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Private 5G networks for industry and business

Generations

The high speed and low latency of 5G is predicted to add value to industrial manufacturing, logistics, education, and data-heavy advanced applications. By Harald Kraft

Communications networks play an important role in digital transformation. With the rapidly increasing number of intelligent machines and industrial plants and of networked processes and systems, considerably more bandwidth is needed than before. In the corporate environment, a private fifth generation (5G) campus network on the company's own premises (Figure 1) is an interesting alternative to wireless local area or public networks (see the "Campus Networks" box). The high-performance transmission standard is a great fit for the demanding communications infrastructure of a networked factory.

Campus Networks

Campus networks are geographically limited local mobile networks that can be deployed on both 4G and 5G technology. A 5G campus network is designed to meet special requirements (e.g., to allow Industry 4.0 [1] applications to communicate). The market for 5G campus networks is still in its early stages, but "the global private 5G network market size ... is expected to expand at a compound annual growth rate of 47.5% from 2022 to 2030" [2].

Photo by Tyler Nix on Unsplash

However, 5G is more than just an innovative wireless technology with an expanded frequency spectrum. In combination with the Internet of Things (IoT) and artificial intelligence (AI), 5G looks to promote the development of new services and business models that would be virtually inconceivable with WiFi or wired networks, primarily because of its fundamental characteristics, simple frequency allocation, and moderate costs.

Wireless technology is expected to enable an almost unimaginable terminal device density of 1 million devices per square kilometer, which means it can connect an extremely large number of people, objects, and devices. Data is the fuel for digital

Figure 1: For the first time, 5G licenses enable private companies to set up their own campus networks.

transformation, and 5G will transmit data at up to 10Gbps in the future – which is 100 times faster than the current 4G/LTE standard. Additionally, the transmission delay (i.e., latency) is extremely low, which in turn keeps the response time for actions low.

In the future, 5G will be able to achieve latency times of less than 1ms. That is less than the blink of an eye and a crucial prerequisite for innovative developments such as autonomous driving. High availability is an elementary requirement for business-critical applications in particular, and because of 5G's system architecture, the system is particularly fail-safe, achieving operational reliability of 99.999 percent uptime.

Flexible Customization

For the first time, 5G licenses give private companies the ability to build proprietary campus networks. The motivations range from the desire to implement future-oriented applications that would not be feasible with conventional transmission technologies (or where a great deal more overhead would otherwise be involved) to the need to install a network tailored to one's own needs that can also be flexibly adapted to new requirements in the future.

A wide spectrum of application scenarios are possible, whether in production or on the construction site, in logistics, or in energy supplies.

An industrial production site, for example, would have IoT applications for transmitting sensor measurement data, augmented reality for plant maintenance and to provide guidance for repairs, and drones for monitoring the site or checking emission levels. Because 5G also minimizes wiring overhead and requires significantly fewer access points, production layouts can be redesigned to be far more flexible, which is likely to be necessary in the future, with markets and customer requirements changing at an increasing pace.

Another application of the 5G network is automated guided vehicles (AGV) to transport goods. This capability goes beyond classic fleet management for industrial trucks, such as those already implemented today with 4G or WLAN, to autonomous systems, whose numbers will increase rapidly in the future and whose tasks, such as autonomous route computation, will become far more complex.

Step-by-Step Expansion

The performance parameters of 5G are not yet fully available for all application scenarios because they are being developed step-by-step in a series of releases. Most of the performance features are currently based on Release 15, the enhanced Mobile Broadband (eMMB). This release aimed at extremely broadband communication by boosting data rates in the mobile communications system – with peak rates of up to 10Gbps and data volumes of 10Tbps per square kilometer. In June 2020, ultra-reliable and low-latency communications (URLLC) was added in Release 16 to improve latency to less than 1ms for real-time applications. Next up is expected to be massive machine-type communications (mMTC) in Release 17 in 2022 for an extremely high number of IoT end devices per unit area. The dates given are those for the specifications; however, network infrastructures and terminal devices are always subject to a delay because development and tuning to the respective release takes 15 to 18 months on average.

The advantage of 5G is the lightning-fast, delay-free, and secure exchange of data between many users and the associated use cases. To benefit, a holistic approach is essential when implementing a 5G campus network. The work starts with a comprehensive requirement analysis that takes the business objectives into account. In the beginning, it is essential to clarify which specific applications will help achieve these goals and how the information required for this purpose will reach the applications from machines, motors, production control, or video surveillance. Once all parameters are on the table, a reliable statement on whether a legacy WiFi or wired network, 5G with its new performance features, or a mixture of both is the best solution for a company.

Formula for Licensing Fees

Getting onboard with a private 5G network will differ according to where you live [3]. In the US, for example, you can have licensed or unlicensed spectrum managed by the enterprise or a service provider. The Citizens Broadband Radio Service (CBRS) spectrum band [4] is a 150MHz portion of radio spectrum from 3.5 to 3.7GHz for 5G wireless networks made available by the US Federal Communications Commission (FCC) for private use. "Private entities can access the CBRS band to build enterprise infrastructure services without expensive licensing fees" [5]. In tier 2, enterprises can acquire by auction priority access licenses (PALs) of 10MHz channels that can be renewed after 10 years, whereas tier 3 allows free access, although it requires registration with the Spectrum Access System (SAS). In this case, when the enterprise installs an access point, the device checks with the centralized SAS repository of all CBRS users and asks for the use of a specific channel. In this way, the repository helps avoid interference among devices.

In Germany, on the other hand, a property owner or tenant, with the owner's consent, can submit an application for frequency assignment. A joint application by several property owners for an area is also possible. Allocation by the German Federal Network Agency also takes place in 10MHz increments for a maximum period of 10 years. The fees in the 3.7 to 3.8GHz frequency range can be calculated by a simple formula, in which only the bandwidth, the period, and the area need to be entered as variables.

For example, if you have a site measuring half a square kilometer, the cost of 100MHz over 10 years is EUR16,000. The costs are very

moderate, which makes 5G interesting for smaller companies. Additionally, companies in agriculture, forestry, or industry in less densely built-up areas can be subsidized.
The EU and federal governments or states provide additional funding for a whole catalog of topics.
The architecture of a 5G campus network is independent of the system manufacturer and basically comprises the same building blocks. The wireless access network connects the end devices and enables them to access the independent core network. The end devices run various applications that are either installed locally on campus or located in a cloud.
The implementation of a campus network can basically be broken down into five phases: (1) planning and (2) network design, including (3) the frequency license application, followed by (4) the network installation and (5) commissioning phase. Setting up a campus network on your own requires a great deal of expertise in the fields of network technology and wireless communications.
Turnkey private campus networks are offered by systems integrators who can draw on appropriate experience in the planning, assembly, commissioning, and maintenance of communications networks. They integrate the 5G technology with the existing IT and production network. The crucial factor here is smooth integration with existing information and the communications technology system landscape so that production and processes can continue to run without disruption – after the 5G network has gone live, as well.
Regardless of whether a company implements a private campus network on its own or commissions a service provider, the system components require regular maintenance during ongoing operation. In addition to technical support and software updates, new issues also appear on the agenda (e.g., SIM card and terminal device management) because of the large number of end devices.

Network Security

As advanced as 5G is, the technology still faces challenges in the area of network security. Many attack vectors open up for criminals when IoT solutions based on 5G technology are implemented that involve a very large number of terminal devices communicating on the network. To prevent attacks by cybercriminals, companies need to establish a security strategy right from the start and reliably implement requirements that protect subscribers and use end-to-end encryption and network segmentation.
The zero trust strategy is ideal, in that it basically makes no distinction between users, devices, and services inside and outside your network. In principle, it trusts no one, checks all data traffic, and requires that all participants authenticate. In practice, companies often lack the personnel capacity or the know-how to implement security effectively. This gap can be closed by automating security, shifting the perspective away from "security by function" to holistic "security by design."
This principle additionally integrates security into processes with written definitions (e.g., for risk analysis or quality assurance) and maps roles, responsibilities, and activities within the organization, as well as the required technologies. Such a well thought out security concept is required from the outset, starting from the designated task of the technology, through analysis of the prerequisites for process-compliant applications by the user, among other things. If companies keep this necessity in mind, they can use 5G technology to build their own corporate campus network that is precisely tailored to future-proof IoT applications and their individual security needs.

Conclusions

5G campus networks offer added value not only in industrial manufacturing and logistics but also in many other areas. For example, schools, universities, and other educational institutions can expand digital learning with fast connections and high data volumes, as well as explore advanced application concepts of 5G in cooperation with partners from industry.
The same applies to agriculture and forestry, where more data on weather and the climate can be collected to deploy machinery in a more targeted way. There are virtually no limits to what you can imagine happening when it comes to application scenarios, because many users can benefit from private 5G networks thanks to the low latency, high data rates, and low susceptibility to interference. ■

Info

[1] Industry 4.0: [https://en.wikipedia.org/wiki/Fourth_Industrial_Revolution]
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[4] Enterprise CBRS: [https://www.techtarget.com/searchnetworking/feature/Best-practices-for-enterprise-CBRS-deployment]
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