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5G Narrowband-IoT Everywhere

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By 2025, forecasts suggest that there will be more than 75 billion Internet of Things (IoT) devices in use. Every one of them requires some form of connectivity. However, 85 percent of the world's surface lacks or has limited access to terrestrial connectivity services. It compels companies to take up satellite connectivity from low Earth orbit (LEO) to go beyond terrestrial networks. Sea, remote, and mining regions are just a few examples of places where satellite connection has the upper hand for both reach and cost.

This lack of connectivity is holding back the growth of the IoT from adding $2 to $3 trillion (USD) to the global Gross Domestic Product (GDP) over the next ten years, according to McKinsey. It is an immense opportunity for satellite IoT to provide complementary services to ground-based cellular and non-cellular IoT networks. Forecasts estimate the value of the satellite IoT market to reach about $6 billion between 2025 and 2031.

We are already seeing the growing usage of satellite-based services across a number of industries, including military and defense, oil and gas, automotive, agriculture, and energy and utilities—especially when low-latency services are required. Compared with larger legacy satellites in geosynchronous equatorial orbit (GEO) by incumbent operators, small satellites in LEO are more effective in connecting, monitoring, and tracking on a real-time basis. To unleash the full potential of the IoT, constellations of small satellites in LEO providing ubiquitous connectivity are indispensable.

Low-latency market and use cases

Many applications for smart metering, precision agriculture, asset tracking, vehicle telematics, artificial intelligence, critical alarms, and environmental monitoring require a latency below ten milliseconds. One key cellular technology for providing services requiring such ultra-low latency and reliable communication is 5G. PWC estimates that 5G technology will add $1,339 billion to the global GDP by 2030, up from $150 billion in 2022.

The speed of 5G would allow sharing of data in real-time across an entire supply chain. A 2022 survey by KPMG found that only 13 percent of businesses currently have complete visibility of their supply chain. Through sensor data and cameras, a company can aggregate an accurate real-time view of asset and equipment locations, as well as control self-driving vehicles and drones. Essentially, it would erase the lag time between when data gets generated to when we can act on it.

One hurdle to accomplishing these figures is investment cost. Most satellite IoT players use proprietary and expensive satellite connectivity technologies to support IoT devices. However, during the last few years, newcomers have started to embrace existing terrestrial wireless IoT connectivity technologies such as the 3rd Generation Partnership Project (3GPP), which is uniting seven telecommunications standard development organizations in a new radio technology developed for the standardization of Narrowband Internet of things (NB-IoT).

Using the 3GPP standard, OQ Technology has launched the world's first satellite-based NB-IoT constellation providing a global network for 5G connectivity in remote regions with limited or no coverage. The company has also developed a technology using standard mobile chips that are significantly cheaper than the commonly used legacy satellite chips. Its 'cell tower inside the satellite' technology enables IoT devices to seamlessly switch between terrestrial and satellite connectivity to overcome connectivity issues without modifying cellular standards.

Creating a 5G IoT constellation

Having achieved the world's first in-orbit demonstration for NB-IoT waveforms and synchronization procedures in 2019, OQ Technology launched its first mission that gave customers access to full 5G services in 2021. A 6U nanosatellite dubbed "Tiger-2" aboard the SpaceX Transporter-2 rideshare mission, the first commercial 5G IoT satellite in LEO, provided satellite-based IoT and machine-to-machine (M2M) services using low frequencies. It also demonstrated the feasibility of using high frequencies for 5G IoT radio links. To deliver widespread coverage and 5G IoT/M2M communication that is in line with 3GPP recommendations, the satellites use spectrum in the mid band 5G (sub-6 GHz) frequency bands. A year later, a third satellite "Tiger-3" was launched for the same purpose.

Having the satellite in orbit already allowed the provision of basic commercial IoT and M2M services to customers with a focus on Africa, the Middle East, Asia, and Latin America. Tiger-2 also tested a hybrid satellite-cellular user terminal in harsh desert conditions achieving a high level of signal-to-noise ratio. For several weeks, variousoperations were conducted to verify the performance of the satellite's payload. Also tested and calibrated were terminals in different fixed and mobile environments in the desert and for indoor usage. Even when buried in the desert sand, required for many agricultural applications, or moving at high speed inside a car (without having a direct line of sight to the sky), the terminal was sending signals and its GPS location to the satellite. This ensures accurate tracking and monitoring as assets transit between connections. It transforms the visibility of global freight assets on land and at sea.

A second important step en route to commercial services was a real-life pilot test for connecting remote assets such as pipelines and smart meters. The trial was done in collaboration with the Saudi Communication, Space, and Technology Commission (CST), the oil and gas company Saudi Aramco, and the Saudi Ministry of Energy. It was conducted in one of Aramco's remote sites, located in the Ain Dar area in Saudi Arabia.

For the trial, gas and temperature sensors from a remote oil wellhead and pipelines were connected to the Tiger-2 satellite. The terminal gathered temperature, humidity, CO2, and GPS readings every two hours and stored the data until the next satellite pass. The satellite can also store the data until it sends it—using NB-IoT technology—to the next ground station.

The setup minimizes the need for human intervention wherever possible and provides the latest data to safeguard the business case. A field sensor sent its data via Bluetooth to a tech terminal, which forwarded the sensed data to the corresponding satellite and down to the ground network station. From there, the data passed on to the cloud-based dashboard.

Measuring transmission speeds showed an ultra-high reliability connection with all the transmitted data successfully received and decoded. Also, to relay billing and power consumption data, indoor electricity smart meters were connected.

The result of both successful trials turned OQ Technology into the world's first satellite telecom operator for global IoT connectivity using 5G protocol to provide connectivity anywhere. As a result, the company was also able to sign the first commercial customer contract in the world for using a constellation of LEO satellites to provide 5G coverage for IoT devices based on NB-IoT.

The tests also allowed the company to introduce the world's first secure private network providing 5G connectivity for IoT devices based on standardized 3GPP cellular technology for narrowband-IoT. Together with its other satellites in orbit, including Tiger-3 launched in April 2022, the company was able to close the gap for latency critical applications and provide high data density, quality of service, and fast response times.

The future of 5G SatIoT

The results and new services give a first glimpse of the revolutionary future 5G can provide. Over the next decade, 5G and other technologies with upgraded standards will expand their coverage as networks grow.

PWC estimates that $330 billion will be added to global GDP by 5G applications in smart utilities management by 2030. And McKinsey reckons that the agriculture industry could add $500 billion to the global GDP by 2030.

The predicted 5G expansion might also lead to overcrowding in the radio frequency spectrum, and regulators need to free up frequencies from GEO operators that have been sitting on these signals and doing nothing with it for a long time.

While today the data transmission from sensors to the dashboard is one directional, the technology can replicate the function of wired systems for sending commands back to various assets in real-time. This would enable a whole new range of use cases for industrial automation, especially when combined with AI. For example, farmers could direct silos to release food or manage irrigation systems, or oil and gas enterprises could use drones, cranes, and robots remotely. This would reduce or eliminate the need for expensive human interaction, boost efficiency, and increase the safety level of workers.

With the adoption of the technology, enough available spectrum, and more satellites and constellations being launched, 5G at its peak has the potential to be instrumental in developing revolutionary applications and enormous benefits across multiple industries, unlike anything that exists today outside a wired environment.