Roger Gann

Networks explained

If you wish to gen up on networking, whether for business or pleasure, you need the best teacher around. Enter *PCA's* network guru Roger Gann. Read on for the lowdown on both wired and wireless networks and the hardware involved

If you have more than one PC in your home, imagine how convenient it would be to share files, programs, printers and other peripherals among all your computers. With a network setup, what's on one system is on all systems. If you have a Pentium II that's in semi-retirement, simply dust off the mothballs and hook it up to give it access to many of the bells and whistles on your shiny new Athlon 64.

So why network? That's simple. Networking lets you share both data and expensive peripherals such as printers, not to mention internet connections. It's great for multiplayer gaming too. And in terms of business use, networking makes it easy to centralise backing up and it also improves security.

So what exactly is a network? Nothing more than a way of connecting computers so that they can share things. When you surf the web you're actually connecting to the world's largest network via a phoneline. Most ordinary networks – called local area networks or LANs – are much smaller and have permanent cable links between them. More recently, wireless networking has become very popular.

The good news is that all flavours of Windows make wired or wireless networking very easy. And you'll be surprised at just how little it'll cost to set up a network. Give me £20 and I'll be able to fully network two PCs to let them share their resources. And yes, that does include VAT so we're talking real bargains here.

Windows is just about the best network client you can have – out of the box it can be hooked up to pretty much any network you care to mention. All you have to do is add the networking hardware.

Peers and servants

There are two types of wired networks: peer-to-peer or client and server. Peer networks consist of PCs that are linked to each other so that every computer can access every other system's hard disk – and perhaps even printer. Each PC is no less important than any other hence the name 'peer'.

Peer networks are fine for linking small numbers of PCs together in workgroups. They're cheap and easy to maintain.

Larger networks use the client/server arrangement where one powerful PC – the server – is dedicated to 'serving' the needs of all the computers connected to it – the clients. PCs can only access the server and can't normally directly access other PCs on the network. Most corporate networks follow the client/server model.

So what do you need to set a network up? The good news is 'not a lot'. Each PC needs a network-interface card in to which the linking cable is plugged. Basic cards can transfer data at 10Mbps (megabits per second) but most sold these days are capable of 100Mbps data rates. Because they cost no more it makes sense to run your network at this speed.

Despite dropping in price Gigabit ethernet is still dear enough to keep it confined to corporate networks with heavy data-traffic requirements.

In this case, each PC is connected to the network via a cable. Older networks used what was called a thin ethernet cable, which looked like a

thin TV coax aerial cable and used special twist-and-lock BNC plugs. Several years ago thin ethernet cables were superseded by twisted pair (aka CAT 5) cabling, which is very much like phone cabling. It uses a clear RJ-45 plug that resembles a big version of a modem telephone connection.

The hub of the network

The topology of CAT 5 networks is very different to that of thin ethernet. The old-style cabling was daisychained between computers, so if a PC was disconnected not only would that computer go off the network but all systems downstream of it would go offline. By contrast, CAT 5 follows a star arrangement where each PC connects to a central hub rather like a telephone exchange. It is the hub that makes sure each PC gets the data it requests. And if one connection goes bad, only that PC is affected.

Hubs lack the intelligence to route network data to a specific PC, so it sends every packet of data to all networked computers. It's a bit like you calling a friend and every phone on their exchange ringing out – not very efficient.

A more sophisticated version of the hub is the switch, which operates like a proper telephone exchange – reading the network data and working out who it should be sent to.

A switch effectively sets up a direct link between the source and the target, making for much faster network connections. Switches cost more than hubs, but as network hardware prices continue to spiral downwards the premium has dropped and is now often just a few pounds.

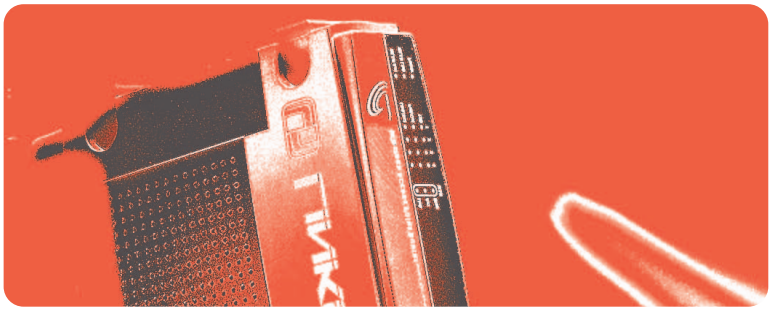
Another take on the hub concept is the router. Like the switch the device is intelligent and can work out if data needs to be sent to an external network such as the internet. It works out a route for the data, hence the name. Combo devices are now common combining, for example, an ADSL modem, router and switch in one box. These can be bought for less than £100.

Using a gateway router, several PCs can share one internet connection

Wire-free setup

Setting up a wired network in a home or office isn't really a problem if the PCs to be networked are reasonably close to each other. Once they're in separate rooms, however, the problems posed by cabling begin to

above: with this Linksys router you can connect wireless and wired-ethernet devices



Explaining ethernet

To be technical, ethernet is networking technology as defined in the 1983 IEEE 802.3 standard. When it was originally patented it was described as a 'multipoint data communication system with collision detection'.

A key concept is its system of collision detection and recovery, called CSMA/CD. With this protocol devices transmit only after finding the data channel clear. If two devices transmit simultaneously, causing a 'collision', they delay their retransmissions for a random length of time.

Ethernet was the brainchild of Robert Metcalfe, who worked at Xerox's Parc (Palo Alto Research Centre) where some of the first personal computers were developed. In the early 1970s Xerox was creating the world's first laser printer – it outputted a single page per minute – and wanted all of Parc's computers to be able to print with it.

By the end of 1972, Metcalfe and a number of other Parc researchers had completed an experimental 3Mbps (megabit per second) LAN (local area network). The following year Metcalfe defined the general principles of what he called ethernet, the technology that made the first PC network possible. His network was initially called the Alto Aloha. It was later changed to ethernet, a play on the 'lumeniferous ether' that was thought to fill the vacuum of space and thus permit the transmission of electromagnetic waves.

After leaving Xerox, in 1979 Metcalfe successfully persuaded Digital Equipment, Intel and Xerox to work together to promote ethernet as a 10Mbps networking standard. One major computer force did not get on board: IBM, which developed a very different LAN mechanism called Token Ring. Despite IBM's resistance, ethernet went on to become the most widely installed technology for creating LANs.

Today there's fast ethernet, which runs at 100Mbps, and gigabit ethernet which, unsurprisingly, runs at 1Gbps. Metcalfe went on to form 3Com, which then became a major networking vendor that's still around today.

mount. Running cabling between rooms can be a hassle to set up and it causes constant disruption as well as being a real eyesore.

But these days we don't need to endure the pain of cabling to network our PCs in the home. We can now connect systems wirelessly. Not only are wireless LANs faster and more reliable than before, they're also much more affordable. They offer all the capabilities of normally cabled networks with the added benefit of flexibility.

Not only is adding another PC to the network a simple procedure, but if you want to move a PC, that's not a problem either. This can be a real advantage for laptop users who work wherever it's convenient – for example, outside in the garden.

The basic hardware setup required for a wireless or Wi-Fi network is similar to a wired one – every PC needs a network card. If there are only two systems to be connected then they can operate in ad hoc mode and no other kit is required. But if more computers need to be connected then you need an access point – a kind of wireless hub.

Wi-Fi network interface cards can take several forms. They can be PCI cards – fitted internally – or they can be USB devices that plug in to a spare port. And for laptop users there's PC card wireless adapters. Access points are available in various permutations, with or without switching, routing, firewalling or ADSL capabilities.

Need for speed

The big question over wireless networking is speed – what sort of speeds are available? Several is the short answer. The original flavour of Wi-Fi, called 802.11b, offered an

Access points such as this US Robotics model are available for around £100

11Mbps data rate but that was just a theoretical maximum speed. In common with cabled networks actual throughput is a lot less – maybe only half of this, around 5Mbps.

More recently, faster wireless networking has arrived. The 802.11a standard offers speeds of 54Mbps. This is five times the speed of 802.11b but is incompatible with it. Then there's 802.11g, offering the same 54Mbps data rate but it's also backward-compatible and interoperable with 802.11b.

Outfits such as Netgear and US Robotics offer highly proprietary turbo versions of 802.11g, claiming to offer 108Mbps of bandwidth. Real-world throughputs are, once again, much lower – 802.11g 54Mbps gives you 20Mbps at best while the turbo versions deliver about 30Mbps. The law of diminishing returns applies to Wi-Fi with a vengeance.

Routers such as the Netgear DG834 provide continuous broadband access

Security remains an issue with wireless networking – anyone with a Wi-Fi card in their laptop can attach to your wireless network unless you turn on its security features. Unfortunately, the WEP (wired equivalent privacy) security offered by most Wi-Fi hardware has been shown to be lacking. It has been superseded by the far superior Wi-Fi Protected Access but so far takeup of the new security standard has been patchy among hardware vendors.

The rule is: if it does TCP/IP then it can be shared. In the same way that one person on one PC can have multiple instances of a web browser running while at the same time downloading software, more than one user can simultaneously share an internet connection

Share and share alike

Internet connection sharing has to be the killer app of home networking and can be set up with almost any kind of connection including cable, ADSL, ISDN, dialup, satellite and fixed wireless. The rule is: if it does TCP/IP then it can be shared. In the same way that one person on one PC can have multiple instances of a web browser running while at the same time downloading software, more than one user can simultaneously share the same internet connection.

As an increasing number of households now have more than one PC, it makes sense to share an internet connection between several machines, whether it's a fast broadband connection or a humble dialup modem. A joint connection will let you and others on your LAN perform different internet tasks at the same time. For example, one

Access points comparison

Model	Website	Price inc VAT	Speed	Security	Wired network ports	Remote management	Content filtering	DHCP server
Canyon GAP-E05L	www.dabs.com	£55	11Mbps	WEP	1	no	no	yes
D-Link DWL-2000AP	www.dlink.co.uk	£75	11/54Mbps	WEP/WPA	1	yes	no	yes
Linksys WRT54G	www.linksys.com	£80	11/54Mbps	WEP/WPA	4+ WAN	yes	yes	yes
Netgear WGT624	www.netgear.com	£100	11/54/108Mbps	WEP	4+ WAN	yes	yes	yes
US Robotics USR8054	www.usr-emea.com	£100	11/54/100Mbps	WEP/WPA	4+ WAN	yes	no	yes

Routers comparison

Model	Website	Price inc VAT	Switched ports	WAN port	Universal plug and play	ADSL modem	Firewall	DHCP server
Belkin F5D5230U4	www.belkin.co.uk	£46	4	yes	yes	no	no	yes
D-Link DSL-504	www.dlink.co.uk	£90	4	n/a	no	yes	no	yes
Linksys BEFSR41	www.linksys.com	£42	4	yes	yes	no	no	yes
Netgear DG834	www.netgear.com	£90	4	n/a	yes	yes	yes	yes
SMC SMC7404	www.smc-europe.com	£93	4	no	no	yes	no	yes

What is TCP/IP?

The roots of TCP/IP (transmission control protocol/internet protocol) lie in the data communication needs of the US DoD (Department of Defense) at the height of the Cold War in the 1960s. Back then the DoD's Arpa (Advanced Research Projects Agency), now called Darpa, began a partnership with US universities and the corporate researchers to design open, standard protocols and build multivendor networks. The fruit of their labours was ArpaNet, the first packet-switching network running the NCP (network control protocol).

In 1974, Vint Cerf and Robert Kahn proposed a new set of core protocols for the ArpaNet. As other networks, including radio, satellite and Usenet, established connections to the ArpaNet in the late 1970s and 1980s, experts realised that the adoption of a single networking protocol would be an important step toward maintaining order within this growing community.

They chose TCP/IP, which provided a technological bridge for small networks to interconnect much more readily than before. The links branch in every direction, hugely increasing the number of people connected within a single, broad system of information and communication. The resulting network was dubbed the internet. But back then it had no private users, only universities and military institutions.

The 'transport layer' TCP (transmission control protocol) was faster, easier to use and less expensive to implement than NCP. In 1978 the 'network layer' internet protocol was added to TCP to take over the routing of messages.

One of the key underlying principles of this networking protocol was great resilience. Even if part of the network was destroyed by an enemy – during a nuclear attack, for example – there would be redundant network paths that would continue to carry the data. The initial specification went through four early versions, culminating in 1979 as version 4 – the version we use today. Its replacement, IPv6, is in the works but is still some way off.

person could send and receive email, while another person downloads a file and a third browses the internet.

It's important to remember that you don't get something for nothing. If two people share one connection, they may only be able to use half the connection bandwidth at peak times. That's a worst-case scenario and the restriction will only be really noticeable if all the users decide to download files at the same time. In practice, typical web browsing or emailing doesn't persistently hog bandwidth so you shouldn't notice any serious bandwidth degradation when several users are online simultaneously.

There are a few ways of sharing a single internet connection, either in hardware via a router or in software using a proxy server. A hardware router is the most elegant but most expensive setup. It hooks up to the internet and the networked PCs then connect to it – so long as the router is running any PC can connect instantaneously. A software-based proxy, such as Windows Internet Connection Sharing, works just as well but requires that the host PC is up and running at all times.

The ground rules

Whichever route you go down, there are some sharing rules. Obviously there must be at least two computers. A functioning network interface card must be properly installed in each PC and the network must be up and running normally, with TCP/IP installed on all the systems.

And the PCs on the network don't have to be running the same operating system either. So long as they can use TCP/IP and are set to automatically obtain an IP address then they'll work just fine from the word go.

If you opt to go down the hardware-based sharing route, there's plenty of choice on the market. The best value comes from combined ADSL routers – cable users normally have to buy a router with a WAN (wide area network) gateway port to plug in the cable modem.

Companies such as 3Com, Linksys, D-Link, Netgear, SMC, Draytek and ZyXEL have kit that offers hardware-based internet connection sharing, with prices starting at about £50. Most offer NAT (network address translation), a useful feature that lets you share one IP address between all the machines on your network.

Windows 98 SE, Me, 2000 Professional and XP all come with Internet Connection Sharing software as standard. Under Windows 2000/XP all you need do is right-click your internet connection, select Properties and click on the Sharing tab. Tick the appropriate box and the connection is shared. Simple, eh? ☒

D-Link's DWL 2000 is a 54G Access Point that will set you back only £75