RF design is easy – Just let someone else do it

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If you’re not designing Wi-Fi (802.11) into your systems already, you’ll be doing so very soon. Wi-Fi is rapidly establishing itself as the standard wireless connection for industrial devices. It’s a big change, but it needn’t be intimidating. There are plenty of vendors out there who have all of the necessary expertise. You don’t have to reinvent the wheel; you only need to put that vendor expertise to work in your own applications. This article will tell you how to go about it.

The tools that you need already exist

The advent of newer communications protocols like USB and Wi-Fi haven’t eliminated older data communications systems. The huge installed base of serial devices, for example, not only remains in place, it’s continuing to grow. So Wi-Fi vendors have responded by developing solutions that are compatible with a wide variety of equipment. The easiest and most versatile solutions appear as self-contained Wi-Fi modules (Figure 1) that can network-enable legacy devices or be embedded in new equipment without compromising final functionality.

Figure 1. Embeddable Wi-Fi modules, such as B&B Electronics' Airborne APMG-Q551, enable OEMs to Wi-Fi enable products to serve as M2M wireless communications hubs, or tie into existing wireless networks.

The Wi-Fi module that you choose should answer each of the vital network/RF integration questions:

1. Is there an integrated network stack?

2. Does it include integrated device drivers?
3. Does it provide pre-tested security implementations for the latest wireless security?
4. Does it contain a complete RF subsystem?
5. Has it completed FCC and ETSI regulatory certification?

If these issues have already been addressed by the vendor, you won't have to do the development work yourself.

Your host system

A Wi-Fi module will assume that you are Wi-Fi-enabling something that is harvesting or creating data. Your job is to get the data to the Wi-Fi module. In most cases, the module will be quite content to receive raw data; and there will be no need to format it. But there's an exception to every rule, and in this case it's the Serial Peripheral Interface (SPI) interface. If you're using SPI you will need to implement the appropriate protocol. The Wi-Fi module will do the rest.

You'll need a communications port, of course. In many cases this will be either a Universal Asynchronous Receiver/Transmitter (UART) or SPI interface. In newer devices and new designs it may be an Ethernet port. All of these interfaces are supported by one or more of the available Wi-Fi modules. Make sure that your module supports the necessary throughput and data rates before making a choice. Make sure that your vendor is talking about actual data throughput, rather than theoretical port bandwidth -- it makes a difference.

UART, SPI and Ethernet are well-established digital interfaces. Your module will not require exotic RF design work. You only need to include a simple PCB trace addition.

Power concerns

Most Wi-Fi modules will work off a single 3.3-VDC rail, making integration easy. Typical power supply requirements are less than 850 mA, and most modules function well below the 500-mA level. The power supply needs to be "clean," meaning that it is protected from over voltage and under voltage conditions. Wi-Fi modules will have power-on reset (POR) circuits, and a noisy supply can cause the modules to reset at inopportune times. Ripple voltage on the supply can delay a module's startup time or cause it to reset.

Check the in-rush current requirements on the subsystems, and account for them in the power supply design and in the selection of voltage regulators. In most cases, a Low-ESR Tantalum capacitor placed near the module will do the job.

The footprint

Most Wi-Fi modules occupy less than two square inches of circuit board space, and some need significantly less than that (Figure 2). You will use flying lead antenna connectors, so there will be no need for exotic PCB technology or advanced stack-up. Simply follow the guidelines provided by your Wi-Fi vendor. Modules may need a

ground plane, and they will most likely require that there be no components under the module. You will be able to choose between surface-mount-technology (SMT) and mechanical mounting options.

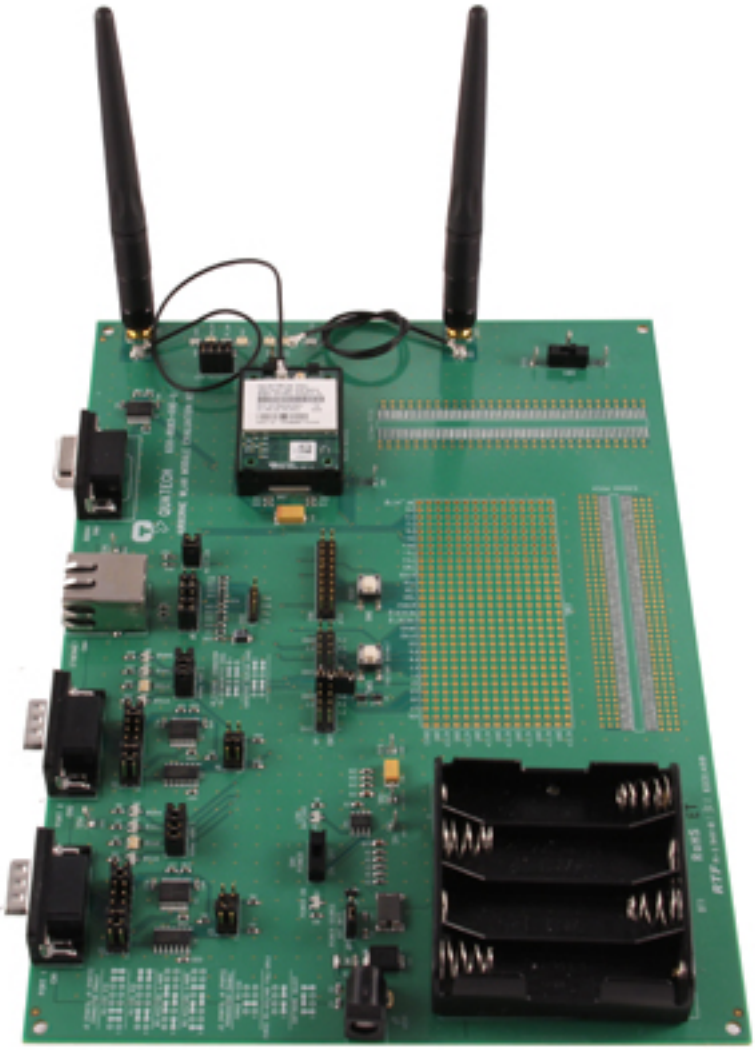

Figure 2. The Airborne Wi-Fi module from B&B Electronics occupies very little real estate (40 mm x 30 mm, or 1.57 inches x 1.18 inches) shown on the Airborne module evaluation kit.

Bear in mind that a mechanical mounting solution (connector-based) allows for in-field maintenance and upgrading of the actual Wi-Fi module, since it can be removed at any time. That may prove to be a great convenience at some point in the future.

Antennas

Antenna choices can be complex. RF signals are influenced by everything from distance and broadcast power to multipath propagation and competing devices that use the same frequency. So ask yourself the following questions:

1. Do you want the antenna on the outside of your enclosure?

2. Will you need extended range? (Anything over 100 meters would be considered extended range.)
3. Do you need more than one antenna?
4. How much do you want to spend?

A 2-dBi to 3-dBi omni-directional rubber duck antenna with an RP-SMA connector is always a great place to start. But don't hesitate to discuss antennas with your Wi-Fi vendor. That's why he's there. Why do all the homework yourself?

Use flying leads to connect the antenna to your Wi-Fi module. This will eliminate the need to create matched impedance trace routes on your board, and it will give you the widest flexibility in your antenna and connector choices.

Stay away from chip antennas unless space is so tight that there is no other choice. Their gain and radiation patterns will generally be utterly unsatisfactory. And worse, a chip antenna forces you to do your own RF work on your PCB. There are better ways to hide an antenna, like board or chassis mounting.

You won't need to choose your flying lead antennas until late into the development process.

FCC regulatory testing

The FCC requires that all intentional RF transmitters, even those in the unlicensed bands used by Wi-Fi, be tested to prove that they don't break the FCC's rules. This entails performing a wide array of specified tests in a qualified lab, and adhering to a very specific set of guidelines. That takes time, and it isn't cheap.

Using an FCC-approved module relieves you of that task. The work has already been done. Your Wi-Fi vendor should provide all the necessary details including all labeling, documentation and packaging notification requirements.

Note that antenna choice also affects FCC certification. If your Wi-Fi vendor offers a selection of antennas that is too limited, forcing you to choose something that isn't on the list, you'll also have to re-start the certification process from square one.

Your vendor

Your vendor, of course, is an important part of any wireless solution. You're not just looking for appropriate equipment; you're seeking out a partner who can provide you with priceless intellectual capital. As your 802.11 firmware and hardware development partner, your vendor will already possess the experience and resources that you'll need for seamless integration of 802.11 capabilities.

The self-contained Wi-Fi module is an elegant solution to almost any wireless communications question. If you invested your own time and development money in Wi-Fi, it's quite likely that you would eventually come up with the same answer. So why bother? The Wi-Fi specialists have already done the hard part -- all you have to do is reap the rewards.

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