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IoT network solutions:

A complete guide to cellular technologies

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The first cellular networks brought the world together through mobile phone conversations and texting. IoT has been piggybacking on consumer cellular technology for years, so it can seem like a confusing mess of protocols, terminology, and piecemeal solutions.

While IoT devices can function on existing consumer networks, technological advancements and better IoT native networks are taking connected technologies to the next level.

This guide covers the cellular technologies currently supporting IoT deployments and what's on the horizon. Specifically, we'll look at:

- **Cellular network technologies**

  We'll explore the basics of cellular network technology — from 2G to 6G and everything in between.

- **Cellular IoT networks**

  There's a lot of variation in IoT networks. We'll walk you through them and cover LTE-M, NB-IoT, LTE Cat 1 bis, and more.

- **How to find the best connectivity solutions for your business**

  The right IoT solution looks different for everybody. We'll consider use cases and features, helping you choose the perfect IoT network for your device deployment.

A successful IoT project requires scalable, reliable, and secure connectivity on networks available in your part of the world. That's a tall order — but as a global leader in IoT connectivity, Onomondo provides what you need for a winning deployment.

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Cellular network technology

Understanding cellular network technology is essential to finding the right solution for your deployment. Let's look at how networks evolved over the past decades and where we are today.

2G and 3G

2G and 3G networks built the backbone of IoT technologies thanks to their low costs, good indoor and outdoor coverage, and global infrastructure. Now, operators are sunsetting 2G and 3G globally to free up bandwidth for 4G and 5G technologies. The problem is that the high-bandwidth demands of today's phone networks mean 2G and 3G just aren't fast enough anymore. And, due to infrastructure maintenance costs, 2G and 3G don't make sense as an "IoT only" setup (check out **2G and 3G sunset dates** here).

4G

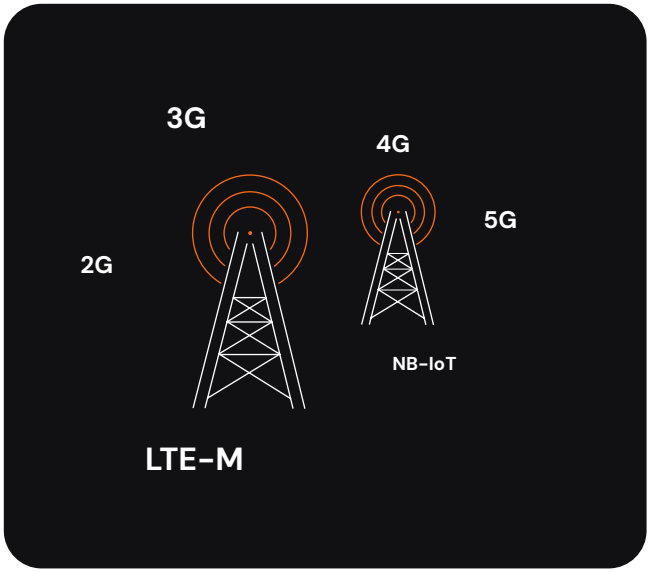
4G networks are a great option as the world sunsets older networks. Currently, 4G is one of the most common and well-developed network options in the world. The 4G network offers sufficient stability and bandwidth to meet the data demands of complicated use cases, from video surveillance to remote patient monitoring. With technology advancing fast, however, 4G still lacks the speed for higher-bandwidth tasks.

5G

Although coverage isn't global yet, 5G's high bandwidth offers new capabilities for IoT. For example, the Enhanced Mobile Broadband (eMBB) 5G focuses on high-bandwidth applications like virtual/augmented reality, HD video streaming, and mobile internet. Ultra Reliability Low Latency Communication (URLLC) delivers the near-instant response times required for applications with reliability and minimal delay at the top of their priority. URLLC is perfect for industrial and mission-critical uses like factory automation, self-driving vehicles, and remote control systems — essentially powering the digital transformation of industries. While 5G promises transformative capabilities for IoT applications, the journey to full 5G maturity and widespread adoption will unfold over several years, up to a decade according to industry estimates. Rather than waiting for the complete 5G rollout (which includes the certification process for 5G IoT devices), businesses should take a pragmatic approach — using current technologies while preparing their IoT strategy for future 5G capabilities.

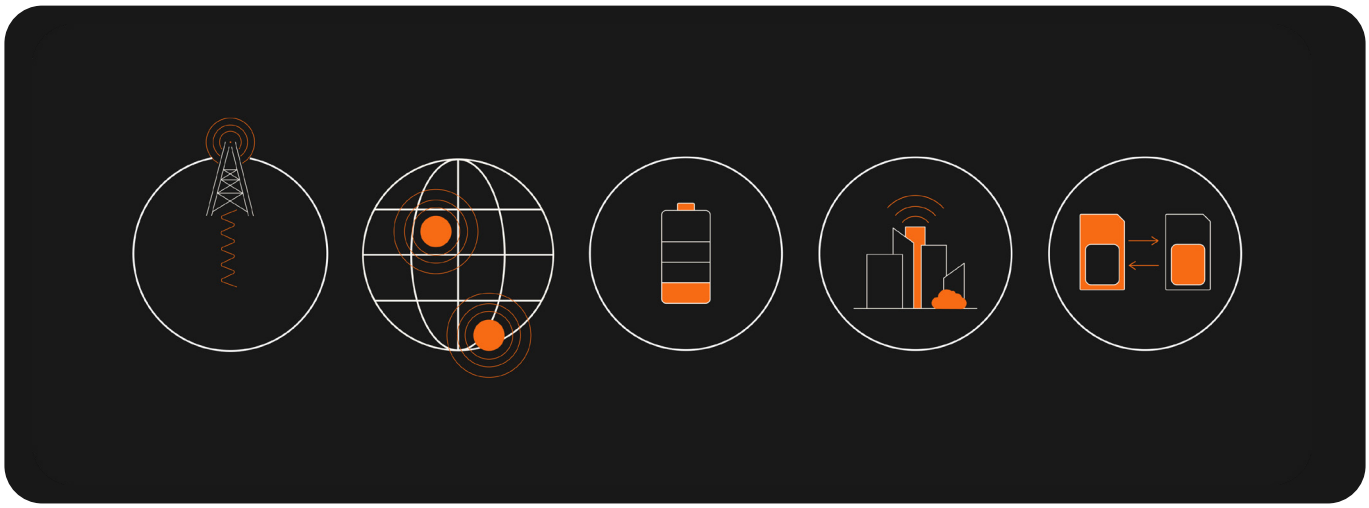
6G and beyond

Looking to the future, 6G networks present some exciting possibilities. Collaborative robotics could power entirely automated factories and warehouses, and the higher bandwidth of 6G could let digital twins of entire road systems reflect status in real-time.



Cellular IoT networks

Today's IoT network options include low-power, wide-area networks (LPWANs). Designed for machine-to-machine communications, LPWANs support low bandwidth transmission across long distances with high reliability. LPWANs are perfect for IoT devices that only transmit small amounts of data such as location, measurements, or status updates. Let's look at the two main options in this category.



LTE-M

LTE-M or Long Term Evolution for Machines is a cellular connectivity technology designed to meet long-range, low-data, low-power, and low-cost requirements for many IoT devices. It's also referred to as LTE Cat-M1/M2.

Available through most of the Americas and some of Western Europe, benefits include low power consumption, extended coverage, and scalability, making LTE-M ideal for connecting devices in remote locations with poor coverage.

LTE-M also has power-saving features: eDRX and PSM since it is an optimized version of LTE intended for the low-power needs of IoT. As an LPWAN, however, it's never meant for high data rate applications with high-speed data transfer needs, and still unavailable in certain countries. Read this LTE-M guide to learn more.

NB-IoT

Narrowband Internet of Things (NB-IoT), is another LPWAN technology based on LTE architecture built to make wireless connectivity for IoT devices more accessible. It's also referred to as LTE Cat-NB1/NB2.

NB-IoT stands out for its low cost and power-saving features, and deep signal penetration. Despite its advantages, NB-IoT does not usually support SMS and VoLTE capabilities, and can't do handovers crucial for high mobility devices. Because of these limitations, NB-IoT is becoming preferred for stationary devices that are in obstructed locations, smart power meters, for example. Read this NB-IoT guide to learn more.

While these options seem very similar, a few key distinctions make them suited for different use cases.

For example, LTE-M shines when your devices require higher data rates, mobility, and real-time communication. NB-IoT is your go-to for cost-effective, low-data-rate applications where device mobility isn't a concern.

Here's a **comparison between LTE-M and NB-IoT** for a closer look.

4G LTE IoT

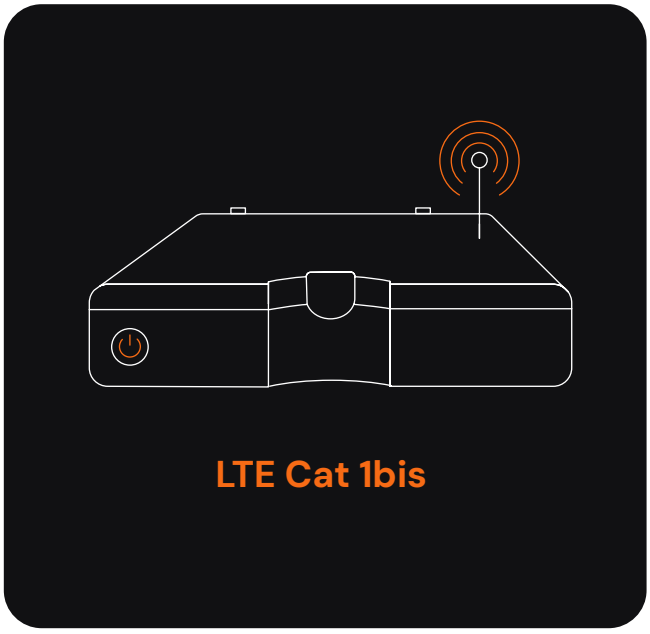
Within the framework of 4G, there are a few variations. 4G LTE is part of 4G, but it's slower than true 4G and far slower than the more recent 5G standard. LTE launched in 2008 with 3GPP's Release 8, and its biggest shift from 3G was enabling fast internet connectivity on mobile devices. 4G LTE also has a few versions to consider.

LTE Cat 1

LTE Cat 1 originally emerged as part of 3GPP Release 8 in 2008. It computationally restricted devices with a maximum throughput of 10 Mbps for download and 5 Mbps for upload. The standard garnered little interest until manufacturers began producing small IoT devices, such as connected watches or precision agriculture monitors, with limited space for advanced LTE features. Today, when most people refer to LTE Cat 1, they mean LTE Cat 1 bis. Read more about **4G LTE IoT** here.

LTE Cat 1bis

The "bis" in this standard's title refers to a Latin word meaning "second time" or "again," because Cat 1bis is a slightly different version of LTE Cat 1. The newer variation meets IoT developers' need for single-antenna IoT hardware. The update makes it possible to manufacture simpler, lower-cost chipsets with the same throughput specs as the original LTE Cat 1 (10 Mbps down, 5 Mbps up, and latency of less than 100 ms). The update enables simpler and lower-cost chipset designs. LTE Cat 1bis is a good choice for use cases that require global connectivity. It doesn't require upgrades on the base stations (cell towers), meaning LTE Cat 1bis works seamlessly on existing LTE networks. **Read more about LTE Cat 1bis here**.



Here's some of the key features of 4G LTE IoT that you can match with your requirements.

Feature requirements	LTE-M	NB-IoT	LTE Cat 1 bis
Throughput	Low data needs (up to 1 Mbps)	Low data needs (up to 250 kbps)	Moderate data needs (up to 10 Mbps)
Latency	Low	Low to medium	Low
Reliability	High	High	High
Range	Up to 11 km	Up to 15 km	Up to 10 km
Mounting location	Outdoor, indoor	Outdoor, deep indoor	Outdoor, indoor
Power consumption	Low, supports PSM, eDRX (network-implementation dependent)	Low, supports PSM, eDRX (network-implementation dependent)	Low to medium, supports PSM, eDRX (network-implementation dependent)
Mobility	Full mobility (supports handover)	Limited (stationary or slow-moving)	Full mobility (supports handover)
Device size	Compact modules	Small modules	Small modules
Coverage	Urban, rural, not all countries	Urban, rural, not all countries	Urban, rural, global coverage
Cost of hardware	Cost of hardware	Low to medium	Medium
Capacity	Moderate device density	High device density	Moderate device density
Voice	Supported	Unsupported	Supported
SMS	Supported	Limited	Supported
Roaming	Supported	Unsupported	Supported
Security	LTE encryption and authentication	LTE encryption and authentication	LTE encryption and authentication

5G IoT

While development is still on-going, 5G networks are being adapted to IoT, leading to several useful iterations of the system for various IoT use cases akin to that of LPWAN from 4G LTE. Read more about 5G IoT here.

5GmMTC

Massive Machine-Type Communications (mMTC) supports massive IoT deployments that require low power and minimal bandwidth to communicate simultaneously within a given area. Devices that benefit from LTE-M or NB-IoT coverage fall under this category.

5G RedCap

5G Reduced Capacity, or simply RedCap, aims to fulfill the connectivity requirements of devices needing moderate bandwidth (up to 20 MHz and 220 Mbps downlink). Think of 5G RedCap (or 5G NR-Light as referred to in 3GPP Release 17 in 2022) as a step above LTE Cat 4 in its maximum downlink capacity.

5G eRedCap

eRedCap, introduced in 3GPP Release 18, is a further simplified version of 5G RedCap, offering reduced complexity and cost compared to full 5G. eRedCap operates with a maximum 5 MHz bandwidth and 10 Mbps downlink, filling needs similar to LTE Cat 1 and LTE Cat 1bis.

How to find the right IoT network provider

There's no one-size-fits-all in IoT. To find the best option for your needs, you need to know the challenges you will face and the potential advantages of the technology. Let's say you need to integrate IoT solutions into your shipping operations. Your company uses planes, trucks, and trains to move goods worldwide. As you scale up, delays and inefficiencies plague your business. To solve these communication problems with IoT, take the following steps.

1. Understand your project requirements and use case

In a perfect world, IoT devices would be the size of a quarter, have infinite range, and cost about as much as a pack of ramen. Unfortunately, we're not quite there yet — so you must choose which features are the most important to your particular needs.

In our example, we are talking about a global logistics company. We need extensive range and coverage to ensure our vehicles don't drop out of range. While smaller is better when talking about device size, if we're putting the devices on airplanes, trucks, and trains, there's likely to be space for brick-size IoT devices. If we own a massive fleet of 10,000 vehicles, we need the price to be as low as possible. But, if we only have 500 devices, prioritizing features over price might be worth it.

2. Research network availability

All the networks we've discussed have different availability depending on location. In our example of a global shipping company, we have to consider exactly where the vehicles are going. Are they sticking to fairly urban areas in North America? Or are they venturing into South American jungles or remote stretches of Siberia? Choosing a network provider that lets you **operate anywhere in the world** is essential for a shipping company, but it is also relevant for many other IoT use cases.

3. Choose a reliable network provider

There are a lot of network providers out there, but it's important to look for a few key features when deciding which option to choose. Generally, a reliable network provider should offer the following:

- **Global connectivity**
  Roaming is great for keeping your phone working when you travel – but not as a permanent operating state for IoT devices constantly in motion. Onomondo solves permanent roaming issues using full-core network integrations with every single radio access network (RAN). So, there's no need to use power-hungry profile switching mechanisms on **eUICC SIMs (eSIM)**. Connectivity is even better with our agnostic software SIM, or simply **SoftSIM**. The SoftSIM allows seamless global connectivity without depending on slow and costly physical SIM distribution.

- **Network management and performance monitoring**
  For an IoT device on the move, network switching is integral to keep things functioning. You can't afford dropped signals, lost data, or other glitches when you've got an IoT device in motion tracking important information. Onomondo's **easy-to-use platform** for network management and **powerful insight tools** keep you up to date when something goes sideways.

- **Integration and future-proofing**
  Given the nature of IoT, cross-compatibility is essential. No matter your use case, there will be times when you need to transfer data between devices, networks, and stakeholders. Onomondo's **API and webhooks** solutions keep devices talking to each other and maintain a constant flow of up-to-date information through the network.

- **Cost optimization**
  You can have all the greatest features in the world, but if you're not able to afford them, they don't do you any good. Onomondo's **pay-as-you-go pricing, no SIM fee for activation or deactivation, and freedom to leave** make high-quality IoT fit into nearly any budget.

Get in touch

Talk to us about our IoT connectivity solutions so you can develop, launch, and manage your devices with confidence. Get in touch to discuss your use case, detailed pricing information, and any technical questions you have directly with our team.

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