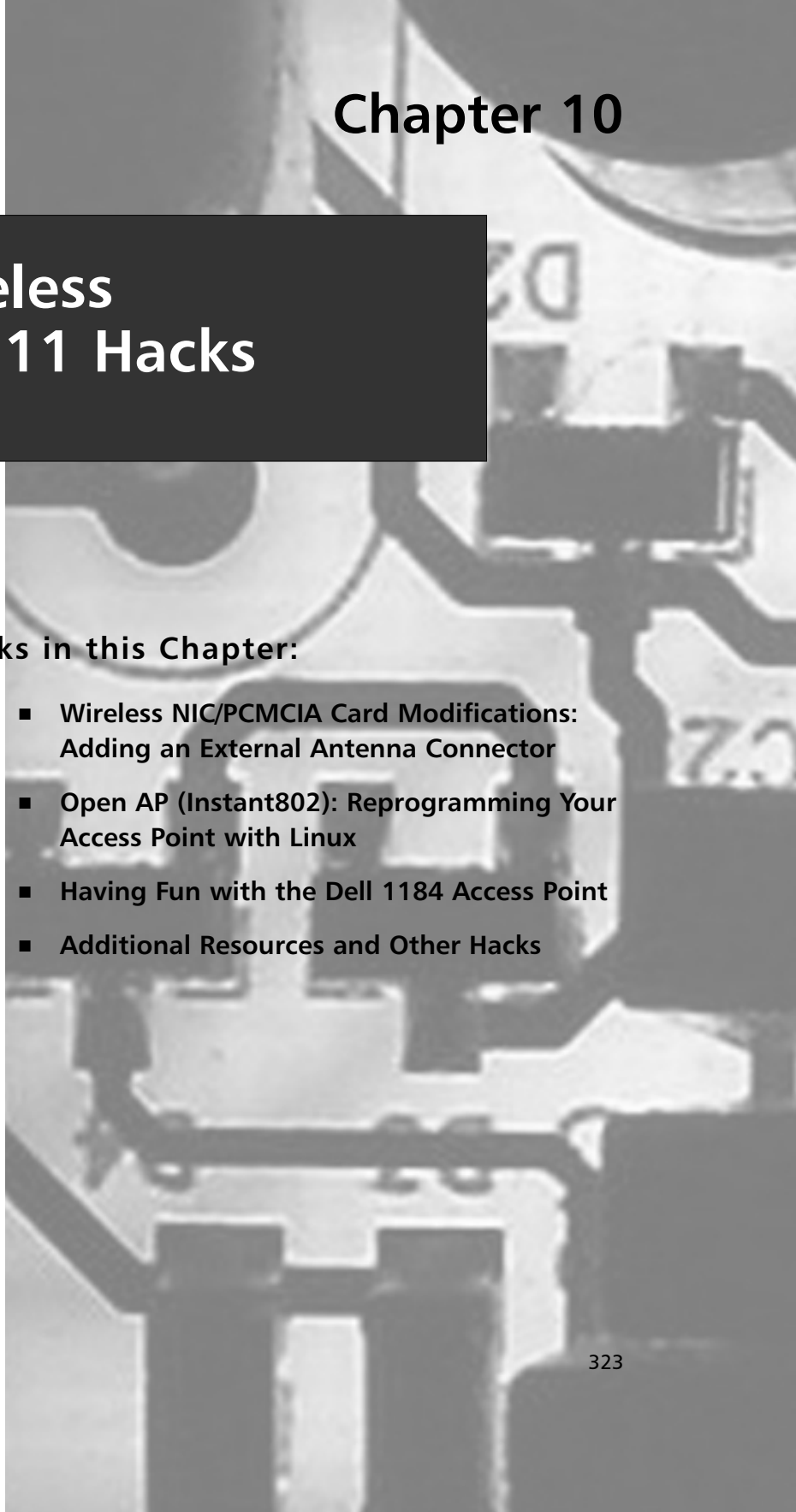


Chapter 10

Wireless 802.11 Hacks

Hacks in this Chapter:

- **Wireless NIC/PCMCIA Card Modifications: Adding an External Antenna Connector**
- **Open AP (Instant802): Reprogramming Your Access Point with Linux**
- **Having Fun with the Dell 1184 Access Point**
- **Additional Resources and Other Hacks**

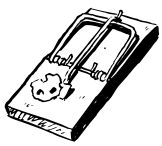
Introduction

Hacking wireless hardware is an endeavor steeped in a rich history of experimentation and hobbyist culture. The wireless hardware hacker of today pursues his or her craft with a passion not seen since the amateur radio (also known as "ham radio" or "hams") operators of the last generation. Many wireless enthusiasts are, in fact, connected with the ham community. Once solely the domain of a small group of Radio Frequency (RF) engineers, wireless gear has never been so inexpensive and accessible as it is today. With rapidly declining hardware costs, anybody can learn and experiment with 802.11 equipment with only a small investment.

In this chapter, we review several wireless hacks, tricks, and hardware modifications, including:

- **D-Link DWL650** Card modification for adding an external antenna.
- **OpenAP (Instant802)** Reprogramming your Access Point (AP) to run an open-source version of Linux.
- **Dell 1184 Access Point** Exploring the embedded Linux operating system.

Warning: Personal Injury



Please use extreme care when performing any kind of experimentation with RF devices. For more information about the dangers of RF exposure, visit the following URLs:

- www.wlana.org/learn/health.htm
- www.arrl.org/tis/info/rfexpose.html

Need to Know...

802.11 is a protocol created by the Institute of Electrical and Electronics Engineers (IEEE). This protocol defines a method for transmitting and receiving data communications wirelessly. The original specification was ratified in 1997. This protocol supported 3 physical methods: Frequency Hopping Spread Spectrum (FHSS) and Direct Sequence Spread Spectrum (DSSS) in the 2.4GHz frequency range, as well as Infrared (IR). (Note that IR was never successfully deployed as a commercial option). Speeds of 1Mbps and 2Mbps were supported. In 1999, the IEEE approved 2 new higher speed additions to the protocol: 802.11a and 802.11b. 802.11a defined (up to) 54Mbps Orthogonal Frequency Division Multiplexing (OFDM) at 5GHz and 802.11b defined 5.5Mbps and 11Mbps using DSSS in the 2.4GHz spectrum. In 2003, 802.11g was established to provide (up to) 54Mbps OFDM in the 2.4GHz spectrum. For more information about the 802.11 protocol, please visit http://grouper.ieee.org/groups/802/11/.

Wireless NIC/PCMCIA Card Modifications: Adding an External Antenna Connector

Wireless Network Interface Cards (NICs) typically have a PC Card (also referred to as PCMCIA) form-factor for use in laptops. These cards come in two basic varieties:

- Those with external antenna adapters
- Those without external antenna adapters

For example, Cisco AIR-PCM35*x* cards have integrated diversity dipole antennas, while the Cisco AIR-LMC35*x* cards have dual MMCX connectors (no antenna is supplied with the device). Figure 10.1 shows a Cisco card with an integrated antenna, while Figure 10.2 shows a Cisco card with dual MMCX connectors.

Figure 10.1 A Cisco Card with an Integrated Antenna

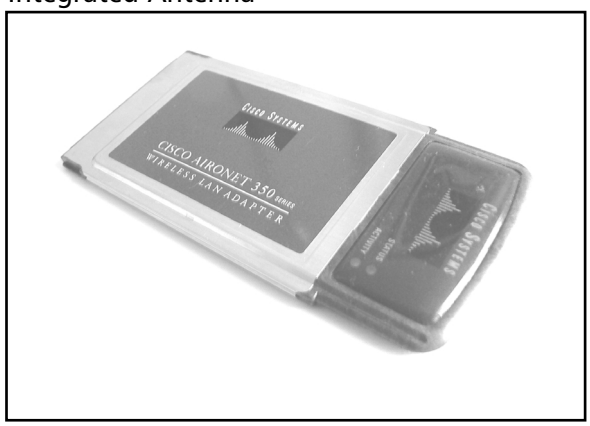


Figure 10.2 A Cisco Card with Dual MMCX Connectors

For typical indoor applications, an integrated antenna should work just fine. However, these antennas are often low on gain (2.2dBi) and lack the range needed for long distance applications. Having an external antenna connector is desirable because it gives you flexibility. This is particularly important for hobbyist applications (such as connecting Pringles can antennas). When it comes to setting up networks and experimenting with wireless LANs, having flexibility is a key benefit.

Historically speaking, cards with external antenna adapters were sold at a premium compared to cards with integrated antennas. This meant that hobbyists had to either cough up additional cash for a more expensive card or hack their own solution using off-the-shelf parts. Can you guess which path we're going to take?

Preparing for the Hack

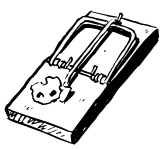
In this hack, we will be modifying a D-Link DWL-650. Note that a number of variations exist for the D-Link 650 card so ensure you obtain a standard 16-bit PCMCIA PC Card by comparing your card to the one in Figure 10.3. This is important because D-Link sold 32-bit CardBus NICs for a short time and called them D-Link 650! So really, the only way to be absolutely certain that the card you have on hand is the correct one for this hack is to look at the card…

The items you will need for this hack are:

Figure 10.3 An Unmodified D-Link DWL-650 Card

- **D-Link DWL-650 Wireless NIC** An inexpensive PCMCIA card that lacks an external antenna.
- **BNC cable** A small length of Thinnet cable connected to a BNC connector.
- **Soldering iron** To solder the connector wires to the leads on the Printed Circuit Board (PCB).
- **X-ACTO knife** To create a hole in the plastic casing for the wiring.
- **Tweezers or a toothpick** To open the casing and gain access to the PCB.

WARNING: HARDWARE HARM



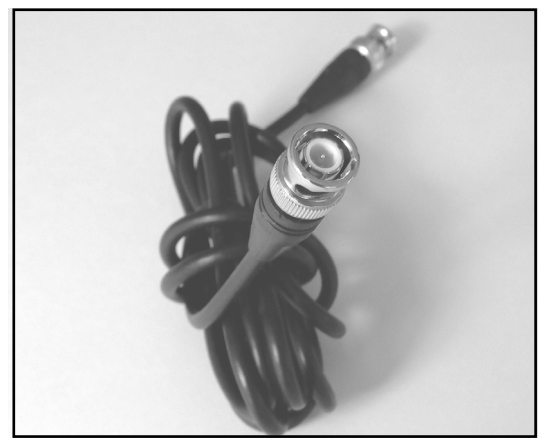
This hardware modification will void your warranty and potentially violate FCC regulations. This hack should be used for test purposes only and not in a production environment.

You can choose from a variety of cable connectors for attaching your card to an external antenna. Some vendors have proprietary connectors, such as the Cisco MMCX connector. Other connectors are industry standard, such as BNC and N. In our hack, we will use a BNC connector. Don't worry if your antenna uses something other than BNC, because adapters to convert BNC to pretty much any kind of connector are easily available and inexpensive. For more information about RF Connectors, the following Web sites are useful:

- www.rfconnector.com
- www.therfc.com

Furthermore, it's fairly uncomplicated to find a BNC plug with a short length of cable, since you can simply take any old BNC Thinnet cable and snip off the connector (saving a few inches of cable). Figure 10.4 shows an unmodified Thinnet cable.

Figure 10.4 An Unmodified Thinnet Cable



Performing the Hack

Hacking the DWL-650 to add external antenna functionality is performed in three basic steps:

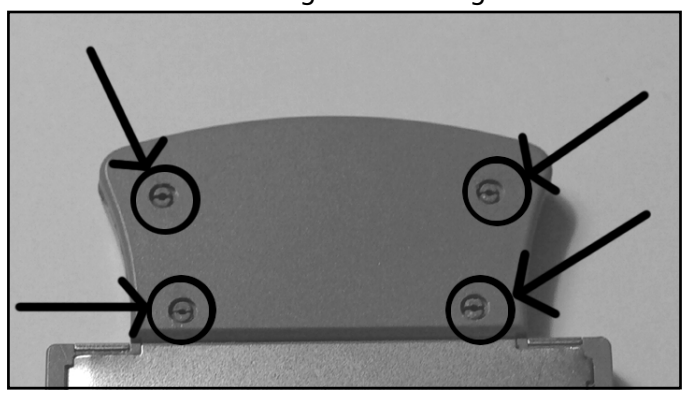
1. Removing the cover.
2. Desoldering a capacitor and soldering it to an adjacent spot on the PCB.
3. Soldering the BNC connector's leads to the PCB.

Removing the Cover

The first step is to open the top cover of the D-Link DWL-650 card and expose the internal antennas. To do this, turn the card upside down (with the MAC address label facing you) and get your tweezers handy. On the short gray tab (protruding from the silver PCMCIA card), you will see four small clasps that hold the plastic cover in place as denoted in Figure 10.5. Each clasp contains two

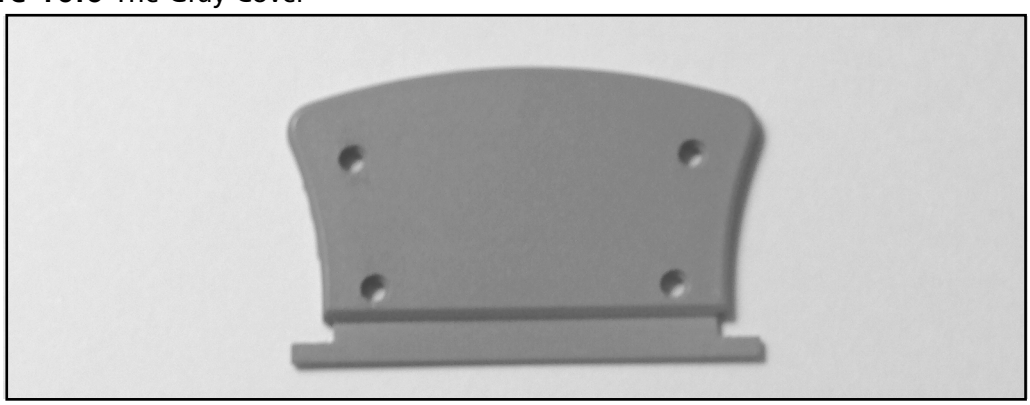
semicircular plastic posts. Use your tweezers to squeeze the semicircular plastic posts together. You might also use a small flat-head screwdriver to wedge the gray plastic pieces apart as you advance to each plastic post. If you don't have tweezers, a toothpick can be wedged into the outer circle and used to leverage the semicircle posts toward each other.

Figure 10.5 The Semicircular Posts Holding the Card Together



Once the posts are sufficiently squeezed together, you can then slowly and gently pry the gray cover off. Note that the cover is held in place by two gray tabs tucked neatly into the silver PCMCIA card edges. You may need to use a small flat-head screwdriver to carefully pry the silver chassis open just wide enough to slide out one end of the gray tabs. Be particularly careful here, since it's nearly impossible to fix the edges of the silver chassis once they are bent by mistake. Figure 10.6 shows the cover once it's been removed.

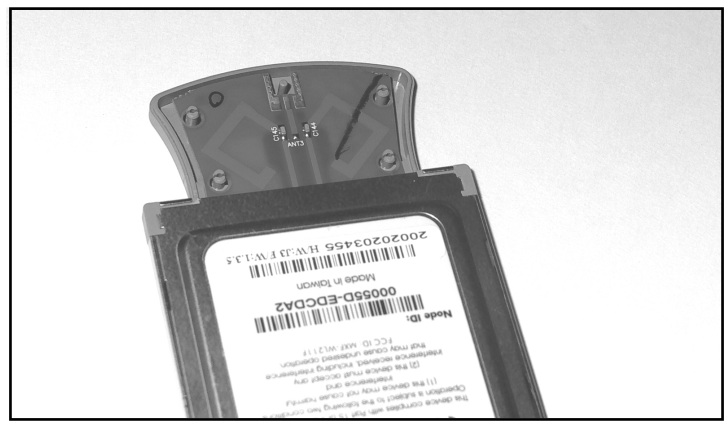
Figure 10.6 The Gray Cover



After exposing the antenna compartment (Figure 10.7), you should see some silk-screened labels next to two surface-mount capacitors (C144 and C145). These capacitors are connected to the card's dual internal antennas. You will also notice a silk-screened label for ANT3. That's right—it seems as if

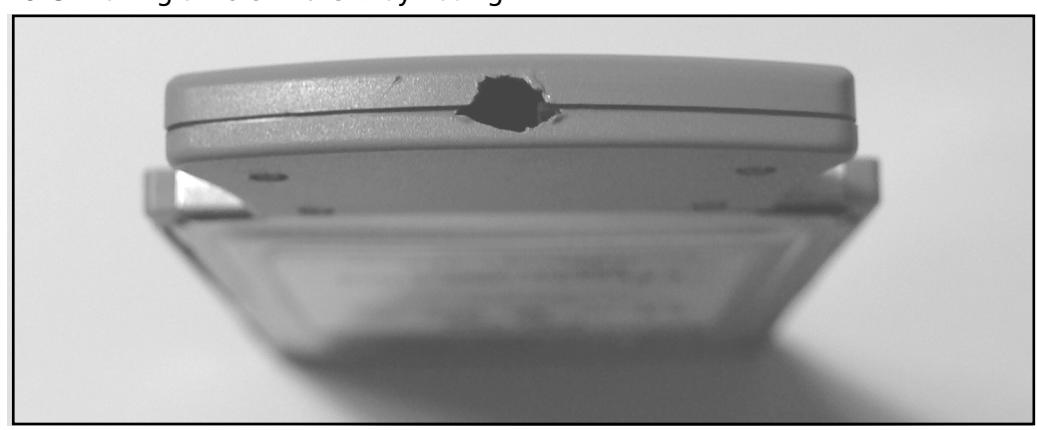
the D-Link card was actually designed to have a third, external antenna. However, it was never implemented and this connector lays dormant—until now!

Figure 10.7 Inside the Antenna Compartment



Moving back to your gray casing and the gray cover you just removed, you will need to bore out a small hole to make room for the BNC cable to pass through. Take your X-ACTO knife and carefully scrape out a small hole in both the top and bottom portions of the gray casing as shown in Figure 10.8. Note that this task is best performed by first removing the gray cover (as described in the previous step) and then separately boring out a semicircle in each half of the gray casing.

Figure 10.8 Making a Hole in the Gray Casing

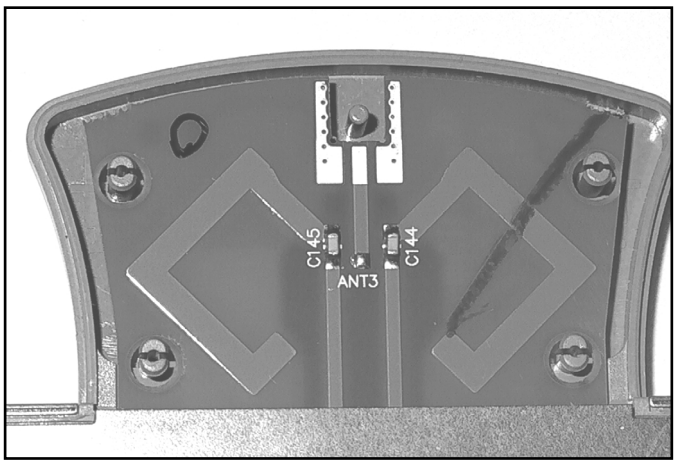


Moving the Capacitor

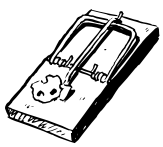
The second step of the hack is to desolder one of the surface-mount capacitors, either C144 or C145. It doesn't really matter which one you choose to remove. Once the capacitor has been removed, you need to resolder it to the lead labeled ANT3. You can do this by rotating the capacitor 90 degrees. If

you chose C145, you will need to rotate the capacitor 90 degrees clockwise. If you chose C144, you will need to rotate the capacitor 90 degrees counterclockwise. In effect, all you are doing is disconnecting one of the surface-mount antennas (the thin diamond-looking leads on the PCB) and electrically connecting it to the ANT3 leads. Figure 10.9 shows a close-up of the antenna compartment before the hack.

Figure 10.9 Antenna Compartment: Close-Up Before the Hack



WARNING: HARDWARE HARM



Be very careful when applying heat to the circuit board with your soldering iron. Too much heat may damage the capacitors or the board and may cause the pads and traces to lift up, causing irreparable damage. In practice, it helps to use the tweezers to hold the capacitor in place in the new location while you carefully apply the solder. Sometimes it helps to have a second person involved to lend a hand with the tricky procedure.

Attaching the New Connector

The final step in the D-Link hack is to connect your BNC adapter to the PCB. Prepare your connector by removing the plastic covering and shielding to expose the center conductor and the surrounding copper strands. Figure 10.10 shows a prepared BNC connector.

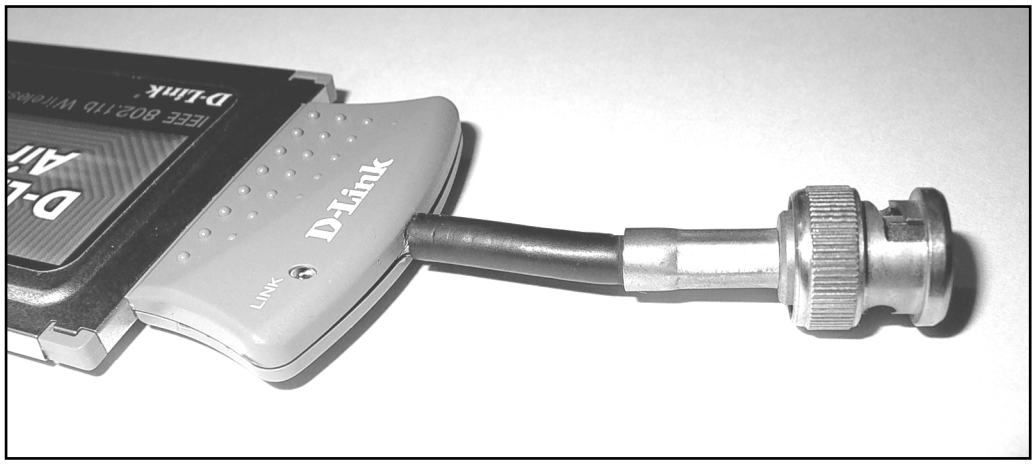
Figure 10.10 A Prepared BNC Connector Ready for the Hack

The BNC connector should be soldered to the PCB at the gold-colored leads near the top of the antenna compartment. The center conductor of the BNC connector needs to be soldered to the center lead of ANT3, while the outer strands should be soldered to the adjacent pads on the PCB.

Once the soldering is complete, you can reattach the gray plastic cover by sliding in one of the little tabs and wedging the rest of the cover back in place. You should be able to snap it back together with ease. If there is too much resistance, go back and get your X-ACTO knife to widen the hole for your BNC cable a little more. Your completed hack should resemble the image in Figure 10.11.

Remember to be very gentle with your new external BNC cable, because the force of inserting and removing antennas may cause the solder connections to come loose from the internal PCB. Many hobbyists have resorted to applying electrical tape or other reinforcing methods to keep the cable in place and protect the connections from getting damaged. One popular method is to use a hot-glue gun to apply glue to the cable and the surrounding gray casing.

Figure 10.11 The Finished Hack: D-Link DWL-650 with External Antenna Connector



Under the Hood: How the Hack Works

This D-Link hack is a simple example of how you can gain additional functionality from a product that has been intentionally unused by its vendor. It is clear from the PCB design that this NIC was originally intended to support an external antenna (as seen by the ANT-3 pads on the PCB), but it was never implemented. Moving the capacitor simply disables part of the internal antenna circuitry and makes the signal available to an external connection. Note that your card will still work even if you don't attach an external antenna, because diversity mode will allow the still-connected second antenna (on the PCB) to transmit and receive a useable signal.

Diversity mode works by monitoring each antenna and automatically switching to the antenna with the stronger signal. This mode helps reduce errors caused by multipath problems. Multipath errors occur when signals bounce off objects in the transmission path and the same signal arrives at the receiver two times.

OpenAP (Instant802): Reprogramming Your Access Point with Linux

Wireless Internet access using standard off-the-shelf APs is lots of fun. However, traditional consumer-grade APs can be quite feature limited. Sure, it's possible to take an old PC, run Linux, and build your own AP, but the hardware form factors for old PCs tend to be large, clunky, and noisy. With a small form factor, you can install your AP in hard-to-reach places, weatherproof boxes, or tucked away in a corner. Wouldn't it be cool if we could take an off-the-shelf AP and reprogram it with a Linux operating system? That's what you can do with OpenAP, a free software package from Instant802 (http://opensource.instant802.com).