E-GUIDE

Playbook for Cellular IoT Connectivity

No nonsense guide to connectivity options.

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The explosive growth of the Internet of Things (IoT) in our homes, across cities, and in commercial buildings, means developers can build IoT solutions like never before. It's estimated that by 2020 there will be nearly 26 billion IoT-connected devices.[1]

At each layer of the IoT stack, industry standards define how components should interact, and yet deploying a functional solution remains prohibitively difficult. In contrast to software application development, where best practices for building and deploying a global app are well known, there is no comparable playbook for IoT. There are several universal challenges with IoT that account for this:

- Every IoT device has its own unique hardware features.
- For most people, manufacturing is a total black box, with unpredictable costs and timelines.
- There are different options for connectivity to suit different IoT use cases.

What's inside

Historically, consumer demand for handsets drove the density and capacity of networks. Today, there's enough demand for the IoT that there are new lenses through which we can look at Wide Area Networks. The first is known as Critical IoT; the continued development of consumer-grade, high-throughput advanced solutions. Critical IoT applications have very high demands for reliability, availability, and low latency with high data throughput.

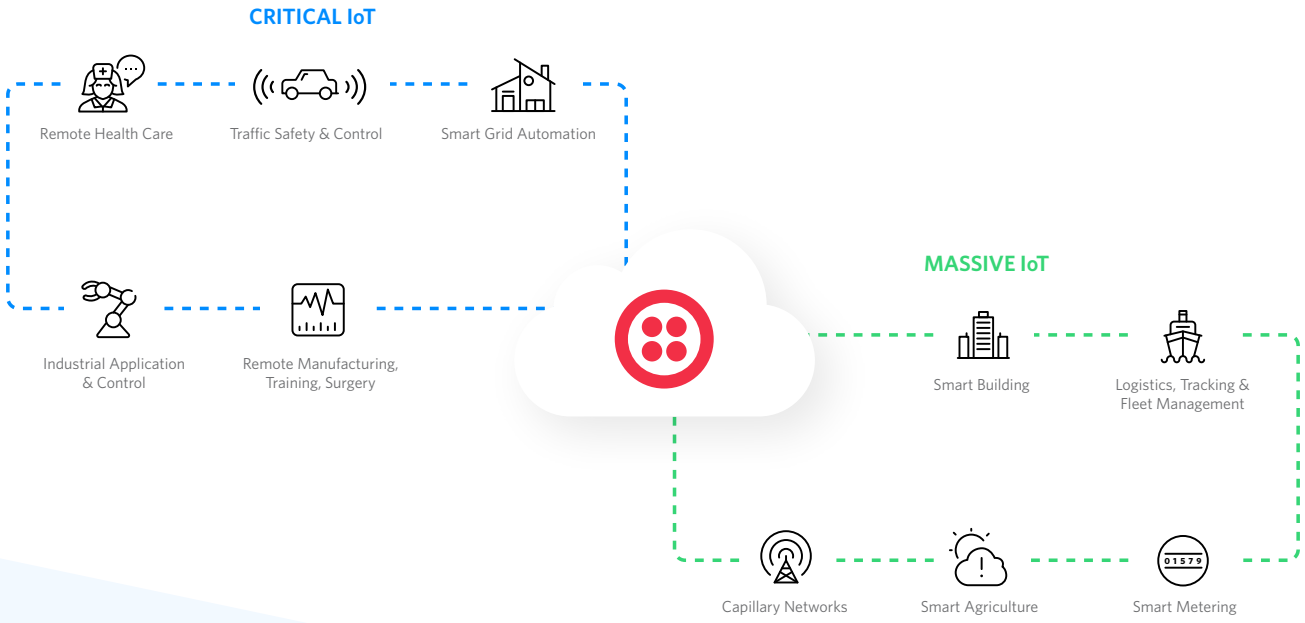
The second lense is Massive IoT: large-scale, mostly low-power deployments.

Massive IoT applications are the tens of billions of devices that require ubiquitous connectivity and report sensor data to the cloud on an intermittent basis. Their requirements are high connection volumes, small data packets, low-cost devices, and low energy consumption. Critical IoT applications have very high demands for reliability, availability, and low latency with high data throughput.

[1] *According to Gartner Research*

Building for Wide Area IoT

With any IoT project, trade-offs must be made when selecting how to connect your device. Factors to consider include latency, battery life, coverage, mobility, and throughput. From a mobility perspective, cellular may seem like the clear winner—providing much better transportability of devices than WiFi—however, not all cellular technologies are designed for devices that move around frequently. In particular, Narrowband IoT is a cellular technology that uses 'active mode mobility,' which means it can move around and report in new locations but it can't 'stream' constant information as it does so.



Businesses have the freedom to choose the connectivity that suits their use cases arising from user need, rather than industry specificity. The introduction of IoT to businesses and consumers alike has the potential to create value in new ways and to transform how we live and work.

The IoT landscape: High-performance cellular vs. low-power wide area networks

There are several factors to consider when choosing the right connectivity for your IoT use-case. In this guide, we compare wide area networks (WANs), including high-performance cellular and Low-Power Wide-Area Networks (LPWAN) alternatives, to help you choose the right connectivity for your specific needs.

Critical IoT
Low cost, low energy, small data volumes, massive numbers

Massive IoT
Ultra reliable, very low latency, very high availability

	CRITICAL	MASSIVE	UNLICENSED LPWA
	Broadband Cellular (LTE Cat 4, Cat 1)	Cellular LPWAN (Cat M1, NB IoT)	(NB IoT)
THROUGHPUT	Medium to high	Low to medium	Low
MOBILITY	Yes	Yes	Varies
LATENCY	Ultra-low	Low	Varies
BATTERY LIFE	Days to weeks	Up to 10+ years	Up to 10+ years
COST	Medium	Low	Low

IDC expects the global market spend for IoT connectivity to reach $224.7 billion by 2021, at a 13.8% CAGR.

High performance cellular

In the past twenty years, mobile phone adoption laid the foundation for 3G and LTE networks globally, providing connectivity for more data and faster speeds. However, 2G, 3G, and high-speed LTE consume too much power and don't suit applications where only a small amount of data is transmitted infrequently. Plus, the continuous evolution of new protocols means that as a generation of radio technology is phased out, devices are discontinued and must be replaced at a heavy cost.

Critical IoT applications have very high demands for reliability, availability, and low latency–all of which LTE or 5G capabilities can fully realize.

Let's take a look at some common functionality of high-performance cellular connectivity

- Built to handle massive volumes of data traffic
- High consumer handset demand
- Battery life directly correlates to usage and consumption
- Limited propagation deep indoors and underground
- **Best for high bandwidth and power-hungry applications**

The volume and scope of Critical IoT applications and solutions will be much smaller than for Massive IoT, but the business value will be much higher. There is more at stake when a connection goes down. For example, if you are performing a medical procedure remotely, a patient's life depends on the connection being reliable.

WHEN LOOKING AT HIGH-PERFORMANCE CELLULAR FOR YOUR PROJECT, THERE ARE A NUMBER OF OPTIONS

LTE Cat-4: The proliferation of smartphones and apps led to the standardization of Cat-4 devices, which support 150 Mbps downlink peak rates and 50 Mbps uplink peak rates–most suitable for higher data consumption use cases, like video.

LTE Cat-1: A cellular IoT option that represents an early push towards connecting IoT devices using existing LTE networks. Use cases include IoT applications that require a browser interface or voice, such as ATMs, kiosks, video surveillance, vehicle telematics. Experts predict Cat-1 will replace 3G when it sunsets.

Low-power wide-area networks (LPWAN)

Massive IoT applications are typically low-cost devices that have low energy demands and require broad coverage—and Low-Power Wide-Area Networks (LPWAN) are the best fit to satisfy the scale and density required.

LPWAN is a category of wide area wireless technology designed to optimize four main application needs of IoT: cost, battery life, coverage, and network. By 2025, it's expected that four billion IoT devices will rely on LPWA networks.[2]

Let's take a look at some common functionality of LPWAN

- Low Power: An LPWAN connected device doesn't need to draw as much power to send and receive data because it has a slower throughput and lower bitrate.
- Lower Cost Devices: The cost of LPWAN modules (the components inside sensors that transmit and/or receive radio signals) is expected to drop over the next several years as the market grows. Also, the low power requirements of an LPWAN modem means smaller batteries are needed.
- Low Maintenance Costs: LPWAN sensor batteries can last ten years or more, depending on the application, and longer battery life means longer replacement cycles.
- **For low bandwidth and low-power applications**

[2] *ABI Research, Market Opportunities for Low Power and Cellular Wireless ICs for the IoT*

When looking at the technical specifications for LPWAN the differences are small but important. Let's take a more in-depth look at Cellular LPWAN:

Cellular LPWAN networks, offered by mobile network operators, complement and extend conventional WANs that make use of 2G, 3G, and 4G LTE cellular technologies. The main advantage of cellular LPWAN technologies is that in many cases they only require a simple software update to the providers existing infrastructure—no new radio hardware is required.

Cellular LPWAN technologies have significant advantages over their non-cellular counterparts

- Strong support from the telecommunications ecosystem
- Can operate across the existing cellular infrastructure
- Scalability for deploying new IoT solutions

UNLICENSED VS. LICENSED SPECTRUM

Wide Area Networks can use licensed or unlicensed radio-frequency spectrum. Many cellular network operators, already own licensed spectrum that can be 'refarmed' for use in IoT.

WHEN LOOKING AT CELLULAR LPWAN FOR YOUR PROJECT, THERE ARE A NUMBER OF OPTIONS

There are two leading cellular LPWAN technologies: Long Term Evolution for Machines (LTE M) and Narrow band IoT (NB-IoT)

LTE Cat-0: Eliminates the features that supported high data rate requirements for Cat-1 and is expected to replace 2G in the future.

NB-IoT: A standard adopted by over 20 cellular operators around the world, NB-IoT features all of the safeguards and security associated with operating in a licensed spectrum. This is fuelled by fast-growing demand in China where NB-IoT is set to replace 2G in mass-market applications as the country's preferred LPWAN technology. In fact, NB-IoT device shipments worldwide will reach 613.2 million units by 2023. NB-IoT is a good choice for applications that don't need frequent communication or high data throughput.

LTE M: LTE M (or LTE Cat-M1) relies on legacy networks and can be considered low power because maximum system bandwidth is capped at 1.4 MHz. LTE M targets LPWAN applications where only a small amount of data transfer is required. LTE M supports half-duplex mode (the same as NB IoT), which allows data to travel in only one direction at a time. The advantage of half-duplex mode is that it requires less power for situations where there is no need to both send and receive at the same time. Cat-M1 has a slightly higher data rate than NB-IoT, so it can be used for applications such as wearables, security cameras, and automotive use cases. Unlike NB-IoT, Cat-M1 can be configured for low latency communication for use cases where data must be transmitted immediately.

Your connectivity provider for IoT

For the majority, the IoT is not a point solution. You'll need to work with many organizations and vendors to stitch together a coherent end-to-end system. As part of your Wide Area IoT project, you will need to deal with a connectivity provider, and that's where Twilio's APIs can make building solutions easy.

Twilio Programmable Wireless is the connectivity provider for IoT. With Twilio Programmable Wireless, devices can be connected to the internet quickly and Twilio's API-first approach means all aspects of SIM management are fully automated:

- SIMs with transparent usage-based, pay-as-you-go pricing, self-service ordering, API-based provisioning, and no shenanigans.
- SIM lifecycle management via a REST API, or via the Twilio Console.
  - Ability to choose country access for billing.
  - Ability to configure global access permissions.
  - Data billing models to support fleets of high and low usage devices.
- A Commands API lets you send and receive M2M Commands over the SMS channel.
- See where and when SIMs are connected and monitor data consumption in near-real-time.

Thanks for reading.

Would you like to
learn more about Twilio
Programmable Wireless?

More Info on Cat-M vs NB-IoT