Networking and the Internet

Lecture 4 – COMPSCI111/111G SS 2018

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

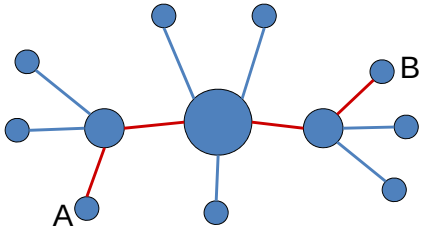
- 1940: first successful transmission of digital data through over telegraph wires by George Stibitz

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

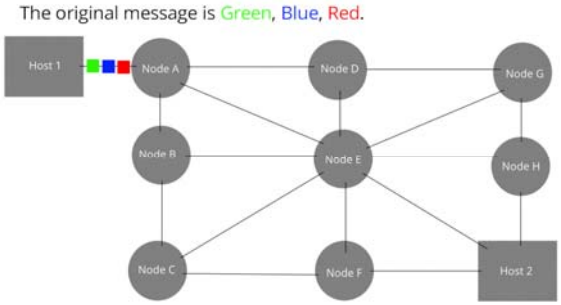
Circuit-switching network

- 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

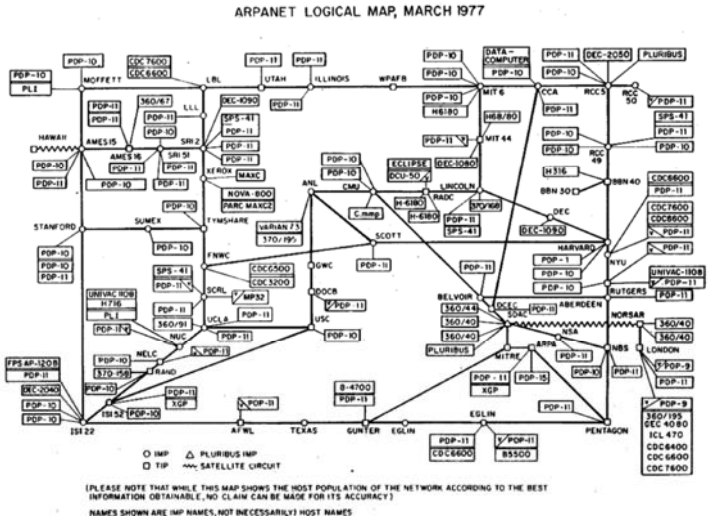
- Data is broken into **packets**, which are then sent on the best route in the network
- Each node on the route sends the packet onto its next destination, avoiding congested or broken nodes



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

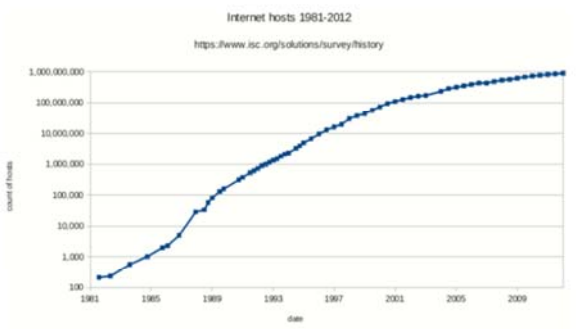
- Networks similar to ARPANET sprang up around the USA and in other countries
- 1984: **domain name system** (DNS) implemented
- 1985: NSFNET was established
- 1989: Waikato University connects to NSFNET
- 1991: **World Wide Web** (WWW) created at **CERN** (European Organization for Nuclear Research) by Tim Berners-Lee
- 1995: NSFNET is retired

WWW vs Internet

- The Internet is a global system of interconnected computer networks.
  - Carries a vast range of resources and services.
- WWW is a global collection of documents and other resources accessed through the Internet using HTTP – one of many Internet communication protocols.
  - Documents are linked via hyperlinks and are identified by their URL.

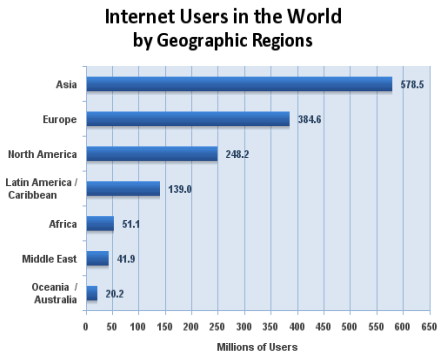
Internet growth

Year	Hosts
1969	4
04/71	23
06/74	62
03/77	111
05/82	235
10/84	1,024
02/86	2,308
07/88	33,000
10/90	313,000
01/92	727,000
01/94	2,217,000
01/96	9,472,000
01/98	29,670,000
01/00	72,398,092
01/02	147,344,723
01/04	233,101,481
01/06	394,991,609



Number of hosts on logarithmic scale until 2012

Internet usage



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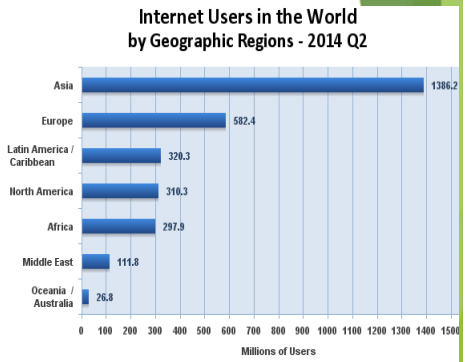

Source: Internet World Stats - www.internetworldstats.com/stats.htm
3,035,749,340 Internet users estimated for June 30, 2014
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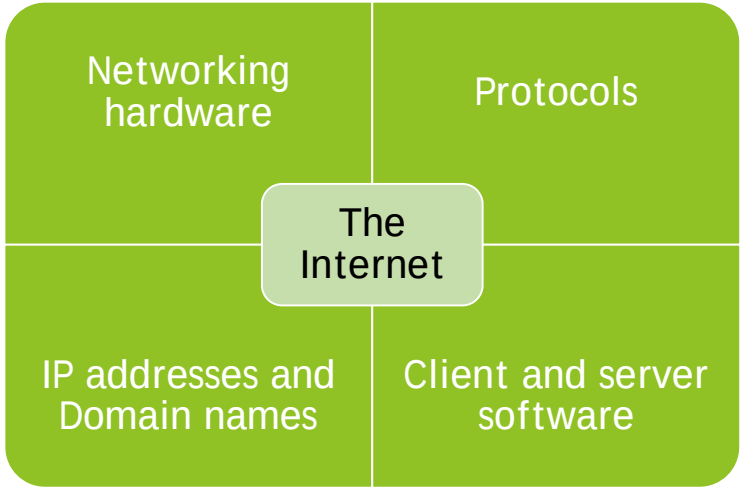
Types of networks

- 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

- 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

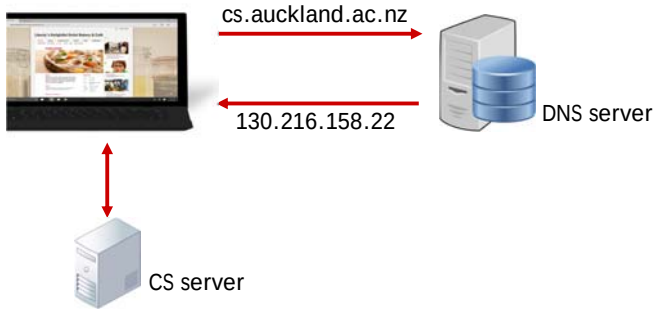
- Common Internet protocols:
  - TCP/IP: transports data reliably
  - UDP: transports data faster but less reliably
  - FTP: used for transferring files over a network
  - HTTP: used for client/server communication such as transferring web pages
  - POP3, IMAP, SMTP: used for email
- Many protocols used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

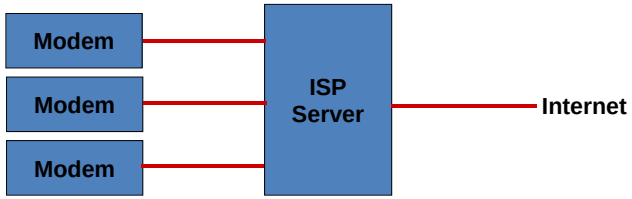


Client and server software

- Client software:
  - Web browsers
  - Email clients:
- Server software:

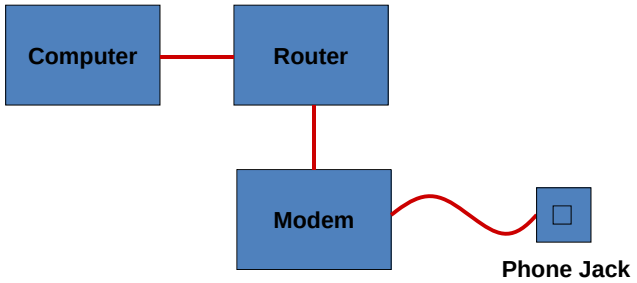
Connecting to the Internet

- An Internet Service Provider (ISP) provides you with an IP address and a connection to the Internet



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

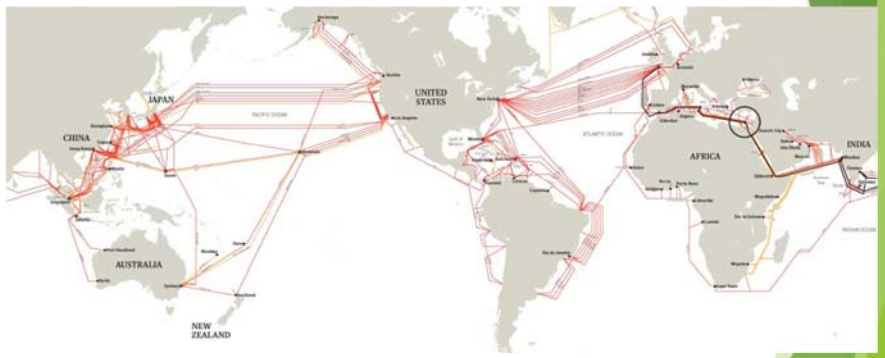


The Internet's backbone

- 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

Answers

- What network model does the Internet use?
- What Internet protocol should your program use if it is time-sensitive?
- What is the name of the documents that describe the technical details of protocols?

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)