# A Beginner's Guide to Private Cellular Networks

Just a few years ago, private cellular networks would get a passing mention as part of a talk in conference sessions or a single paragraph in a report or white paper, but now the topic commands its own conferences, white papers and webinars as it moved from proof-of-concept stage to producing business case results for industries and governments.

However, organizations still face many questions as they consider whether they should deploy a private LTE or 5G network, including how these private networks work and what are specific advantages they offer over Wi-Fi and other private networks.

This whitepaper will help answer these questions, along with providing information on additional resources organizations can use to learn if a private LTE or 5G network makes sense for their organization.
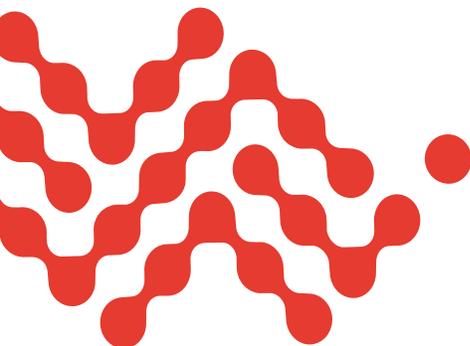
What are private 5G and LTE networks?

Private LTE and 5G networks (referred to as "non-public networks" by 3GPP, the mobile telecommunications standards organization) are networks that use licensed, shared, or unlicensed wireless spectrum and LTE or 5G cellular networking base stations, small cells, and other Radio Access Network (RAN) infrastructure to transmit voice and data to edge devices, including smart phones, embedded modules, routers and gateways.

LTE is a 4G cellular networking technology that offers secure, reliable, and fast connectivity. It is the same technology that you use today when you use your smart phone to call friends and family, check your email, play games, or watch videos.

5G is a new cellular network technology. 5G offers many performance advantages over LTE, including faster data transmission, lower latency, and the ability to connect to more edge devices. To learn more about 5G, and how it is impacting today's communications, read our previous whitepaper: Is 5G Living Up to the Hype?

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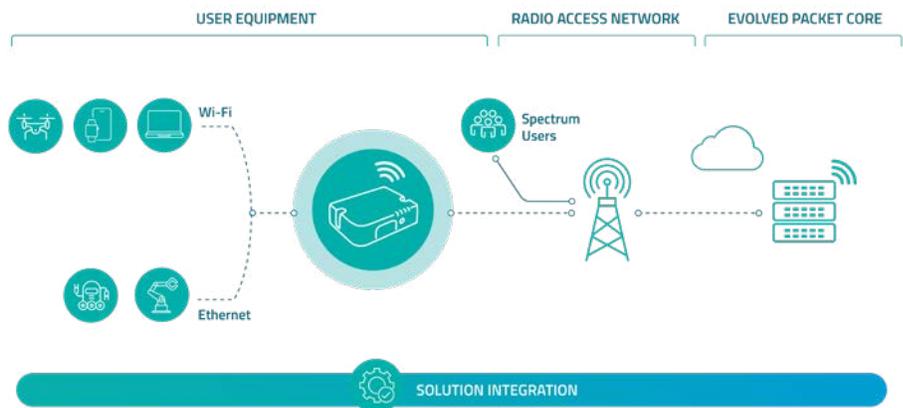
How do private LTE and private 5G networks work?

Technically, private LTE and 5G networks work the same as public LTE and 5G networks operated by Verizon, AT&T, Vodafone, and other Mobile Network Operators (MNOs). Edge devices use wireless spectrum to transmit data to nearby cellular base stations, access points and other network infrastructure. The infrastructure then carries this data to the enterprise's internal network over a secured wired connection. Using this secured connection, data from the edge devices can be sent to various cloud services and applications. To transmit data back to the edge devices, the same process happens in reverse.

The difference between public and private LTE and 5G networks resides in who has a license or priority access to the wireless spectrum, and who owns and operates the network's base stations and infrastructure.

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With public LTE and 5G networks, the MNO owns and operates the spectrum and the network infrastructure. In addition, generally all MNO customers (outside of first responders or similar public safety organizations) have the same access rights to the network.

With private LTE and 5G networks, private organizations own, operate, or have some level of priority access to the network's infrastructure or spectrum. The amount of network infrastructure and spectrum owned and operated can vary greatly.

With **Full Private** LTE and 5G networks, the organization owns the wireless spectrum it uses for the network, as well as the network base stations and other infrastructure. This provides it with full control over the network and allows it to completely isolate its users from other MNO public networks.

However, there are other types of private networks. With **Private Shared** and **Hybrid Private** LTE and 5G networks, parts of the network are either owned, shared, or operated by the MNO or another organization.

Who can build a private LTE network or private 5G network?

Virtually any organization can set up and operate their own private LTE or 5G network if they want to, just as anyone can set up and operate their own Wi-Fi network. They just need spectrum, network infrastructure equipment, and edge devices that can connect to this equipment.

Full Private LTE and 5G networks require a higher initial capital investment than Wi-Fi and other networks. This is why organizations that are deploying or are considering deploying private LTE or 5G networks are generally organizations that need to provide connectivity to a large number of users and devices or need to cover a large geographic area for IIoT applications.

This group includes:

MOBILE NETWORK OPERATORS (MNOS)
Many MNOs are deploying private networks to supplement their existing wireless services in areas where there is high demand, or they have limited licensed spectrum. For example, with private LTE networks, they can provide additional service to customers outside of the licensed LTE spectrum they already have. In addition, some MNOs set up and manage private LTE or 5G networks on behalf of organizations that want a private cellular network, but don't want to own or operate the private cellular network infrastructure themselves.

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NEUTRAL HOSTS

Similar to MNOs, neutral hosts are private LTE and 5G networks that supplement existing public wireless networks in a particular location. For example, a neutral host might set up a private cellular network in an airport, office building, stadium, or hotel. The neutral host network can provide faster and better connectivity to the travelers, office workers, sports fans, or hotel guests at the location. The facility owner will pay the neutral host network provider for improved connectivity in their facility. MNOs may also compensate the neutral host provider for offering connectivity to their public LTE or 5G networks in facilities where the MNO's own coverage is limited.

PRIVATE ENTERPRISES

Practically any type of organization –manufacturing, mining, university, transportation, utility, government, etc. – can install and operate a private LTE or 5G network to provide connectivity to their factory, mine, campus, airport, utility or military service area.
To do this, the organization needs:

- Wireless spectrum purchased from the government or provided to them by an MNO or third-party spectrum provider. They can also use unlicensed spectrum or spectrum that is "shared," like CBRS spectrum in the U.S.

- LTE or 5G infrastructure – base stations, mini-towers, small cells, and other equipment – purchased from network infrastructure equipment providers.

- Smartphones, embedded modules, routers, gateways, and other edge devices with SIM cards and modems to connect to their private LTE or 5G network.

Have any organizations deployed private LTE or private 5G networks yet?

According to the Global mobile Suppliers Association (GSA) in their February 2023 Member Report, there are at least 1077 organizations in 74 countries that have deployed LTE or 5G private cellular networks.

Examples include:

- Hard Rock Stadium, Miami, Florida
- Alcatel Submarine Networks factory, Calais, France
- L&T Heavy Engineering's A M Naik Heavy Engineering Complex, Hazira, India
- Del Conca Group tile factory, Tennessee, USA
- St. Vrain Valley School District, Longmont, CO
- Purdue University Airport, USA
- City of Las Vegas and City of Mesa, Arizona, USA

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Can any smartphone, embedded module, router or other type of edge device access private LTE and private 5G networks?

Though private LTE and 5G networks use the same cellular technology as MNOs for their public LTE and 5G networks, you can't just turn on your LTE or 5G smartphone, embedded module, router, or other edge device and expect it to connect to a private cellular network.

First, your device needs to be able to operate on the wireless spectrum utilized by the private network. Second, it will need a unique Subscriber Identity Module (SIM) card that identifies it and allows it to securely communicate over the private cellular network. If the private network is operated by an MNO, or by a neutral host or other organization with an operating agreement with the MNO, the device typically can use the MNO's SIM to connect to the network (there might be charges from the MNO).

Organizations with Full Private LTE or 5G networks that do not connect their private LTE network to an MNO will need a unique SIM card that connects to their own private LTE network. SIM cards are inexpensive and easy to obtain from network equipment providers.

In addition, Smart SIM cards are available that enable devices to connect to a private cellular network when they are in private network coverage, and then switch to public cellular networks when they can no longer connect to their private network.

In the United States the Citizens Broadband Radio Service (CBRS) is a band of wireless spectrum that has been made available by the FCC for private LTE networks. Edge devices — including smartphones, embedded modules, routers — that have been certified to use the CBRS band by the FCC can connect to these private CBRS LTE networks.

More and more edge devices are becoming available that have been certified for use with private wireless spectrum. For example, Sierra Wireless's EM7511 module along with several Sierra Wireless routers, such as the AirLink® XR90 and XR80, have been certified for CBRS.

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What is a private LTE CBRS network?

As mentioned above, a private LTE CBRS network is a private LTE network using CBRS wireless spectrum. Though the FCC auctioned some CBRS licenses, called Priority Access Licenses (PALs), companies can still use General Authorized Access (GAA) CBRS spectrum without obtaining a license, sharing this spectrum with PAL license owners (who have priority access to the spectrum) and other GAA users. This allows both PAL license owners and GAA users to build and operate private LTE networks in the United States using the CBRS 3.5 GHz band of wireless spectrum.

Is CBRS the only band of spectrum available for private LTE and private 5G networks?

No – not at all!

Organizations interested in building their own private LTE networks in the U.S. have other spectrum options beyond CBRS. For example, the FCC approved rules that will allow a 900 MHz band of spectrum owned by Anterix to be used for private networks.

In addition, many governments in Europe and elsewhere around the world allow companies to purchase wireless spectrum for private LTE or private 5G networks. For example, Germany has allocated spectrum in the 3.4–3.8GHz band for private 5G networks. In France, frequencies in the 2.57-2.62 GHz band have been offered to businesses for private cellular networks.

Organizations around the world can also use unlicensed spectrum in the 5 GHz band for private LTE and 5G networks.

What makes private LTE and private 5G networks better than private Wi-Fi networks?

As mentioned above, there are various pros and cons to consider when comparing Wi-Fi vs. private LTE and private 5G networks.

Private LTE and private 5G networks typically require a higher up-front initial investment than Wi-Fi networks. They also require edge devices that have been certified for the wireless spectrum used by their private cellular network. If the private cellular network is not connected to an MNO, the edge devices also need SIM cards for access to the private network.

However, private LTE and private 5G networks offer many advantages over Wi-Fi networks. For example, these types of networks deliver better wireless coverage than Wi-Fi over large geographic areas, underground and inside buildings or other facilities. LTE and 5G networks are also more secure than Wi-Fi because they encrypt data by default. And private LTE and 5G networks are easier (and thus less expensive) to administer and maintain than Wi-Fi networks.

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In addition, because Private LTE and 5G devices use the same technology as public cellular networks, they can hand themselves off to public cellular networks if they leave their private network's coverage area. For example, a company could still monitor and control an automated forklift after it has crossed the street and moved out of range of its private 5G network, as long as it has the capability to hand itself off to the MNO's public 5G network.

There are other benefits to using the same network technology as public cellular networks. Companies that are in the process of building a private LTE or 5G network can start off using a public LTE or 5G network to provide connectivity at their facility, and then switch over to their own private network after it is fully deployed. In addition, with private LTE and 5G networks, organizations can use public networks as a "backup" if their own private network goes down, as long as their devices have smart SIM cards or dual SIM cards.

The question then comes down to the connectivity use case. If the organization wants to provide extensive coverage to a large number of edge devices over a wide, remote, or underground area, ensure the security of its data, lower its long-term network administration costs, or maintain a great deal of control over its cellular network – it should consider investing in a private LTE or 5G network.

What are some private LTE and private 5G use cases?

Organizations around the world need to deploy secure, fast, easy-to-manage networks that can deliver them reliable coverage inside buildings or in remote areas for voice or data communications.

Because private LTE and private 5G networks meet this need, the number of use cases for these networks is growing every day.

Some examples of private LTE and private 5G network use cases include:

- **Utilities:** By providing utilities with secure, flexible, reliable connectivity over a wide geographic area, private LTE and 5G networks enable utilities to more easily and affordably connect their IoT applications to smart meters, transformers, battery-based energy storage systems, and other types of grid infrastructure, as well as to vehicles used by their mobile workforce.

- **Mining, Oil, and Gas:** Private LTE and 5G networks provide mining and energy extraction companies with reliable connectivity they require for IIoT applications that connect to drilling machines, rugged handhelds, and other equipment – even if this equipment is underground or in a remote location.

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- **Manufacturing:** Manufacturing facilities can use private LTE and 5G networks to connect their Information Technology (IT) systems to their manufacturing equipment, enabling them to deploy automated guided vehicles (AGV), remote machine and robotic control, manufacturing process monitoring, predictive maintenance, and other IIoT applications. A report by Capgemini, *The Growing Need for Private 5G Networks in Manufacturing Plants,* notes that "the establishment of 5G standards and the emergence of private 5G spectrum are opening bigger opportunities for factories to consider private 5G networks."

- **Warehouses:** With a private LTE or 5G network, online retailers and warehouse operators can deploy robotic product picking, product tracking, and other IIoT warehouse applications without worrying about dead spots in their warehouse or spending a lot on network maintenance.

- **Chemicals:** Many chemical processing facilities have equipment that is used by multiple tenants or they rent out their equipment to customers for discreet projects. Private LTE and private 5G networks enable these facilities to carefully monitor how their equipment is used by their tenants or customers, allowing them to deploy an "equipment-as-a-service" business model that charges these tenants or customers based on equipment use.

- **Campuses:** Universities, hospitals, military bases, hotels, offices, apartment buildings and other campuses, venues, and facilities where a large number of people or IoT devices need fast, reliable, and secure Internet connectivity can benefit from a private LTE or private 5G network.

- **Airports, Train Stations, Stadiums, and other Large Public Venues:** Large public venues often need strong coverage both inside their facility and outdoors to support the connectivity needs of their employees, IoT devices and hundreds to thousands of visitors – private LTE and 5G networks can securely deliver it.

Can organizations upgrade their private LTE networks to 5G?

Yes. 5G's support for sub-6 Gigahertz (GHz) spectrum means that companies can easily transform their private LTE network into a private 5G network, using the same spectrum they are currently using for their private LTE network, while benefiting from many of the speed, latency, and other performance improvements offered by 5G.

Private 5G networks that use this sub-6 spectrum can address most IIoT use cases that organizations are considering for private cellular networks today. However, many governments around the world are also planning on making 5G millimeter wave (mmWave) spectrum between 24 GHz and 53 GHz available for private networks in the future. This higher GHz spectrum will enable private 5G mmWave networks to provide much higher data transmission rates than LTE and 5G sub-6 GHz networks. In addition, 5G's use of mmWave spectrum, in combination with other technological advancements, including a new core network called 5G Core Network (5GCN), will deliver new connectivity capabilities, including ultra-high reliability, very low latency, and very fast handoffs.

The advantages offered by both sub-6 and mmWave 5G networks are why in a recent article, a researcher from Deloitte wrote "For many of the world's largest businesses, private 5G will likely become the preferred choice, especially for industrial environments such as manufacturing plants, logistics centers, and ports."

Where can I learn more about private LTE and private 5G networks?

The following industry organizations, research firm reports, media articles and other content can help you learn more about private LTE and private 5G networks and whether such a private cellular network might make sense for your organization.

- Capgemini: The growing need for private 5G networks in manufacturing plants
- 5G Industry Campus Europe
- GSMA Intelligence: Exploring 5G private network opportunities in Asia Pacific
- Arthur D. Little: Private Campus Networks
- CBRS Alliance website
- Global mobile Suppliers Association (GSA)
- Harbor Research: The Private LTE Opportunity for Industrial and Commercial IoT

In addition, the following Sierra Wireless white papers, ebooks, articles and blogs can also provide you with more background on CBRS and other types of private LTE networks:

- Brave New World: Leveraging the Private Networking Opportunity
- The Where, What and How of Private Cellular Networks
- Is a Private LTE or 5G Network in Your Future?
- 5G Private Networks: Driving Digital Transformation and Business Growth
- 3 Use Cases for Private CBRS LTE Networks

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- Why Utilities Should Harness the Power of Private LTE Networks
- Why Are Utilities Embracing Private LTE Networks? A Q&A with Mike Brozek of Anterix

Start with Sierra

As the world's leading provider of IoT solutions, Sierra Wireless can help organizations fully realize the benefits of private LTE and 5G networks thanks to its:

- **Deep IoT Expertise:** Sierra Wireless possesses more than two decades of experience in the IoT market, and actively participates in 3GPP meetings, making recommendations on LTE, 5G, and other wireless standards.

- **Broad Portfolio of IoT solutions:** Sierra Wireless also offers a range of robust, edge-to-cloud solutions, along with private networking routers for a range of use cases. From low-power solutions to extreme 5G performance, we can help you find the right solution for your needs. For example, Sierra's AirLink® RX55 is a compact, rugged and low-power router that is CBRS-certified.

  In addition, Sierra Wireless' AirLink device management software provides organizations with a secure device management solution for over-the-air device registration, configuration and software updates.

- **Global Connectivity Services:** As a Mobile Virtual Network Operator (MVNO) offering LTE connectivity to customers around the world, Sierra Wireless can provide organizations with network connectivity in areas where it does not make sense to build out their private network. In addition, Sierra Wireless can serve as a backup network for customers as they build out or update their private network, or if their private network goes down.

- **Commitment to Quality and Security:** Sierra Wireless has implemented processes across its supply chain to ensure its solutions have advanced end-to-end security built-in, while also meeting the highest quality standards.

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