# Wireless networks

■ **Dave Mitchell puts 12 of the best wireless Ethernet kits through their paces**

Ratified in 1999, the IEEE 802.11b High Rate specification aimed to drag the wireless LAN (WLAN) out of the Dark Ages. Initially hindered by a plethora of proprietary solutions and a paltry top speed of 2Mbits/sec, WLANs at last could benefit from speeds of 1, 2, 5.5 and 11Mbits/sec, bringing them alongside basic wired networks in terms of performance. This has been good news for a huge variety of businesses, as they can finally take advantage of the freedom offered by wire-free networks.

Notebook users have been a primary driving force behind WLAN uptake, as by their very nature they demand easy access to the network from a variety of locations, without the constraints placed on them by a physical connection. In this month's group test we take a look at 802.11b-complaint wireless products from 12 of the top vendors. We asked each company to send in a minimum of a wireless access point and two PC Cards.

Even though the 802.11b standard has solved a number of problems, it has come under a certain amount of criticism. Performance has seen significant improvements, but it's well short of the maximum quoted speed. Problems at the physical layer degrade performance, as a special preamble is included in each packet, which is used for synchronisation and to determine transmission speed. Called the PLCP (Physical Layer Convergence Protocol), this consists of 24 bytes as opposed to Ethernet's 8-byte preamble and immediately introduces inefficiencies at the physical layer. Signal degradation can hit performance, so a poorly placed access point and obstacles in the path of the signal can cause wireless nodes to drop to lower speeds in an effort to maintain contact. Ethernet's collision avoidance methods also have a part to play, as, by their nature, they'll never allow the full bandwidth to be utilised. The bottom line is that the best performance an 802.11b wireless network is likely to deliver is around 5Mbits/sec.

A bigger problem has been the recent issues surrounding wireless security, bringing about the rise of 'drive-by' hackers. It's quite easy for anyone with a laptop, a wireless PC Card and software downloadable from the Internet to take a tour around their local area and locate unprotected wireless networks, the channels in use, the network names and see whether encryption is activated. Furthermore, vulnerabilities in the WEP (wired equivalent privacy) protocol have been

> ' **IEEE members spent most of last year arguing about how it [802.11g] should be implemented** '
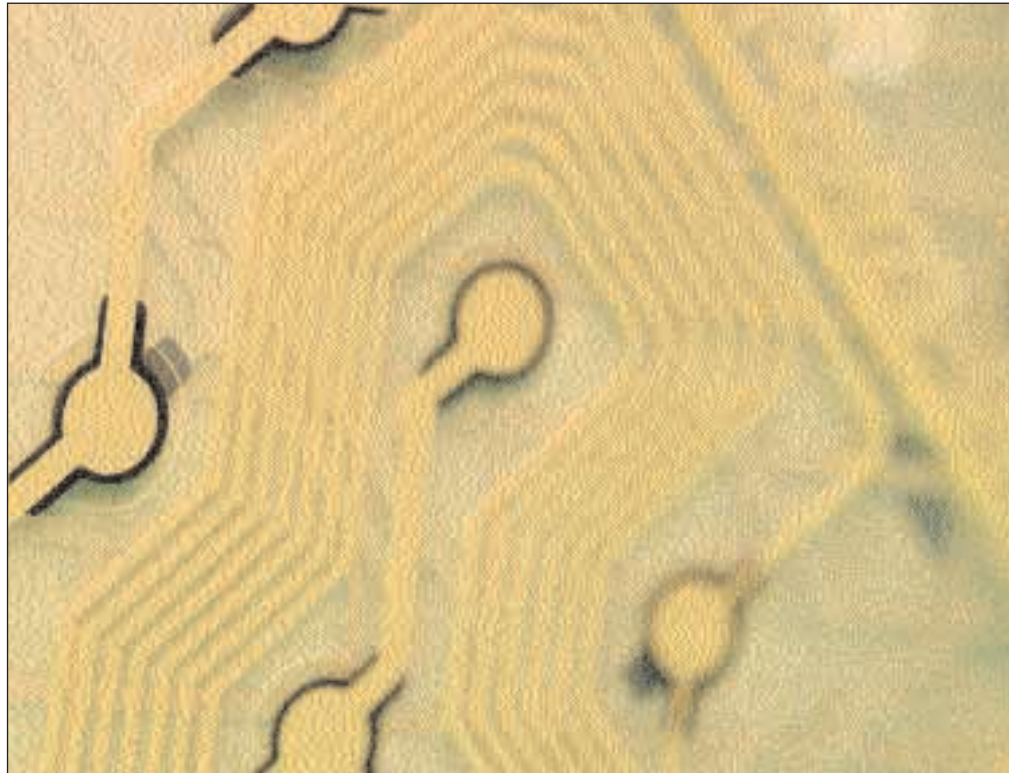
exposed, showing that hackers with appropriate hardware and plenty of time can intercept the transmission of data, read their contents and modify them without detection.

Small businesses are less at risk, as the rewards of breaking into their networks are less likely to justify the initial outlay and time required. Even so, no company can afford to leave its wireless networks unprotected and should implement security in depth. On installation, change all default network names and passwords, enable WEP encryption – preferably the 128-bit variety – and change the keys regularly. Where available, use MAC address blocking and set up the network as a closed system. Security can be tightened even further by implementing VPNs (virtual private networks) or a RADIUS authentication server.

Higher wireless speeds are on the horizon, but it may be some time before we see standards-based solutions in the UK. The 802.11g specification is going through a tough time, as IEEE members spent most of last year arguing about how it should be implemented. It calls for a doubling of current speeds to 22Mbits/sec in the same 2.4GHz spectrum being used by 802.11b-compliant wireless

networks and offers up to 70 per cent more area coverage.

Backward compatibility with existing 802.11b-compliant products makes this appealing, but the stumbling block appears to be the coding method. Intersil's OFDM (orthogonal frequency division multiplexing) looked the main contender early last year, but Texas Instrument's PBCC (packet binary convolution coding) has been putting up some strong competition, and the company has already produced its ACX100 controller. This has been taken up by Buffalo Technology, which expects to have a proprietary solution available at the beginning of 2002. Clearly, there's work to be done on the 802.11g specification, which means standards-based products could still be some way off.
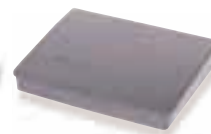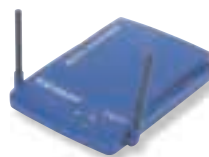
Many vendors have already announced 802.11a wireless products but, once again, it could be a while before we see them over here. 802.11a offers an increase in speed up to 54Mbits/sec and will operate in the 5GHz band, but this isn't expected to get the go-ahead in Europe until the second half of this year. The new standard also operates over a much shorter range, and 802.11a-compliant products won't be interoperable with 802.11b wireless kit. So, if you're looking at wireless networks, the 802.11b products will be the safest bet for some time to come.

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Specifications & features

	3Com	Agere Systems	Buffalo Technology	Cisco Systems	Compaq	D-Link
Access point	AirConnect Access Point	ORiNOCO AP-500	AirStation WLA-L11G	Aironet 350 Series	WL510	DWL-1000AP
PC Card	AirConnect PC Card	ORiNOCO PC Card Silver	AirStation WLI-PCM-L11G	Aironet 350 Series	WL110	DWL-650
Contact	01442 438000	01344 865900	01753 677500	020 8824 1000	0845 270 4000	020 8731 5555
Web site	www.3com.co.uk	www.agere.com	www.buffalo-technology.com	www.cisco.com	www.compaq.com	www.dlink.co.uk
Price (exc VAT)						
Access point	£573	£350	£169	£866	£652	£210
PC Card	£91	£70	£69	£132	£112	£90
Access point						
Radio technology	DSSS	DSSS	DSSS	DSSS	DSSS	DSSS
Wi-Fi certified	✓	✓	✓	✓	✓	✓
Aerials	1	1	1	2	1 (Second optional)	1
Type	Removable external	Fixed internal	Fixed internal	Fixed external	PC Card	Fixed external
Network port	10BaseT	10BaseT	10/100BaseTX	10/100BaseTX	10/100BaseTX	10/100BaseTX
Serial port	✓	✗	✗	✓	✓	✗
USB port	✗	✗	✗	✗	✗	✗
Power over Ethernet	✓	Optional	✗	✓	Optional	✗
Wall-mounting bracket supplied	✓	✓	✗	✓	✓	✓
Power supply	External	External	External	External with PoE injector	External	External
Other features	✗	✗	✗	✗	✗	✗
Security						
40-bit WEP	✓	✓	✓	✓	✓	✓
128-bit WEP	✓	✓ (PC Card Gold)	✗	✓	✓	✗
MAC address filtering	✓	✓	✓	✓	✓	✓
Protocol filtering	✗	✓	✗	✓	✓	✗
Management						
CLI	✓	✗	✗	✓	✓	✗
Management software	✗	ORiNOCO AP Manager	AirStation Manager	✗	Compaq AP Manager	D-Link AP Manager
Web management	✓	✗	✓	✓	✗	✗
Protocol support						
TCP/IP	✓	✓	✓	✓	✓	✓
IPX/SPX	✓	✓	✓	✓	✓	✓
NetBEUI	✓	✓	✓	✓	✓	✓
NDIS	✓	✓	✓	✓	✓	✓
IP address assignment	Manual/DHCP	Manual/DHCP	Manual/DHCP	Manual/DHCP	Manual/DHCP	Manual/DHCP
Range: indoors (m)						
11Mbits/sec	24	25	25	40	50	35
5.5Mbits/sec	36	35	35	Not specified	70	Not specified
2Mbits/sec	60	40	40	Not specified	90	Not specified
1Mbits/sec	91	50	50	107	115	100
Range: outdoors (m)						
11Mbits/sec	Not specified	160	50	244	180	100
5.5Mbits/sec	Not specified	270	70	Not specified	270	Not specified
2Mbits/sec	Not specified	400	90	Not specified	400	Not specified
1Mbits/sec	303	550	115	610	550	300
Sire survey software included	✓	✓	✓	✓	✓	✗
PC Cards						
PCMCIA interface	Type II	Type II	Type II	Type II	Type II	Type II
PC Card management	3Com Launcher	ORiNOCO Client Manager	AirStation Client Manager	Aironet Client Utility	Compaq Client Manager	Configuration Utility
Transmission rate selection						
Manual	✓	✓	✓	✓	✓	✓
Dynamic	✓	✓	✓	✓	✓	✓
Network environment						
Infrastructure	✓	✓	✓	✓	✓	✓
Ad-Hoc	✓	✓	✓	✓	✓	✓
OS support						
Windows 95B	✓	✓	✓	✓	✓	✗
Windows 98	✓	✓	✓	✓	✓	✓
Windows ME	✓	✓	✓	✓	✓	✓
Window NT 4	✓	✓	✓	✓	✓	✓
Windows 2000	✓	✓	✓	✓	✓	✓
Other	✗	✗	✗	Linux	✗	Linux
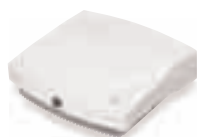
| Elsa	Enterasys Networks	Intel	NetGear	SMC Networks	U.S. Robotics
LANCOM Wireless IL-11	RoamAbout R2	PRO/Wireless 2011	ME102	Wireless Barricade	Wireless Access Point
AirLancer MC-11	RoamAbout CSIBD-AB-128	PRO/Wireless 2011	MA401	SMC2632W	PC Card
0800 056 3445	01635 580000	0870 607 2439	01344 397021	01189 748700	01628 640140
www.elsa.com	www.enterasys.com	www.intel.com	www.netgear.com	www.smc.com	www.usr.com
£499	£984	£466	£269	£250	£299
£139	£141	£120	£128	£109	£109
DSSS	DSSS	DSSS	DSSS	DSSS	DSSS
✓	✓	✓	✓	✓	✓
1	1	2	2	2	1
Fixed internal	PC Card	Removable external	Fixed external	Fixed external	Removable external
10BaseT	10/100BaseTX	10BaseT	10BaseT	10/100BaseTX (three ports)	10BaseT
✗	✓	✓	✗	✓	✓
✗	✗	✗	✓	✗	✗
✗	✓	✓	✗	✗	✗
✓	✓	✓	✓	✗	✓
External	External	External	External	External	External
ISDN router	✗	✗	✗	Broadband/ISDN router, print server	✗
✓	✓	✓	✓	✓	✓
✓	✓	✓	PC Cards only	✓	✓
✓	✓	✓	✓	✓	✗
✓	✓	✗	✗	✗	✗
✗	✓	✓	✗	✗	✓
Elsa LANconfig	RoamAbout AP Manager	✗	USB/SNMP Manager	✗	WLAN AP Utility
✓	✓	✓	✗	✓	✓
✓	✓	✓	✓	✓	✓
✓	✓	✓	✓	✓	✓
✓	✓	✓	✓	✓	✓
✓	✓	✓	✓	✓	✓
Manual/DHCP	Manual/DHCP	Manual/DHCP	Manual	Manual/DHCP	Manual/DHCP
30	25	30	53	Not specified	Not specified
35	35	Not specified	82	Not specified	Not specified
40	40	Not specified	122	Not specified	Not specified
50	50	90	152	Not specified	Not specified
150	160	120	255	Not specified	245
250	270	Not specified	352	Not specified	Not specified
300	400	Not specified	402	Not specified	Not specified
400	550	460	503	330	Not specified
✓	✓	✓	✗	✗	✗
Type II	Type II	Type II	Type II	Type II	Type II
AirLancer Client Manager	RoamAbout Client Utility	Intel NWPA	LAN Configuration Utility	LAN Configuration Utility	LAN Configuration Utility
✓	✓	✓	✓	✓	✓
✓	✓	✓	✓	✓	✓
✓	✓	✓	✓	✓	✓
✓	✓	✓	✓	✓	✓
✓	✓	✓	✓	✓	✓
✓	✓	✓	✓	✓	✓
✓	✓	✓	✓	✓	✓
✓	✓	✓	✓	✓	✓
✓	✓	✓	✓	✓	✓
✗	Linux, Macintosh	✗	Linux	✗	✗

Wireless desktops

The wireless network is ideally suited to mobile users as it allows them to roam freely around a building or campus without the constraints of a physical connection. However, a major selling point of wireless is that it's an ideal solution for environments where it's not feasible to lay a cable-based network, or for companies that don't wish to invest in structured cabling. So is it actually possible to have a completely wire-free network?

Although this month's wireless network group test concentrates on access points and PC Cards, the majority of vendors offer a complete range of products that includes PCI and USB adaptors, allowing workstations to join the wireless club. The PCI adaptors are designed to fit into a standard expansion slot

NetGear's USB adaptor.
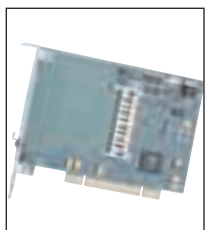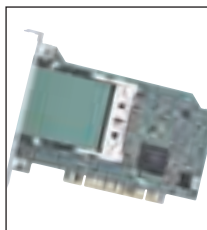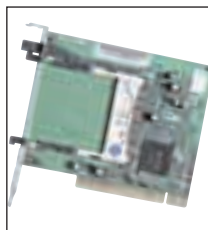
and have a slot on the backplate through which a wireless PC Card can be inserted. It's worth checking the specifications carefully first before buying. SMC and Cisco, for example, offer PCI adaptors with fixed wireless PC Cards, whereas the NetGear MA301 adaptor requires a separately purchased PC Card. U.S. Robotics has the best solution as its PCI adaptor includes a removable card. The clear advantage here is that the latter arrangement allows you to swap a single

PC Card between your workstation and laptop as required.

For even easier transition between laptop and workstation, a USB wireless adaptor is a better choice. There's need to select and stop PCMCIA devices before they can be safely removed as you can easily swap your USB wireless adaptors between workstation and laptop. Unfortunately, support for USB isn't as widespread – SMC, D-Link, NetGear and Buffalo have all released USB adaptors, whereas Cisco, 3Com, Enterasys Networks and U.S. Robotics don't currently support this interface. Even so, if all your wireless equipment is Wi-Fi compliant, you should be able to mix and match as required.
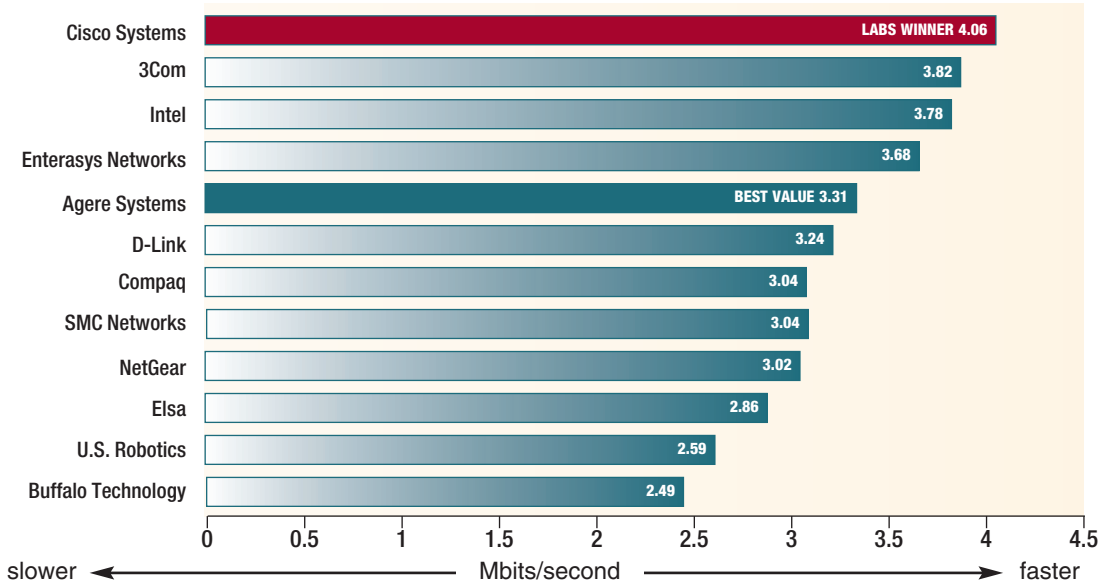
How we tested

For performance testing, we created a real-world scenario consisting of two notebook clients operating in InfraStructure mode and connected to our main test network via each vendor's access point. We used a Tiny notebook equipped with an Pentium III/800 processor, 128Mb of RAM and running Windows 98 SE, while our second client was an ACi notebook with a 1GHz Pentium III processor, 256Mb of RAM and running Windows XP

Professional. After the wireless PC Cards were installed, each client was connected over the network to its own dedicated Windows 2000 Server system to avoid any contention, with the access point and servers linked via an Intel 500T Fast Ethernet switch. Each client was placed two metres away from the access point and in clear line of sight. Although we wouldn't recommend this for everyday use, we switched encryption off to reduce any further

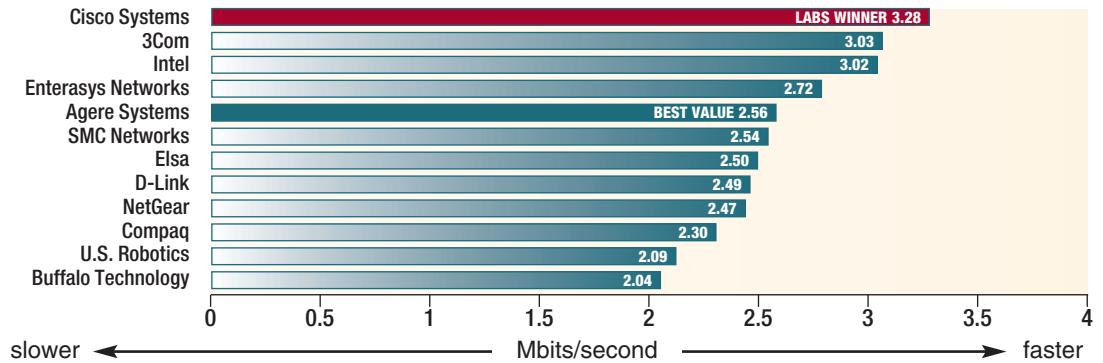overheads that might interfere with throughput.

To measure sustained transfer rates, we copied a 690Mb video file from the server to one notebook and followed this with a copy of a 93Mb mixture of data, comprising 280 documents, spreadsheets and presentations. To increase the pressure, we then reran the copies simultaneously to both clients. Each run was timed and an average transfer rate in megabits per second was calculated.

OVERALL PERFORMANCE

Vendor	Mbits/second
Cisco Systems	LABS WINNER 4.06
3Com	3.82
Intel	3.78
Enterasys Networks	3.68
Agere Systems	BEST VALUE 3.31
D-Link	3.24
Compaq	3.04
SMC Networks	3.04
NetGear	3.02
Elsa	2.86
U.S. Robotics	2.59
Buffalo Technology	2.49

slower ← Mbits/second → faster

Individual performance graphs

LARGE FILE COPY – TWO CLIENTS

Vendor	Value
Cisco Systems	LABS WINNER 3.28
3Com	3.03
Intel	3.02
Enterasys Networks	2.72
Agere Systems	BEST VALUE 2.56
SMC Networks	2.54
Elsa	2.50
D-Link	2.49
NetGear	2.47
Compaq	2.30
U.S. Robotics	2.09
Buffalo Technology	2.04

0   0.5   1   1.5   2   2.5   3   3.5   4

slower ◄——— Mbits/second ———► faster

MIXTURE COPY – TWO CLIENTS

Vendor	Value
3Com	3.44
Intel	3.37
Cisco Systems	LABS WINNER 3.14
Enterasys Networks	2.92
D-Link	2.72
Agere Systems	BEST VALUE 2.63
Compaq	2.44
NetGear	2.43
Elsa	2.37
SMC Networks	2.24
U.S. Robotics	2.14
Buffalo Technology	2.07

0   0.5   1   1.5   2   2.5   3   3.5   4

slower ◄——— Mbits/second ———► faster
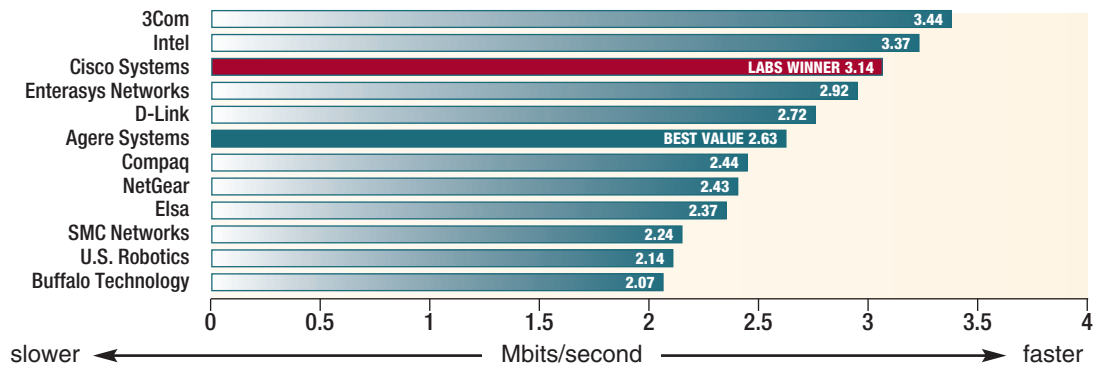
LARGE FILE COPY – ONE CLIENT

Vendor	Value
Cisco Systems	LABS WINNER 4.79
Intel	4.53
3Com	4.42
Enterasys Networks	4.30
Agere Systems	BEST VALUE 3.96
D-Link	3.93
SMC Networks	3.93
Compaq	3.88
NetGear	3.88
Elsa	3.68
U.S. Robotics	3.46
Buffalo Technology	3.32

1   1.5   2   2.5   3   3.5   4   4.5   5

slower ◄——— Mbits/second ———► faster

MIXTURE COPY – ONE CLIENT

Vendor	Value
Cisco Systems	LABS WINNER 5.04
Enterasys Networks	4.84
3Com	4.39
Intel	4.19
Agere Systems	BEST VALUE 4.07
D-Link	3.82
Compaq	3.55
SMC Networks	3.44
NetGear	3.31
Elsa	2.90
U.S. Robotics	2.66
Buffalo Technology	2.53

2   2.5   3   3.5   4   4.5   5   5.5   6

slower ◄——— Mbits/second ———► faster

3Com AirConnect

- **Price: Access Point, £573; PC Card, £91 (exc VAT)**
- **Supplier: 3Com 01442 438000**
- **Internet: www.3com.co.uk**

The AirConnect from 3Com was one of the first high-speed WLAN products to market, and the base station is almost identical to that offered by Intel. Build quality is just as good, although 3Com has marred the proceedings by fitting a single aerial assembly and linking it to the main unit by a pair of flimsy wires, which are directly in front of the Ethernet and serial ports and have to be moved aside for access. Early PC Cards also failed to inspire confidence, as the aerial assembly wasn't securely fixed and had to be treated with care. However, 3Com has remedied this, since the versions on review have the aerial assembly firmly fixed to the card body.

PC Card installation also goes down the same route as Intel, with our Windows XP Professional client refusing to work with 3Com. Although the card appears in the Device Manager as correctly installed, a connection to the access point couldn't be achieved, leaving us to run performance tests on two Windows 98 clients where the cards behaved perfectly and delivered similar results to Intel's PRO/Wireless products. A Launcher background task is accessed from the System Tray and provides plenty of troubleshooting utilities and tools. A small window shows connection status along with general settings and power modes. The card detects whether the laptop is on mains or battery power and chooses either a CAM (continuous access mode) or PSP (power save poll) mode accordingly. Signal strength can be viewed in graphical format, and link performance can be tested using PING (packet Internet groper). Under Windows XP, we also found that the Launcher utility couldn't detect the 3Com PC Card.

Initial contact with the access point will be via the serial port using a HyperTerminal session. You can manage the unit from here, but we found it easier to assign it an IP address and move over to Web browser access. Configuration is a cinch, plenty of statistics are to hand and you can see who's logged onto the access point. 3Com also provides a PowerBaseT adaptor, which uses a standard eight-wire CAT-5 cable to consolidate power and network connection, so the access point doesn't necessarily have to be positioned close to a power outlet.

3Com AirConnect

verdict: No significant differences to Intel's wireless products, so you'll be paying similarly high prices for the same problems with Windows XP, but balanced by a fine performance and good management features.

OVERALL	○○○●●●
performance	○●●●●●
features	○○●●●●
value for money	○○○○●●

Agere Systems ORiNOCO

- **Price: AP-500, £350; PC Card Silver, £70 (exc VAT)**
- **Supplier: Agere Systems 01344 865900**
- **Internet: www.agere.com**

Formerly part of the Lucent empire, Agere Systems' wireless products cover the complete spectrum, from home and small business users right up to the enterprise level. The ORiNOCO AP-500 sits squarely in the middle of this extensive family and targets small to medium-sized companies. It's a compact plastic box that can be wall mounted with the supplied bracket. It uses an embedded PC Card to provide the wireless connection, and the network port is of the basic 10BaseT variety. Three indicators on the front provide visual cues to power and wireless activity. The AP-500 can also work in conjunction with an optional Range Extender Antenna, which Agere claims can improve indoor coverage by up to 30 per cent.

The ORiNOCO PC Card is offered in two varieties and your choice depends on the levels of encryption you require, as the Silver version on review only supports 40-bit WEP, while the Gold version includes 128-bit WEP as well. The hand of Lucent can be seen throughout this group test, since Agere, Compaq, Elsa and Enterasys Networks all use this company's PC Card products. This is no bad thing, as installation is simple and it's virtually guaranteed that each vendor's products will interoperate as well.

The PC Card Silver has a chunky aerial assembly, which provides a pair of LEDs showing connection status as well as activity, and comes with the excellent Client Manager utility for local monitoring and configuration. Installation on our Windows 98 client could have been made easier – Agere had bundled the CD-ROM for its OR-1000 router with both cards. However, Agere's Web site is one of a few that shows the PC Cards as being Windows XP compatible and we had no problems installing the card on our XP client.

Using the ORiNOCO AP Manager, we had the AP-500 up and running in a matter of minutes. This is exactly the same SNMP utility as supplied by Compaq with its WL510, which provides access to a high level of security features. Performance is nothing to write home about, but, along with the PC Cards, it looks good value, making it ideal for small businesses that want a cost-effective wireless solution with top security.

Agere Systems ORiNOCO

verdict: A compact access point with high levels of security, although you'll need the PC Card Gold version to take advantage of 128-bit encryption. Performance is good, making it ideal for smaller businesses worried about security.

OVERALL	○●●●●●
performance	○●●●●●
features	○●●●●●
value for money	○●●●●●

Buffalo Technology AirStation

- **Price: WLA-L11G, £169; WLI-PCM-L11G, £69 (exc VAT)**
- **Supplier: Buffalo Technology 01753 677500**
- **Internet: www.buffalo-technology.co.uk**

Buffalo Technology has always concentrated on delivering budget-priced networking products, and the AirStation range is no exception. It's a complete family of products comprising four access points, a PC Card and PCI adaptor cards (*see Wireless desktops, p182*). The AirStation WLA-L11G on review is the entry-level model, which provides simple network access for wireless users, while the other three models offer either modem or ISDN links for shared Internet access along with an ADSL version as well. Build quality is reasonable, although the access point can't be wall mounted as it's designed for the desktop.

Access point installation is neatly automated. You simply load the AirStation Manager utility and then use a Wizard that searches for the unit on the network, assigns it an IP address and loads a Web browser management interface. From here, you can enter a wireless LAN group name or select the roaming function, which will allow remote users to switch automatically from one access point to another without losing touch with the network. Security options are similar to other low-cost products, as the AirStation only supports 40-bit WEP encryption. However, the Web interface displays available wireless clients along with their MAC (media access control) address, and connections can be permitted or denied on an individual basis.

The PC Cards were simple enough to install. A Client Manager utility makes life easier as it searches the network for available base stations and allows you to change operating modes on the fly. The tools are somewhat rudimentary, but link quality and speed can be tested, and a list of the most commonly used base stations can also be created for faster access. However, although the hardware worked correctly on the XP Professional system, the Client Manager failed to function, as it was unable to locate the card.

Overall performance was disappointing, with the AirStation falling some way behind the front runners. If performance isn't a major issue, the AirStation products look good value. It's also worth noting that by the time you read this, Buffalo expects to have its 22Mbits/sec wireless LAN products available, with both access point and PC Cards likely to only cost around £20 more than their slower cousins.

Buffalo Technology AirStation

verdict: A wide range of wireless LAN products, all at a tempting price. Installation is simple enough, but performance is poor, so it could be worthwhile waiting for Buffalo's 22Mbits/sec products.

OVERALL	●●●●●○○
performance	●●●●●○
features	●●●●●○
value for money	●●●●●●

Cisco Systems Aironet 350 Series

- **Price: Access point, £866; PC Card, £132 (exc VAT)**
- **Supplier: Cisco Systems 020 8824 1000**
- **Internet: www.cisco.com**

Part of Cisco's Mobile Office initiative, the Aironet 350 Series targets a wide range of applications for small to medium-sized businesses and enterprises and comprises wireless access points, bridges, PC Cards and PCI adaptors (*see Wireless desktops, p182*).

The Aironet access point is a compact, well-built unit with a pair of moveable aerials and three indicators on the front panel showing LAN connection status along with wireless signal quality and activity. A useful feature is that the unit doesn't have a separate power connector, as Cisco supplies a PoE (Power over Ethernet) injector module as standard. Link one side to a hub or switch and the other to the access point's Ethernet port over CAT-5 cable and the unit injects power into the unused wires, allowing the unit to be placed some distance from a power point.

Installation is fairly straightforward as you use Cisco's IP Setup utility, which searches for access points using the supplied MAC address and allows you to modify its IP address and SSID (service set identifier). You can also use a serial port connection and a terminal emulation session, but the interface is overly complex. Cisco doesn't supply any management utilities, so it's straight over to a Web browser for further configuration. The interface is well designed, providing easy access to a wealth of features. Security is good, with support for both 40-bit and 128-bit encryption, protocol and MAC address filtering and user authentication via a RADIUS server. Multiple access points can be easily managed from here, and a useful association table displays all wireless devices along with their IP and MAC addresses, status and even their software versions.

Both clients accepted the Aironet PC Cards and proceeded to deliver some of the best results in the performance tests. Cisco was the only vendor to top 5Mbits/sec in the single client test and also held on to first place when we brought the second client into the equation. The Client utility provides plenty of information about the wireless network. You can view statistics, monitor signal strength and quality as well as run a simple link test. A Site Survey tool helps ensure the access point is optimally located, and a Status Meter gives a real-time read-out on connection quality.

Cisco Systems Aironet 350 Series

verdict: Excellent wireless performance combined with good management tools, easy installation and extensive security. Relatively expensive, although you're paying for a wealth of quality features.

OVERALL	○●●●●●
performance	●●●●●●
features	○●●●●●
value for money	○○●●●○

Compaq WL510/WL110

- **Price: WL510, £652; WL110, £112 (exc VAT)**
- **Supplier: Compaq 0845 270 4000**
- **Internet: www.compaq.com**

It may be one of the more costly solutions on review, but Compaq's WL510 access point is aimed squarely at the enterprise and offers a wide range of features well suited to large office environments. Based around an Agere AP-1000 unit, the WL510 is a solidly built steel box that comes complete with a wall-mounting bracket and an optional splitter unit for supplying power and data over a standard CAT-5 Ethernet cable. A plastic cover can be clipped over the top and an unusual feature is the pair of PC Card slots at the rear.

The WL510 comes supplied with one card as standard, but adding a second allows users to connect to the network over two wireless channels. Security is particularly good, as you can activate 128-bit WEP encryption, deny access to MAC addresses and even implement protocol filtering. Access control options extend security further, since you can allow access to specific MAC addresses only and provide the access point with details of RADIUS servers.

Installation is remarkably simple, as you just install Compaq's AP Manager, which scans the network and displays the access point ready for configuration. All management must be conducted using this SNMP-based utility, as Web browser access isn't supported. From the tidy interface you can select a network name and wireless channel for each installed PC Card, use storm thresholds to avoid excessive network traffic and set up advanced IP and IPX bridging filters. Although the information is only offered in tabular format, the AP Manager also provides a wealth of operational and performance statistics for the Ethernet port and each installed card.

The WL110 PC Cards are the same as those provided by Agere, Elsa and Enterasys Networks and are just as easy to install. We encountered no problems on either client, although performance proved to be a disappointment. Compaq also bundles the same Client Manager software, which provides local PC Card monitoring and management. It offers one of the best link test facilities with a ful dashboard of graphs showing signal quality, signal-to-noise ratios and noise levels along with graphs showing a recent history of the test results. Poor overall performance aside, Compaq's wireless products offer a wealth of features ideally suited to the enterprise.

Compaq WL510/WL110

PC PRO

verdict: An enterprise-level solution comprising a well-built access point, and PC Cards offering a wide range of features and top-notch security, although let down by uninspiring performance.

OVERALL	●●●○●●●
performance	●●●●●○○
features	●●●●●●●
value for money	●●●●●○○

D-Link DWL-1000AP/DWL-650

- **Price: DWL-1000AP, £210; DWL-650, £90 (exc VAT)**
- **Supplier: D-Link 020 8731 5555**
- **Internet: www.dlink.co.uk**

Firmly aimed at the small business market, D-Link's budget-priced wireless products comprise the full range of access points, PC Cards and PCI adaptors (*see Wireless desktops, p182*). The access point is one of the more compact on review and it would be advisable to wall mount it for the best reception, as we found its indoor range was unimpressive. During testing, we frequently lost contact with only a couple of doors or a concrete office ceiling in the way. A small aerial is mounted in a recess at the rear of the access point, which can be swivelled through 180 degrees. D-Link advises that a site survey be conducted to determine where best to place the access point, but doesn't offer any assistance with this task.

Installation is simple, with D-Link's AP Manager utility scanning the network for access points and displaying them ready for configuration. A useful feature is that an IP address can be manually assigned without any fuss, as the unit can also be accessed via its MAC address. Web browser management isn't supported so all tasks must be carried out using the AP Manager, although you can use it to manage multiple access points. There's not much to see, since the sparse interface only offers a main window listing discovered units along with basic configuration details and WLAN security settings. Only 40-bit WEP encryption is supported, although access can also be granted or denied using the MAC address of each PC Card. But this information must be gathered manually, as AP Manager doesn't display details about connected users.

The PC Cards are well built. The aerial assembly is firmly fixed to the card body and has a single LED showing connection status and wireless activity. These are accompanied by a utility showing signal strength and link quality plus quick access to the network configuration and WEP security settings. Performance was impressive, with D-Link close to 4Mbits/sec with one client running the tests, although this dropped significantly with two clients.

The D-Link wireless package clearly looks a good choice for small businesses on a tight budget. However, although it does deliver a comparatively good performance, it's basic in terms of features, management tools and documentation.

D-Link DWL-1000AP/DWL-650

PC PRO

verdict: A basic, low-cost wireless solution with a good turn of speed. The modest security options make it a poor choice for big businesses, although it's still worth considering for small business use.

OVERALL	●●●○●●●
performance	●●○●●●●
features	●●●○●●●
value for money	●●○●●●●

Elsa LANCOM Wireless IL-11/AirLancer MC-11

- **Price: IL-11, £499; MC-11, £139 (exc VAT)**
- **Supplier: Elsa 0800 056 3445**
- **Internet: www.elsa.com**

Communications specialist Elsa was one of the first manufacturers to deliver 802.11b-compliant wireless products to the small to medium-sized business and its access points have always stood out from the crowd thanks to the number of features on offer. The IL-11 is a compact unit designed to sit comfortably on the desk or fixed to a wall and uses a removable MC-11 PC Card. The asking price may seem high, but the IL-11 not only delivers basic wireless access to the network, but its integrated ISDN interface also allows it to provide routing facilities for on-demand Internet access.

First-time installation of the base station is helped along nicely by Elsa's LANconfig utility. It's the same tool provided with Elsa's standard ISDN routing products, which automatically searches for Elsa routers as soon as it's loaded. Once you've assigned an IP address to it, Wizards take you through the process of setting up Internet access, dial-in access and connections between two LANs. All users on the same network can take advantage of the IL-11 for Internet access, whether they're wireless or wired clients, and support for BACP (bandwidth allocation control protocol) allows the second ISDN B-channel to be fired up when demand increases and dropped when usage falls below a predefined threshold. The IL-11 offers an impressive range of IP/IPX routing features, and Elsa bundles a copy of RVS-COM, allowing the ISDN channels to be used for faxing and file transfers directly from a user's Desktop.

The cards are also simple to install, working well on both client notebooks. Elsa provides a handy AirMonitor utility that keeps you in touch with signal quality, also running diagnostics on the card and providing a site monitor to help you place the base station in the best position. A comprehensive link test checks all four data rates and shows bar charts for signal-to-noise ratios plus signal and noise levels.

The IL-11 may offer more features than most, but performance isn't one of its strengths, with the AirLancer-equipped clients reporting comparatively poor overall transfer rates. However, if you want to implement both wireless networking and Internet access to all users, then the LANCOM Wireless IL-11 and AirLancer MC-11 combo look a good choice.

Elsa LANCOM Wireless IL-11/AirLancer MC-11

PC PRO

verdict: Overall performance at this price is very unimpressive, but Elsa's wireless package does offer a comprehensive range of management and monitoring facilities along with shared Internet access over ISDN.

OVERALL	○○○●●●
performance	○○○○○●
features	○○●●●●
value for money	○○○●●●

Enterasys Networks RoamAbout

- **Price: R2, £984; CSIBD-AB-281, £141 (exc VAT)**
- **Supplier: Enterasys Networks 01635 580000**
- **Internet: www.enterasys.com**

The RoamAbout range from Enterasys Networks provides an extensive selection of wireless options. The indoor solution offers a pair of access points, along with a full range of PC Cards, plus ISA and PCI adaptors (see Wireless desktops, p182). The outdoor solution adds point-to-multipoint support, allowing up to seven buildings to be connected together in a campus-wide wireless network.

Build quality for the RoamAbout R2 access point is easily the best, as it's enclosed in a solid metal chassis complete with cooling fins. The whole assembly can be hidden behind a lockable plastic cover. A single PC Card provides the wireless connection, and Enterasys Networks advised us that it also offers a mezzanine adaptor, which allows two cards to be fitted, supporting any mixture of 11, 22 and 54Mbits/sec varieties.

The R2 offers a huge range of features, but is still as easy to install as the entry-level products on review. The unit can be accessed directly via its serial port, but it's easier to load the RoamAbout AP Manager utility, as it searches for access points and provides a wealth of tools for configuring and monitoring the R2. Designed to improve management of multiple access points, AP Manager can run comparisons on all available units to ensure, for example, that firmware versions are all the same or encryption settings are consistent. Regular WEP key changes tighten security and these can be easily deployed across the entire wireless network with one action. Load balancing could prove useful where multiple access points are installed, as it forces clients to associate with the least busy unit.

Enterasys Networks also uses Lucent's wireless PC Cards and offers them with a variety of options. The card on review supports 128-bit WEP encryption, but you can opt for lower-cost versions with fewer security features. Card settings can be swiftly changed, as the utility also stores different profiles that are easily accessible from the Control Panel. Although not as swift as Cisco's entry, performance of the RoamAbout products was good, with Enterasys Networks consistently in the top half of the performance charts.

The RoamAbout is the most costly wireless solution on review, but it looks a top choice for companies that are planning to implement a large wireless network and want quality security features and management tools.

Enterasys Networks RoamAbout

PC PRO

verdict: Superb build quality combined with excellent management facilities, top performance and tight security. Comparatively costly but, as with Cisco's similarly priced solution, you're getting a lot for your money.

OVERALL	○○●●●●
performance	○●●●●●
features	○●●●●●
value for money	○○○●●●

Intel
PRO/Wireless 2011

- **Price: Access Point, £466; PC Card, £120 (exc VAT)**
- **Supplier: Intel 0870 607 2439**
- **Internet: www.intel.com**

The acquisition of Xircom in mid-2001 has enabled Intel to offer a complete range of wireless LAN products. The Xircom access point targets the home and small office market, while the PRO/Wireless products on review are aimed at larger companies. The access point is a well-built slab of grey plastic that uses a pair of stubby aerials plugged into BNC-style connectors at the rear of the unit, which allow them to be swivelled around to improve reception. Alongside is an Ethernet port, which is only a 10BaseT variety that doesn't even support full-duplex mode, although this clearly didn't have an impact on performance. Good build quality extends to the PC Cards, as the aerial assembly is securely attached to the main card body, accompanied by a single LED showing wireless activity.

Access point installation starts by assigning it an IP address either via a DHCP server or manually by using a terminal emulation session over a serial port connection. The CLI (command line interface) is well laid out and easy to understand, although once an address has been entered you can move directly to Web browser management where you'll find plenty of useful tools and options. A quick setup screen makes light work of initial configuration and you'll find good levels of security. The PRO/Wireless products support both 40-bit and 128-bit WEP encryption along with MAC address blocking. Good levels of statistics are also available as you can view overall traffic or select individual mobile users. There are plenty of other options to play with and these are supported with good PDF-based documentation.

PC Card installation was a mixed bag, since it failed to work on the Windows XP system as it refused to talk to the access point. A check on Intel's Web site revealed that a download would be available during November, but this hadn't materialised at the time of writing. Consequently, testing was conducted on two notebooks running Windows 98, which presented us with no further problems. Intel's NCPA (Network Control Panel Applet) provides easy access to the card's settings along with graphs of wireless signal strength. The cards also support CAM (continuous access mode) and PSP (power save poll) modes to control power usage when using batteries.

Intel PRO/Wireless 2011

verdict: A well-built range of wireless products that delivers good performance and management facilities, although this all comes at a comparatively high price. And it didn't work with Windows XP during testing.

OVERALL	○○●●●●
performance	○●●●●●
features	○○●●●●
value for money	○○○○●●

NetGear
ME102/MA401

- **Price: ME102, £269; MA401, £128 (exc VAT)**
- **Supplier: NetGear 01344 397021**
- **Internet: www.netgear.com**

NetGear has always had its focus firmly set on the home and small business networking market, offering an impressive range of budget-priced products. Along with the ME102 access point and MA401 PC Cards on review, NetGear's wireless range also includes PCI and USB adaptors (*see Wireless desktops, p182*).

The compact access point is solidly built with a basic 10BaseT Ethernet port and a pair of aerials that can be rotated to improve reception. It's the only product on review that includes a USB port and this is used to manage the access point locally. The ME102 can also be managed remotely with NetGear's SNMP utility, but initial configuration must be carried out via the USB port, which only takes a few minutes. The USB Manager utility displays a basic list of access point settings, which can be individually selected for modification. You can choose an IP address, ESS ID name and wireless channel and activate encryption. You can also play around with the transmission rates, preamble length and RTS thresholds. We can't see the target market needing to change these settings, but the documentation does provide some basic information about their purposes. The SNMP Manager provides remote access to the same parameters, but also adds a couple of tables showing Ethernet and wireless packet statistics.

The MA401 PC Cards are well built with a solidly attached aerial and a single LED showing link status and activity. Installation is just as simple, and NetGear provides the same configuration utility as D-Link. This displays bar graphs showing link quality and signal strength, and also provides easy access to the card's configuration. Under the Encryption tab you'll find an option for 128-bit WEP, although this is academic, as the access point only supports 40-bit WEP encryption.

Performance proved to be a weak point, but was still reasonable considering the price point of the NetGear products. A long preamble is the default setting, which offers improved reception, but we reran the tests with a short preamble selected and saw a small speed improvement of around 5 per cent. Overall, the NetGear wireless products look a good choice for the home office and small business, although it's worth noting that D-Link offers similar features and better performance for a slightly smaller outlay.

NetGear ME102/MA401

verdict: A simple wireless solution ideally suited to the small business. Easy to install and use, although performance is modest and it isn't as good value as the D-Link DWL-1000AP/DWL-650.

OVERALL	○○○●●●
performance	○○○○●●
features	○○○●●●
value for money	○○○●●●

SMC Wireless Barricade/SMC2632W

- **Price: Barricade, £250; PC Card, £109 (exc VAT)**
- **Supplier: SMC Networks 01189 748700**
- **Internet: www.smc.com**

SMC supplies a complete range of low-cost wireless products and also offers some interesting alternatives to this theme. Not only does the Barricade function as a wireless access point, but it combines this with a broadband router, an integral Ethernet hub and a print server as well. The Barricade is solidly built with a useful display panel showing the status on each Ethernet port, the WAN port and wireless network activity.

Three 10/100BaseTX Ethernet ports are provided at the rear, and the network port count can be expanded by linking the Barricade to another hub or switch. An RJ-45 WAN port is provided for connecting a suitable cable or xDSL modem, a 25-pin parallel port supplies the printer connection and a nine-pin serial port can be used to add a standard 56K modem or external ISDN TA (terminal adaptor) as a backup link in case the main WAN connection fails.

A simple installation routine sets a PC up in the same IP network as the Barricade's default address. No utilities are provided by SMC, as you move directly to a Web browser for any further configuration and management. The interface is well designed and provides easy access to all settings. A wide range of useful security measures are on offer – 40-bit and 128-bit WEP encryption are supported, you can block or allow up to 32 MAC addresses and define which Internet services are available to specific user groups. NAT (network address translation) also hides your internal network behind a single IP address that's presented to the outside world. However, the Barricade isn't a good choice if ISDN provides your primary Internet feed, as it doesn't have many of the essential features found in standard ISDN routers.

PC Card installation is also a cinch. SMC bundles the same configuration and monitoring utility as D-Link, which provides easy access to the network configuration and encryption settings plus two simple bar graphs showing signal strength and link quality. Small businesses looking for an all-in-one solution to their networking needs will find the Barricade a good choice. Supporting documentation could be better, while wireless performance is only average, but it's simple to install and provides good levels of security for both wired and wireless users.

SMC Wireless Barricade/SMC2632W

verdict: Look no further if you want a good-value one-stop solution to all your small business networking and Internet requirements. Average wireless performance, but easy to install and manage with good security options.

OVERALL	○○●●●●
performance	○○○○●●
features	○●●●●●
value for money	○●●●●●

U.S. Robotics Wireless Access Point/PC Card

- **Price: Access Point, £299; PC Card, £109 (exc VAT)**
- **Supplier: U.S. Robotics 01628 640140**
- **Internet: www.usr.com**

The U.S. Robotics (USR) brand name disappeared for a while when 3Com acquired the company back in 1997. But it resurfaced last year as a result of an agreement between 3Com, Accton Technology and NatSteel Electronics, where all of 3Com's analog modem products were assumed by the newly formed company. Along with its well-respected modems, the company offers a range of wireless products comprising an access point, PC Cards and PCI adaptors (*see Wireless desktops, p180*).

The PC Cards are well built, with the aerial firmly attached to the card body and a single LED showing link status. Installation on both clients was smooth enough, although it's worth noting that the USR cards were the only ones that defaulted to an Ad Hoc peer-to-peer setting and won't communicate with the access point until InfraStructure mode is selected. There are some similarities with the D-Link products, as you get the same configuration and monitoring utility. This allows you to select the operating mode, pick an SSID to join and decide whether to allow the card to select the best transmission rate or set it manually. USR scores better than D-Link for security options as its cards support 40-bit and 128-bit WEP encryption.

The plastic access point is solidly built, with a good range of LEDs on the top panel showing power status plus separate indicators for network and wireless connection and activity. A single removable aerial is fitted at the rear along with a basic 10BaseT Ethernet port. A nine-pin serial port is also provided, although the manual doesn't give any indication as to its use. An AP Utility gets installation off to a flying start as it searches the network for access points and provides a simple screen for assigning an IP address to the selected unit. On completion you can then launch directly into the Web browser interface. There's not much to see as it only provides basic information about the access point and access to its IP address and encryption settings. No information about connected clients is provided and no link performance statistics are available.

Pricewise, the USR package compares well with the other budget products from D-Link and NetGear. Performance isn't great, but it does offer better support for strong encryption. That said, Agere's ORiNOCO still offers better value PC Cards and more features.

U.S. Robotics Wireless Access Point/PC Card

verdict: A simple, cost-effective wireless solution well suited to small offices. A pedestrian performance, but the products are easy to install and use, offering good security, with only one or two quirks.

OVERALL	○○○○●●
performance	○○○○○●
features	○○○●●●
value for money	○○○●●●