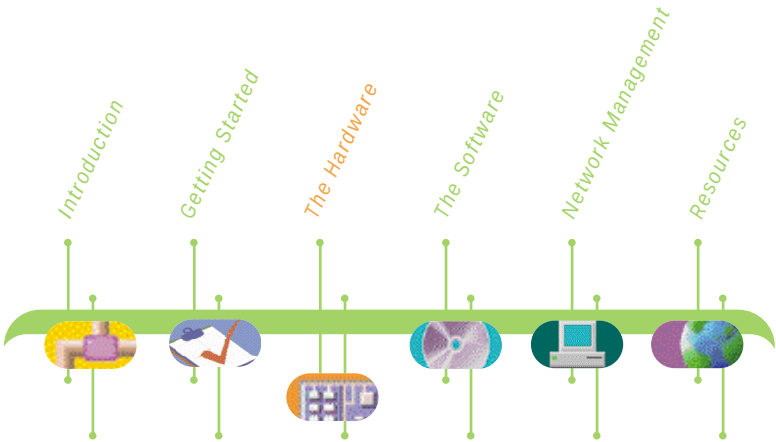


The Hardware

Installing network cards

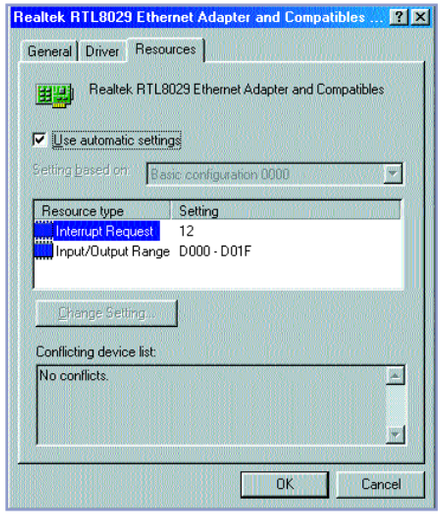
Physically installing a network card in a PC is easy. Setting it to use the resources you want it to can be hard with older cards. If you have a good old-fashioned 'hardware setup' ISA network card, there will be jumpers — little plastic blocks with contacts inside that slide over pins on the card. A few cards use very small switches. Many people prefer these old hardware setup cards because you can see the settings at a glance, and you know the card isn't going to have a crisis of confidence and reset itself when you're not looking.

Current Plug and Play (PnP) cards are generally well behaved, but many middle-vintage non-PnP network cards don't use hardware setup. Many offices have these cards languishing in a cupboard because nobody can find their special setup program any more, and without them you can't tell what resources the cards are set to use; you just have to guess.

A PC network card needs an Interrupt Request (IRQ) and an Input/Output (I/O) range to itself, and most cards only support a few of each. If you're running Windows 98 or NT you can easily see what resources are available by going to System Properties as in the example on the right.

The I/O range shouldn't be a problem, but packed machines are often short of IRQs. It's possible for IBM compatibles full of expansion cards to run out of IRQs altogether, and in some other cases there *would* be enough to go around, but the address limitations of particular cards make it impossible. Plug and Play doesn't solve the problem, but it does take care of all the address assigning by itself; in conjunction with the wider address possibilities of most proper PnP cards, running out of resources is unlikely.

Whether you're dealing with a cutting edge PnP PCI card or an antique jumper-setup ISA card, the procedure is much the same.



ONE

Take the case off your computer.

TWO

Find the appropriate empty slot; it's impossible to insert a PCI card in an ISA slot or vice versa — well, not without using a hammer, anyway.

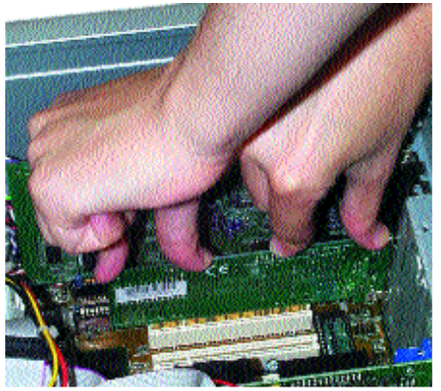
THREE

Remove the slot cover at the back of the computer, if there is one.

FOUR

Push the card firmly into the slot and screw it in with the screw that, most probably, previously retained the slot cover.

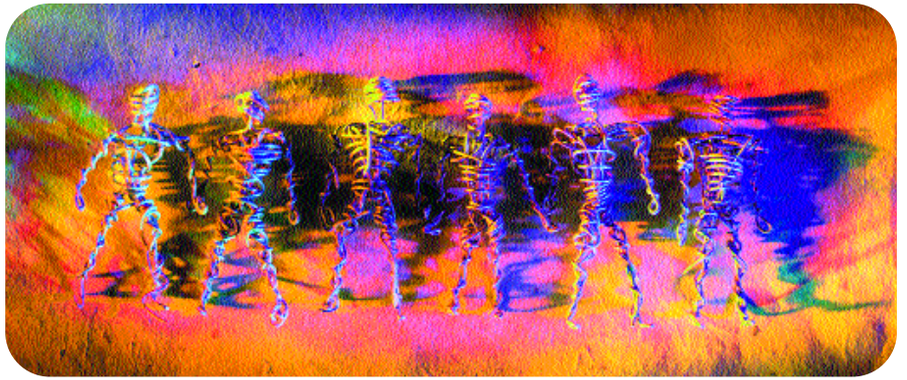
If the card doesn't fit into the slot, chances are it's a mismatch between the metal 'tang' on the back of the card and the cutout it's meant to slip into in the case panel to which the motherboard is screwed. Peer at the end of the tang as you try to insert the card; the problem can often be solved by slightly bending the tang fore or aft. You should never need to use undue force to install an expansion card.



FIVE

Turn the machine on and see if the network card is recognised.

If you're using Windows 95 or 98 and it detects a resource conflict between devices — which can be caused by non-PnP devices, or just by running out of resources — the 'broken' devices will be highlighted. Windows doesn't catch *all* conflicts, but it's pretty good at it. Working out the problem is a matter of shuffling resource allocations around; both 95 and 98 have a Hardware Conflict Trouble-shooter as part of their help system which will step you through the process.



Installing a hub

BASIC, STANDALONE 10BASET and 100BaseT hubs are literally a 'plug-and-go' proposition. Plug 'em in, connect the network cables, turn everything on and presto, one network. If your computers are set up properly and nothing works, you probably have a dead hub. You should check the setup first, though.

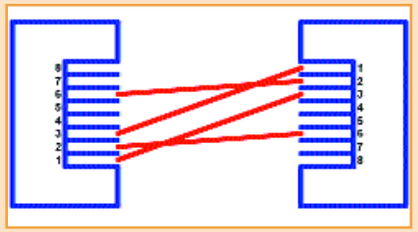
Use a crossover cable to connect machines in pairs; if they recognise each other the setup is fine and the problem lies elsewhere. If several computers don't see the network properly, it's most likely a software setup problem. If only one fails to work, it's probably a bad cable or, less likely, a bad network card.

Hooking it all up

There aren't many tricks to network cabling. With both coaxial and twisted-pair cable, you should avoid running cables over fluorescent light battens and other sources of electromagnetic noise, such as long power cords. Where network cables cross other cables that carry a reasonable current — computer data cables don't count — they should do so at a right angle, to minimise interference. You should also use the shortest practical network cable. A 10m cable coiled up on the floor between two computers on the same desk will reduce your network signal strength unnecessarily, and is a waste of money.

Realistically, even really dodgy network cable installations work just fine for most people. If your network doesn't function properly, bad installation can certainly be the reason, but lots of amateur installers get away with it.

Making a 10BaseT crossover cable



Two, and only two, 10BaseT or 100BaseT devices can be connected using a crossover cable without the need for a hub. The picture shows how to wire one yourself (the pin numbers can be seen as you look at the contact side of the plug, with the cable running away from you). You can buy crossover cables off the shelf — they're the same kind of cable generally used to cascade multiple hubs into one network. Some hubs, though, can be connected with regular non-crossover cables.

10Base2 tips

10Base2 cables are great when they work, and really annoying when they don't, thanks to the difficulty of locating defective components in a bus network. For this reason, treat your 10Base2 cables with respect, and don't be slow to discard cables that have been yanked, kinked or shut in a door. Sure, they may work fine now, but if another $10 for a new cable is less annoying to you than a possible intermittent network outage in a month, get a new cable.

If a 10Base2 cable is known to be flaky, stand on one of its connectors and give the cable a healthy yank. This will pop the connector off and make sure no poor sucker rescues the cable and tries to use it again. It is also a highly satisfying way of punishing the cable that's had you hunting around for the last hour.

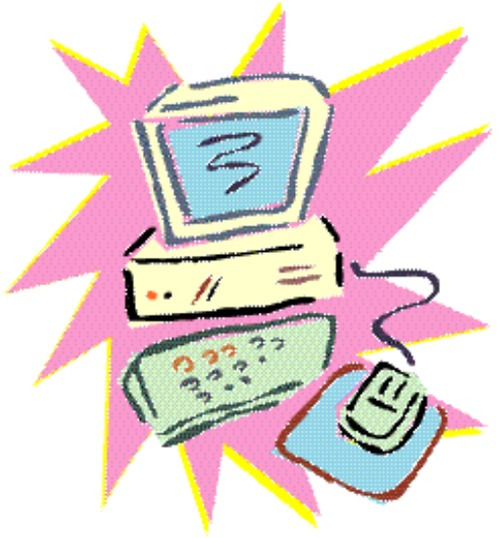
10Base2 cable should, ideally, have its shield grounded at one end. That's what those funny little chains hanging off some 10Base2 terminators are for. Screw the lug at the end of the chain to the back of the computer. If you don't ground the cable, it'll probably work OK. If your cable is ungrounded and your network is slow, try grounding it.

If a 10Base2 network has a repeater, it probably grounds it at that end. This is important, because you must only ground 10Base2 at *one* end; differences in ground potential between the ends of the cable can cause lots of network errors at best, and can be dangerous at worst. This is why you should never run coaxial network cable between buildings; there can be large ground potential differences, and if one end is grounded deliberately or accidentally the other end can deliver quite a jolt to anyone touching it and a local ground. Both 10BaseT and 100BaseT cable does not have this problem.

10/100BaseT tips

10BaseT and 100BaseT cables are as simple to work with as 10Base2, but the networks they're used in are easier to manage. Again, take care of your cables and discard non-functional ones promptly. Putting them in a drawer may result in them being pressed back into service.

The RJ-45 connectors that 10/100BaseT cable uses are much more fragile than BNCs; the springy plastic clip on the back of the connector is easy to snag on other cables while pulling the cable out from behind a desk, and it commonly breaks off. An RJ-45 with a broken clip will work, at a pinch, but there's nothing stopping it from falling out of the socket — except, in many cases, sticky tape.



Ensuring it all works

THE SIMPLEST WAY TO TELL if your network card is working after installation is to just plough ahead with the setup process and see if the network works (see the Software chapter). If you're curious or trying to solve a problem, remember that your network card's setup program is likely to double as a diagnostic program — or there'll be a separate diagnostic program on the disk. It will be able to display the resources used by the card, and can probably perform send-and-receive diagnostics as well. You'll need more than one machine to use that feature, of course.

Proper hardware network diagnostics are basically impossible without real cable checkers and signal tracers. Fortunately, a PC makes an OK piece of network-checking gear. You can either just try to set up networking on all connected machines and see if they work — and, if you do it right, they should — or you can use the diagnostic software included in the operating system. In Windows 95/98, open a DOS window and type net diag. This will look for a 'diagnostic server', and if it doesn't find one, will offer to be one. Choose Yes, and do the same thing on another computer. If the network is working, the second machine will see the first one as a server.

Windows 95, 98 and NT come with a program called winipcfg, which reports the IP address you're using for both cabled and dialup networking, if applicable. You can run this program by selecting 'Run...' from the Start Menu and typing its name.

If you know what you are doing and set up TCP/IP, you can perform a similar trick by using the Ping program. From DOS type ping [address], where [address] is the IP address of another machine on the network — or your own, for that matter. It's OK to enter your own IP address, although all this will tell you is whether your own TCP/IP installation works.

If all is well, you'll rapidly be looking at the results of four, quick data exchanges. If you use the -t option, as in ping -t 192.168.1.205, Ping will keep pinging until you abort it with Control-C. This is a good way to find dud 10Base2 cables; start a ping -t going and wiggle connectors until you see timeouts.

Internet sharing hardware

SHARING AN INTERNET CONNECTION is one of the handiest things you can do on a LAN. For small business and home purposes, the budget may only run to a simple modem connection, but that's adequate for undemanding use.

The Windows 98 service pack promises, among other things, to introduce Internet connection sharing as a standard Windows feature. Windows 95 and the current version of 98 don't have it, though, so you have to use a third-party solution. There are both hardware and software solutions to a modem-sharing problem, all of which work, essentially, as proxies.

A basic network modem sharer.

What's a proxy?

When one computer dials an Internet Service Provider and receives its IP address, it can be used to Net-surf. It can't directly share that Internet access with other computers, because they all need to have different IP addresses — otherwise, the data doesn't know where to go. A proxy overcomes this problem by taking requests from multiple machines, keeping track of who asked for what, and translating the requests so they all appear to come from its IP address. When the requested data comes back, the proxy retranslates it, addressing it to the requesting computer.

Hardware proxy boxes are dedicated devices that plug into both a network and one or more modems. The multi-modem ones often have the ability to use only the required number of modems needed for the current load. They are more reliable than a PC and cheaper too. They're often every bit as configurable as the software versions, including features like email address sharing, where mail addressed to 'Fred[foo@bar.com]' and 'George [foo@bar.com]' all gets delivered to the foo@]bar.com account, but is split up by the proxy for delivery to different recipients.

A software proxy is priced according to the number of connected computers it allows. SyGate tops out at $US199 for unlimited users. Software proxies are no harder to set up than hardware ones and they offer many extra features. On the other hand, the proxy computer has to be on all of the time, and Internet access will drop out if it crashes. For many small network applications, this is an acceptable limitation.

If you decide to go for a software-based proxy, the current Windows frontrunner is SyGate (http://www.sygate.com/). The previous king of the hill, WinGate (http://www .wingate.com/) is still worth a look, and offers a free evaluation version that can be used on two machines for as long as you like. There's also a free evaluation version of SyGate, but it will only transfer 75M of data. Both WinGate and SyGate work on Windows 95, 98 and NT.

Scenarios

GIVEN WHAT YOU'VE NOW LEARNED, what type of network is best for your needs? The following scenarios list possible networks designed to meet specific situations. Chances are you will recognise your desired network here, or at least something similar. Rough, estimated prices are listed to give you an idea of how much you can expect to spend on hardware as well as a plan for how the network is likely to be set up.

Scenario 1 — Simple home network

A home with three Windows 95 or 98 PCs. Two have adequate hardware for the latest games, the third is older. What hardware do you need to set up a cheap network that lets the owners of the fast machines play games with each other, while using the older computer to store shared files and, perhaps, work as a print server?

Option 1	
3 plain 10BaseT/10Base2 network cards	$90 ($30 each)
2 10Base2 cables of adequate length	$40
2 10Base2 terminators	$10
3 10Base2 T-pieces	$10 (but probably free with the network cards)
Total	$150

Plan

The three computers are connected in line, with a terminator at each end, as a simple 10Base2 network. For 'domestic' file and printer serving, Windows 95 or 98 is more than adequate, and very easy to set up.

Option 2	
3 plain 10BaseT/10Base2 network cards	$90 ($30 each)
3 10BaseT cables of adequate length	$60
1 four-port 10baseT hub	$90
Total	$240

Plan

The three computers are each connected to the hub, which can be set up anywhere that is convenient. This solution is a little more expensive, but 10BaseT cable problems are less common and less annoying than 10Base2 ones. For only three computers, 10BaseT may be overkill.

Scenario 2 — Small home network

A share-house full of gamers. Six computers, all with everything that opens and shuts, have to be connected for vitally important friend-shooting purposes. There's also a single dial-up Internet connection that everyone wants to be able to use.

Option 1	
6 plain 10BaseT/10Base2 network cards	$180 ($30 each)
5 10Base2 cables of adequate length	$100
2 10Base2 terminators	$10
5 10Base2 T-pieces	$15 (but probably free with the network cards)
Total	$305

Plan

The six computers are connected in line as a simple 10Base2 network, with a terminator at each end. If all of the computers are running Windows, a proxy program like WinGate or SyGate running on the one with the Internet connection will allow it to share its connection with the others. A six-user WinGate or SyGate licence costs $US69.95. If one of the gamers can handle Linux, one of the computers can run it and be the Internet sharing machine without any commercial software purchases being necessary. A lowly 486 is more than adequate as a Linux Internet access sharer.

A six-computer 10Base2 network is likely to be more than acceptably reliable, but it's a fact that a fault in any of the cables will bring down the whole network. 10BaseT is less of a problem in this department.

Option 2	
6 plain 10BaseT/10Base2 network cards	$180 ($30 each)
6 10BaseT cables of adequate length	$120
1 eight port 10BaseT hub	$110
Total	$410

Plan

The six computers are each connected to the hub with SyGate or WinGate or some other proxy server used as above. When the network is working, it looks to all of the computers just like the 10Base2 solution above. But it's more straightforward to wire up and cable faults won't kill the whole network; they are easy to locate and fix. On the other hand, it's a bit more expensive.

Scenario 3 — Small business network

A new business has 20 PCs and needs one server for safe file storage. It's just ordinary business computing, so no fancy high-speed networking is required. The business can't afford to hire dedicated network administration staff, so the system has to be as easy to use as possible.

Option 1

20 plain 10BaseT/10Base2 network cards	$600
20 10BaseT cables of adequate length	$400
1 24-port 10BaseT/100BaseT hub	$450
1 big fat server PC	$5,000
Total	$6,450

Plan

For ease of administration and security, the server computer should run Windows NT. For basic file serving, Windows NT Workstation is adequate; you don't need the full-blown Server package. Even NT Workstation is an expensive operating system, but it does the job and anybody who can run Windows 95 or 98 can figure out NT 4 fairly easily.

Installing the network cards and hooking up the network is the same as for any other 10BaseT network, and, again, once it's up it should be very robust. Any problems should be confined to the computer with the dud cable and should not cause trouble for the whole network. If the server cable or network card doesn't die, the network as a whole will still work as designed.

Scenario 4 — Sharing Internet access

A business has an existing Windows network, but wants to share an Internet connection as well. None of the staff is much of a computer whiz, so it has to be a simple solution.

Option 1

Requires proxy server software like WinGate or SyGate. Licences for these programs in their various versions start at $US40 and top out at $US299.95 for unlimited users for SyGate, or $US699.95 for unlimited users for WinGate. Setup is very simple on any computer with existing Internet access, and anybody who can see that computer via the network can also set up their PC to share its Internet connection. However, the sharing computer has to be turned on whenever anybody wants to use the Internet.

Option 2

A dedicated hardware modem sharer. These are available with single or multiple modem connectors, or even ISDN connectors. They plug into a 10Base2 or 10BaseT network, and cost as little as $350 for basic models — less than the higher level software proxy licences. Current models are only slightly trickier to set up than a software proxy — the sharer typically can be configured via any Web browser on any computer connected to the same network — and they're always on and ready to go.

Scenario 5 — Upgrading business network

A business has 30 PCs connected to a 10Base2 network. It's old and unreliable; all the cables have been abused over the years and the network can be counted on to stop working at least once a day, until the right person jiggles the right connector. Rather than continue hunting and replacing dead cables, they want to ditch the old 10Base2 network hardware and upgrade to something less annoying.

Option 1	
30 plain 10BaseT/10Base2 network cards	$900
30 10BaseT cables of adequate length	$600
2 16-port 10BaseT/100BaseT hubs, and a connecting cable	$600
Total	$2,100

Plan

All of the crusty old 10Base2-only network cards are yanked out of the PCs and replaced with modern 10BaseT/10Base2 dual-mode cards. Any computer that already has 10BaseT ports on its network cards won't need to have its old cards changed, but older 10BaseT-capable cards may need to be manually set to 10BaseT mode.

The two hubs are set up where convenient and cascaded together with the connecting cable. They can be as far from each other as any computer can be from them — about 185m worth of cable. All the computers are hooked up to the closest hub.

As far as the PCs are concerned, nothing has changed — the network is just as it always was, except now it actually works all day, every day.

Option 2	
30 10BaseT/100BaseT network cards	$1,500
30 Category 5 cables of adequate length (pretty much all plain 10BaseT cables are Category 5)	$600
2 16-port 10BaseT/100BaseT hubs and a connecting cable	$600
Total	$2,700

Plan

If you spend a bit more money, you can upgrade the network to 100BaseT for faster performance. If you use ordinary hubs, though (as opposed to a switch), every computer has to be using 100BaseT or they'll all be choked back to the speed of the slowest one. Hooking up the 100BaseT network is exactly the same as hooking up the 10BaseT one, except the end result is faster.

Scenario 6 — Improving network speed

A small advertising agency has an existing 10BaseT network, with 17 computers all running from a pair of connected 10-port hubs, but the three designers are complaining that it takes them ages to load and save big graphics files from the server. How can they get more speed without upgrading everyone?

Option 1

Putting a two-port 10BaseT bridge in between the 13 'low-bandwidth' design and server computers and the four 'high-bandwidth' ones (the three designers and the server) will prevent traffic between computers on one side of the bridge taking up bandwidth on the other. This will provide a noticeable improvement only if the low-bandwidth computers are actually generating a lot of traffic, and if that traffic doesn't generally involve the server. A Windows NT machine with two network cards can easily be configured as the bridge, but if you use Linux instead you can set it up on a cheap 486 or Pentium for a much more cost-effective, and more reliable, solution.

Option 2	
3 10BaseT/100BaseT network cards	$150
1 eight-port 10/100 switch, and a connecting cable	$600
Total	$750

Adding a switch that can connect to the existing hubs will allow the high bandwidth design and server machines to have their own dedicated 10 or 100MHz network connections, upon which traffic that doesn't specifically concern them won't impinge. The switch will need as many ports as there are high bandwidth users and must support 100BaseT Ethernet for a really worthwhile improvement. Any computer that wants to use 100BaseT to connect to the switch will need a 100BaseT network card, but 10BaseT connections to the switch won't slow down the 100BaseT communications.

Scenario 7 — Mobile networking

How do you connect a laptop computer to an existing 10BaseT network quickly and simply so that a salesperson or travelling executive can walk in, sit down, plug in and be connected?

Option 1	
PCMCIA 10BaseT network card	$250

If the laptop only ever needs to be connected to this one network, the little PCMCIA network adapter can live on the laptop user's desk. If the laptop needs to be connected to other networks, the card can travel with it.

The laptop will automatically recognise the network card when it's inserted, and the user can then log on to the network exactly as if it were an ordinary desktop computer. But while it's plugged in, the laptop is tethered. It isn't possible to take it to, say, the meeting room and still be connected to the network, unless there's another network cable for it in that room.

Option 2	
Diamond Homefree laptop/PC wireless networking package	$600

Diamond's Homefree is the cheapest wireless networking system on the market. You install a card with an antenna in a PC that is connected to your regular network, and the PCMCIA card goes in the laptop as normal, except that instead of a cable it has another antenna. The two computers are now networked together at about one fifth of the speed of standard 10BaseT — provided there aren't too many obstructions or too much distance in between.

Unfortunately, the stock Homefree software doesn't let the wireless network connect to a second, wired one; you'll need a separate 'NAT' package for that. You can buy separate Homefree network cards and thus build a whole network using these alone, but it isn't fast enough for everyday business use.

Homefree's range isn't fantastic, and this together with the speed make it unsuitable for many applications, despite its attractive price. Proxim's Symphony system is more expensive (about 50%) and isn't any faster, but it offers considerably better range and superior software.