and has connected over 100 million devices worldwide

As an IoT solutions provider, Digi puts proven technology to work for our customers so they can light up networks and launch new products. Machine connectivity that’s relentlessly reliable, secure, scalable and managed — and always comes through when you need it most. That’s Digi.

Next Steps

- Ready to talk to a Digi expert? [Contact us](#) →
- Want to hear more from Digi? [Sign up for our newsletter](#) →
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Contact a Digi expert and get started today

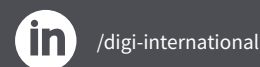
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