

FIG A.

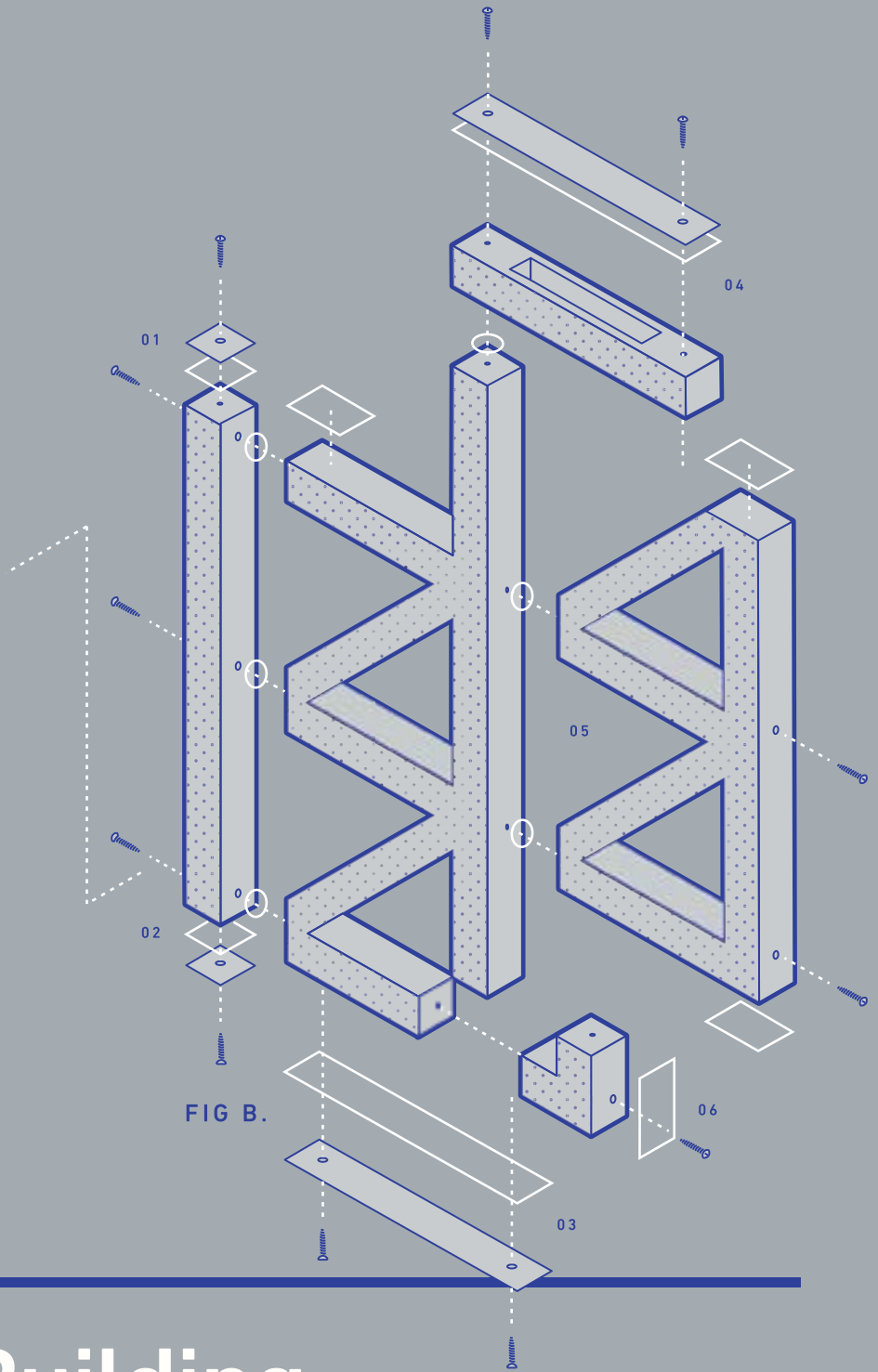


FIG B.

A Guide to Building Cellular Connected Products

Streamline Complexities, Save Time, and Scale More Efficiently: Here's How



OVERVIEW

Even though machine-to-machine (M2M) technology has been around for decades, the Internet of Things (IoT) is a relatively new playing field. The platforms, tools, and resources of years past are quickly becoming obsolete. The biggest change: the IoT ecosystem is no longer limited to the world of enterprise, as the playing field for new product development is becoming more even. How can software and hardware developers build products and scale without wasting money or valuable engineering time.

In this guide, we tackle the 7 biggest reasons why developers get stuck building M2M products. At the end, we leave you with tutorials so you and your team can tinker on your own time.

Let's get to it.



PART I: SETTING THE STAGE

BACKGROUND

Imagine that you've taken a time machine back to 1999. If you can remember that far, what was life like? You might remember that Y2K was just around the corner, and the Internet was just making its way into desktop computers in households. Some homes were lucky enough to have high-speed broadband. But bandwidth was still limited. The concept of a smartphone didn't exist.

It was within this context, also in 1999, that MIT's Auto-ID Labs founder Kevin Ashton (allegedly) coined the term "Internet of Things" (IoT) while giving a presentation at Procter and Gamble. From there, the concept of connected devices had a buzzword.

17 years later, developers finally received the publicly available tools they need to create machine-to-machine (M2M) products at scale:

- Monitoring heavy equipment (cranes, semi-trucks, etc.) and automatically scheduling maintenance.
- Tracking thousands of shipping pallets and containers worldwide on a real-time dashboard.
- Observing crop soil conditions with sensors automatically triggering water equipment.

As Intel puts it:

"The 'Internet of Things' is exploding. It is made up of billions of 'smart' devices—from miniscule chips to mammoth machines—that use wireless technology to talk to each other (and to us)."



And according to a study from IDC and Intel, the IoT world is growing rapidly, from 2 billion objects in 2006 to a projected 200 billion by 2020—26 smart objects for every human on earth. Today, smart objects are primarily in factories, businesses, and healthcare. They're underground, analyzing soil levels. They're dispersed through cities to help law enforcement detect and respond to crises.

WHERE THAT LEAVES DEVELOPERS, TODAY.

The way that we interact with technology is changing. From connected kitchens to warehouse inventory management, our imaginations are ready to build products that our markets need. But according to Gartner, there's one big challenge in our way:

"Many standards and ecosystems for the IoT are still in development and some of the vendors and ecosystems may fail during the working lifetime of current IoT projects," said Alfonso Velosa, research director at Gartner.

"This is especially critical if the project involves infrastructure that may be in the field for decades. A gateway-based architecture will be a key approach to future-proofing IoT projects."

To make a long story short: we're stuck with fragmented systems and piecemeal solutions. And while a cobbled-together approach may work for an immediate launch, it will hold us back from scaling our products into new geographies, markets, and use cases.

So, let's say that you're a product developer at a transportation insurance provider looking to build a cellular connected device that tracks data from shipping and logistics vehicles. Maybe you're planning to launch in the U.S. and expand your tech into Mexico, Canada, and select European



markets, shortly after. How should you plan to manage billing between different carriers? What about switching between networks? And how do roaming agreements enter the picture? Will your U.S. prototype work, as-is, everywhere else? What level of attention will your business development team need to give to carrier negotiations when you're ready to expand?

All of these complexities can add up. And the last thing you want is to make early decisions that waste time, leak resources, and stunt growth down the line. In the rest of the guide, we'll help you get your bearings—introducing you to tips and best practices for choosing tools, technologies, and partners that will enable you to save development time, reduce the potential for error, and scale more efficiently.



PART II: NAVIGATING COMPLEXITIES

WHY DEVELOPERS GET STUCK

If ubiquity in connected systems is the dream, we still have a long way to go. Even though M2M tech has been around for decades, ecosystems are still in their infancy. Not to mention, every product will have its own unique considerations, which you'll want to address in your research. Here are 7 key questions to ask before building or scaling your next product.

1. SHOULD YOU WORK WITH AN MNO OR MVNO?

In the early days of M2M, product developers had no choice but to form direct relationships with telecommunications operators. You might have heard the term “mobile network operator” (MNO) to describe the service providers for wireless voice and data communication. In the United States, examples include AT&T, Verizon, Sprint, and T-Mobile.

The benefits of working directly with a telecommunications provider? You can negotiate high-volume pricing and data usage. You'll receive account management support. You can handpick multiple carriers with whom you'd like to work. But these strengths are exactly what makes MNOs challenging as strategic partners. Let's say that you're on the development team of small startup (or even a Fortune 500 company), looking to launch just one connected product in multiple countries. You'll be stuck needing to work with multiple MNOs to make this launch happen. Long term, you may save money if your bandwidth usage is high enough. But if your needs are simpler—i.e. If you need to meet a minimum order threshold, an MNO won't be the right fit. So what should you do, instead?



Consider working with a mobile virtual network operator (MVNO), a licensed operator that works with carriers on the device-builder's behalf. Unlike MNOs, MVNOs don't own the infrastructure (i.e. cell towers) on which they operate. Rather they buy bandwidth in bulk. In doing so, they are able to offer developers an added layer of flexibility.

Let's say that you're on the development team of a startup—or even a Fortune 50 company—and you're thinking about testing a new device in 5 major markets. Working with an MNO, you'll need to commit to minimum orders and negotiate relationships, by geography. Working with an MVNO, you can get up and running with less overhead and more efficient pricing: you won't be under pressure to buy more bandwidth than you need, and you won't be stuck dealing with billing on multiple networks.

2. HOW SHOULD YOU HANDLE ROAMING AGREEMENTS WITH CARRIERS?

Let's say that you want your device to operate on multiple carriers within a given country. To get started, you'll need to understand their roaming agreements—how telecommunications companies define relationships with one another.

Working with an MNO, you'll likely need to negotiate custom relationships. This process may be sustainable for a few initiatives, but you may run into roadblocks when you start working with carriers in multiple networks. Let's say that you build a product that needs to work worldwide, for instance. You'll need to, essentially, build your roaming agreements from scratch. Why not work with an MVNO like Hologram, which has gone out and negotiated more than 600 carrier relationships worldwide, instead? You cut down development complexities and bring your products to market faster, as a result.



3. WILL YOUR HARDWARE WORK IN DIFFERENT COUNTRIES?

When you're operating—or planning to operate—in different countries, you may be dealing with a strategic jigsaw puzzle. Beyond choosing SIM carriers, you'll need to pay close attention to your hardware, as different countries have different certifications. How will your SIMs travel between countries? If you work with an MNO, you'll need to give strong consideration to this question and conduct a careful due diligence of the technologies and carriers you're thinking of using. You should also be prepared to make changes down the line: you may not be thinking of expanding in a new geography now but will in the future. One way to avoid this challenge altogether is to work with an MVNO with tech that is pre-built to work elsewhere.

USE CASE SPOTLIGHT: AGRICULTURE TECH

A 15-year-old agriculture tech and wireless solutions company came to Hologram because they were looking to take their up-and-running, U.S. based technologies into new markets overseas. Currently operating devices on both GSM and CDMA networks, they knew that they would need to use a completely different chip set to work internationally.

Instead of dealing with different chip sets and pricing in different countries, however, the company came to Hologram for one cohesive solution—so they could essentially use one device, everywhere.

Hologram allowed the company to simplify challenges with respect to roaming and hardware certifications: all that was necessary was one SIM that worked in multiple countries. The alternative? Without Hologram, the company would have needed to negotiate rates independent.



4. WHAT'S THE RIGHT SIM PRICING MODEL FOR YOU?

If you think about your cell phone plan, you're probably paying a certain amount per month, for a fixed number of gigabytes. But with M2M, you have more options when it comes to choosing an optimal pricing model. If you work directly with a carrier, you should expect to pay per megabyte or per unit of kilobyte (i.e. tons of kilobyte). But some MVNOs like Hologram will allow you to purchase data on a per kilobyte basis. With this level of granularity, you can optimize your pricing around the amount of data that you're using.

When choosing a pricing model, it's important to pay attention to your anticipated usage. Paying per kilobyte will give you the flexibility and granularity for the majority of IoT solutions. But it may not be the right option for developers and companies with high-volume bandwidth needs such as live video & photos.



Here is a chart that walks you through different payment options, along with some typical pros and cons.

PLAN TYPE	DESCRIPTION	PROS	CONS
Hologram 3G Pay-as-You-Go	Pay-as-you-go plans are built for mobile IoT applications and provide worldwide cellular coverage with the lowest monthly device fee in the industry (\$0.40). These plans offer a full hardware to cloud solution without lock-in, meaning you can bring your own hardware and cloud solutions.	<ul style="list-style-type: none"> • Lowest monthly device fee in the industry (\$0.40). • Competitive data pricing. • Worldwide coverage. • Simple tools and cloud to send data to your applications. • Hardware & software agnostic, use ours or a custom solution. • Remotely monitor and change device code with Over-the-Air programming. • No annual agreements, pay for what you use cancel anytime. • Pay per KB (1,000 smaller than a MB). 	<ul style="list-style-type: none"> • No projectors. • No opportunity to negotiate with mobile carriers directly. • Higher per-unit costs past certain thresholds of bandwidth usage.
Other MVNOs 3G	MVNOs make agreements with one or more major carriers. IoT applications tend to work best with MVNOs since there is better coverage, pricing and right now 3G performs better in IoT environments.	<ul style="list-style-type: none"> • Competitive data pricing. • Usually works on multiple carrier networks with a few offering worldwide coverage. 	<ul style="list-style-type: none"> • Minimum \$2-\$4 monthly per device fee. • Usually lock-in compatible hardware and cloud infrastructure. • Locked to an annual agreement. • Pay per MB or GB.
MNOs w/4G LTE	Verizon, AT&T, Vodafone and other major wireless carriers usually offer their 4G plans with 3G as a fall back. Majority of IoT applications do not use MNOs because of high monthly device fees but may make sense for projects requiring high throughput.	<ul style="list-style-type: none"> • 4G throughput for IoT applications requiring transfer of large media (video/photo). • Usually lower data fees useful for high bandwidth applications. 	<ul style="list-style-type: none"> • Minimum \$5-\$20 monthly per device fee. • Smaller coverage area. • Separate agreements and SIMs for each provider/country. • 4G is overkill for majority of IoT products. • 4G hardware hard to find for IoT. • Locked to an annual agreement.



What's important to keep in mind is that carriers are looking to maximize a metric called an ARPU (average revenue per unit) for every device in the field. There are fixed costs associated with having these devices in the field, which means that on top of these costs, you may need to pay an MRC (monthly recurring charge). A typical M2M device has much lower bandwidth usage than say, a smartphone. So MNOs have an incentive to enforce minimum rates and monthly surcharges. MVNOs, working with carriers directly and negotiating pricing in bulk, are able to absorb these fees (passing them on to end customers as a result).

5. WHAT TYPE OF HARDWARE WILL YOU NEED?

Will the hardware you need work in your chosen geography? What's the lifecycle of that hardware? And what are some cost-related tradeoffs that you'll need to make? If you're looking for an inexpensive modem, for instance, you may consider using 2G. But what you'll want to remember is 2G is being sunset for the U.S. market, you'll need another option in the near term.

And when it comes to options—when you do a little digging, you'll see what you have quite a few on the table. Price, alone, won't help you come to a decision. Because there are so many devices, at similar price points, from which to choose, you may find yourself stuck with option overload. At the end of the day, you can simplify your decision-making to one of three options:

- An inexpensive, off-brand modem from China
- A modem from one of three leading manufacturers: UBlox, Telit, or Sierra Wireless
- A well supported IoT cellular boards like the Hologram Dash or others from Arduino, Adafruit and Seeed

When choosing the option that's right for you, you'll want to consider the following:



- Device lifecycle
- Configurability
- Security constraints
- Ability to work in different geographies
- Software compatibility
- Relevant certifications
- Error handling
- Stability

At a minimum, you'll want to know what features you're looking to build and what geographies you'll be launching your product(s). From there, you can hone in on the hardware you'll need to support those goals.

6. WHAT WILL BE THE RIGHT SOFTWARE DEVELOPMENT ENVIRONMENT?

Many platforms for building connected products will come with an included, web-based IDE. The idea is to keep developers within a contained ecosystem, to simplify the process for choosing tools. On the other end of spectrum? You can build your own development environment from scratch.

Or, you can pick an option that allows you to pick the features you need from a pre-designed selection set. For instance, Hologram's platform components are modular and give the developers the ability to connect to carriers, store data in the cloud, and write code.

The advantage of working with a platform like Hologram is that you can customize exactly what you need for your software development process. You can even set up alerts that track the following:

- When a device hasn't connected in a while
- The location of a device, based on cell tower
- When there's an anomaly or behavior change
- Analytics on connections, disconnections, and disruptions



- Information on data being sent and the types of data being sent

The key is to choose a development environment that gives you enough context to make your best decisions. How can you build your product more efficiently? What are the usage trends that should influence the tradeoffs you're making in your everyday decisions? Ultimately, you'll want to choose a platform that helps you get to market sooner and flexible enough to not hamper growth.

7. IS YOUR PLATFORM OPEN ENOUGH TO SUPPORT YOUR PRODUCT'S EVOLUTION?

At the early stages, many developers choose a platform for one reason: it's extremely hard to even get connected. Established companies and independent developers, alike, will often experience a resource drain from detecting and recovering from errors. And when you add new features and variables to your product, even more complexities can arise. Working with a platform like Hologram, you can instantly bypass these challenges.

Over the long term, however, the last thing you want is for this same platform to make your life harder. Over time, you may want to test new hardware. Or, you might want to expand your product into new geographies. If choosing an off-the-shelf solution for product development, make sure it's flexible enough to evolve with your needs, down the road (even if you don't know what needs might arise yet).



PART III: TRY IT YOURSELF

Looking for additional resources or hands-on tutorials to try? Check out this list:

- [Cellular Connectivity for the Internet of Things: Why does it matter?](#)
- [Hologram SIM with Arduino + GPRS Shield Tutorial](#)
- [Hologram SIM with Raspberry Pi Tutorial](#)
- [Hologram + AT&T M2X Tutorial](#)
- [Real-time Asset Tracking with Hologram Dash Tutorial](#)

If you want advice on your own strategy, get in touch with the Hologram team. We're a team of passionate developers who understand exactly what you're going through (that's why we built a solution for it). Ping us with your questions: success@hologram.io

