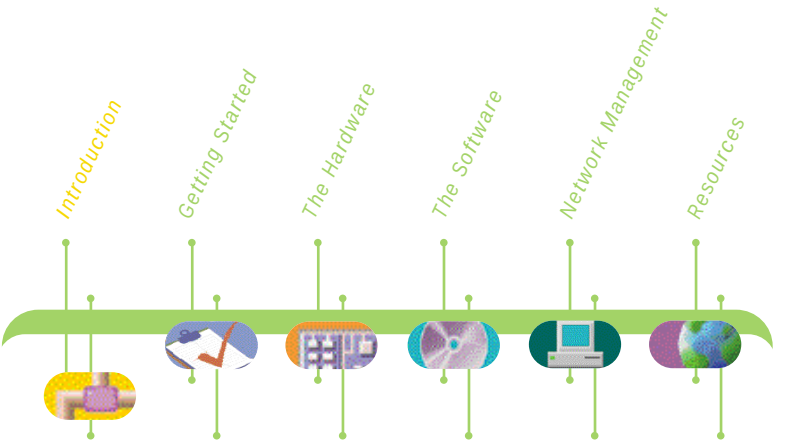


Introduction

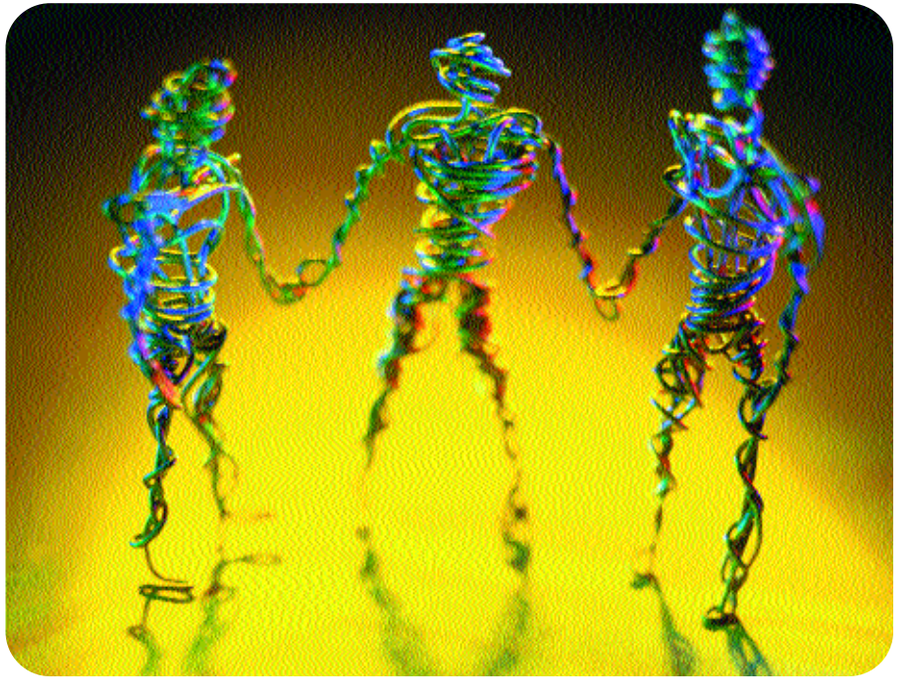
Why network?

THERE'S A TRUISM ABOUT NETWORKING that connecting people and their computers doesn't add to their productivity, it multiplies it. The Local Area Network (LAN) has become a fixture in the modern office and networking hardware that is ludicrously cheap and easy to set up has resulted in more and more home networks.

Networking used to be expensive and difficult, and books on the subject were a lot thicker than this handy Pocketbook. Today, every operating system has support for networking built in and an IBM-compatible personal computer network card costs less than $50 (sometimes a *lot* less). This makes it very easy to get into basic networking and reap the benefits.

Even if you only have two computers it can be worth while linking them. The more computers you have, the more useful a network becomes.

Using a LAN, everyone can effortlessly share one contact and appointments database. You can immediately read and edit a document someone else just saved. Huge blocks of data can reside on one computer and be accessed by others as needed, rather than taking up space on everybody's machine. And, of course, you can play multiplayer games with your family and friends at the drop of a hat.



What's it all about?

At its most basic level — a straightforward 'peer-to-peer' arrangement where you string together your existing computers without adding any special new devices — a network offers huge benefits. First and foremost, you can access files on another computer, from ordinary business documents to databases and application CDs. You can also use someone else's printer, so you don't need your own. If one computer has a modem connected, it's quite easy to let everyone share it for faxes, data communication or full-blown Internet access. Specifically designed 'groupware' applications are intended for use by lots of people on a network. They facilitate collective efforts while smoothing out problems like how to handle multiple access to the same project at once.

Adding more serious dedicated hardware provides you with a single, high-powered file server that delivers data to everyone's computer almost as fast as they could get it from their own hard drive. Such machines are more secure, using redundant storage systems and automatic backup that can tolerate a hard drive going bad. You can 'segment' networks so that traffic on one segment doesn't slow down another. You can share one high-speed Internet connection among many machines. You can even connect networks of different kinds, so you can integrate a collection of computers locally or link business networks across town or across the world.

We do discuss this more advanced equipment in this Pocketbook, but our chief focus is the kinds of networks required for small offices and homes, which are simpler, cheaper and easier to work with.

A brief history of networking

Computers in general haven't been around for very long, personal computers even less. The history of PC networking is shorter still. Advanced Research Projects Agency Network (ARPAnet), the progenitor of the Internet, was set up in 1968 and represented the first connection of different types of computer. ARPAnet had only four connections, or nodes, in 1969; it had grown to more than 60,000 nodes by 1989, when it was subsumed into the Internet.

Computer systems with a central mainframe and multiple terminals were, superficially, somewhat like a modern LAN, but the terminals were generally incapable of doing anything without their connection to the mainframe. These systems were the first 'client/server' networks. They spurred the development of the first long-distance high-speed networking system, the X.25 protocol, which was standardised in 1976. X.25, running over high speed-digital connections, led to the development of the first common large networks.

The first real LANs used Datapoint's ARCNET (Attached Resource Computer Network) technology, which was released in 1968. Various other networking standards arose over the next few years, but one of them beat out the rest.

Ethernet, the most popular modern network and the subject of most of this book, was first developed in 1973 at Xerox's prolific Palo Alto Research Center (Xerox PARC). By 1980 it was being promoted by Digital Equipment, Intel and Xerox as a general networking system. At the time, home or business PCs didn't really exist; certainly not one that could make use of a LAN. Moving data from computer to computer was commonly achieved via 'sneakernet' — schlepping a floppy disk around.

The second most popular LAN protocol, token ring, was released by IBM in 1985. At that time, sneakernet was *still* far and away the most popular system in smaller businesses, but Novell's NetWare, the first really successful Network Operating System (NOS), was catching up fast.

Today, every operating system has support for networking built in, so the complexities of networking in the 'old days' have largely been dispelled. We've also seen the arrival of low-cost, high-powered PCs capable of a wide range of business and entertainment functions, many of which benefit from intercomputer communication.

Fortunately, this means you can now buy a large number of very powerful and quite easy-to-use computers for far less than a specialised minicomputer with much less power in the early 1980s.

Unfortunately, many of the people now grappling with networking have nowhere near the expertise of the trained computer wranglers that were required to keep LANs in line — and who still are for big networks. Networking might be easier now, but it still isn't something a beginner can tackle without help.

This Pocketbook provides the help you need, whether you're a rank amateur who wants to play multiplayer games at home, a small business owner who doesn't want to spend a small fortune to have a LAN set up by a professional, or an experienced computer user who's just wondering what the heck the actual difference is between a bridge, a switch and a router, and whether or not you need one. The aim of this book is to cover everything the small office and home user needs to know about Local Area Networks for Windows 95, 98 and NT, Linux and the Mac, and how these networks interact with each other and the rest of the world.

Networking Concepts

What *is* a network?

A network, in computer parlance, consists of two or more computer systems linked together so they can send information to each other. Computer networks are broken down into:

- Local Area Networks (LANs), in which the computers are physically close together, almost always in the same building, and
- Wide Area Networks (WANs), in which the computers are further apart. The Internet is a WAN, as is the network of a company that connects a LAN in one office to another LAN in another office, across the street or across the city.

This book talks mainly about LANs, but also deals with the hardware that allows ordinary users to hook their LANs up into WANs, including how to give a whole LAN access to the Internet.

The flow of information

When networked computers talk to each other, the information they transfer travels at a speed which is set by the kind of network in use. In most LAN systems, only one computer can 'talk' at a time, but data from different sources can be interleaved so tightly that from the user's point of view it looks as if everyone can talk at once. The more computers are trying to send data at a given time, the less each one can transmit per second. This is why larger networks need extra hardware and/or faster connections to maintain acceptable performance. We deal with these gadgets in the Hardware section, but rest assured that for most small office and practically all home applications, basic hardware is more than enough.

Clients and servers

Networks can also be classified by 'architecture' — how the computers interact with each other. The two basic kinds of architecture are peer-to-peer and client/server.

In peer-to-peer networks, all the computers are essentially equal. They can share data and provide particular services — for instance, one computer can have a printer connected to it that all the others can use — but each computer is capable of being used for basically the same things as every other one.

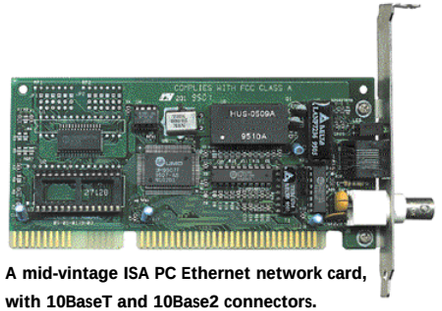
A client/server network has one or more high-powered 'server' machines, which handle the more onerous duties such as doling out lots of data (a 'file server'), providing access to a fast printer (a 'print server') or just administering the network (a 'network server').

The distinctions between peer-to-peer and client/server are blurring somewhat as personal computers increase in power. Pretty much any modern PC can now handle server duties for a quite substantial network and still operate as a regular computer. A 'proper' client/server setup, though, is essential for large networks, because the functions provided by the server are too important to

assign to a computer that's being used for ordinary work and which may bog down or crash, or be turned off by its user.

A full-blown server has multiple redundant power supplies that can be changed without turning off the computer and a battery-backed uninterruptible power supply (UPS). It lives in a big case with lots of cooling fans to keep its drives happy, and these drives are set up in redundant arrays so the failure of one drive doesn't result in the loss of data. The server will also have a regular, automatic data backup system and probably multiple processors to handle the load of dozens or hundreds of simultaneous requests — not to mention comprehensive security precautions to make sure that unauthorised people can't steal or destroy data. These extra requirements make big servers far more expensive than ordinary desktop PCs. On raw performance statistics, they may not seem superior to desktop PCs, but they are absolutely essential for large, demanding networking applications.

For most networks, though, a high-powered server is overkill. Most people want to be able to share files, printers and perhaps an Internet connection, and send each other email. They probably also want to play network games (although they may not admit it). All these functions can be achieved with ordinary PCs running popular operating systems such as Windows 95 or 98. And all you need is some low-cost, off-the-shelf hardware.



A mid-vintage ISA PC Ethernet network card, with 10BaseT and 10Base2 connectors.

The network card

The Network Interface Card (NIC), also known as a 'network adapter', is the essential component for IBM-compatible computer networking. Some PCs come with a network adapter built into the motherboard; many more come with an NIC already installed. All Macintoshes have networking built in. If your computer doesn't have a network adapter, it's very easy to install a network card (see the Hardware chapter).

Most network cards come with connectors for the two most popular types of Ethernet, 10Base2 and 10BaseT, which we'll discuss in more detail later. Slightly more expensive models also support the faster 100BaseT standard.

Cables and connectors

Different networks use different connections. Some networks are wireless — microwave link, for example, is a popular way to send lots of data over medium distances without a wire. Radio networking systems are also available for home and small business use. Even the cheapest wireless networks, though, are still fairly expensive when you consider their limited range and speed compared to cheap, cabled LANs. For this reason, most LANs are cabled.

The standard connectors for Ethernet networks, RJ45 (left) and BNC (right).

There are three basic network cables — twisted pair, coaxial and fibre-optic. Only the first two are likely to be used in most situations for quite a while yet.

Twisted pair

Twisted pair cable is similar to telephone cable. It consists of one or more pairs of wires, twisted together to reduce interference, with or without a grounded 'shield' conductor enclosing them. Unshielded Twisted Pair, or UTP, is the kind of cable used by the very popular 10BaseT and 100BaseT Ethernet systems. Shielded Twisted Pair (STP) cable is more expensive than UTP but can be used over longer distances by networking systems which support it.

10BaseT and 100BaseT cables use RJ-45 (Registered Jack 45) connectors. RJ-45s look similar to the RJ-11 modular telephone connectors which are valiantly attempting to replace the antiquated giant Australian phone plugs, but which have eight pins compared to the RJ-11's six.

Coaxial

Coaxial cable is round and has one centre conductor covered with a layer of insulation, a braided and/or aluminium foil second conductor and an outer jacket. It's used in various versions for all sorts of high-frequency applications. Coaxial is less susceptible to interference than twisted-pair cable, but it is more expensive and less physically flexible. RG-58 coaxial cable, which has an outer diameter of about 6mm, is used by the older 10Base2 kind of Ethernet, and a thicker, tougher variant is used by the 'industrial strength' big brother of 10Base2, 10Base5.

10Base2 and 10Base5 cables use twist-on BNC connectors. 'BNC' variously stands for Bayonet Navy Connector, British Naval Connector, Bayonet Neil Concelman, or Bayonet Nut Connection, depending on who you ask. It has a skinny pin in the middle and a rotating locking housing on the outside.

Fibre-optic

Fibre-optic cable is completely immune to electromagnetic interference and allows very long cable runs and very high speeds. Unfortunately, fibre-optic technology hasn't percolated down to the low-cost market, and for less demanding applications ordinary

copper cabling offers just as much speed, only over shorter distances. At a glance, fibre-optic cable looks like coaxial.

Picking your protocol

The three most popular PC networks are all Ethernet varieties: 10Base2, 10BaseT and 100BaseT. 'Ethernet' refers both to the kind of cable used in the network and the kind of signals sent on the cable. A number of the terms used here have different meanings when applied to older and more esoteric networking systems, but only these three Ethernet flavours are currently in use for home and small business — and often large business — applications.

10Base2 is also called 'cheapernet' or 'thin Ethernet', because of the thinness (and cheapness) of its coaxial cable. 10BaseT looks to the computer like 10Base2, but offers a more flexible layout. (We'll get into the details of network layout in the next chapter.) 100BaseT is a 10-times-faster version of 10BaseT, and uses the newer Fast Ethernet system.

The '10' in the names of the two slower flavours of Ethernet refers to the signalling speed which is 10MHz. This means there is a maximum useful data throughput, from the user's point of view, of less than 1M per second. A maximum of 10 million actual bits can be sent every second, which is 1.19M per second, but Ethernet has to use a lot of the bits to package up the data being sent so that it's comprehensible to the other computers on the network. Multiple computers talking at once and creating 'collisions' further reduce the usable data rate. 100BaseT uses 100MHz signalling and is therefore faster — although, typically, not nearly as fast as you might expect.

'Base' means they're 'baseband' networks; they have only one channel for data transmission, so only one device can transmit at a time. This is important because as baseband networks have more and more machines attached to them, it's more and more likely that two machines will try to transmit at once, causing a collision. After a collision, the machines involved wait a brief, random period of time before trying again. This means that even severely congested baseband networks still work, but they become slower and slower as more and more machines are added. From the user's perspective it seems that the computers are sharing the available network speed, but if you add the effective throughput of every machine on the network, you'll find that the total gets smaller and smaller as more and more machines are added. Special devices like switches, bridges and routers are used to deal with this problem (see Hardware chapter).

The '2' in 10Base2 indicates the maximum segment length in hundreds of metres. The segment length is the maximum aggregate length of cables you can use with up to 30 computers connected, before you need to use routers, bridges or switches. In reality, the maximum reliable 10Base2 segment length is 185m.

The 'T' in 10BaseT and 100BaseT has nothing to do with cable length — it indicates that these systems use unshielded twisted-pair cable, as opposed to the RG-58 50-ohm coaxial cable used by 10Base2. 10BaseT and 100BaseT do not have a distinct maximum cable length, although 100m is generally the accepted limit, but high-grade, low-loss cable can extend this. This maximum length is the distance each computer can be from its hub, not the total cable length in the system, so a single $200 17-port hub makes it easy to cable up a good-size office. There's more information about hubs in the next chapter.

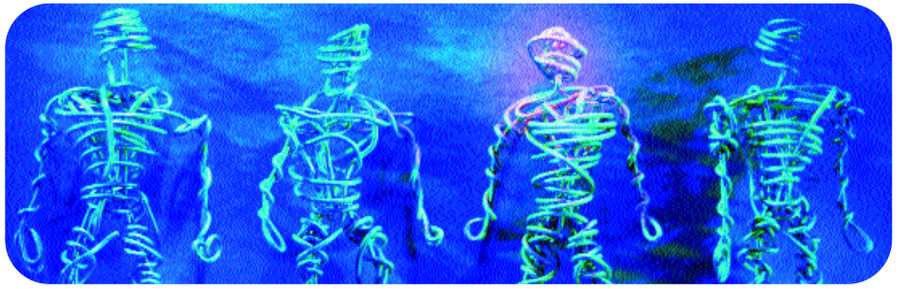
Fun with networking

If you find hooking up a network fun, you really should get out more. But as anyone who's worked in an office with a 'No DOOM' policy would be aware, networks are not just for business.

Most of today's hottest PC games support multiplayer networking, and it's common for game-happy PC owners to congregate at the house of the gamer with the most table space and hook up an impromptu LAN.

Game-specific networks are generally quite small (20 machines or fewer) and are thus as cheap and simple to set up as a small office business network.

Their ephemeral nature, however, means streamlining the setup process is important. Spending a couple of hours working the bugs out of your new permanent office network is annoying, but acceptable. Having to do this every time you drop around to your friend's place to play Total Annihilation, however, is not normal. This Pocketbook will tell you exactly what to do in the Network Management chapter.



Delving the depths of networking

NETWORKING, REALLY, IS SIMPLE. The premise of physically connecting one machine to another and telling them to communicate conjures up ideas of easy installation and configuration. Ultimately, small networks such as those in the home or small businesses really are simply a matter of plugging them in and turning them on.

Problems sometimes arise when it comes to standardising your network regarding the NICs, cable and protocols used by the operating systems. If you settle these early on — and this Pocketbook will help you choose what you need — the seemingly daunting task of networking your PCs can be a quick and painless procedure.

Understanding what you want your network to do and how you want to use it is essential to building and managing your network. Knowing exactly how a network works and what all the bits and pieces do is also essential. As a result you'll find the initial chapters of this Pocketbook heavy in background information, but it's worth reading and reading well in order to understand how it all fits together and what you'll need to build your own.

As you progress through this Pocketbook keep a cup of your favourite beverage near by and sip it regularly, especially during those sections that at first might be a bit hard to consume. You don't need to be a PC expert to read this book, although it helps when it comes to the acronyms and discussions on how your networking hardware works and why. So take your time, learn the secrets contained herein and, patience permitting, you'll be well on your way to becoming a networking guru.

And just think, how much fun will that be?

The Networking Pocketbook Team