PRIVATE NETWORKS, CHARACTERISTICS, TECHNOLOGIES, SECURITY AND USES

What is a private network?

A private cellular network is a dedicated wireless communication network that is owned and operated by a single organization or enterprise for their own use. Private cellular networks are used to provide secure and reliable wireless communication services for a wide range of applications, including industrial automation, smart cities, logistics, healthcare, and more.

Unlike traditional cellular networks that are operated by telecommunications companies to provide wireless services to the general public, private cellular networks are designed to serve the specific needs of a single organization or enterprise. They offer greater control over network performance, security, and privacy, as well as the ability to customize the network to meet the unique requirements of the organization.

Private cellular networks can be built using a variety of wireless technologies, including 4G LTE and 5G. Private cellular networks can be deployed in a variety of settings, including factories, warehouses, hospitals, airports, and stadiums. They can provide high-speed, low-latency wireless connectivity for a wide range of devices, including smartphones, tablets, sensors, and industrial equipment.

A summary of the wireless technologies used in private cellular networks follows:

- **4G LTE** is a mature wireless communication technology that provides high-speed data transmission and low latency.
- **5G** is the latest generation of wireless communication technology that provides even higher speeds, lower latency, and greater network capacity than 4G LTE.
- **WiFi** is a wireless communication technology that uses unlicensed radio frequencies to transmit data.
- **Bluetooth** is a short-range wireless communication technology that is commonly used for connecting devices such as smartphones, tablets, and smart home devices.
- **Zigbee** is a wireless communication technology that is designed for low-power, low-bandwidth applications.
- **LoRaWAN** is a low-power, wide-area wireless communication technology that is used for IoT applications.

In this document, we will focus in the highly efficient 4G LTE and 5G networks

What are the primary differences between 4G LTE and 5G private cellular networks?

The primary differences between 4G and 5G are speed, latency, capacity, and flexibility. Here are some operational facts about 4G and 5G:

- **Speed**: 5G networks offer faster download and upload speeds compared to 4G networks. While 4G networks typically offer download speeds of up to 100Mbps, 5G networks can deliver download speeds up to 20Gbps. This means that you can download large files, stream videos, and play games faster on 5G networks than on 4G networks.

- **Latency**: 5G networks offer lower latency than 4G networks. Latency is the time it takes for a signal to travel from the sender to the receiver. With 5G networks, latency can be as low as 1 millisecond, while 4G networks typically offer a latency of around 30 milliseconds. This low latency is especially important for applications that require real-time interactions, such as online gaming, video conferencing, and remote surgery.

- **Capacity**: 5G networks can support more devices simultaneously compared to 4G networks. This means that more people can connect to the network without experiencing a decrease in performance. 5G networks also have the ability to support more data-intensive applications, such as virtual and augmented reality, without experiencing network congestion.

- **Flexibility**: 5G networks have a more flexible architecture compared to 4G networks. This means that they can be customized to support different types of applications, such as low-power Internet of Things (IoT) devices and high-speed mobile devices.

- **Coverage**: While 4G networks have a wider coverage area compared to 5G networks, 5G networks are expanding rapidly. As of 2021, 5G networks were available in more than 60 countries, and more are expected to join the list in the coming years.

- **Infrastructur**e: 5G networks require more infrastructure compared to 4G networks. This is because 5G networks operate at higher frequencies that require more base stations and antennas to provide coverage. However, the deployment of 5G networks is expected to become more cost-effective as technology and infrastructure continue to evolve.

The following table summarizes the differences between the main features of both networks

Feature	4G LTE	5G
Download speed	Up to 100 Mbps	Up to 20 Gbps
Upload speed	Up to 50 Mbps	Up to 10 Gbps
Latency	Around 30 milliseconds	As low as 1 millisecond
Capacity	Supports around 2,000 devices per square kilometer	Supports around 1 million devices per square kilometer
Frequency bands	Uses lower frequency bands (below 6 GHz)	Uses higher frequency bands (above 24 GHz) in addition to lower frequency bands
Coverage	Wider coverage area	Narrower coverage area, but expanding rapidly
Infrastructure	Requires fewer base stations and antennas	Requires more base stations and antennas
Network architecture	Relies on a centralized network architecture	Utilizes a distributed network architecture
Security	Offers limited security features	Offers advanced security features, such as end-to-end encryption and network slicing

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It's worth noting that these differences are generalizations, and the exact performance of a 4G LTE or 5G network can vary depending on factors such as the coverage, location, and device used

What is better for a private cellular network 4G LTE of 5G?

The choice between 4G LTE and 5G for a private cellular network depends on the specific use case and requirements of the network.

4G LTE is a mature technology that offers good coverage, stable performance, and a well-established ecosystem of devices and applications. It may be a suitable choice for private cellular networks that prioritize reliable connectivity over high speed and low latency. For example, 4G LTE may be a good choice for industrial IoT applications, such as remote monitoring, asset tracking, and predictive maintenance.

On the other hand, 5G offers significantly faster speed, lower latency, and higher capacity compared to 4G LTE. It may be a good choice for private cellular networks that require high-speed data transfer and low-latency communication, like autonomous vehicles, remote surgery, and augmented reality applications. 5G also offers the flexibility to support a wide range of devices with varying performance requirements, from low-power IoT sensors to high-performance smartphones and laptops.

Overall, the choice between 4G LTE and 5G for a private cellular network depends on factors such as the performance requirements, device compatibility, coverage area, and budget. It's important to consult with a qualified consultant to determine the best solution for your specific use case.

In favor of 4G LTE

4G LTE is a mature and widely deployed cellular technology that has been in use for many years. It offers reliable connectivity, stable performance, and a well-established ecosystem of devices and applications. 4G LTE networks are widely available in most regions, and the technology is well-understood by network engineers and operators. This makes it a suitable choice for private cellular networks that prioritize reliable connectivity over high speed and low latency.

One of the key advantages of 4G LTE is its coverage area. 4G LTE networks can cover large geographic areas with relatively few base stations, which can help to reduce deployment costs for private networks. Additionally, 4G LTE networks are designed to support a large number of devices, which can make it a suitable choice for industrial IoT applications that require connectivity for a large number of sensors and other low-power devices.

4G LTE also offers a variety of performance features that can make it a suitable choice for private networks. For example, 4G LTE supports multiple antenna technologies such as MIMO (multiple-input multiple-output) and beamforming, which can help to improve coverage and signal quality. Additionally, 4G LTE supports QoS (Quality of Service) features, which can prioritize traffic and ensure that critical applications receive the necessary bandwidth and low latency.

In terms of security, 4G LTE offers several features that can help to protect private networks. For instance, 4G LTE supports end-to-end encryption; which can help to prevent eavesdropping and data tampering. Additionally, 4G LTE supports authentication and access control features, which can help to prevent unauthorized access to the network.

Overall, the choice of 4G LTE for private networks depends on the specific requirements of the network. If the network requires reliable connectivity, wide coverage, and support for a large number of devices, 4G LTE can be a suitable choice. However, if the network requires high-speed data transfer and low-latency communication, 5G may be a better choice. It's important to consult with a qualified consultant to determine the best solution for your specific use case.

Elements of a 4G LTE network

The elements of a private 4G LTE network typically include:

- **Radio Access Network (RAN):** The RAN is the part of the network that connects end-user devices, such as smartphones or IoT devices, to the network. It consists of base stations, small cells, and other radio access equipment that transmits and receives wireless signals.

- **Core Network**: The core network is the central part of the network that provides services such as authentication, security, and routing of data between different parts of the network. The core network is responsible for managing the overall network performance and ensuring that data is transmitted securely and reliably.

- **Spectrum**: The spectrum is the range of radio frequencies used by the network to transmit and receive wireless signals. In a private 4G LTE network, the organization or enterprise has exclusive access to a portion of the radio spectrum for their own use.

- **Devices**: The devices used in a private 4G LTE network include end-user devices, such as smartphones and IoT devices, as well as specialized devices, such as sensors and industrial equipment that require high-speed, low-latency connectivity.

- **Network Management**: Network management tools are used to monitor and control the performance of the network, including the RAN, core network, and devices. These tools provide insights into network performance, identify potential issues, and enable administrators to make changes to the network configuration as needed.

- **Security**: Security is a critical element of a private 4G LTE network, and it includes measures such as user authentication, encryption, and secure transmission of data. Private 4G LTE networks can also implement additional security features, such as network segmentation and monitoring, to ensure that the network is secure and protected from cyber threats.

The specific elements of a private 4G LTE network will vary depending on the specific use case and requirements of the organization or enterprise. It's recommended to consult with a qualified network provider or consultant to determine the best approach for building and operating a private 4G LTE network.

In favor of 5G

5G is the latest and most advanced cellular technology that offers significantly faster speed, lower latency, and higher capacity compared to 4G LTE. It is designed to support a wide range of applications that require high-speed data transfer, low latency, and high reliability, making it a suitable choice for private networks that require advanced connectivity features.

One of the key advantages of 5G is its speed. 5G offers up to 20 Gbps download speeds, which is more than 20 times faster than the maximum speed offered by 4G LTE. This makes 5G suitable for applications that require high-speed data transfer, such as 4K video streaming, virtual reality, and augmented reality. Additionally, 5G offers lower latency compared to 4G LTE, which is essential for real-time applications such as remote surgery, autonomous vehicles, and industrial automation.

Another advantage of 5G is its capacity. 5G is designed to support a large number of devices and can accommodate up to 1 million devices per square kilometer, which is more than 500 times higher than the capacity of 4G LTE. This makes 5G suitable for applications that require support for a large number of IoT devices, such as smart cities, industrial IoT, and smart homes.

In terms of network architecture, 5G utilizes a distributed network architecture that allows for more efficient use of network resources and more flexible network management. This can help to improve network performance and reduce operating costs for private networks. Additionally, 5G offers advanced features such as network slicing, which allows for the creation of multiple virtual networks within a single physical network, each tailored to specific performance requirements.

In terms of security, 5G offers several features that can help to protect private networks. For example, 5G supports end-to-end encryption, which can help to prevent eavesdropping and data tampering. Additionally, 5G offers advanced authentication and access control features, which can help to prevent unauthorized access to the network.

Overall, the choice of 5G for private networks depends on the specific requirements of the network. If the network requires high-speed data transfer, low latency, and high reliability, 5G can be a suitable choice. However, if the network requires wide coverage, support for a large number of devices, and stable performance, 4G LTE may be a better choice. It's important to consult with a qualified consultant to determine the best solution for your specific use case.

Elements of a private 5G network

The elements of a private 5G network typically include:

- **Radio Access Network (RAN):** The RAN is the part of the network that connects end-user devices, such as smartphones or IoT devices, to the network. It consists of base stations, small cells, and other radio access equipment that transmits and receives wireless signals.

- **Core Network**: The core network is the central part of the network that provides services such as authentication, security, and routing of data between different parts of the network. The core network is responsible for managing the overall network performance and ensuring that data is transmitted securely and reliably.

- **Spectrum**: The spectrum is the range of radio frequencies used by the network to transmit and receive wireless signals. In a private 5G network, the organization or enterprise has exclusive access to a portion of the radio spectrum for their own use.

- **Devices**: The devices used in a private 5G network include end-user devices, such as smartphones and IoT devices, as well as specialized devices, such as sensors and industrial equipment that require high-speed, low-latency connectivity.

- **Network Management**: Network management tools are used to monitor and control the performance of the network, including the RAN, core network, and devices. These tools provide insights into network performance, identify potential issues, and enable administrators to make changes to the network configuration as needed.

- **Security**: Security is a critical element of a private 5G network, and it includes measures such as user authentication, encryption, and secure transmission of data. Private 5G networks can also implement additional security features, such as network segmentation and monitoring, to ensure that the network is secure and protected from cyber threats.

The specific elements of a private 5G network will vary depending on the specific use case and requirements of the organization or enterprise. It's recommended to consult with a qualified network provider or consultant to determine the best approach for building and operating a private 5G network.

What devices can I use now in a 5G private cellular network?

The availability of devices that can be used on private 5G networks is growing rapidly as the adoption of 5G technology increases. Currently, there are several types of devices that can be used on private 5G networks, including:

- **Smartphones**: There are several models of smartphones that support 5G technology and can be used on private 5G networks. These devices typically require a 5G-capable SIM card and support for the specific frequency band used by the private network.

- **IoT devices**: There are a wide variety of IoT devices that can be used on private 5G networks, including sensors, smart meters, and other devices that require low-power, low-data-rate connectivity. These devices typically use specialized modules that are designed for use on 5G networks.

- **Industrial equipment**: Private 5G networks can also be used to support industrial equipment, such as robots, drones, and autonomous vehicles. These devices require high-speed, low-latency connectivity and can benefit from the advanced features of 5G technology.

- **Fixed wireless access devices**: Private 5G networks can be used to provide high-speed wireless broadband access to homes and businesses. Fixed wireless access devices can be used to connect homes and businesses to the private 5G network, providing an alternative to traditional wired broadband access.

- **Private network equipment**: Private 5G networks require specialized network equipment, including base stations, small cells, and core network equipment. These devices are typically provided by network equipment vendors and can be used to build and operate a private 5G network.

It's important to note that the availability of devices that can be used on private 5G networks may vary depending on the specific frequency band and network technology used by the private network. It's recommended to consult with a qualified network provider or consultant to determine the best devices for your specific use case.

Who offers better security?

Both 4G LTE and 5G offer advanced security features to protect the confidentiality, integrity, and availability of data transmitted over the network. However, 5G offers some additional security features that are not available in 4G LTE, which makes it a more secure technology overall.

Both 4G LTE and 5G use end-to-end encryption to protect data as it travels over the network. End-to-end encryption ensures that data is protected from eavesdropping and tampering by encrypting it at the source and decrypting it only at the destination. Both 4G LTE and 5G also support mutual authentication, which ensures that both the device and the network are authenticated before data is transmitted.

However, 5G offers some additional security features that are not available in 4G LTE. For example, 5G introduces a new security architecture that separates user plane and control plane traffic, which reduces the attack surface and makes it more difficult for attackers to gain access to the network. Additionally, 5G introduces a new authentication mechanism called the 5 G-AKA (Authentication and Key Agreement) protocols, which is more secure than the authentication mechanisms used in 4G LTE.

Another advantage of 5G is that it offers network slicing, which allows for the creation of multiple virtual networks within a single physical network. Each virtual network can have its own security policies and protocols, which allows for more fine-grained control over network security.

In summary, both 4G LTE and 5G offer advanced security features to protect data transmitted over the network. However, 5G offers some additional security features, such as a new security architecture, a more secure authentication mechanism, and network slicing, which make it a more secure technology overall.

Who are the leading manufactures of 5G equipment?

There are several leading manufacturers of 5G equipment for private cellular networks, including:

- **Nokia**: Nokia offers a range of compatible products, including base stations, small cells, and core network equipment. These products are designed to provide high-speed, low-latency connectivity for a variety of use cases, including industrial automation, smart cities, and fixed wireless access.

- **Ericsson**: Ericsson offers a range of compatible products, including base stations, small cells, and core network equipment. These products are designed to provide high-speed, low-latency connectivity for a variety of use cases, including smart manufacturing, autonomous vehicles, and private networks for utilities and transportation.

- **Samsung**: Samsung offers a range of compatible products, including base stations and small cells. These products are designed to provide high-speed, low-latency connectivity for a variety of use cases, including smart factories, logistics, and healthcare.

- **CommScope**: CommScope offers a range of compatible products, including base stations, small cells, and antennas. These products are designed to provide high-speed, low-latency connectivity for a variety of use cases, including enterprise networks, smart buildings, and logistics.

- **Federated Wireless**: Federated Wireless offers a range of compatible products, including Spectrum Access System (SAS) solutions and radio access network equipment. These products are designed to enable enterprises to build and operate their own private 5G networks using CBRS spectrum in the USA.

It's important to note that the availability and suitability of specific equipment will vary depending on the specific use case and network requirements. It's recommended to consult with a qualified network consultant to determine the best equipment for your specific use case.

What countries allow the use of 4GLTE and 5G technologies for private cellular networks?

The use of private cellular networks using 4G and 5G technologies is becoming increasingly common, and several countries have approved the operation of these networks. Some of the countries that have approved the operation of private cellular networks using 4G and/or 5G include:

United States: In the US, private cellular networks using both 4G and 5G technologies are permitted under the Federal Communications Commission (FCC) regulations. Private networks using shared or unlicensed spectrum, such as CBRS (Citizens Broadband Radio Service) and Wi-Fi are also permitted.

United Kingdom: Private cellular networks using 4G and 5G technologies are allowed in the UK, subject to certain conditions and regulations. The UK regulator, Ofcom, has allocated spectrum for private networks, and organizations must obtain a license to operate a private network.

Germany: Private cellular networks using both 4G and 5G technologies are permitted in Germany. The regulator, Bundesnetzagentur, has allocated spectrum for private networks, and organizations must obtain a license to operate a private network.

China: Private cellular networks using both 4G and 5G technologies are allowed in China, subject to certain regulations and approvals from the government.

Japan: Private cellular networks using 4G and 5G technologies are allowed in Japan, subject to certain conditions and regulations. The government has allocated spectrum for private networks, and organizations must obtain a license to operate a private network.

South Korea: Private cellular networks using 4G and 5G technologies are allowed in South Korea, subject to certain regulations and approvals from the government.

Australia: Private cellular networks using both 4G and 5G technologies are permitted in Australia, subject to certain regulations and approvals from the government.

What is the size of the private cellular market for 4g LTE and 5G networks?

The market for private cellular networks is expected to continue to grow in the coming years as more organizations and enterprises seek to deploy secure, high-performance wireless networks for their operations. While there are no precise projections available for the market size of private cellular networks in 2023, several market research reports provide estimates of the market's growth potential.

According to a report by Markets and Markets, the global private LTE market size is expected to grow from USD 3.3 billion in 2018 to USD 4.5 billion by 2023, at a compound annual growth rate (CAGR) of 6.9% during the forecast period. The report cites the increasing demand for secure and reliable wireless communication networks, as well as the growing adoption of IoT and Industry 4.0 technologies, as key drivers of the market's growth.

Another report by Research and Markets (www.researchandmarkets.com) estimates that the global private 5G network market will grow from USD 19.48 billion in 2020 to USD 175.35 billion by 2027, at a CAGR of 36.2% during the forecast period. The report cites the increasing demand for high-speed and low-latency connectivity, as well as the growing adoption of 5G-enabled applications and services, as key drivers of the market's growth.

Overall, the market for private cellular networks is expected to continue to grow in the coming years, driven by the need for secure, high-performance wireless networks in a wide range of industries and applications.

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He is a lifelong member of the College of Mechanical Engineers and actively participated in the National Permanent Committee of Telecommunications Experts (CONAPPTEL).

He has experience in technology analysis at Televisa and Pegaso Comunicaciones y Sistemas, where he was the technical responsible for the cellular telephone network before the Federal Telecommunications Comission (COFETEL). He was the Director of Operations at Pegaso Banda Ancha, a company dedicated to offering Internet access services via satellite (VSAT).

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