Today’s lecture

History of the Internet
How the Internet works
Network protocols
The telephone

1876: first successful bi-directional transmission of clear speech by Alexander Bell and Thomas Watson

1940: first successful transmission of digital data through over telegraph wires by George Stibitz
WWII and the Cold War

Computer technology played an important role in code-breaking during WW2

Cold War between US and USSR led to a technology and arms race
  ◦ Peaked with the launch of Sputnik in 1957

1958: Advanced Research Projects Agency (ARPA) established

April 1969: construction of ARPANET begins, a packet-switching network
Circuit-switching network

Nodes are connected physically via a central node

Used by the telephone network

Originally, switchboard operators had to manually connect phone calls, today this is done electronically
Packet-switching network

Data is broken into **packets**, which are then sent on the best route in the network.

Each node on the route sends the packet onto its next destination, avoiding congested or broken nodes.

The original message is **Green, Blue, Red**.
ARPANET

October 1969: ARPANET is completed with four nodes

1973: Norway connects to ARPANET via satellite, followed by London via a terrestrial link
ARPANET in 1977
ARPANET

1983: TCP/IP implemented in ARPANET
1990: ARPANET is formally decommissioned
ARPANET to the Internet

Networks similar to ARPANET sprang up around the USA and in other countries

1984: **domain name system** (DNS) implemented

1985: NSFNET was established

1989: Waikato University connects to NSFNET

1991: **World Wide Web** (WWW) created at **CERN** (European Organization for Nuclear Research) by Tim Berners-Lee

1995: NSFNET is retired
WWW vs Internet

World Wide Web (WWW) refers to the applications (eg. web pages, email, Skype, Youtube etc) that run on hardware

The Internet refers to the hardware on which the WWW runs
Internet growth

<table>
<thead>
<tr>
<th>Year</th>
<th>Hosts</th>
</tr>
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<tbody>
<tr>
<td>1969</td>
<td>4</td>
</tr>
<tr>
<td>04/71</td>
<td>23</td>
</tr>
<tr>
<td>06/74</td>
<td>62</td>
</tr>
<tr>
<td>03/77</td>
<td>111</td>
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<tr>
<td>05/82</td>
<td>235</td>
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<tr>
<td>10/84</td>
<td>1,024</td>
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<tr>
<td>02/86</td>
<td>2,308</td>
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<tr>
<td>07/88</td>
<td>33,000</td>
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<tr>
<td>10/90</td>
<td>313,000</td>
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<td>2,217,000</td>
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<td>01/96</td>
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<td>01/00</td>
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<td>233,101,481</td>
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<td>01/06</td>
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</table>

Number of hosts on logarithmic scale until 2012
Internet usage

Internet Users in the World by Geographic Regions

- Asia: 578.5 million
- Europe: 384.6 million
- North America: 248.2 million
- Latin America / Caribbean: 139.0 million
- Africa: 51.1 million
- Middle East: 41.9 million
- Oceania / Australia: 28.2 million

Internet Users in the World by Geographic Regions - 2014 Q2

- Asia: 1306.2 million
- Europe: 582.1 million
- Latin America / Caribbean: 320.3 million
- North America: 316.3 million
- Africa: 297.9 million
- Middle East: 111.8 million
- Oceania / Australia: 26.8 million

Source: Internet World Stats - www.internetworldstats.com/stats.htm
Estimated Internet users is 1,463,632,361 for Q2 2009
Copyright © 2008, Minikatts Marketing Group

Source: Internet World Stats - www.internetworldstats.com/stats.htm
3,036,749,340 Internet users estimated for June 30, 2014
Copyright © 2014, Minikatts Marketing Group
Types of networks

Local Area Network (LAN)
- Operates within 1 km radius
- Client-server or peer-to-peer configuration
- Can connect multiple LANs to form an intranet

Wide Area Network (WAN)
- Distances over 1km

The Internet
- Network of networks that use the TCP/IP protocol
How the Internet works

Networking hardware
Protocols
IP addresses and Domain names
Client and server software
Networking hardware

Connection
- Wired, eg. Ethernet
- Wireless, eg. Wi-Fi, cellular

Network card
- Can be built into the motherboard or an expansion card
- Some network cards support wired and wireless connections

Switch
- Used to connect multiple devices to the same network

Router
- Directs traffic around the network and connects networks together
Networking hardware

Modem (modulator/demodulator)
- Responsible for transmitting and receiving data on the physical medium
- For example, a modem:
  - Modulates data from computer/router onto a phone line
  - Demodulates signals from a phone line and sends to the computer/router

There are different kinds of modems
- Dial-up modems up to 56Kbs
- Broadband (DSL - digital subscriber line) modems between 256Kbs to 20Mbs
Protocol

Protocol: a standardised method of communication

Ensures that the sender and receiver can communicate properly

Protocols include rules for:

- Opening and maintaining a connection
- Sending and receiving data
- Ending the connection
Protocols

Common Internet protocols:
- TCP/IP: transports data reliably
- UDP: transports data faster but less reliably
- FTP: used for transferring files over a network
- HTTP: used for client/server communication such as transferring web pages
- POP3, IMAP, SMTP: used for email

Many protocols used in networking are defined in a RFC (Request for Comments) document
- RFC 791: IP
- RFC 2616: HTTP
Protocols – TCP/IP, UDP

IP - Internet Protocol:
- A unique identifier for computers on the Internet
- Defines routing information
- v4: 32-bit addresses (eg. 192.168.1.1), ran out of addresses
- v6: 128-bit addresses (eg. 2001:0db8:0a0b:12f0:0000:0000:0000:0001)

TCP - Transmission Control Protocol:
- Divides the message into packets (typically about 1 KB)
- Checks that all packets arrive (error detection)
- Ensures packets are not sent faster than they can be received (flow control)
- Combines packets to recreate the data

UDP – User Datagram Protocol:
- Lacks error detection and flow control, better suited to real-time data such as video streaming, Skype calls etc.
IP addresses and domain names

**Domain name system (DNS)** is used to convert between IP addresses and human-readable text (domain name).

DNS servers perform the translation between IP address and URL.

![Diagram showing the process of converting between IP address and domain name](image.png)
Client and server software

Client software:
- Web browsers
- Email clients:

Server software:
Connecting to the Internet

At home, you plug your modem into your phone jack

Your modem sends and receives information from the Internet over your phone line
Connecting to the Internet

An Internet Service Provider (ISP) provides you with an IP address and a connection to the Internet.
The Internet’s backbone

High-capacity fibre optic cables laid on land and under the sea

Owned by companies who rent out capacity on the cables

They connect countries together to form the global Internet so are extremely important

- Having multiple backbone cable connections provides extra capacity and redundancy
The Internet’s backbone

Go to www.submarinecablemap.com to see the undersea backbone cables
NZ’s backbone cables
Summary

The Internet is packet-switching network consisting of multiple networks joined together

A number of protocols and technologies underpin the Internet

As more people use the Internet, organisations tasked with maintaining it need to ensure the Internet can handle the increased demand (eg. moving from IPv4 to IPv6)