

Welcome to

COSC244

Data Communications, Networks and the Internet

Teaching Team

- Instructors (Lectures)

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- Tutorials

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- Professional Practice Fellow (Labs)

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Course Goals

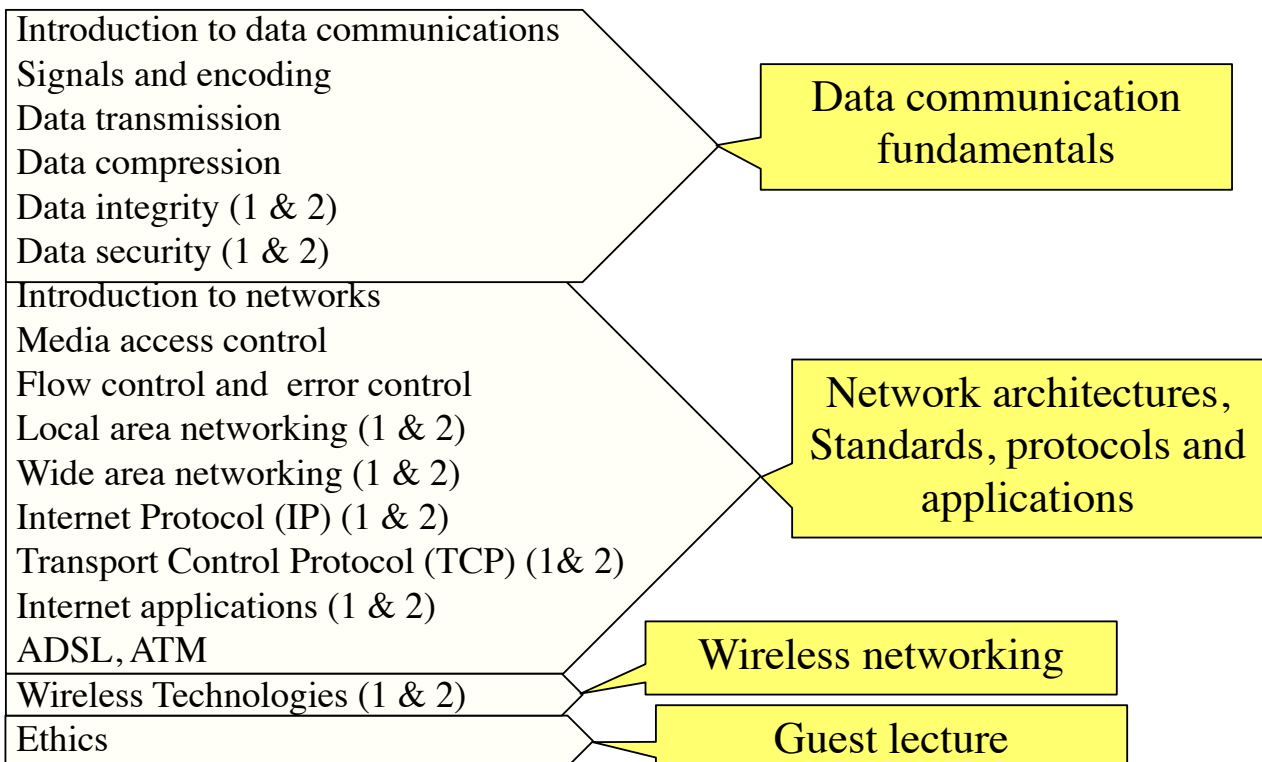
- Introduce the fundamental concepts, principles, and problems in data communications.
- Introduce well-known network structures, standards, protocols, and application.
- Understand the essence of data communication from a computer science point of view.

What will you get from this course?



Necessary knowledge and fundamental skills you'll need in your future career

Outline of Lectures



Assessment

- Internal Assessment (30%)

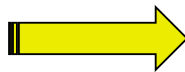
- Participation in tutorials (6%)
- Lab work (7%)
- Test on lectures 1-6 (7%)
 - 12 August in the lab
- Assignment on Ethics (4%)
 - 23 September in the lab
- Practical Lab Test (6%)
 - 7 October in the lab

Refer to course web page for details: <http://www.cs.otago.ac.nz/cosc244/assessment.html>

- Exam (70%)

- 3 hours

Useful Study Tips



Attend lectures



Lab practice



Tutorials

Course Details

- Textbook
 - Behrouz Forouzan, *Data communications and networking (5th Edition)*, McGraw-Hill, 2012.
- Home page
 - <http://www.cs.otago.ac.nz/cosc244>
- Consultation
 - Send an email to book a time slot
- One tutorial per week (except the first week)
- One lab per week (starting in the first week)

Overview

- This Lecture
 - Introduction
 - Source: Section 1.4, 3.1-3.3, 7.2-7.3
- Next Lecture
 - Signals and encoding
 - Source: Section 1.1, 3.4, 4.1, 4.2, 5.1

History of Communications

- In the beginning, no data communications



sciencephoto.com

History of Communications

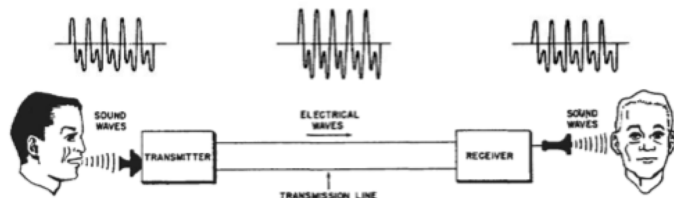
- Telegraph, 1837, Samuel Morse
 - Messages over long distances via electrical impulses (send short and long beeps)



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History of Communications

- Telephone, 1876, Alexander Bell

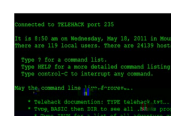


armycommunications.tpub.com

Data Communications

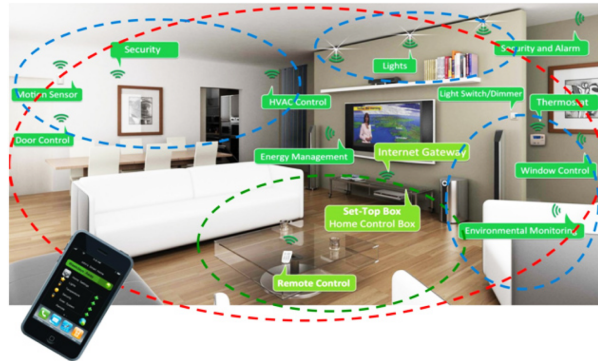
- Computer, 1945, ENIAC (Electronic Numerical Integrator And Computer)
- Computer network, 1969, ARPANET
 - **The First Internet** (UCLA, UCSB, SRI, Utah)
- Internet, 1980
 - connects millions of computers together globally, forming a network in which any computer can communicate with any other computer.
- World wide web, 1990 (**WWW/the Web**)
 - a way of accessing information over the medium of the Internet, web browser, mouse button, hyperlink

<http://www.wikipedia.org/>



Data Communications

Everything can be connected



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Definitions

- Communication
 - Impart, convey or exchange of information
- Telecommunication
 - Exchange of information over long distance
- Data communication
 - Use of transmission media and protocols to exchange data between two devices such as computers
- Components of Data communication
 - Message, Sender, Receiver, Medium, Protocol

Five Components of Data Communication

- Message: data to be communicated. (voice, image, numbers, text, ...)
- Sender: device that sends the message. (computer, phone, satellite...)
- Receiver: device that receives the message. (computer, antennas...)
- Medium: physical path by which a message travels from sender to receiver. (twisted pair wire, coaxial cable, optic cable, radio waves...)
- Protocol: a set of rules that govern data communication. (TCP, IP...)

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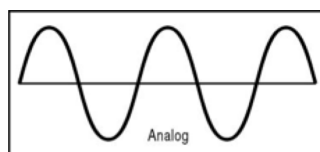
Analog/Digital Signals

- Information can be voice, image, numbers, characters...
 - Data can be analog or digital (continuous vs. discrete)
- To be transmitted, information needs to be converted to either a digital signal or an analog signal for transmission:
 - Signals can be analog or digital

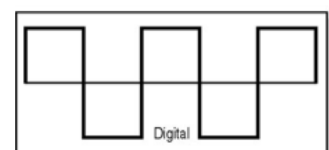


analog-clock-gif.software.filesdudes.com

Analog signals
(Telephone/Radio)



Digital signals
(0/1 bit)



Analog Signals

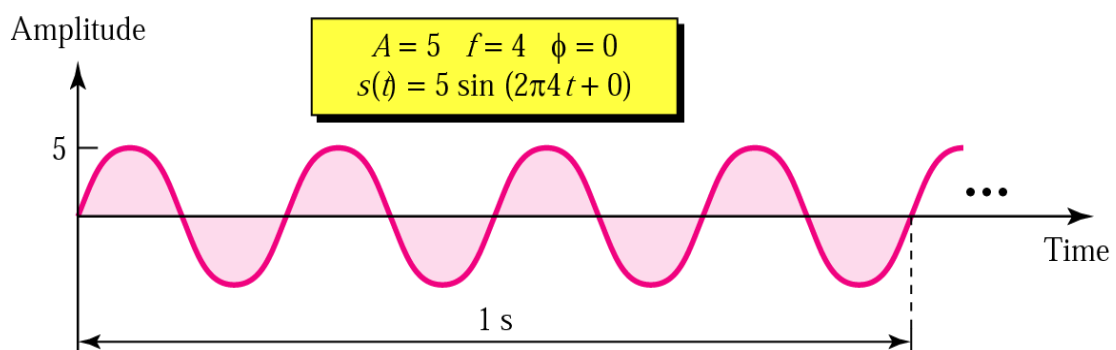
- Electromagnetic waves are used to carry data, the basic analog signal is a sine wave

$$y = A \sin (2\pi f t + \emptyset)$$

- Sine wave can be fully described by three characteristics: Amplitude (A), Frequency (f), Phase (\emptyset)

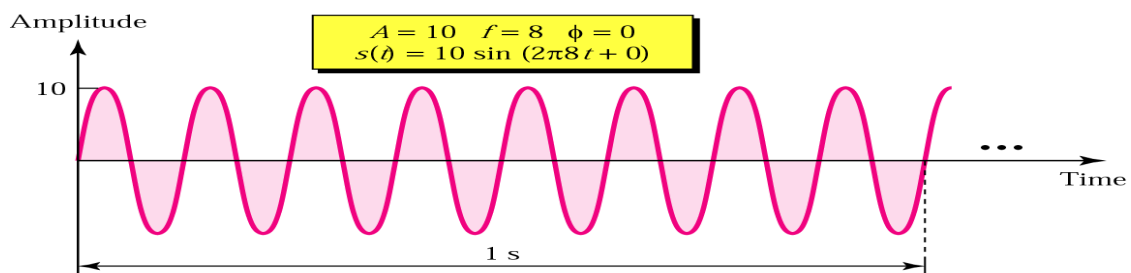
Analog Signals

- Amplitude (A): Values between which the signal oscillates



Analog Signals

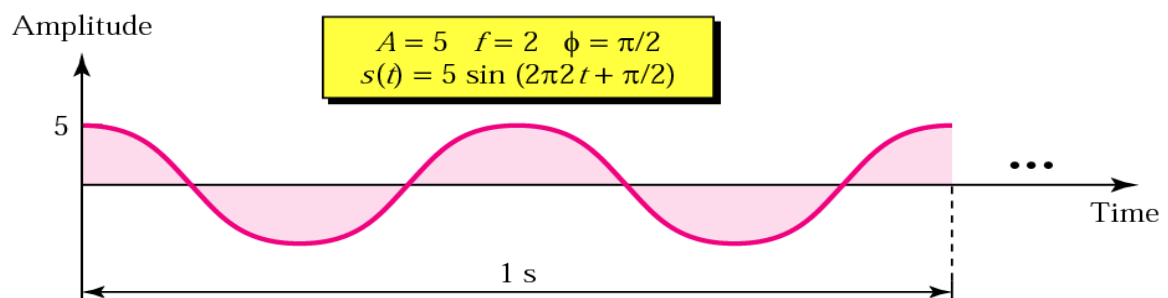
- Frequency (f) & Period
 - Period is the time it takes to complete the pattern once.
 - Frequency is the number of periods per second. $f = 1/p$
 - Unit of measure for frequency is hertz (Hz)



- Wavelength = speed of light / frequency
 - Distance between identical points in the adjacent cycles of a waveform

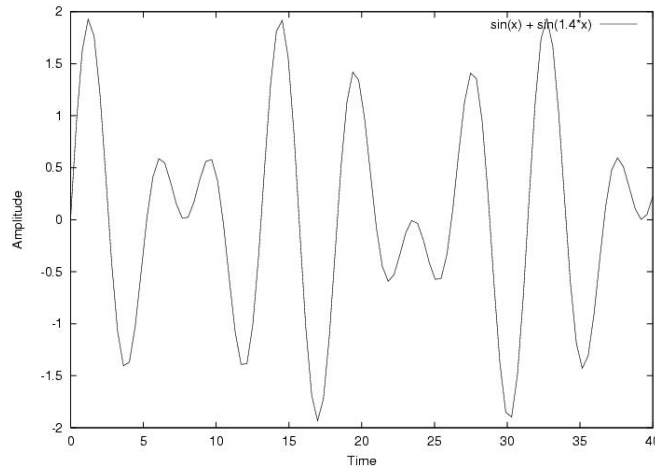
Analog Signals

- Phase \emptyset
 - the position of the waveform relative to time zero



Analog Signals (cont.)

- Composite signal: A single-frequency sine wave is not useful in data communications; we need to send a composite signal, which is made of many simple sin waves

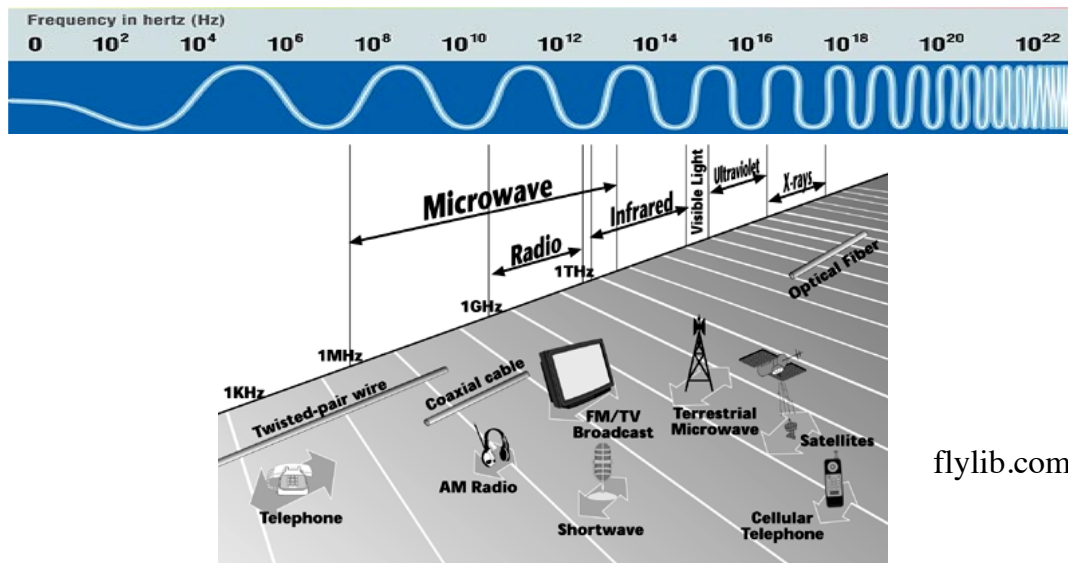


Bandwidth

- *Bandwidth in Hertz (analog bandwidth):*
 - Bandwidth of a composite signal: range of frequencies contained in a composite signal. (Human hearing: 20 Hz - 20,000 Hz)
 - A transmission medium can handle signals within a range of frequencies. (Telephone: 300 Hz - 3300 Hz)
 - Bandwidth of a medium: range of frequencies for the signals it can carry. (Telephone bandwidth: 3000 Hz)
- *Bandwidth in Bits per Seconds (Data Rate, digital bandwidth):* Number of bits(0/1) transmitted per second (bps).

Frequency Spectrum

- Range of frequencies



flylib.com

Transmission Media

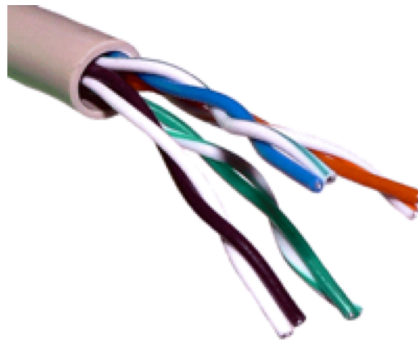
- Transmission Media:
 - carry signals from one place to another
 - Guided (wired) and unguided (wireless)



<http://www.ircp.co.th/telecom.html>

Guided Media: Twisted Pair

- Two insulated copper wires twisted around each other (cheap/susceptible to electrical interference)
- Limited bandwidth and limited distance



<http://www.twistedpair.co/>

Guided Media: Coaxial Cable

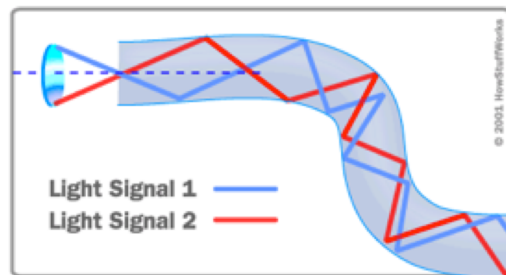
- Inner conductor and outer conductor
- Higher bandwidth and longer distance



<http://computernetworking007.blogspot.co.nz/2012/12/common-network-cables.html>

Guided Media: Optical Fibre

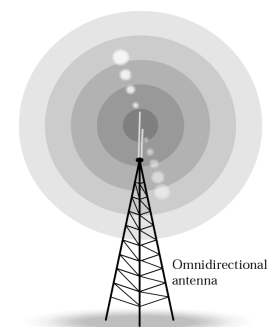
- Conduct light, laser, in the fibre
- Laser frequency - about 10^{14} Hz
- Fast, long distances, immune to electrical interference, expensive, electrical/optical conversion, installation/maintenance, fragile



<http://www.howstuffworks.com/fiber-optic2.htm>

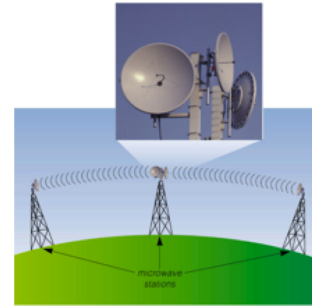
Unguided Media: Radio Wave

- Waves ranging in frequencies between 3KHz and 1GHz normally called radio waves.
- **Omnidirectional:** signal spreads out in all directions, received by many antennas
- travel long distances

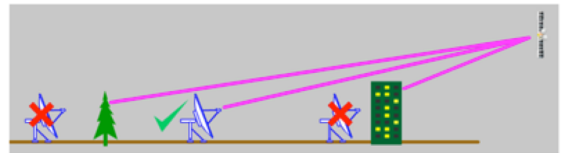


Unguided Media: Microwave

- Waves ranging in frequencies between 1 and 300GHz normally called Microwaves.
- Data rate - up to 300 Mbps
- **Line-of-sight: travel in a straight line**
- Solid objects and atmospheric conditions cause interference, uses a parabolic dish antenna
- Satellite: one of the station is a satellite: requires no obstacles between transmitter and receiver



staffwww.fullcoll.edu



Skynet-mps.com.mm

Unguided Media: Infrared

- frequencies from 300GHz-400THz for short range communication (several meters).
- **can not penetrate walls**



e-globaledge.com

Unguided Media

- WiFi: Wireless LANs IEEE 802.11 (Ethernet over radio)
- LiFi: Visible light Communication



<https://www.dreamstime.com/>

Summary

This Lecture: Introduction

- History of Data Communication
- Analog & digital Signals
- Transmission Media

Next Lecture: Signals and Encoding