Wi-Fi

Wi-Fi stands for Wireless Fidelity or Frequencies, which allows multiple computers to communicate and provides a means to connect to the Internet from the access point to the computer or laptop. Wi-Fi networking technology combines and transmits Data and Information between devices using different bands of radio waves. Wi-Fi is a widely used technology in today's smartphones and PCs.

Like a mobile phone, a Wi-Fi network uses **Radio Waves** to send data across a network. The computer should include a wireless adaptor that converts data transferred to a radio signal. The identical signals deliver to a router decoder through an **Antenna**. After decoding, the data is sent to the Internet over a connected Ethernet connection.
Because the wireless network is bidirectional, data from the Internet will also transit via the router and coded into a radio signal that the computer's wireless adapter will receive.

Wi-Fi In IoT

Because Wi-Fi is so vulnerable to malicious assaults, a microchip is required for connectivity between devices in the IoT and robust firmware to maintain the device's Wi-Fi credentials. Wi-Fi-enabled IoT devices are frequently massive immovable hubs. There are, however, smaller gadgets that are Wi-Fi capable. If we want to use Wi-Fi, the Wi-Fi IoT device must be reasonably close to the Wi-Fi access point.

WiFi-enabled IoT vs. Bluetooth-enabled IoT.

Speed

In terms of speed, Wi-Fi offers a maximum speed faster than Bluetooth IoT. Wi-Fi IoT devices have a minimum data rate of 54 Mbps, whereas Bluetooth devices have a data rate of just 3 Mbps. The reason is that Bluetooth is better for delivering tiny data files, such as numerical numbers, from a Bluetooth-enabled IoT timepiece. At the same time, Wi-Fi is better for sending essential data files, such as HD films and photographs.

Location detection

Through the Bluetooth IoT and Wi-Fi IoT devices to which they are linked, Wi-Fi and Bluetooth may properly transmit location information. On the other hand, Bluetooth is more dependable due to its closeness. In this scenario, the better alternative is determined by the accuracy and precision required by the equipment in use.

Security

Although Bluetooth does not have a secure IoT protocol, the available security is sufficient for most uses. On the other hand, Wi-Fi offers a safer choice, especially useful when working with sensitive data.

Proximity detection

The proximity data offered by BLE in IoT is substantially more exact than that provided by its Wi-Fi equivalent in terms of proximity detection. It is crucial to note that while neither option guarantees 100 percent accuracy, the Bluetooth option is preferred.

Advantages of Wi-Fi in IoT

1. We can transport a wireless laptop from one location to another.
2. We can reduce the expense of cables by using wireless network communication devices.
3. Wi-Fi setup and configuration are much more straightforward than wiring.
4. It is fully secure and will not disrupt any network.
5. We may also use hot spots to connect to the Internet.
6. Wireless internet access is possible.

Disadvantages of Wi-Fi

1. Wi-Fi emits radiation that is harmful to human health.
2. When we are not utilizing the server, we must terminate the Wi-Fi connection.
3. There are certain limitations to data transfer; we cannot transport data across great distances.
4. When compared to a conventional connection, Wi-Fi deployment is more costly.

Applications of Wi-Fi

1. Apps for smartphones
2. Applications for business
3. Applications for the home
4. Computerized software
5. Automotive industry
6. Video conferencing while surfing the Internet

Global Positioning System (GPS)

The Global Positioning System (GPS) is a navigation system that allows users to determine their exact location on the earth's surface. GPS has become an essential tool for a variety of applications, including navigation, surveying, mapping, and tracking.

GPS uses satellites to monitor the movement of anything equipped with such a GPS tracking device, including automobiles, humans, and even pets. It operates in any weather condition and offers precise location updates in real-time. As one of the earliest ways to track and disseminate digital information from the real environment, GPS has significantly impacted IoT technology. The Internet of Things (IoT) may gather and measure enormous amounts of data on anything from individual health to public transportation; GPS tracking is required to provide location information for such objects.

A more reliable and easily accessible data set can be built using GPS and the Internet of Things. In the same way that GPS pinpoints the precise location of a vehicle, the Internet of Things is able to monitor moving items and collect data on their movements in real time.

How Does GPS Function

GPS satellites complete two accurate orbits around the planet every day. An individual satellite's signal and orbiting parameters can be decoded and used to pinpoint the satellite's location via a GPS receiver. This data, together with triangulation, is used by GPS receivers to pinpoint the precise location of its owners.

The uses of GPS and the Internet of Things

When applied to Internet of Things (IoT) gadgets, GPS technology might provide benefits you might not have anticipated. In the age of the Internet of Things, it is possible to amass vast amounts of data from a wide variety of sources. Information such as medical files and facial mapping is included.

Up until now, we've been able to find our misplaced smartphones by using their GPS systems. We can now locate misplaced suitcases. Symphonia Bags are high-tech backpacks that can be tracked via GPS. When their children are not in sight, parents can use the backpack to track them down. With this bag, you won't have to worry about leaving your belongings behind at the airport or on the road. No one can deny their eager anticipation of the day when they can hop in a driverless automobile and kick their feet up while it whisks them away. There's a chance that today's youth will never use their driving skills. Automobiles equipped with GPS technology will be fully autonomous.

Benefits of GPS Integration in IoT

The integration of GPS with IoT can help organizations to optimize their operations and simplify complex processes, reducing downtime and increasing efficiency. Tracking vehicles in real-time can reduce transport time, simplify logistical planning, and optimize delivery schedules.

Challenges and Limitations of GPS in IoT

Despite the benefits of GPS-enabled IoT devices, there are also challenges and limitations that need to be addressed. The accuracy of GPS tracking is limited and is affected by physical and environmental factors such as signal interference, weather, and the location of the receiver. Issues with privacy and data security must also be addressed when implementing GPS tracking in IoT devices.

Real-World Applications of GPS in IoT

Smart Transportation and Fleet Management

GPS technology is widely used in many transportation and logistics applications, such as tracking cargo shipments and optimizing distribution routes in real-time. Fleet managers can monitor and analyze vehicle performance, fuel consumption, and driver data. This information helps them to increase operational efficiency, reduce costs, and improve safety.

Precision Agriculture and Environmental Monitoring

GPS technology is also useful in precision agriculture and environmental monitoring. GPS receivers on drones, for instance, allow farmers to collect data on crop growth and soil conditions, improving yields and reducing costs. The technology can also be used to monitor environmental factors such as water levels and air or water quality, allowing for informed conservation and sustainability practices.

Personal Tracking and Wearable Devices

GPS technology in wearable devices, such as smartwatches and fitness trackers, can track personal health and activity data. The accurate location information can enable people to monitor exercise routines, sleep patterns, and nutrition, leading to better health outcomes.

Finding the Right Balance

GPS technology in IoT devices is transforming the way we live and work. In instances such as natural disasters, medical emergencies, and search and rescue operations, these devices can help save lives. Despite some limitations and concerns, GPS in IoT has enormous potential to transform industries and provide new benefits. It is therefore essential to find the right balance between utilization and responsible management of the technology to realize its full potential.

Global System for Mobile Communications

GSM stands for Global System for Mobile Communications. It's a standard that specifies how 2G (second generation) cellular networks operate. GSM was a significant improvement over the first generation of cellular networks and represented a transition from analog to digital telecommunications.

GSM is currently the most widely used network technology in Internet of Things (IoT) applications for its simplicity, affordability, and accessibility. But that's likely to change over the next few years.

When the Global System for Mobile Communications was first introduced in Europe in 1991, these 2G networks created faster, more secure wireless connections. For the first time, voice communications became encoded into digital signals before being transmitted through the network.

GSM reigned for years as the world's most widely used standard for mobile communications. But today, 2G networks are significantly slower than other cellular networks, and in several countries 2G networks are being switched off.

Mobile Network Operators (MNOs) are competing to balance the fastest speeds with the best coverage. With decades of built up infrastructure, GSM-based networks can offer good coverage, but they can't compete with the speed, versatility, and security of 3G, 4G, and 5G networks.

Additionally, GSM standards were designed with cell phones in mind—not the Internet of Things (IoT). Today, billions of other devices like parking meters, industrial equipment, car entertainment systems, and security systems rely on cellular networks and use them in different ways than phones do. As a result, specialized networks have emerged to address the modern landscape of cellular connectivity.

Structure of GSM networks

GSM standards divide networks into four distinct parts:

1. Mobile Station
2. Base Station Subsystem (BSS)
3. Network and Switching Subsystem (NSS)
4. Operations Support System (OSS)

Each part of the network contains several components. Together these components form one complete cellular network. Every cellular provider has their own infrastructure with all of these pieces.

Mobile Station

The Mobile Station is essentially the access point someone uses to connect to the network. It's a device (such as an alarm system) with a Subscriber Identity Module (SIM). The SIM associates the device with an individual subscriber, which allows the device to connect to the nearest Base Station Subsystem.

Base Station Subsystem (BSS)
The BSS contains Base Transceiver Stations and a Base Station Controller. The Base Transceiver Stations include components like receivers and antenna, which allows connected devices to send and receive signals, and the Base Station Controller allows the Base Transceiver Stations to relay signals through the network, via the Network and Switching Subsystem.

Network and Switching Subsystem (NSS)
The Network and Switching Subsystem is a term for the major components of a 2G core network. The NSS originally helped facilitate connection-oriented voice calls with the Home Location Register (HLR), Authentication Center (AuC), Message Service Center (MSC), and Visitor Location Register (VLR).

With the introduction of the GPRS core network and its support nodes (GGSN and SGSN), the NSS began playing a role in data connections as well.

Operations Support System (OSS)
The Operations Support System is a conglomeration of processes, data, applications, and tech that allows providers to manage their network. Carriers can use their OSS to:

1. Configure network elements
2. Manage and configure the services they offer
3. Handling system errors and managing the system's state
4. Monitor performance based on quality of service and quality of experience KPIs

More advanced cellular networks have similar structures, but with additional components to improve the networks' security and capabilities.

Is GSM still useful?

GSM networks are now three decades old, and there are three generations of cellular networks with far higher data transfer rates, more secure connections, and advanced networking capabilities. Over the years, telecommunications organizations have implemented upgrades to get more mileage out of GSM-based networks, but in several countries 2G is coming to an end.

This doesn't have much impact on consumers, as phones usually support multiple technologies. But GSM has been one of the most popular connectivity choices in cellular IoT. Modern IoT manufacturers need to evaluate whether 2G connectivity is still a viable option for their application in the region where they want to deploy.

Choose the right connectivity for your application

GSM played a foundational role in modern cellular communications. And while some operators are transitioning to newer networks, this technology is still immensely popular for its global availability and extremely low-cost connectivity. As operators expand their infrastructure for affordable alternatives like LTE-M and NB-IoT, 2G will become less relevant. But until then, it's still an attractive solution for many cellular IoT applications.