Internet

* A set of interconnected computer networks that use TCP/IP to communicate.
* Early 1960s, DoD funded research (Paul Baran) into a fault tolerant routing for telecoms messages, in contrast to then-current method of pre-allocating network bandwidth (not Bell, RAND corporation). Initially not well accepted.
* 1965 British block Donald Davies at NPL independently created Packet Switching.
  + Packet switching describes the transfer of data where a node is occupied only whilst it is transmitting data. The individual packets are composed of a header, a footer and data. This allows for variable bit rates and a much higher capacity network.
  + Allocation of resources (nodes) to transmission of given bits typically by Statistical Multiplexing, Dynamic Bandwidth Allocation. Very similar techniques that basically partition the total capacity of the network into some number of mini-channels. These mini-channels are then shared amongst the clients.
* Simultaneously, ARPANET (Advanced Research Projects Agency Network) was started in 1966 to enable access to remote computers. DoD started to fund it in 1969 Made the decision to use Davies’ packet switching design and was one of the first networks to use TCP/IP protocol suite <https://personalpages.manchester.ac.uk/staff/m.dodge/cybergeography/atlas/arpanet3.gif>

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* By 1980 the first non-US branch of Arpanet is established at UCL
* Networking research at Stanford in 1970s lead to formulation of Transmission Control Program, which allowed for separate networks to be integrated into a network of networks. TCP/IP was chosen by the DoD as standard for all military computing networks, and then was installed into ARPANET in 1983. This was used to connect a network of HPC across major US universities.
* By late 1980s and early 1990s commercial entities took interest, leading to ARPANET being decommissioned in 1990. The first commercial dialup ISP in the US (called The World) was opened in 1989. Still offers text-based dial-up. The first Dial-up in the UK was established in 1990 and began providing services in March 1992.
* 1989, Tim Berners-Lee working at Cern proposed a large database with typed links. Next year specified HTML (Hypertext Markup Language) as the language that would be used, and then HTTP (HyperText Transfer Procol) as the protocol. The combination of these two concepts defined what we know as the world wide web. Defined the idea of connectivity between different documents/services. BT started using the WWW in 1991 in collaboration with Oracle. At first, to share files, they posted floppy disks between London and California, but by July 1991 (two months after getting involved), BT engineers implemented a custom packet switching network, and their first data transmission was made in October 1991.
* BBC registered with the Defense Data Network (based on ARPANET) in 1989, effectively giving it internet access, via Brunel University. Bbc.co.uk was registers in 1991, and the website went live in 1994.

Wifi

* Doesn’t actually officially stand for Wireless Fidelity, but represents the WiFi alliance, which as an agglomeration of some hundreds of companies. Was introduced 22 years ago, 21st September 1998.
* Refers to a family of wireless network protocols (IEEE 802.11). Designed to integrate seamlessly with the wired sibling Ethernet.
* Information is transferred using by sending data packets delivered over radio, using modulating and demodulating carrier waves
  + Standard practice for radio transmission
  + Carrier waves – a usually sinusoidal waveform that is modified with some other waveform that carries information.
  + Modems – Portmanteau of Modulator-Demodulator
* Wifi typically uses one of two frequencies – 2.4 or 5 GHz. In each frequency set there are a range of channels that can be used to avoid overlap of the signal which would lead to interference. Channels in the 2.4GHz spectrum are 20MHz wide, with centers separated by 5Mhz, in a spectrum of only 100MHz, so there are 11 overlapping channels. At 5Ghz, there is much more spectrum available,e so each channel occupies its own 20Mhz non-overlapping slice. Recent updates to WiFi protocol allow for binding together of channels to make extra wide (and therefore fast) channels. However, this reduces the total number of channels, and also decreases the SNR.

SSH

* Secure shell, a method for remote login from one machine to another, maintaining security and integrity with strong encryption. Was developed by Tatu Ylonen at Helsinki University of Technology after a password sniffing (software that intercepts and logs traffic passing over the network, so if packets are unencrypted, or weakly encrypted, the sniffer can acquire the data) attack on his university network.
* Run -v to establish a connection in verbose mode so you can see the processes that are going in.
* A very simplified description of SSH –
  + Client contacts the server
  + Server replies with a public key
  + Server “negotiates” parameters with the client to open a secure channel
  + User login supplied from client to the server host operating system

TCP/UDP

* TCP/IP took a lot of design ideas from French CYCLADES project. Was a French research network established in the early 1970s, explicitly designed around the concept of packet switching and to facilitate internetworking.
* A communications protocol where the data is transmitted between systems in the form of packets. Includes error-checking and guarantees the delivery and preserves the order of the data packets. UDP is very similar except it does not guarantee error-checking or data recovery. It will continue to send data, irrespective of any issues at the receiving end.
* UDP is substantially faster and lightweight. TCP is heavier but also more secure, though it does have some major vulnerabilities, including packet sniffing, Denial of service….
* TCP is connection oriented, meaning that a connection must be established before and data can be sent. A TCP connection is uniquely identified by a 4-tuple Server IP address, Server port number (which together are considered a socket), Client IP address, Client port number

TCP server/client documentation

* Server
  + Create a socket
  + Bind the socket to and address. For a server socket on the internet, the IP address is the local address, so the address for binding the socket consists of a port number on the host machine
  + Listen for connections
  + Accept a connection
  + Send and receive data
* Client
  + Create a socket
  + Connect the socket to the server address
  + Send and receive data
* Some notes - port numbers are 16 bit integers. If you try and use a number larger than 65535 in C, it will overflow. It won’t error out, but you could connect with the overflowed number. Python will return an error.
* sockaddr