

# The **Wireless Networking Starter Kit**



*The practical guide to Wi-Fi networks for Windows and Macintosh*

## **Addendum A: 802.11g's "Extreme" Emergence**

Please enjoy this free addendum to *The Wireless Networking Starter Kit* and feel free to distribute it in this form. For more information about the book or to order your own copy at a discount, visit <http://wireless-starter-kit.com/>. You can also find updates to the book, a lively discussion board for wireless networking questions, a dedicated Web log for Apple's AirPort technology, and our recommendations for the best wireless hardware on the market.

Copyright © 2003 by Adam Engst and Glenn Fleishman



# *802.11g's "Extreme" Emergence*

*Updated July 2003*

In 2002, Wi-Fi—mostly in the form of IEEE 802.11b equipment—ruled the land. The faster, 54 megabit-per-second (Mbps) 802.11a devices that shipped starting in late 2001 were compellingly faster, but because they used a different frequency than 802.11b and cost more, only a small number of early adopters and testers bought in.

More promisingly, 802.11g winked at us from the horizon. That specification operates at 54 Mbps like 802.11a. But it uses the same radio frequencies as 802.11b, while supporting full backward compatibility with that older specification. Because of political and technical conflicts, the 802.11g committee at the IEEE engineering standards group took nearly three years to ratify the protocol, which was finally formally adopted on June 12, 2003.

Technology doesn't wait for engineering groups, though: against some industry experts' better judgment, several companies started to ship equipment as early as December 2002 using chips based on then-current draft versions of 802.11g to achieve its higher speeds.

These early versions from Apple, Belkin, Buffalo, D-Link, Linksys, and others provided the speed, but were flaky in handling mixed networks in which both 802.11b and 802.11g devices were in use, often backing speed down to 802.11b levels, thus eliminating 802.11g's advantages.

Fortunately, as drafts continued to circulate at the IEEE, manufacturers also continually upgraded firmware to fix these early problems. Shortly after the June ratification, most manufacturers released final 802.11g firmware updates that cemented the 802.11b/g improvements, and even included a speed boost.

In this addendum to *The Wireless Networking Starter Kit*, we discuss the 802.11g standard, some of the current issues about compatibility, and offer a practical look at Apple's line of equipment.

## Moving Forward and Backwards

The 802.11g specification uses a relatively new method of encoding bits onto radio waves in such a way as to squeeze up to 54 Mbps of raw data across a single channel. (For the technical among you, this method is called Orthogonal Frequency Division Multiplexing or OFDM, and is similar to how DSL puts bits onto copper wire.)

As is the case with most raw network throughputs, the net throughput of real data—the actual contents of files or transactions minus networking overhead and conflicts—is lower, closer to 20 Mbps. In contrast, 802.11b's 11 Mbps raw throughput generally translates to about 5 Mbps at best, and it often drops well below that as distance from the access point increases. 802.11g also has several intermediate steps for speed, so you don't just drop from 54 Mbps all the way down to 11 Mbps or slower.

The several major wireless chipmakers—Agere, Broadcom, Intersil, and Texas Instruments—all have plans to improve throughput even with existing equipment. Broadcom and Intersil both offer “packet bursting” technology that works by taking short 802.11g packets and wrapping them into one longer packet. This reduces the number of pauses which are required between packets. Broadcom predicts a 25 percent improvement with 802.11g alone and 75 percent with mixed b/g networks. Depending on the manufacturer, packet bursting may already be part of the firmware, and some of it may interoperate among chips made by different companies. (These changes are part of 802.11e, a group devoted to improving multimedia streaming and digital voice over wireless.)

802.11g attracted so much attention so quickly where 802.11a languished because it includes full backwards compatibility with 802.11b. This compatibility isn't optional for manufacturers, but is rather a mandatory part of the spec. How compatibility will continue to play out with real-world devices is still an open question. Manufacturers may have to continually re-engineer and release updates to improve that interaction.

One of 802.11g's big advantages over 802.11b is that it better handles the inevitable signal reflection. Radio signals bounce off different pieces of matter—floors, metal, even the air around you—at different angles and speeds. A receiver must reconcile all the different reflections of the same signal that arrive at slightly different times into a single set of data. 802.11g (like 802.11a) slices up the spectrum in a way that enables receivers to handle these reflections in a simpler but more effective way than 802.11b.

In July 2003, the Wi-Fi Alliance officially added 802.11g to its certification suite. The Wi-Fi Alliance tests equipment to make sure it works according to spec and is interoperable with all other certified equipment, and if so, the

## Is 802.11a Dead?

Apple chose not to support the 802.11a specification as part of AirPort Extreme, and no other major manufacturer has backed it as a replacement for either 802.11b or 802.11g. 802.11a operates in the 5 GHz band and its use of a different frequency means that it is not backwards compatible with 802.11b, which employs 2.4 GHz signals.

Because of this lack of compatibility with millions of 802.11b devices currently in use, Apple CEO Steve Jobs said at the Macworld trade show in January 2003 that 802.11a is doomed to failure. It's more appropriate to say that 802.11a is now relegated to niche status for particular purposes, such as dense installations in corporations, server room backup links, or high-speed point-to-point bridges.

Because 802.11a has 8 distinct indoor channels—which may rise to 11 or more due to additional international frequency allocation—more 802.11a devices can be used without interference in the same place. It offers real advantages for scenarios in which avoiding interference is important.

Likewise, the four channels reserved in the upper end of the 5 GHz band for 802.11a outdoor, point-to-point use can employ higher power levels, which may provide a better throughput than 802.11g in the same circumstances. (The 802.16a standard may replace 802.11a's point-to-point advantage in the same frequencies, however; it's designed only for long-haul, unlike 802.11a which is essentially short-range.)

Home entertainment companies appear to also have migrated to the uncrowded 802.11a standard for beaming high-definition digital signals around a home. Microsoft has openly shown products based on this in which multiple DVD streams can be flying among multiple screens with nary a glitch in quality.

Ultimately, most 802.11a devices will be paired with b and g: manufacturers that initially shipped 802.11a-only cards quickly revamped to offer a/b (dual-mode/dual-band) or a/b/g (tri-mode/dual-band) products. Many access points now can handle a or b/g, or a combination in which all three standards can be used at once.

maker is allowed to use the Wi-Fi logo. Early in July, companies started to announce that their devices had been tested compliant. It's expected that all current 802.11g equipment will easily pass the tests given the small number of companies that released chips in the first half of 2003.

The addition of 802.11g to Wi-Fi parallels the release of a new security specification called WPA (Wi-Fi Protected Access). All of the 802.11g chips that appeared were engineered to support WPA, making it easy to add both the faster speed and better security at around the same time. Updates are still trickling out in July, even though they were expected as early as May 2003, but Apple and Microsoft have both agreed to support WPA in the operating system, and all the chipmakers will support it as well. Microsoft released its WPA update in Spring 2003; Apple says that WPA support will be part of Mac OS X 10.3 (Panther), due out before the end of 2003. WPA support becomes mandatory for Wi-Fi certification near the end of 2003.

## Apple's Approach

To support 802.11g, Apple introduced both a new wireless gateway and a new internal card for Macs. While the AirPort Extreme Base Station is, by its nature, backward compatible with AirPort and other Wi-Fi gear, the card works only on new models of the Macintosh.

### AirPort Extreme Base Station

Apple offers two different AirPort Extreme Base Station models, priced at \$200 and \$250 (**Figure A.1**). Both units have 10/100 Mbps WAN and LAN ports, sport a USB port for printer sharing (but not for spooling), and can bridge to other AirPort Extreme Base Stations, acting as an access point and a bridge simultaneously. The \$250 unit also includes a V.90 56K modem and a jack for an external antenna. (Apple released a beta Windows administration utility in June, but we're not yet aware of a Java version for Unix/Linux.)

The 10/100 Mbps bump up in speed on the WAN port recognizes that some users might be hooking into wide-area networks or broadband connections that provide more than 10 Mbps of bandwidth. If you're running only a 10 Mbps wired Ethernet, it might be time to upgrade to 10/100 Mbps switches if you're installing AirPort Extreme equipment to take full advantage of the intra-network speed.

The addition of USB printer sharing enables a network of Macs to share a printer without connecting the printer to a Mac that must be turned on

**Figure A.1**  
AirPort Extreme  
Base Station



whenever anyone on the network wants to print. However, the printer itself must be turned on: this feature is indeed “printer sharing,” which makes it seem just like the printer is connected to each machine, rather than “printer spooling,” in which print jobs are sent to the print spooler, stored in a file, and then printed out whenever the printer becomes available. (Adam absolutely adores print spooling because his printer is seldom on, and whenever he turns it on, his print spooler immediately prints all the waiting print jobs.)

In the past, adding an external antenna to an AirPort Base Station required serious surgery that made a mockery of your warranty and required significant manual dexterity. Now, with the \$250 model of the AirPort Extreme Base Station, you can simply plug an external antenna into the Apple-proprietary antenna jack.

Don't blame Apple for yet another proprietary jack—the FCC mandates that any wireless networking equipment that can take an antenna must feature a hard-to-find connector. That's because the FCC doesn't want just anyone attaching uncertified antennas that could spew more than the legal amount of signal. (An uncertified antenna is anything that the manufacturer didn't have the FCC test with a given gateway or card.)

You can't buy external antennas for the AirPort Extreme Base Station from Apple; they're available only from third party companies. The initial antenna models are made and marketed by veteran Macintosh peripheral firm Dr. Bott ([www.dr bott.com](http://www.dr bott.com)). Apple said they didn't want to get into the antenna business, but Apple is having the entire \$250 AirPort Extreme Base Station plus Dr. Bott antenna system certified by the FCC. (Companies pay a separate fee for each certification—which may account for part of why the cheaper AirPort Extreme Base Station lacks an external antenna jack.)

The Dr. Bott ExtendAIR Omni (\$100) is a 3.5 dBi omnidirectional antenna suitable for extending the range of an AirPort Extreme Base Station in all directions; the ExtendAIR Direct (\$150) is a 6.5 dBi 70-degree directional antenna. (For more on antennas, read Chapter 8, *Going the Distance*, pages 223-256.)

Other antennas with higher gain and lower cost are available from companies like HyperLink Technology; see [http://www.hyperlinktech.com/web/apple\\_antenna\\_kits.html](http://www.hyperlinktech.com/web/apple_antenna_kits.html) for their Apple-specific offerings. Although it's legal to buy these antennas, the FCC and other international regulatory authorities typically prohibit anyone from mixing and matching antennas.

Although you can still use the 56 Kbps modem (V.90, not V.92, unfortunately) to connect via a dialup Internet connection, you might still want the modem-equipped version of the AirPort Extreme Base Station even if you have a broadband connection to the Internet. That's because the AirPort Extreme Base Station also supports PPP dial-in connections. Forget a file while you're traveling? As long as your Mac is turned on and has file sharing enabled, you can use your laptop's modem to dial up your AirPort Extreme Base Station and retrieve that file. Exactly how this feature will work won't be clear until we can test the hardware, but it could be a welcome addition. Of course, this assumes a phone line dedicated to incoming data calls.

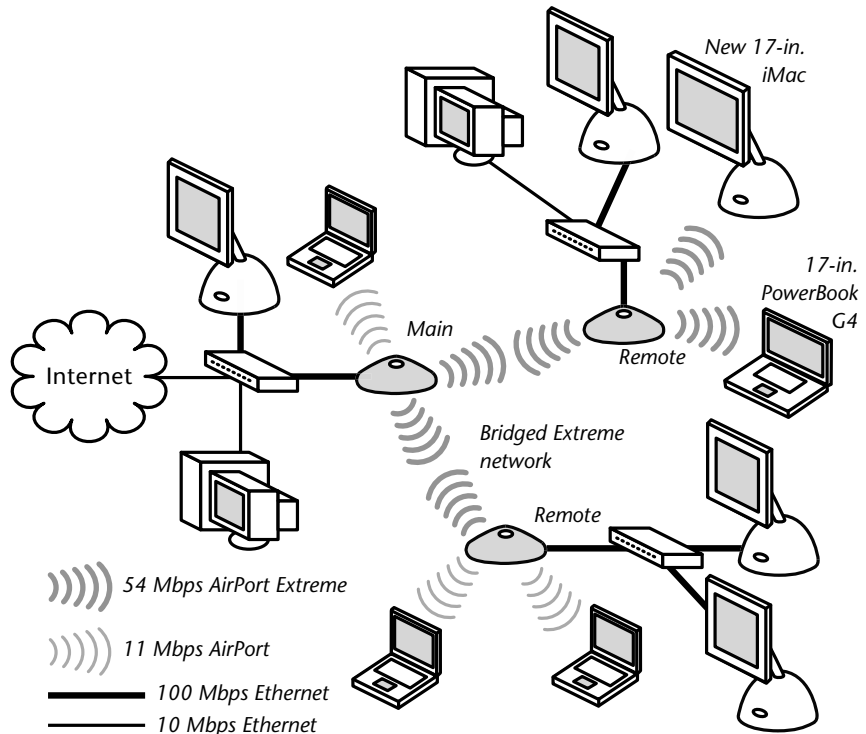
The AirPort Extreme Base Station's bridging feature is part of a new trend for equipment in this price range. It lets you extend the range of a network without wires. Just buy two or more AirPort Extreme Base Stations, connect one to your Internet connection (the "main" unit, as Apple calls it), and set one to four others to work in bridge mode as "remotes."

The bridge unit passes traffic back and forth from anything connected wirelessly or via its Ethernet part back to the main AirPort Extreme Base Station: it's a bridge and an access point at the same time (**Figure A.2**). The master unit can support up to four remotes. (Apple is using WDS—Wireless Distribution System, which is part of the original 1999 spec for 802.11b, but is just starting to appear in equipment. It's not independently tested as part of Wi-Fi—yet.)

In June 2003, Apple's AirPort 3.1 upgrade that brought AirPort Extreme to full 802.11g compatibility also added a third element to the bridge: a "relay." The relay can bridge to the main unit and up to four remotes can connect to it. However, you can have only one relay in a network.

In the past, you would have had to spend well over \$500 to buy a single device that could act an access point and bridge simultaneously, or combine separate

**Figure A.2**  
AirPort Extreme network with bridging and both AirPort and AirPort Extreme clients.



pieces of equipment like the Linksys WAP11 and WET11 to achieve the same effect. (See pages 152–160 for more on bridging.)

Even if you don't have a single AirPort Extreme card or 802.11g adapter on your network, remember that two AirPort Extreme Base Stations can connect to each other at the full 54 Mbps raw speed of 802.11g. If your wired network runs at 100 Mbps, the high-speed bridging is another reason for the 10/100 Mbps WAN port on the new units.

With AirPort Extreme Base Stations, you could locate islands of wired and wireless access in various locations without running wire among those islands. This could enable you to create larger coverage area or connect neighboring buildings or homes.

Even though the AirPort Extreme Base Station bridging works with up to four units at once, or five if you insert a relay, that's as many hops away from the main unit that you can go. If you need more coverage, consider running Ethernet among several master AirPort Extreme Base Stations and using bridging on the edges of the network.

**Figure A.3**  
AirPort Extreme  
Card



## Apple AirPort Extreme Card

The new AirPort Extreme Card is based on the mini-PCI Card form factor, and has a new shape and connector (**Figure A.3**). The card is built into every 17-inch PowerBook G4, and is a user-expandable or build-to-order option with the 12-inch PowerBook G4, 2003-series 17-inch iMacs, all 2003 Power Macs, and 2003-series eMacs. More updates are expected during 2003.

The PowerBooks were announced at the same time as AirPort Extreme, while the other units followed. The two new PowerBook models also have built-in Bluetooth and a pair of antennas. Apple said that the two antennas reconfigure themselves dynamically to provide either antenna diversity for better reception of Wi-Fi or 802.11g signals, or for one antenna to be dedicated to Bluetooth and the other to 802.11 depending on what's needed.

The antenna redesign also solves a problem inherent in the 15-inch Titanium PowerBook G4 design that restricted the signal strength entering and leaving the computer. In the new PowerBook G4 aluminum case design, the antennas are located at the top of both sides of the LCD display with rubber seals providing radio "transparency."

Will there be an upgraded AirPort Extreme card for older Macs? The answer is a firm no. Greg Joswiak, Apple's VP of hardware product marketing, confirmed for us that the older AirPort card relied on a too-slow bus, or communications channel, inside each Mac. This slow bus can't operate at the speed required by 802.11g, thus making it impossible to revise the card or plug a different card into that slot.

However, there's a simple way out. Because Apple chose to use chips from Broadcom, the same used by several other wireless equipment makers, Mac users who can run at least Mac OS X 10.2.6 with AirPort 3.1 software installed can deploy 802.11g PC and PCI cards from Asanté and Buffalo, and we've heard that Linksys and other Broadcom-based cards may work as well. Check for compatibility, since not all 802.11g cards are guaranteed to work with Macs.

Machines without PC or PCI card slots but which have 10/100 Mbps Ethernet can use the Linksys WET54G Ethernet adapter, which can be associated with any access point and bridge the Ethernet traffic to 802.11b or 802.11g. (With a 10 Mbps-only Ethernet, you might opt for the older and cheaper WET11, which we cover extensively in the book.)

Machines without Ethernet and no slots are pretty much out of luck, but realistically, that's not true of many computers that are sufficiently modern to retain much utility in today's world.

## Other 802.11g Makers

The consumer equipment makers leapt on the 802.11g bandwagon before or just after Apple's January announcement. **Asanté** ([www.asante.com](http://www.asante.com)), **Belkin** ([www.belkin.com](http://www.belkin.com)), **Buffalo** ([www.buffalotech.com](http://www.buffalotech.com)), **D-Link** ([www.d-link.com](http://www.d-link.com)), **Linksys** ([www.linksys.com](http://www.linksys.com)), **NetGear** ([www.netgear.com](http://www.netgear.com)), **Proxim** ([www.proxim.com](http://www.proxim.com)), and **SMC Networks** ([www.smcnetworks.com](http://www.smcnetworks.com)) are just some of the companies offering access points (usually a gateway and a "plain" access point used to extend a network) and PC and PCI cards.

Although each of these companies offers many products, they're mostly very similar in terms of cost and features. Deciding between them becomes a matter of buying the least expensive device that comes with good technical support. And don't assume technical support is comparable for these companies; readers of the book have posted tech support horror stories on our discussion forum at <http://wireless-starter-kit.com/phpBB2/>. We recommend investigating technical support reports on the Internet before buying.

## Future of G

The future of 802.11g is assured now that the IEEE has ratified it, and 802.11g has already proven itself in the consumer marketplace. Companies will start adopting 802.11g after the new WPA security standard appears—no company wants to deal with two changes in quick succession when they can wait a bit for just one. Prices should continue to fall, even though 802.11g equipment already costs less than 802.11b equipment did a year ago. (802.11b devices will get cheaper and migrate into more consumer electronics, too.)

We're bullish on 802.11g because it's backwards compatible, and because it doesn't rely on unproven technology. Faster speed at about the same price? Count us in.