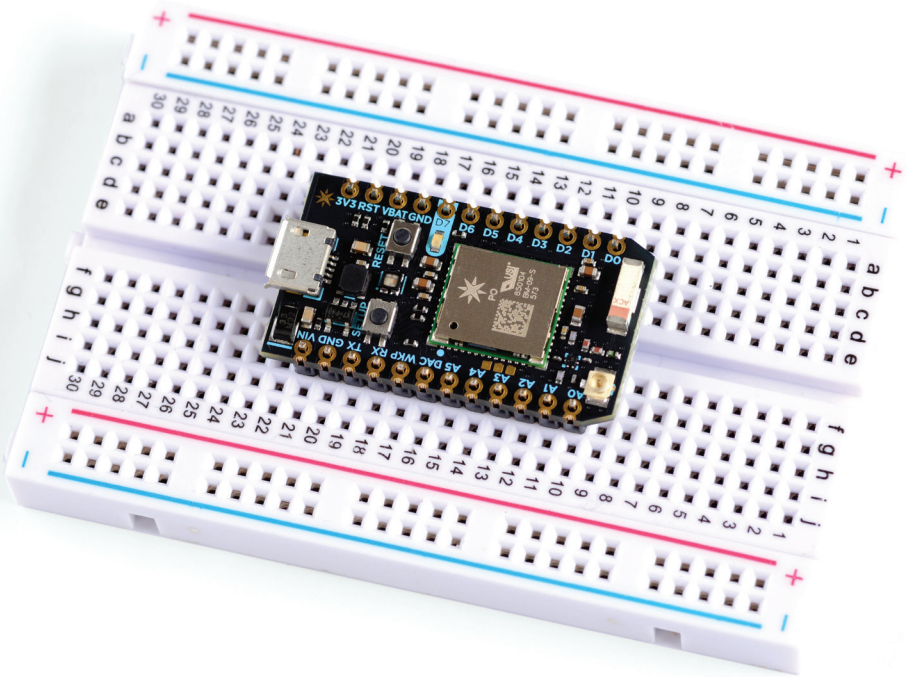
Make:
Getting Started with the Photon



Making Things with the Affordable, Compact, Hackable WiFi Module

Simon Monk

Foreword by Zach Supalla

Getting Started with the Photon

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Make: Getting Started with the Photon

by Simon Monk

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Foreword

According to *MIT Technology Review*, 2013 was the year of the Internet of Things. The following year, Cisco said 2014 was the year of the Internet of Things. This year, CNBC says that 2015 is the year of the Internet of Things. It is likely that every year for the next decade will be the "year of the Internet of Things." But what does that mean, exactly?

The Internet of Things (IoT) is a broad concept that suggests that as the cost of connectivity comes down, more and more objects around us will be Internet-connected. We're used to thinking about the Internet in terms of devices with screens: your personal computer, for instance, and your smartphone. The Internet of Things covers devices that you wouldn't typically think about being connected to the Internet, and includes categories like wearables (Fitbit, smart watches), smart home (connected lights, appliances, and toys), the industrial Internet (feedback systems on wind turbines), smart cities (connected parking meters and traffic lights), smart farms (connected irrigation systems), and more. It's a category that is difficult to define because of its breadth, but the common thread is that things that weren't connected before are becoming connected now.

I believe that the Internet of Things is the third wave of personal computing (the first being the PC, and the second being smartphones). And, unlike the tech press, I don't think we've reached the "year of the Internet of Things" quite yet. I believe we're still in the prototyping days, where even most IoT products coming to market are just the first experiments that will give way to a large, vibrant ecosystem in a few years' time. This is like the early 90s for the Internet, or the early 2000s for smartphones.

And, like PCs and smartphones, the rapid growth that we're seeing now—and that we'll continue to see for the next decade—will present massive opportunities for the people who jump in early.

Industries will change, jobs will be created, and fortunes will be made and lost.

This book is about a tool: the Photon. The Photon is a simple development kit, but it represents a starting point that can take you much further. Your journey may start with the Photon and end with a connected garage-door opener for your house. Or it may end with a connected garage-door opener that you bring to market and sell to hundreds of thousands of people around the world.

For you, dear reader, the "year of the Internet of Things" will be the year that you join in. Every great company starts as an idea, and every great product starts as a prototype. What will you build first?

—Zach Supalla, Founder and
CEO of Particle, April 2015

Preface

What's in a Name?

This book has been written at a time when the Spark organization was rebranding itself as Particle. As a result of this, you will find that some of the screenshots have the old company name, as they were taken before the new web interface became available. You will also find that the code for this book uses class names and third-party code libraries that still show the Spark name. These are set to work in the short term, but when they eventually become deprecated, watch for information on these changes at the Particle website.

Conventions Used in This Book

The following typographical conventions are used in this book:

Italic
: Indicates new terms, URLs, email addresses, filenames, and file extensions.

`Constant width`
: Used for program listings, as well as within paragraphs to refer to program elements such as variable or function names, databases, data types, environment variables, statements, and keywords.

`Constant width bold`
: Shows commands or other text that should be typed literally by the user.

Constant width italic
: Shows text that should be replaced with user-supplied values or by values determined by context.

This element signifies a general note, tip, or suggestion.

This element indicates a warning or caution.

Using Code Examples

The code examples are all available as a code library directly from the Web IDE. They are also available for download at *https://github.com/simonmonk/photon_book*.

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We have a web page for this book, where we list errata, examples, and any additional information. You can access this page at *http://bit.ly/make_gs_photon*.

To comment or ask technical questions about this book, send email to *bookquestions@oreilly.com*.

1/The Photon

In this chapter, you will learn a little about the Internet of Things in general, as well as the Photon in particular. The Photon and its older brother, the Spark Core, are explored along with some background about where it has come from and where it sits in the pantheon of developer boards.

The Internet of Things

It used to be that the only way you could interact with the Internet was to use a web browser on your computer. A browser would allow the computer to send requests to a web server that would send back information to be displayed.

The browser would display this information using a computer monitor, and the user would type text on her keyboard and follow hyperlinks with the click of a mouse. As far as inputs and outputs were concerned, those were your options.

The Internet of Things (IoT) has changed all this. Now all sorts of sensors and appliances can be connected to the Internet. The IoT encompasses a wide range of systems:

- Home automation systems that control lighting, heating, and doors by using web browser or network-enabled smartphone applications. These may be used to control systems over the local area network, or over the Internet using WiFi or a cellular network.
- Arrays of sensors, such as the Safecast open radiation-monitoring system that was developed following the Fukushima nuclear disaster.

Products and maker projects that will become part of the IoT are springing up all over the place. These include successful projects like the Nest smart thermostat as well as many IoT products that use the accelerometer, location services, and

communication features of smartphones to capture information about people's health and activity levels.

Since so many people are creating IoT projects, it makes perfect sense to provide a simple modular framework for both hardware and software that provides an easy-to-use IoT technology kit. This is exactly where the Particle team comes in. They provide IoT technology in a box—a very small and low-cost box. What's more, the technology is easy to use, open source, and based on the very popular Arduino software framework.

Sparks in the Clouds

The hardware component of this IoT framework is the Photon. The Photon is the next generation of Particle's IoT platform that began with the Spark Core. The Photon is backward compatible with the Spark Core, and so most of what is detailed in this book about the Photon will also work with the older Core.

Although other technologies exist to help you build IoT devices, they often neglect the all-important software framework that allows the device to communicate with other devices and browsers over the Internet. The Particle approach, by contrast, integrates the hardware and software seamlessly.

Figure 1-1 shows how a typical IoT device built using a Photon or Core might interact with the Internet.

An IoT device using a Photon/Core might provide remote unlocking of a door. In such a case, a user would access a web page on a browser that has an Unlock button. This page will have been served from a web server somewhere on the Internet. When the user clicks the Unlock button in the browser, the browser sends a message to the cloud service that forwards the message along to the Photon running inside the connected device. The Photon/Core controlling the electromechanical door latch then knows it should unlock the door.

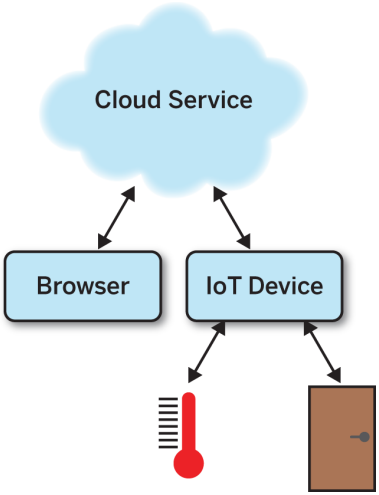

Figure 1-1. *Internet of Things communication*

If, on the other hand, the IoT device were acting as a sensor—let's say, for temperature—then the Photon/Core could send temperature readings to a cloud service. Those readings could be stored temporarily until the user's browser has a chance to pick them up and display the latest reading on the browser window.

To use Particle's cloud service, you first register online with Particle and then identify each of your Photons/Cores, which will have registered themselves with the cloud service as being yours. All the Photon needs to do to register itself is to have access to your WiFi network. This process not only allows you to ensure that you know which Photon or Core you are interacting with but also allows you to program your Photons and Cores over the air from the comfort of your web browser.

Other IoT Platforms

Before plunging into the delightfully warm and pleasant waters of the Photon pool, it's worth exploring some of the Photon's competitors. This will also reveal something of the motivations behind the design of the Photon.

The Photon is of course not the only IoT device around. In fact, the single most used platform for IoT development is the Arduino microcontroller board, although the Raspberry Pi single-board computer is also used extensively in IoT projects.

Arduino

Microcontrollers are essentially low-powered computers on a chip. They have input/output (I/O) pins to which you can attach electronics so that the microcontroller can, well, *control* things. The Arduino is a simple-to-use and low-cost, ready-made board that allows you to make use of a microcontroller in your projects.

The Arduino has become the platform of choice for makers and hackers looking for a microcontroller to use, and the most common Arduino model is the Arduino Uno.

The popularity of Arduino is due to many factors:

- Low cost (around $25 for an Arduino Uno)
- Open source hardware design—there are no secrets to its design and built-in software
- Easy-to-use integrated development environment with which to program the Arduino
- Plug-in shields that plug onto the top of the Arduino and add features such as displays and motor drivers

There is, of course, one factor that makes an Arduino Uno by itself useless as an IoT device: it has no network connection, either wired or wireless. You either need to use one of the specialized Arduino models that include an Ethernet network port (such as the Arduino Ethernet or Yun) or add a WiFi or Ethernet shield to the Arduino that then gives it the network connection it needs to communicate over the Internet. This adds considerably to the size and cost of your project.

Figure 1-2 shows an Arduino Uno with a WiFi shield attached. The total cost of this combination is over $100.

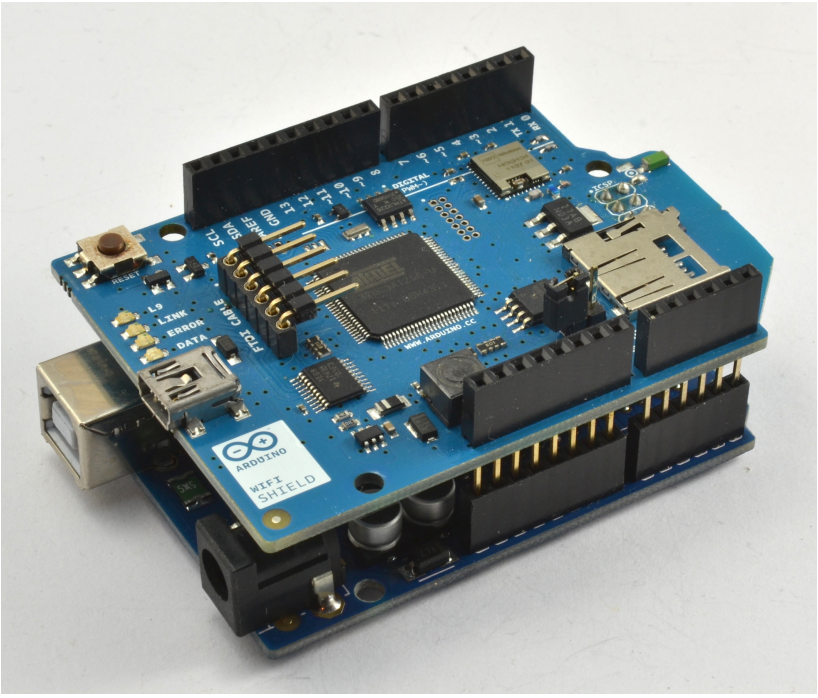

Figure 1-2. *An Arduino Uno with WiFi shield*

Another possibility is to use the Arduino Yun. This device is the same size as an Arduino Uno but has a built-in WiFi module. On the face of it, this provides similar hardware capabilities to the Photon, but at a much higher price of around $75.

All of these Arduino-based solutions suffer from one major disadvantage as an IoT platform, and that is software. They provide the base capabilities to communicate with the Internet but do not offer any software framework to make it easy to create IoT projects without a lot of tricky network programming.

Later, you will see how the Photon borrows many of the concepts of Arduino, including its programming language, but then provides a software framework with which to build your IoT projects, all at a much lower cost than Arduino can compete with.

Raspberry Pi and BeagleBone

The Raspberry Pi and BeagleBone Black (Figure 1-3) are both single-board computers, about the size of a credit card, that run the Linux operating system. They have USB ports and HDMI video output, so you can set them up with a keyboard, mouse, and monitor and use them just like a regular computer.

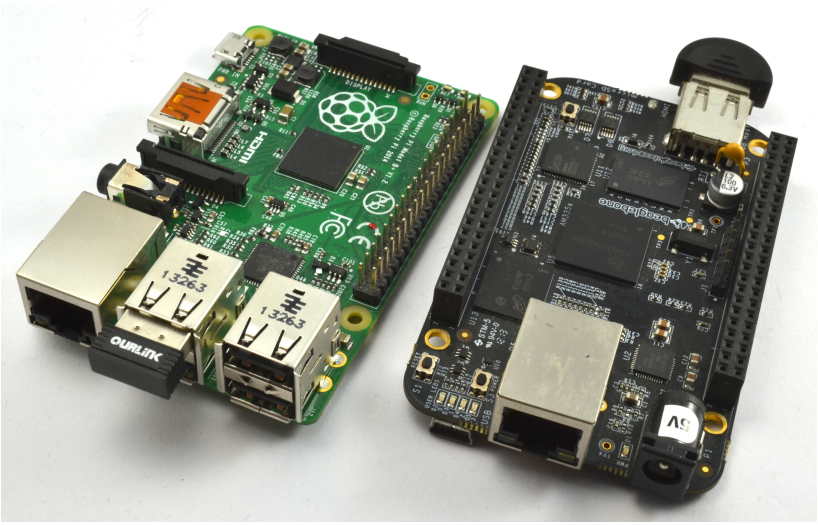

Figure 1-3. *A Raspberry Pi and BeagleBone Black*

The Raspberry Pi is shown on the left of Figure 1-3 and the BeagleBone Black on the right. Both boards can use low-cost USB WiFi adaptors and have I/O pins to control electronics and interface with sensors, making them quite suitable for IoT projects.

Although both boards are low in cost, the Raspberry Pi from $35 and the BeagleBone from $55, they are quite large (compared to a Photon) and generally contain a lot more than you need for a simple IoT project.

Intel Edison

Intel has developed a small Linux-based board called the Edison. The Edison is designed to be embedded into IoT projects and is perhaps the most direct competition to the Photon.

The Edison is small but is considerably more expensive than the Photon. It has a delicate 70-contact connector that requires a separate breakout board if you want to start attaching external electronics to it. There are several such prototyping boards available, the most popular of which is an Arduino-compatible board.

Although receiving a lot of interest in the Maker community, this is probably a board that will lend itself best to high-end or professional use, not least because the device is a lot harder to get started with.

A Tour of the Photon

Figure 1-4 shows a Photon with some of its main features labelled.

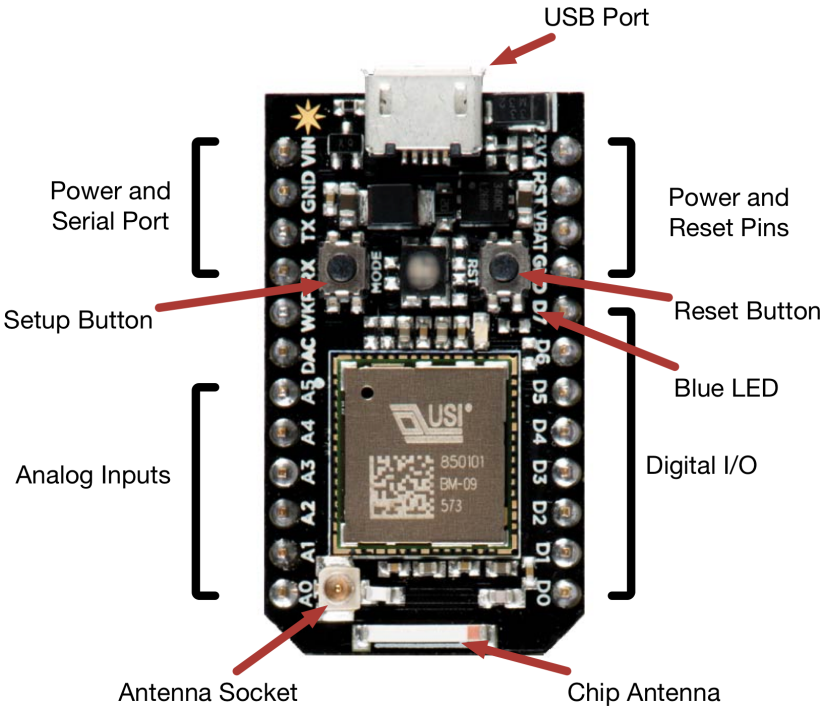

Figure 1-4. *The Photon*