

5G Fundamentals

In telecommunications, 5G technology is the fifth-generation technology standard for cellular networks, which cell phone companies began deploying around the world in 2019, and is the successor to 4G technology that provides connectivity to most current cell phones. Like its predecessors, 5G networks are cellular networks, where the service area is divided into small geographic areas called cells. All 5G wireless devices in the cell are connected to the Internet and the phone network via radio waves through a base station and antennas in the cell.



Module 1: What is the 5G network?

5G is the fifth generation of wireless cellular technology, and it offers faster upload and download speeds, more consistent connections, and improved capacity compared to previous networks. 5G is much faster and more reliable than currently common 4G networks, and has the potential to change the way we use the Internet to access applications, social networks, and information. For example, technologies such as self-driving cars, advanced gaming applications, and live streaming media that require highly reliable, high-speed data connections are set to benefit greatly from 5G connectivity.

While previous generations of cellular technology such as 4G LTE focused on connectivity, 5G takes connectivity to the next level by bringing connectivity experiences from the cloud to customers. 5G networks are software-driven virtual networks that use cloud technologies.

5G will also simplify mobility, with seamless open roaming capabilities between cellular and Wi-Fi access. Mobile users can stay connected as they move between outdoor wireless connections and indoor wireless networks without user interference or the need to re-authenticate.

The new Wi-Fi 6 wireless standard (also known as IEEE 802.11ax) shares some features with 5G technology, including improved performance. Wi-Fi 6 wireless devices can be placed in locations where users need them, providing better geographic coverage and lower cost. These Wi-Fi 6 wireless devices are based on a software-based network with advanced automation.

5G technology should improve connectivity in underserved rural areas and in cities where demand could exceed 4G capabilities. The new 5G networks will also have a dense architecture based on distributed access, and will bring data processing closer to the edge of the network and users to enable faster data processing.

What is the importance of 5G technology?

The demand for Internet access, combined with the emergence of new technologies, such as artificial intelligence, the Internet of Things (IoT) and automation, is dramatically increasing the amount of data being generated. Data creation is increasing dramatically, with volumes set to increase by hundreds of zettabytes over the next decade. Current mobile infrastructure was not designed to handle this large information load, and requires an upgrade.

At the same time, with 5G's high speed, massive capacity, and low latency, it can help support and extend numerous applications, such as cloud-connected data traffic control, drone connectivity, video chats, and console-quality gaming on the go. From global payments and emergency response, to remote education and mobile workforces, the benefits and applications of 5G are limitless. It has the potential to change the world of work, the global economy and people's lives.

Module 2: How do companies benefit from 5G technology?

The potential of 5G technology can support innovation and improved customer experiences for businesses. Below are some of the areas that were taken into consideration.

Autonomous Mobility Solutions

Previously, the idea of self-driving cars was not considered feasible due to the long time it takes for a car to send and receive information. However, the lower latency of 5G suggests that self-driving cars may become more common, with roads connected to transmitters and sensors that send information to and receive information from vehicles in 1/1000th of a second. Reducing time is crucial, allowing the AI and radar technology to interpret what it sees (i.e. other cars, pedestrians and stop signs) and control the car accordingly.

Smart Factories

5G mobile networks are an opportunity that allows manufacturers to create highly connected smart factories. 5G supports the Internet of Things (IoT), which means factories can wirelessly connect to several thousand smart devices, such as cameras and sensors, to automatically collect data in real time. Factories can analyze and process this data to make operations more efficient and cost-effective. For example, smart sensor technology can make accurate predictions about equipment life cycles, provide information that helps make planning decisions, and predict the time needed to maintain machines.

Virtual Reality

Virtual reality and augmented reality (VR/AR) technology allows mobile phones, headsets, smart glasses and other connected devices to add digital overlays to live performances. VR/AR technology has a range of use cases, including targeted maintenance, repairs, operations in industrial plants, workplace training, sales, marketing, and real-time collaboration. The low latency and high bandwidth of 5G mobile technology will make VR/AR available to more businesses and in more use cases.

Edge Computing

Edge computing is the process of offering data storage and analysis capabilities near your endpoints. Build high-performance applications that can process and store data close to where it was created, enabling ultra-low latency and intelligent, real-time responsiveness. With the ever-increasing quality of edge computing use cases and data requirements, a high-speed network is essential to meet the need for near real-time responsiveness. As such, 5G network infrastructure supports and enables the increasing complexity and specialization of edge computing.

How does society benefit from 5G networks?

The growth of 5G networks is expected to generate trillions of dollars in economic value and create millions of jobs, but there are also many areas where society can benefit.

Smart Cities

Smart cities rely on Internet of Things (IoT) devices to collect data from traffic, people, and infrastructure in real time. By analyzing that data, city planners make more informed decisions, reduce emissions, improve public services, reduce traffic, and improve air quality. The advent of 5G technology could be a catalyst for the world's major cities to become truly connected.

Health Care

5G networks can add significant value to healthcare technology. For example, low latency will allow real-time information to be shared via high-definition video, making remote surgery more common. Wearable devices and ingestible devices are also expected to become more popular, providing healthcare professionals with feedback data. Real-time monitoring will enable increasingly personalized health care for patients and help doctors detect signs of disease earlier.

The Environment

5G technology has the potential to help reduce global emissions. One of the advantages of the 5G network is the efficiency of transmission and the low power it consumes compared to previous networks. It will also support real-time monitoring of emissions, air quality, water quality and other environmental indicators. 5G will also help accelerate the development of electric vehicles, smart construction, smart grid projects, and remote work, all of which will benefit the planet through efficient use of resources and reduced pollution.

Module 3: How does 5G technology work?

As with previous cellular networks, 5G technology uses cell sites that transmit data via radio waves. Cell sites connect to networks using wireless technology or a wired connection. 5G technology works by modifying the way data is encoded, providing telecom companies with a much larger number of usable airwaves. 5G technology will introduce updates across the network architecture. 5G New Radio, the global standard that provides a higher capacity 5G wireless air interface, will cover spectrums not used in 4G networks. The new antennas will incorporate a technology known as massive MIMO, which enables multiple transmitters and receivers to transmit more data at the same time, but 5G technology is not limited to new wireless spectrum. Rather, it is designed to support a converged and heterogeneous network that includes both licensed and unlicensed technologies. This will increase the bandwidth available to users.

5G architectures will be software-defined interfaces in which business functions are managed by software, not hardware. Advances in virtual services, cloud-based technologies, and IT and business automation will enable the 5G network to become an agile, flexible network that provides access to users at any time and from anywhere. 5G networks can create software-defined subnetwork assemblies known as network slices. These network segments enable network administrators to define network functions based on users and services.

5G technology also enhances digital experiences through automation enabled through machine learning. Meeting the requirement to accelerate response times to within milliseconds (such as in self-driving cars) will require 5G networks to integrate automation with machine learning, deep learning, and ultimately artificial intelligence. Providing and proactively managing data traffic and services will reduce infrastructure costs and enhance the communication experience.

Orthogonal Frequency Division Multiplexing (OFDM)

OFDM is a key part of 5G technology. OFDM is a modulation format that encodes high-band airwaves that are not compatible with 4G, providing lower latency and improved flexibility compared to LTE networks.

Smaller Cell Towers

5G technology also uses smaller transmitters placed on buildings and other infrastructure. 4G and previous cellular technology relied on independent cell towers. The ability to operate the network from small cell sites will support many devices at breakneck speeds.

Network Segmentation

Mobile network operators use 5G technology to deploy multiple independent virtual networks on the same infrastructure. You can assign each network segment to different services and business cases, such as streaming services or enterprise tasks. By configuring a set of 5G network functions for each specific use case or business model, you can support different requirements from across vertical industries. Separation of service means that users benefit from a more reliable experience and improved efficiency on their devices.

Module 4: What is the difference between 5G - 4G - 3G?

While 5G technology operates on the same radio frequencies as previous generations, there are several key differences between 5G – 4G – G LTE – 3G. They include the following:

Higher speeds

5G networks can achieve speeds of up to 10 gigabits per second, making them ten times faster than 4G networks. This means that previously intensive tasks, such as downloading a movie or backing up a database, will now take a fraction of the time they did before.

Low response time

The main reason for this jump in speed is the decrease in latency. Latency is the delay between sending and receiving information. 4G networks can achieve transmission times of around 200 milliseconds. This reduces to a fraction of a second with a 5G network

Higher bandwidth

5G can operate over a wider range of bandwidth (low-band, mid-band, and high-band) through increased radio spectrum resources, from the sub-3 GHz used in 4G to 100 GHz and beyond. 5G can operate in both lower frequency and mm Wave bands, resulting in dramatically increased capacity, multi-gigabit-per-second transmission rate, and low latency. This bandwidth means that more devices can be connected to send and receive data simultaneously.

What are AWS 5G projects?

AWS is working with a number of organizations on 5G projects, including:

Verizon

Verizon is the first company in the world to launch a commercial 5G mobile network with a commercially available 5G smartphone and has used AWS cloud services to support its 5G rollout, leveraging the capabilities of hyperscale computing to reduce time and cost.

Ericsson

Ericsson is one of the leading providers of information and communications technology to service providers. As 5G capabilities come to market and low-latency communications emerge, Ericsson needed to leverage these advantages to deliver high-value use cases to its enterprise customers. The company uses AWS Outposts, a suite of fully managed solutions that deliver AWS services, tools and infrastructure at any location, and which has its own 5G core to deliver compute power directly to customer enterprises.

Dish

AWS partners with DISH to create America's first fully cloud-native 5G network that uses AWS infrastructure, such as AWS Regions, AWS Local Zones, and AWS Outposts, to develop a more flexible, fast, and cost-effective 5G network that transforms the end-user experience. The centralized software network will be convenient for developers, so that more companies can create innovative 5G applications that quickly change the trends in their fields.

Module 5: What are some of the advantages of a private 5G network?

There are several reasons why companies should consider operating a private 5G network in their facilities. They include the following:

- Improve network connection
- Wider network range compared to Wi-Fi networks
- Improved coverage
- Low latency for manufacturing environments and smart factories
- Complete control over enterprise devices, which can be configured to improve network security

How can AWS support your 5G requirements?

AWS Private 5G is a managed service that makes it easy to deploy, operate, and scale your private cellular network, and AWS provides all the hardware and software required. With AWS Private 5G, you can:

Connecting thousands of devices and machines with low latency and high bandwidth to a private 5G network.

Get your network up and running in a few days without long planning cycles, without complex integrations, and with automated setup.

Secure your network with granular access controls for all connected devices, integrating with existing IT policies.

Increase or decrease your network capacity on demand, or add devices with just a few clicks, and pay only for the capacity and transfer rate you use.

What is the real impact of 5G technology?

5G technology will not only usher in a new era of improved network performance and speed, but will also provide new communication experiences for users.

In healthcare, 5G technology and Wi-Fi 6 connectivity will enable patients to be monitored via connected devices that continuously provide data on key health indicators, such as heart rate and blood pressure. In the automotive industry, 5G technology combined with algorithms based on machine learning will provide information about traffic, accidents and other aspects, and vehicles will be able to share information with other vehicles and entities on the roads, such as traffic lights. These two areas represent just two industrial applications of 5G technology that can provide better and safer user experiences.