

# Computer Networking

## What is a Computer Network?

Computer networking is a way for computers to communicate with each other. The computers could be located in the same room or across the other side of the world. They could share information such as your online status on a social network, your favourite recipe on a website or to confirm a bank transaction when you use a contact-less debit card.

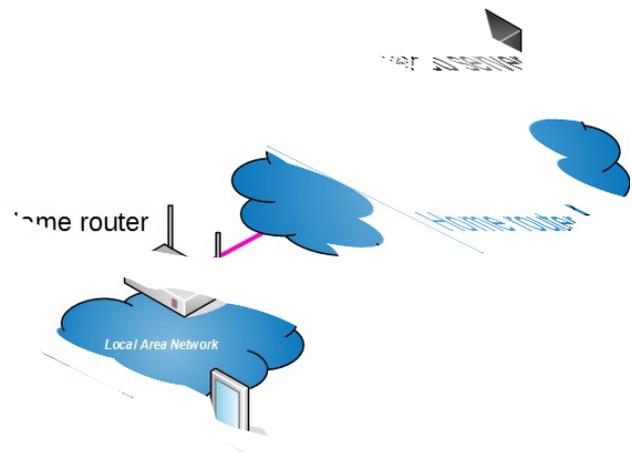
Unfortunately there are lots of terminology used in computer networking, but this will help explain what the different terms mean and how they are used to create the network.

## Local Area Networks and the Internet

The best known network is the Internet which provides a means to connect with computers all around the world. The Internet isn't just a single network that everyone connects to. Instead the Internet consists of many interconnected networks.

When connecting to the Internet then most computers will first connect to a local network known as a Local Area Network (LAN). This connection can be through a physical network cable or using a wireless protocol such as Wi-Fi.

The diagram on the right shows how a local network connects to the Internet through a home router. The networks are shown as clouds which is often used in network diagrams.



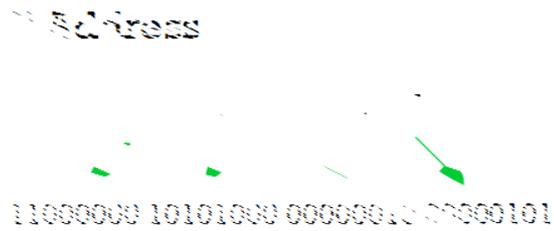
## Protocols (speaking the same language)

For computers to be able to communicate then they need to be able to agree on the rules and terminology they use. This is similar to people having to speak a common language, although whilst you can sometimes get by with physical gestures when you don't speak a foreign language computers are much more fussy. We refer to the rules as protocols.

## Internet Protocol (addressing the computers)

Arguably the most important networking protocol is Internet Protocol (IP) which provides a way of addressing computers and how the data can travel over the network to reach its intended destination. Currently most computers use an IP version 4 address (IPv4) which is used to determine where the data should be sent. This is a numerical address normally represented by 4 numbers separated by dots, such as 192.168.2.5. As with all data it is transmitted as a series of ones and zeros.

This diagram shows an IP address and how it is represented as a series of ones and zeros.



When a computer needs to send data then it adds its own IP address and the destination IP address to the data (along with some more information) into what is known as a packet. By

using the destination IP address in the packet other devices can understand where the data is intended for and so help it on its way.

## DHCP (automatic addressing)

When you connect to a web server the address needs to stay the same so that other computers can connect to that server, therefore they are assigned a fixed (static) ip address. You do not normally need a fixed IP address for a home computer, and in fact a fixed IP address could be a problem for a laptop that may connect on different local networks and may need a different address for each network it connects to.

To make this easier to manage another protocol called DHCP (Dynamic Host Control Protocol) is used to allocate IP addresses dynamically. This can be a dedicated server in large environments, but for your home it is normally performed by your home router.

## Domain Name Service (people friendly computer names)

Whilst computers work using numerical addresses that is not very useful for people, who find it much easier to remember web site names rather than long numbers. The domain name service (DNS) is used to convert the user friendly site names into the IP addresses that the computers use.

The website domains are allocated by registries. The official registry for the UK is Nominet.



This diagram shows a computer requesting the address of the Nominet web site.

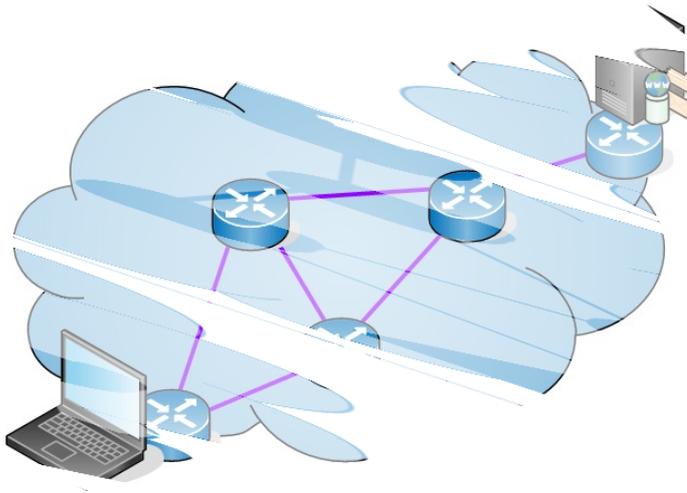
## Routing (pointing the packets in the right direction)

For a data packet to reach its destination it may need to go through many different networks. To achieve this there are routers, which are network devices whose job is to forward the packets through the network. These routers look at the destination IP address and can determine the next router to forward the packet to, or delivery it to the local network.

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To compare the computer network with the postal service you can imagine the routers as being regional sorting offices. If you wanted to send a letter to another country then it would pass through a local sorting office, then towards another that arranges for the letter to be sent abroad. When it is received at the other end it may then go through several other sorting offices before reaching its end destination. This is similar to how routers pass the packets through the computer network passing them from router to router.

This diagram shows the routers using the standard network diagram symbol. As you can see there may be multiple possible routes between the client computer and the server. The routers will determine the most appropriate route based on the availability of other routers and the rules configured on the router.



Whilst this diagram shows the computers connected directly to the router they are normally connected to a switch which allows a large number of computers to be connected to the network. Most home routers have a switch built-in (often 4 physical ports), whereas on commercial networks it is usually a separate device.

## Application Protocols

As well as being able to communicate across the network applications need to be able to speak a common language to exchange information. Some common protocols are HTTP used to send a web page over the World Wide Web (WWW) from a web server to a browser, the SMTP protocol used for sending emails and SIP used for a VoIP (Voice over IP) phone call.

Although there are lots of different protocols in use I will briefly explain just a few that are used to implement the World Wide Web. This will give a small insight into how different protocols are used together to provide a network service.

## Hypertext Transfer Protocol (the protocol of the WWW)

When you request a web page over the world wide web then the client (your computer or hand-held device) needs to use another protocol to ask for the web page. The protocol used is known as the Hypertext Transfer Protocol which you can see as the http prefix used in web browsers. There are also other protocols such as https which adds encryption for additional security.

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## HTML (writing a web page)

The web pages are normally stored in a file format known as HyperText Mark-up Language (HTML). This is a text based language which you can create yourself using a standard text editor. It provides the text you see on the screen along with special tags which indicate special text such as titles and to add images or other objects.

The HTML does not normally include details of how the page will actually look which is normally stored in Cascading Style Sheets (CSS) referenced within the web page.

Some sites also include programming code which can be included in the HTML page or as a separate file. The most common language using within the page for programming interactivity is JavaScript.

```
<html>
<head>
<title>Web page title</title>
</head>
<body>
<h1>Web page title</h1>
<p>A paragraph of text on
the chosen subject.</p>
More text to explain about the
image shown above.</p>
...

</body>
</html>
```

## The Future

The Internet has been around for over 25 years (longer if you think about the networks that first made up the Internet) and during that time it has evolved to accommodate new technologies. There are many small additions to the protocols, but there are some new technologies in the pipeline that promise to make big changes in the way we use the Internet.

## IPV6 (provides more IP addresses)

The biggest problem facing the Internet today is the shortage of IP addresses. The current version of the Internet Protocol IPV4 was created a long time ago when there were relatively few computers. These days most people have two or three computers (including mobile phones, tablets, smart TVs and other devices) which are often designed to be connected to the Internet all the time. Although some techniques have been implemented to delay this they have essentially now run out of IP address ranges that can be allocated.

The new version known as IPV6 replaces the 32bit address with a much larger 128bits address, which gives a huge increase in the number of addresses. It is unlikely we will ever run-out of IPV6 addresses. It also adds additional security, and can work better with large data files.

Due to the size of the Internet and number of devices running IPV4 it will be some time until everything can move over to IPV6, but more devices are becoming IPV6 ready.

## Software Defined Networking (more programmers required)

There is a new technology that is now being used for managing the routing of data through networks which is called Software Defined Networking (SDN). This replaces the traditional routers with networking devices that are controlled by a central computer that can instruct them what to do.

This now means that rather than having configurations created directly on the routers the configuration is written in software that runs on the server. This means that future network engineers may also need computer programming skills in addition to understanding about networking.

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