COMPSCI 314 S2 T

Data Communications Fundamentals

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Lecturers

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- Brian Carpenter

Test Date

Friday 14 September, 3:35 – 4:20 pm

Assignments due

(via the CS DropBox, dates subject to revision)

Saturday	11 August
Monday	17 September
Monday	8 October

Other matters

- Class representative
- Assignment extensions

  We will consider extensions to the assignment due date only for —
  1. Illness or other unforeseeable emergency
  2. Conflicts with other assignments, but only if the request is made within *one* week of the assignment being distributed

  We will not be sympathetic if told "The 314 assignment is due tomorrow and I have 3 other assignments also due then; can I please have an extension?" The dates have been published weeks ahead; you should have planned your work better or arranged earlier for an extension
- Questions

  Your may contact any of your lecturers.
  Also, you could ask on the class forum
- Email

  Email must include the course number (314) and your UPI

Approach to material

- This year we are (mostly) following the textbook (Shay, 3rd edition)
- The lectures will provide in-depth discussion and comment on the course material. You should read the relevant sections in the textbook!
- The course does *not* cover *all* of the textbook. The sections that are covered are shown on the course outline, as it appears on the *course web page*
- *Changes* to the course outline and/or content will be notified on the course web page
- We assume that students already have some understanding of Data Communications, e.g. they have completed COMPSCI 215

Approximate plan of course

Week starting	Tuesday	Thursday	Friday	
16 Jul 2007	1 Introduction	—	2 Signals	
23 Jul 2007	3 Codes	4 Analog & Digital	5 Analog & Digital	
30 Jul 2007	6 Compression	7 Compression	8 Data Integrity	***Ass 1 due 11 Aug***
6 Aug 2007	9 Data Integrity	10 Skype	11 Powerline	
13 Aug 2007	12 Flow Control	13 Flow Control	14 LAN: link control	
20 Aug 2007	15 Ethernet	16 Ethernet	17 Wireless 802.11	
27 Aug 2007	— Mid Semester Break —			
3 Sep 2007	— Mid Semester Break —			
10 Sep 2007	18 Encryption	19 Authentication	—	**TEST: Fri 14 Sep**
17 Sep 2007	20 Bridges	21 Switches	—	***Ass 2 due 17 Sep***
24 Sep 2007	22 Routing	23 Routing	24 IP, Addressing	
1 Oct 2007	25 IP, Fragmentation	26 IPv6	27 UDP, TCP	
8 Oct 2007	28 TCP	29 DHCP, DNS	30 SSH, SMTP, FTP	***Ass 3 due 8 Oct***
15 Oct 2007	31 Sockets, HTTP	—	—	
23 Oct 2007	*No lectures – just lots of time to study*			

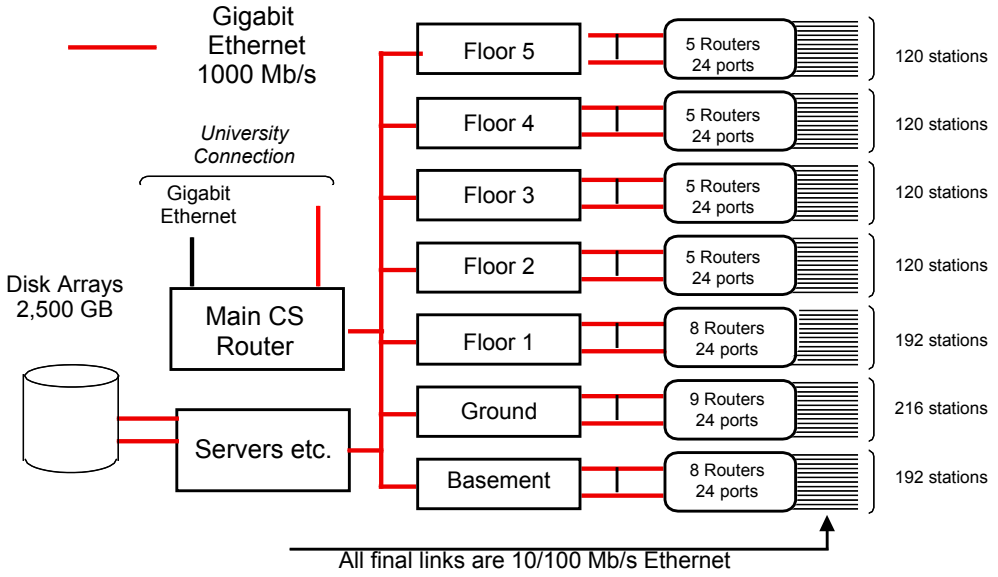
1.1 Overview

- Data communications is often (mostly) implemented using various layers in a protocol stack
- The layers are: 1 (physical) 2 (link), 3 (network), 4 (transport) and 5..7 (Applications)

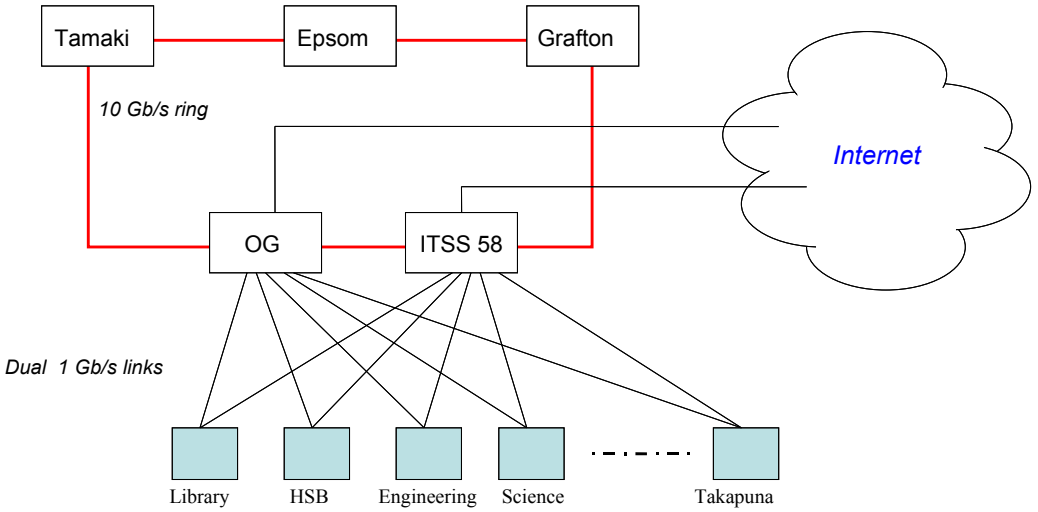
- Our focus is on how things work, especially on the underlying protocols – we won't look at 'how to configure a router,' etc.

- We start with a (very brief) overview of the U Auckland network ..

Simple view of Computer Science Network, 2003



The U Auckland Network, early 2007



Things to do in a network

1. Transmit bits from one place to another (Physical)
2. Assemble bits into bytes and messages, check for reliable transmission (Link)
3. Send messages between end-nodes in mesh-type network (Network)
4. In a mesh network, handle lost packets, broken links etc (Transport)
5. Handle extended connections between endpoints, LANs, etc.
6. Resolve differences between data representation in different computers
7. Do something useful (User application)

These are the seven layers of the "Open Systems Interconnection" (OSI) communications model.

TCP/IP (Internet) combines layers 5-7, into a single Application layer

We focues on the Internet, i.e. on TCP

2.1 Communications basics

- Data is sent from / received by an *interface* on a device (e.g. a PC)
- It may be sent directly, using *baseband* transmission, or it may be mixed with a carrier signal, i.e. sent using *modulated* transmission
- The time taken to transmit one bit ('0' or '1') is called the *bit cell period*. Within each such period, a receiver must decide whether the incoming bit is '1' or '0'

Important information on transmission of bits

Bits, as electrical signals, always travel at a 'propagation speed' of

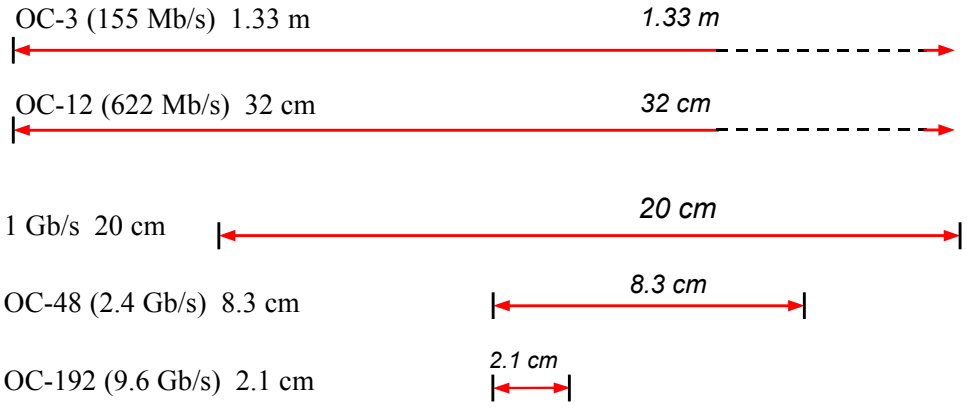
- 300,000 km/s in "free space" (radio, satellites, etc) (30cm per nanosecond)
- 200,000 km/s on copper or fibre-optic cables (20cm per nanosecond)

A 'faster' link has the bits arriving *more often* (say 1000 per microsecond, rather than 100 per microsecond), but they *never travel any faster*.

- The circumference of the Earth is 40,000 km (by the definition of the metre)
- The distance from New Zealand to North America, South America, Japan or Singapore is close to 10,000 km.
- The delay or "latency" from New Zealand to almost anywhere except Australia is at least 1/20 second (50 ms). This delay cannot be reduced!

Distances between bits, on optical fibre

Assume propagation speed of 200,000 km/s in glass fibre
(These distances are nearly correct if the page is printed on A4 paper).



Communication Media: Conductive Metal

- Co-axial Cable (2.3)
  - Centre conductor, surrounded by a metal screen
  - Signal carried by the centre conductor, screened from electrical *noise*
- Twisted Pair (2.2)
  - Carries *balanced* signals, so as to minimise electrical *noise*
  - Cheaper and easier to install and use than co-ax
  - UTP cable has 4 pairs in an outer covering
  - Cat (Category) 5 UTP used for 100 Mb/s, cat 6 for 1 Gb/s

Communication Media: Optical Fibre (2.3)

- Uses thin (about 50 micron) glass fibre to carry pulses of light
- Fibre is either *graded index* or *step index,* restricting the light's *propogation mode* so as to confine it inside the fibre
- Attenuation in fibre is low, making it suitable for long-haul (70 km or more) links
- Submarine cables can use optical amplifiers. For example, Southern Cross connects Sydney-Auckland-Fiji-Honolulu-Los Angeles
- Immune to electrical noise

Communication Media: Wireless (2.4)

- Use electromagnetic waves to carry the signal in air (terrestrial) or free space (satelllite)
- Wireless LANs (*802.11*) commonly used to link laptop PCs to an Internet *access point*
  - Range usually only inside a room or building, say 50m
  - One access point can handle many laptops
- 802.11 can be used (with directional antennas) for much longer hops, so as to form regional networks
- Bluetooth used to link devices without wires
  - Cell 'phone to laptop, mouse to PC
  - Range about 10m or less