Dacorum U3A

Computer Support Group

Friday 29th January 2021

How the World Wide Web and Internet works

Agenda

- Identify topics to discuss in later meetings

- Identify any problems for today

- How the Web and Internet works presentation

- Tea and Coffee break (about 3.00 pm?)

- Breakout into smaller groups

How the Web and internet works

Undoubtedly, you're familiar with the internet.

You've seen how it's changed your life – enabling instant communication and putting a world of information at your fingertips.

But have you ever wondered how it all works?

In this Presentation we give a simple explanation of how the Web and Internet works.

How the World Wide Web (WWW) works

Twenty or thirty years ago, there was something you could take for granted: you could walk into a public library, open up a reference book, and find information on almost any subject you wanted.

What we take for granted nowadays is that we can sit down at practically any computer, almost anywhere on the planet, and access an online information library far more powerful than any public library on Earth: the **World Wide Web**.

Twenty-first century life is so dependent on the Web that it seems remarkable we ever lived without it.

Yet the Web was invented less than 30 years ago and has been a huge popular success for only about 20 of them.

One of the greatest inventions of all time... is also one of the newest!

How the Web and internet works

What's the difference between the Web and the Internet?

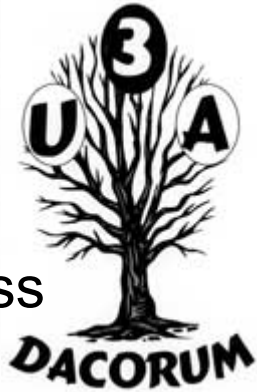Let's get one thing straight before we go any further: the Web and the Internet are two totally different things:

The Internet is a worldwide network of computers, linked mostly by telephone lines; the Web is just one of many things (called applications) that can run on the Internet.

When you send an email, you're using the Internet: the Internet sends the words you write over telephone lines to your friends.

When you chat to someone online, you're most likely using the Internet too—because it's the Internet that swaps your messages back and forth.

But when you update a blog or Google for information to help you write a report, you're using the Web *over* the Internet.

How the Web and internet works

The Web is the worldwide collection of text pages, digital photographs, music files, videos, and animations you can access over the Internet.

What makes the Web so special (and, indeed, gives it its name) is the way all this information is connected together.

The basic building blocks of the Web are pages of text, like this one —**Web pages** as we call them.

A collection of Web pages on the same computer are called a **website**.

Every web page (including this one) has highlighted phrases called **links** (or **hypertext links**) all over it.

Clicking one of these takes you to another page on this website or another website entirely.

The World Wide Web

The world wide web, or WWW, was created as a method to navigate the now extensive system of connected computers.

Tim Berners-Lee, a contractor with the European Organization for Nuclear Research (CERN), developed a rudimentary hypertext program called ENQUIRE.

The program was designed to make information readily available to users, and to allow a user to explore relationships between different pages (eg, clicking to get to a different section of a website).

By 1990, with the help of Robert Cailliau, Berners-Lee developed the skeletal outline of the internet, including a web browser and web server.

Unfortunately, the world wasn't ready for his ideas.

The web was still a series of simple text pages, difficult to navigate, and inaccessible to most people.

How the Web and internet works

The World Wide Web

But all that changed in 1993, with the release of the Mosaic web browser, which allowed users to explore multimedia online. 1993 also saw the introduction of the first modern search engines.

Though early search engines were primitive, mostly manual, and primarily indexed only titles and headers, in 1994 WebCrawler began to "crawl" the net, indexing entire pages of active websites.

This technology opened the door for more powerful search engines, and made it possible to easily search through vast amounts of connected information.

In this same year, Berners-Lee founded the World Wide Web Consortium (W3C) to help further develop ease of use and accessibility of the web, and made it a standard that the web should be available to the public free and with no patent.

How computers can talk the same language

The really clever thing about the Internet is that it allows practically every computer on the planet to exchange information. That's a much bigger deal than it sounds.

Back in the earlier days of computers, in the 1960s, 1970s, and 1980s, it was rare for computers to be able to exchange information at all.

The machines made by one manufacturer were often totally incompatible with those made by everyone else.

In the 1970s, early personal computers (which were called microcomputers) could not even run the same programs. Instead, each type of computer had to have programs written specially for it.

Hooking computers up together was possible, but tricky. So most computers were used as standalone machines, like gigantic pocket calculators.
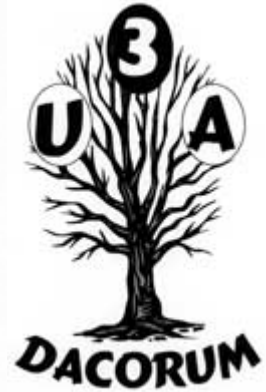
How the Web and internet works

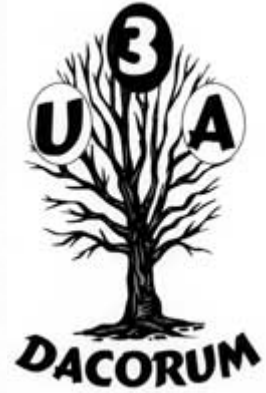The internet has been around for a pretty long time — since the first e-mail was sent in the 1970s.

It gained widespread attention in the 1990s and has since become one of the most important technological developments of all time.

Way back when, we had to dial a connection through our telephones, which ran at a painfully slow 56kbps.

For comparison, an 8Mbps connection is equal to an 8000kbps connection, and we used to connect with just 56kbps. That's a tiny fraction of today's slowest recognised broadband speed within the UK.

How the Web and internet works

This made it very, very difficult to download anything apart from text.

At full speed a single, low-quality song (roughly 3.5MB) would take around 10 minutes to download.

But internet speeds aren't always consistent, so realistically, it would take 30 minutes to a few hours to download one song. If you wanted to download a low-quality movie (around 700MB), it would take 28 hours at full speed, or three to five days at low speed.

In addition to crawling speeds, dial-up internet was also extremely inconvenient because it took up full use of the telephone lines. People were unable to make phone calls and browse the internet at the same time, forcing them to choose between massive inconvenience or the cost of a second line.

How the Web and internet works

And then there was broadband…

Broadband breathed new life into the internet in the early 2000s by allowing the signal in one line to be split between telephone and internet, meaning users could be online and make phone calls at the same time.

This also led to faster connections, making it easier to browse the internet and download files.

The advent of broadband networks meant that people were able to download files, songs, TV shows and movies at greater speeds.

This opened up a whole new world in online media: On the previous 56kbps connection speeds, sites such as YouTube just weren't possible.

How the Web and internet works

Like most new technologies, broadband was extremely expensive when it was first launched, so initial usage was low. Now, nearly everyone uses some form of broadband, whether through their phone lines or other connection types.

Since the launch of broadband, we've seen the rise of new broadband technology, such as 4G mobile broadband, which allows users to get online anywhere, and cable (fibre-optic) broadband, which has boosted connection speeds in the UK to a maximum of 300Mbps.

Now the days of dial-up connection are long gone, as is the time when two or three big players dominated the broadband market. Nowadays, the UK broadband sector is a buyer's market with plenty of great offers to choose from.

How the Web and internet works

How Does the Internet Work?

A Simple Explanation of the Internet

Most people know how to access and use the internet, whether from their phone at work or on their home WiFi.
But what is the internet? And How does the internet actually work?
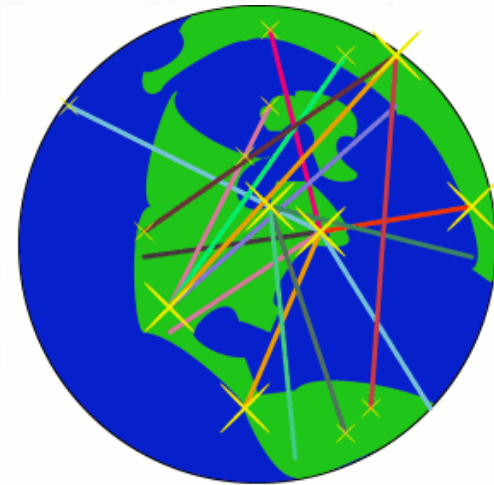
How the Web and internet works
The Internet

When you chat to somebody on the Net or send them an e-mail, do you ever stop to think how many different computers you are using in the process?

There's the computer on your own desk, of course, and another one at the other end where the other person is sitting, ready to communicate with you.

But in between your two machines, making communication between them possible, there are probably about a dozen other computers bridging the gap.

Collectively, all the world's linked-up computers are called **the Internet**.

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How the Web and internet works

The **Internet** is a collection of standalone computers and computer networks in companies, schools, and colleges, all loosely linked together, mostly using the telephone network.

The connections between the computers are a mixture of old-fashioned copper cables, fiber-optic cables (which send messages in pulses of light), wireless radio connections (which transmit information by radio. waves), and satellite links.

How the Web and internet works

So, What Is the Internet?

In basic terms, the internet is a global interconnected collection of networks that communicate using internet protocols.

You can think of it as a network of networks where every network is a node.

However, new devices and technologies have created new ways to connect to networks through the internet.

A combination of them is often used to make these connections.

How the Web and internet works

First, Some Network Basics

First we need to understand how we connect our device to the Internet.

Networks are groups of interconnected devices. Any device that is connected to a network is known as a "node."

Most modern networks use one of the following method.

1. Wired Internet

2. Satellite Internet

3. Cellular Intenet

4. Wireless Access Point

How the Web and internet works
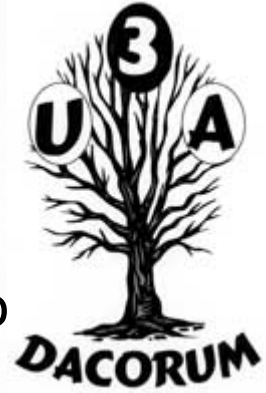
1. Wired Internet

This is the most common form of connection to the internet. Hundreds of thousands of miles of wires are laid throughout the world. They range from phone lines (DSL) to fibre optic cables.

Data can travel up to 70 percent the speed of light through ideal wire mediums such as fibre optic cables, which allow extremely fast transfer of data.

Single lines can span thousands of miles, such as the underwater transatlantic communications cables that connect various parts of the U.S and Canada to Europe. This is the ideal and fastest way to access the internet.

How the Web and internet works

2. Satellite Internet

People who have satellite dishes on their roofs are connecting to the internet via satellite. This is usually required when there are no wired connections available in the local area to connect to the internet, such as third world countries and areas with low populations.

Though satellite is relatively fast, it's still slightly slower than wired connections due to longer transmission distances (up and back down instead of across). Also, if the final address for the data isn't within range of the satellite (like sending that email to your parents), the data needs to pass from satellite to satellite until it arrives at one that is within range.

How the Web and internet works

3. Cellular Internet

A relatively recent addition, cell phones have joined the internet.

Cell phones connect using cell towers, which then connect to physical wires and to the rest of the internet.

In a sense, cell towers are sort of like extremely wide Wireless Access Points, except they're only for cell phones or data-enabled devices. Cell phones may also act as wireless routers using mobile hotspots, in which a laptop or similar device could connect using WiFi to access the internet.

How the Web and internet works

4. Wireless Access Points

Wireless Access Points allow nearby computers and nodes to interact with a network wirelessly, usually via WiFi.

They're nodes that provide wireless capability to a wired network.

Multiple WAPs can be connected to extend the wireless capability range of a network, such as in a large building. However, WAPs aren't a required component of a network, as networks can remain completely hardwired.

How the Web and internet works

How Does email via the Internet Work?

When you opened your email, your email application sent a request to your email provider (for example, Gmail) through your device's Network Interface Card to your Wireless Access Point (WAP) using your local WiFi.

The WAP then sent the request through a wire to the local router.

The local router took that request and sent it to another router, which then sent to another router, and another router, all the way through a chain of routers until the data was transferred over one of the transatlantic communication cables to the United States.

Gmail then processed your request to get any new emails that had come in since you last loaded your email. They packaged up your new, unread emails in a digital package called a "response," and sent that package back to the same address (your device) that requested the updates. The response probably took different routes on the way back, but it went through the same mechanisms.
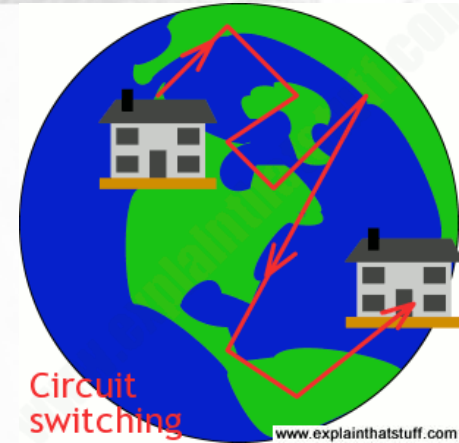
How the Web and internet works

How Does email via the Internet Work?

The data was transferred from the data centre through multiple lines and reached your home router/modem, which made the data available over your home WiFi.

Your laptop's Network Interface Card received the response, sent it to your email application, and then *voilà*—your new emails fill up your inbox!

And that all happened in the blink of an eye. It's pretty amazing how the internet works, isn't it? So the next time someone asks, "what is the internet" or "how does the internet work?" hopefully you can use this simple explanation to help them understand how this technology that's so important to our modern daily life actually works.

How the Web and internet works

Circuit switching
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How does Internet data move?
1- Circuit switching

Much of the Internet runs on the ordinary public telephone network—but there's a big difference between how a telephone call works and how the Internet carries data. If you ring a friend, your telephone opens a direct connection (or circuit) between your home and theirs.

If you had a big map of the worldwide telephone system (and it would be a *really* big map!), you could theoretically mark a direct line, running along lots of miles of cable, all the way from your phone to the phone in your friend's house.

For as long as you're on the phone, that circuit stays permanently open between your two phones. This way of linking phones together is called **circuit switching**.

How the Web and internet works

The Internet could, theoretically, work by circuit switching—and some parts of it still do.

If you have a traditional "dialup" connection to the Net, you're using circuit switching to go online. You'll know how maddeningly inefficient this can be. No-one can phone you while you're online; you'll be billed for every second you stay on the Net; and your Net connection will work relatively slowly.

Most data moves over the Internet in a completely different way called **packet switching**.

Suppose you send an email to someone in China.

Instead of opening up a long and convoluted circuit between your home and China and sending your email down it all in one go, the email is broken up into tiny pieces called **packets**. Each one is tagged with its ultimate destination and allowed to travel separately. In theory, all the packets could travel by totally different routes. When they reach their ultimate destination, they are reassembled to make an email again.

How the Web and internet works

What is packet switching?

Packet switching is like breaking your house into lots of bits and mailing them in separate packets.

Because the pieces travel separately, in parallel, they usually go more quickly and make better overall use of the network.
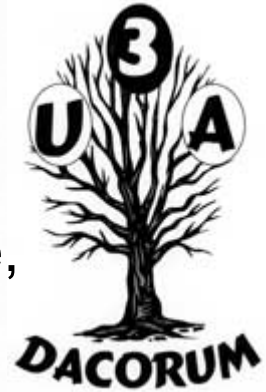
How the Web and internet works

What is packet switching?

Is there a better way? Well, what if you dismantled your home instead, numbered all the bricks, put each one in an envelope, and mailed them separately to Africa?

All those bricks could travel by separate routes. Some might go by ship; some might go by air. Some might travel quickly; others slowly. But you don't actually care. All that matters to you is that the bricks arrive at the other end, one way or another. Then you can simply put them back together again to recreate your house.

Mailing the bricks wouldn't stop other people mailing things and wouldn't clog up the roads, seas, or airways. Because the bricks could be traveling "in parallel," over many separate routes at the same time, they'd probably arrive much quicker.

This is how packet switching works. When you send an email or browse the Web, the data you send is split up into lots of packets that travel separately over the Internet.

How the Web and internet works: TCP/IP and DNS

The real Internet doesn't involve moving home with the help of envelopes—and the information that flows back and forth can't be controlled by people like you or me.

That's probably just as well given how much data flows over the Net each day—roughly 3 billion emails and a huge amount of traffic downloaded from the world's 250 million websites by its 2 billion users. If everything is sent by packet-sharing, and no-one really controls it, how does that vast mass of data ever reach its destination without getting lost?

The answer is called TCP/IP, which stands for Transmission Control Protocol/Internet Protocol.

It's the Internet's fundamental "control system" and it's really two systems in one. In the computer world, a "protocol" is simply a standard way of doing things—a tried and trusted method that everybody follows to ensure things get done properly.

So what do TCP and IP actually do?

How the Web and internet works TCP/IP and DNS

Internet Protocol (IP) is simply the Internet's addressing system. All the machines on the Internet—yours, mine, and everyone else's—are identified by an Internet Protocol (IP) address that takes the form of a series of digits separated by dots or colons.

If all the machines have numeric addresses, every machine knows exactly how (and where) to contact every other machine.

When it comes to websites, we usually refer to them by easy-to-remember names (like www.explainthatstuff.com) rather than their actual IP addresses—and there's a relatively simple system called **DNS (Domain Name System)** that enables a computer to look up the IP address for any given website.

In the original version of IP, known as IPv4, addresses consisted of four pairs of digits, such as 12.34.56.78 or 123.255.212.55, but the rapid growth in Internet use meant that all possible addresses were used up by January 2011.

That has prompted the introduction of a new IP system with more addresses, which is known as IPv6, where each address is much longer and looks something like this: 123a:b716:7291:0da2:912c:0321:0ffe:1da2.

How the Web and internet works

The Birth of the Internet

The origin of the internet began in the late 1960s and early 1970s from a new network technology created by the U.S. Department of Defence.

It was known as the Advanced Research Projects Agency Network (ARPANET).

Its purpose was to connect various Department of Defence scientists and researchers across the United States working on defence projects.

Researchers incorporated ARPANET into the networks they were working at including universities.

As more and more networks joined the system, the internet began to take shape.

How the Web and internet works

ARPANET

Licklider, a psychologist and computer scientist, put out the idea in 1960 of a network of computers connected together by "wide-band communication lines" through which they could share data and information storage.

Licklider was hired as the head of computer research by the Defense Advanced Research Projects Agency (DARPA), and his small idea took off.

By 1966, MIT researcher Lawrence G Roberts had developed a plan for "ARPANET", a computer network designed to withstand power outages, even if a few of the computers were inactive.

The first ARPANET link was made on October 29, 1969, between the University of California and the Stanford Research Institute. Only two letters were sent before the system crashed, but that was all the encouragement the computer researchers needed.
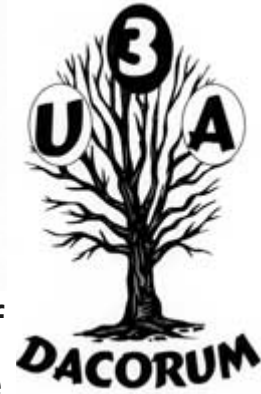
How the Web and internet works

A brief history of the Internet
Precursors

- 1844: **Samuel Morse** transmits the first electric telegraph message, eventually making it possible for people to send messages around the world in a matter of minutes.
- 1876: **Alexander Graham Bell** (and various rivals) develop the telephone.
- 1940: **George Stibitz** accesses a computer in New York using a teletype (remote terminal) in New Hampshire, connected over a telephone line.
- 1945: **Vannevar Bush**, a US government scientist, publishes a paper called *As We May Think*, anticipating the development of the World Wide Web by half a century.
- 1958: Modern modems are developed at **Bell Labs**. Within a few years, AT&T and Bell begin selling them commercially for use on the public telephone system.

How the Web and internet works

1960s: Preparing for a global network

- 1964: **Paul Baran**, a researcher at RAND, invents the basic concept of computers communicating by sending "message blocks" (small packets of data); Welsh physicist **Donald Davies** has a very similar idea and coins the name "packet switching," which sticks.
- 1963: **J.C.R. Licklider** envisages a network that can link people and user-friendly computers together.
- 1964: **Larry Roberts**, a US computer scientist, experiments with connecting computers over long distances.
- 1960s: **Ted Nelson** invents hypertext, a way of linking together separate documents that eventually becomes a key part of the World Wide Web.
- 1966: Inspired by the work of Licklider, **Bob Taylor** of the US government's Advanced Research Projects Agency (ARPA) hires Larry Roberts to begin developing a national computer network.
- 1969: The **ARPANET** computer network is launched, initially linking together four scientific institutions in California and Utah.

How the Web and internet works

1970s: The modern Internet appears

- 1971: **Ray Tomlinson** sends the first email, introducing the @ sign as a way of separating a user's name from the name of the computer where their mail is stored.
- 1973: **Bob Metcalfe** invents Ethernet, a convenient way of linking computers and peripherals (things like printers) on a local network.
- 1974: **Vinton Cerf** and **Bob Kahn** write an influential paper describing how computers linked on a network they called an "internet" could send messages via packet switching, using a protocol (set of formal rules) called TCP (Transmission Control Protocol).
- 1978: TCP is improved by adding the concept of computer addresses (Internet Protocol or IP addresses) to which Internet traffic can be routed. This lays the foundation of TCP/IP, the basis of the modern Internet.
- 1978: **Ward Christensen** sets up Computerised Bulletin Board System (a forerunner of topic-based Internet forums, groups, and chat rooms) so computer hobbyists can swap information.

How the Web and internet works

1980s: The Internet gives birth to the Web

- 1983: TCP/IP is officially adopted as the standard way in which Internet computers will communicate.
- 1982–1984: DNS (Domain Name System) is developed, allowing people to refer to unfriendly IP addresses (12.34.56.78) with friendly and memorable names (like google.com).
- 1986: The US National Science Foundation (NSF) creates its own network, NSFnet, allowing universities to piggyback onto the ARPANET's growing infrastructure.
- 1988: Finnish computer scientist **Jarkko Oikarinen** invents IRC (Internet Relay Chat), which allows people to create "rooms" where they can talk about topics in real-time with like-minded online friends.
- 1989: The **Peapod** grocery store pioneers online grocery shopping and e-commerce.
- 1989: **Tim Berners-Lee** invents the World Wide Web at CERN, the European particle physics laboratory in Switzerland. It owes a considerable debt to the earlier work of Ted Nelson and Vannevar Bush.

How the Web and internet works

1990s: The Web takes off

- 1993: **Marc Andreessen** writes Mosaic, the first user-friendly web browser, which later evolves into Netscape and Mozilla.
- 1993: **Oliver McBryan** develops the World Wide Web Worm, one of the first search engines.
- 1994: People soon find they need help navigating the fast-growing World Wide Web. **Brian Pinkerton** writes WebCrawler, a more sophisticated search engine and **Jerry Yang** and **David Filo** launch Yahoo!, a directory of websites organised in an easy-to-use, tree-like hierarchy.
- 1995: E-commerce properly begins when **Jeff Bezos** founds Amazon.com and **Pierre Omidyar** sets up eBay.
- 1996: ICQ becomes the first user-friendly instant messaging (IM) system on the Internet.
- 1997: **Jorn Barger** publishes the first blog (web-log).
- 1998: **Larry Page** and **Sergey Brin** develop a search engine called BackRub that they quickly decide to rename Google.
- 1999: **Kevin Ashton** conceives the idea that everyday objects, and not just computers, could be part of the Internet. This idea is now known as the Internet of Things.

How the Web and internet works

2000s: Internet and Web for all

- 2003: Virtually every country in the world is now connected to the Internet.
- 2004: Harvard student **Mark Zuckerberg** revolutionises social networking with Facebook, an easy-to-use website that connects people with their friends.
- 2006: **Jack Dorsey** and **Evan Williams** found Twitter, an even simpler "microblogging" site where people share their thoughts and observations in off-the-cuff, 140-character status messages.
- 2017: Russian president **Vladimir Putin** approves a plan to create a private alternative to the Internet to counter the historic dominance of the (traditional) Internet by the United States.

- New Russian laws could soon isolate the country's Runet from the rest of the internet as it seeks to tighten its grip on the information that flows in and out of the country.

- The country's so called "Sovereign Internet" bill is being portrayed by Putin as a defensive response to the Trump Administration's new cyber strategy that would allow the US to launch offensive measures against Russia and any other nation states known for committing nefarious activities online.

How the Web and internet works

Internet Statistics & Facts

Collection of internet statistics and facts for 2021

As of January 2021, there were 4,783,503,852 (4.7+ billion) internet users
.

The average internet user spends 6 hours and 43 minutes online every day
.

As of January 2021, there were over 1.83 billion websites on the Internet
.

Ecommerce sales is expected to reach $4.9 trillion worth of sales in 2021
.

See this web site for latest Internet Statistics and Facts

https://www.websitehostingrating.com/internet-statistics-facts/