University of Glasgow

Introduction to Networks (1)

Networked Systems 3
Lecture 1

Lecture Outline

- Course Administration
  - Aims, Objectives, Intended Learning Outcomes
  - Course Outline
  - Labs and Assessment
  - Reading List
- Introduction to Networks

Course Administration

Contact Details and Website

- Lecturer:
  - Dr Colin Perkins, Room 405, Sir Alwyn Williams Building
  - Email: colin.perkins@glasgow.ac.uk
  - Make appointments by email to discuss the course outside scheduled lecture or lab times

- Lecture notes and other material on online:
  - http://csperkins.org/teaching/ns3/ (or on the School's Moodle site)
  - Paper handouts will not be provided – the act of taking notes helps learning

Aims and Objectives

- To introduce the fundamental concepts and theory of communications
- To provide a solid understanding of the technology that supports modern networked computer systems
- To introduce low-level network programming
- To give students the ability to evaluate and advise industry on the use and deployment of networked systems

Intended Learning Outcomes

- By the end of the course, students should be able to:
  - Describe & compare capabilities of various communication technologies and techniques
  - Know the differences between networks of different scale, and how these affect their design
  - Describe the issues in connecting heterogeneous networks
  - Describe importance of layering, and the OSI reference model
  - Understand demands of different applications on quality of service requirements for the underlying communication network
  - Understand a description of a LAN-based computer system, and explain the purpose and function of its various components
  - Write simple communication software

Course Outline

Week	Tue 12:00-13:00	Wed 14:00-16:00	Thu 12:00-13:00
1	Introduction to Networks	Network Programming	Introduction to Networks
2	Case Studies	Laboratory work	Communications Theory
3	Physical Layer		Data Link Layer
4	Data Link Layer		Network Layer
5	Network Layer		Network Layer
6	Transport Layer		Transport Layer
7	Transport Layer		Transport Layer
8	Applications		Applications
9	Applications		Security
10	Wrap-up		

Note: In week 1, the Wednesday slot will be a lecture from 14:00-15:00, followed by a lab from 15:00-1600; it is a two-hour lab session in other weeks.

Assessment

- Assessed exercises: 20%
  - Assessed network programming labs: programming using C, pthreads, and Berkeley Sockets using Linux
  - Exercises and lab work complement theory from lectures
  - Students *required* to attend all labs
- Examination: 80%
  - Exam format: answer all three questions

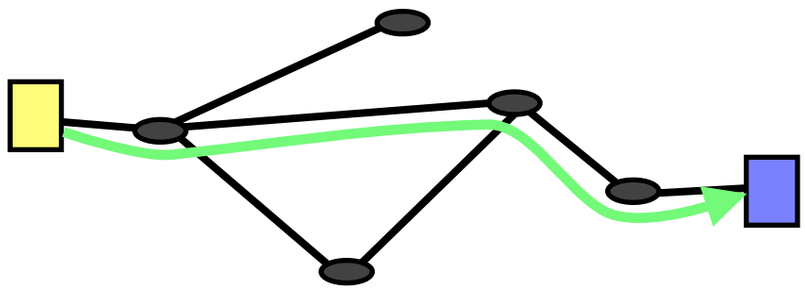
Required Reading

- Any good text on computer networks, for example:
  - Peterson and Davie, *Computer Networks: A Systems Approach*, 3rd Edition, Morgan Kaufman, 2003, ISBN 1558608338
  - Kurose and Ross, *Computer Networking: A Top-Down Approach*, 5th Edition, Addison-Wesley, 2010, ISBN 0136079679
  - Tanenbaum, *Computer Networks*, 4th Edition, Prentice Hall, 2002, ISBN 0130384887

Introduction to Networked Systems

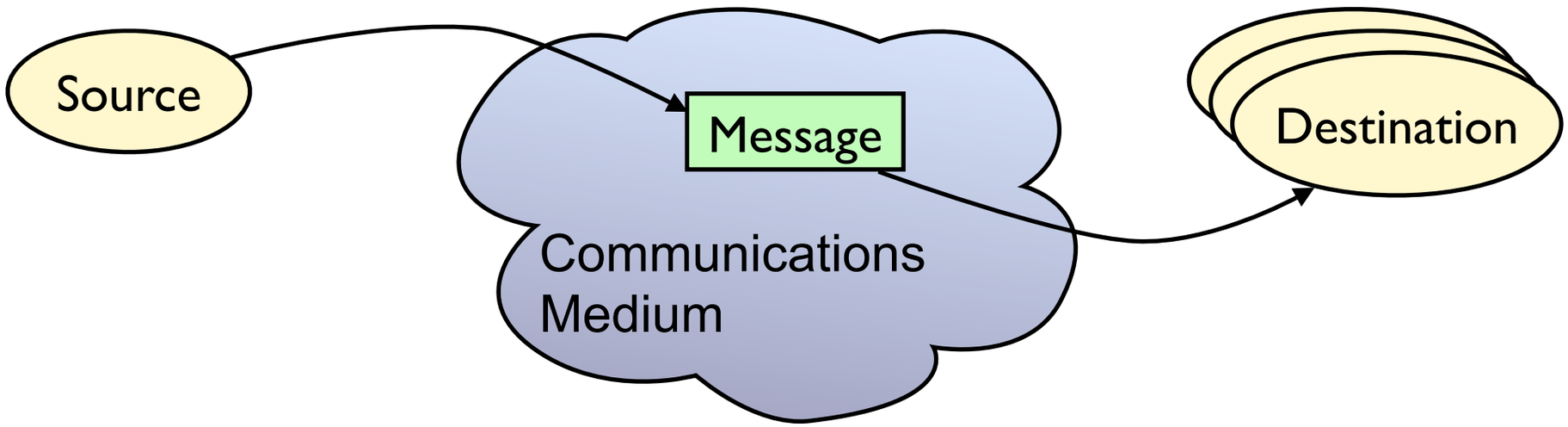
What is a Networked System?

- Interconnected collection of communicating autonomous computing devices



  - Interconnected – direct or indirect, using optical fibre, copper wire, radio, etc.
  - Computing device – PC, phone, TV set-top box, etc.
- Distinct from a distributed system
  - Communication network is explicitly visible

Communications Networks



- Data transferred from source to destination(s) in potentially size limited messages
  - Communication can be simplex, half- or full-duplex
  - Path through communications medium is a channel

Information

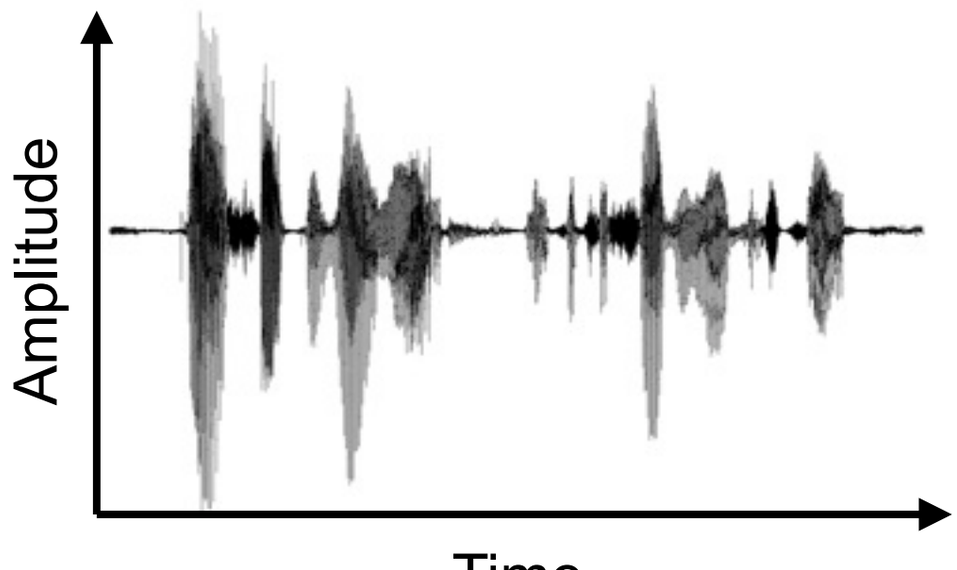
- Messages convey *information*
  - The amount of information in a message can be characterised mathematically – *Information Theory*
- Capacity of channels to convey information can also be modelled
  - How much? How fast? How much power used?
  - Physical limits exist on the capacity of a channel

Signals

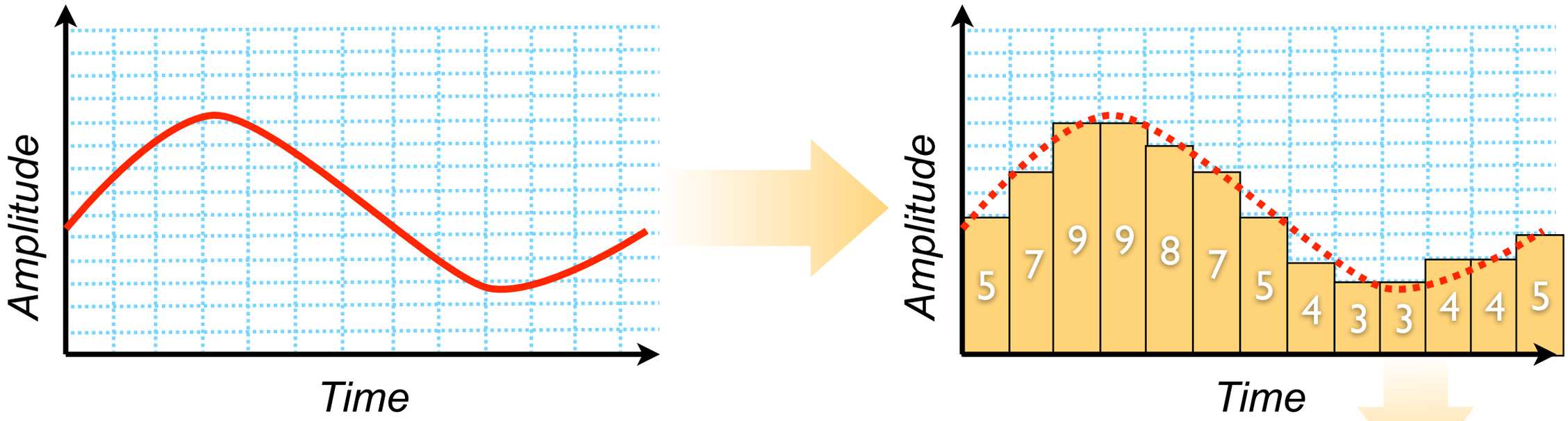
- Physical form of a message is a *signal*
  - May be a material object (carrier pigeon, CD, …)
  - Usually a wave (sound, electrical signal, light, radio, …)
- Signal may be analogue or digital
  - Analogue: a smooth continuum of values
  - Digital: a sequence of discrete *symbols*
    - Mapping information to symbols is known as *coding*

Analogue Signals

- Simplest analogue signal: amplitude directly codes value of interest
  - AM Radio, analogue telephones
- Can be arbitrarily accurate
- Susceptible to noise and interference on channel
- Difficult to process with digital electronics



Analogue Signals

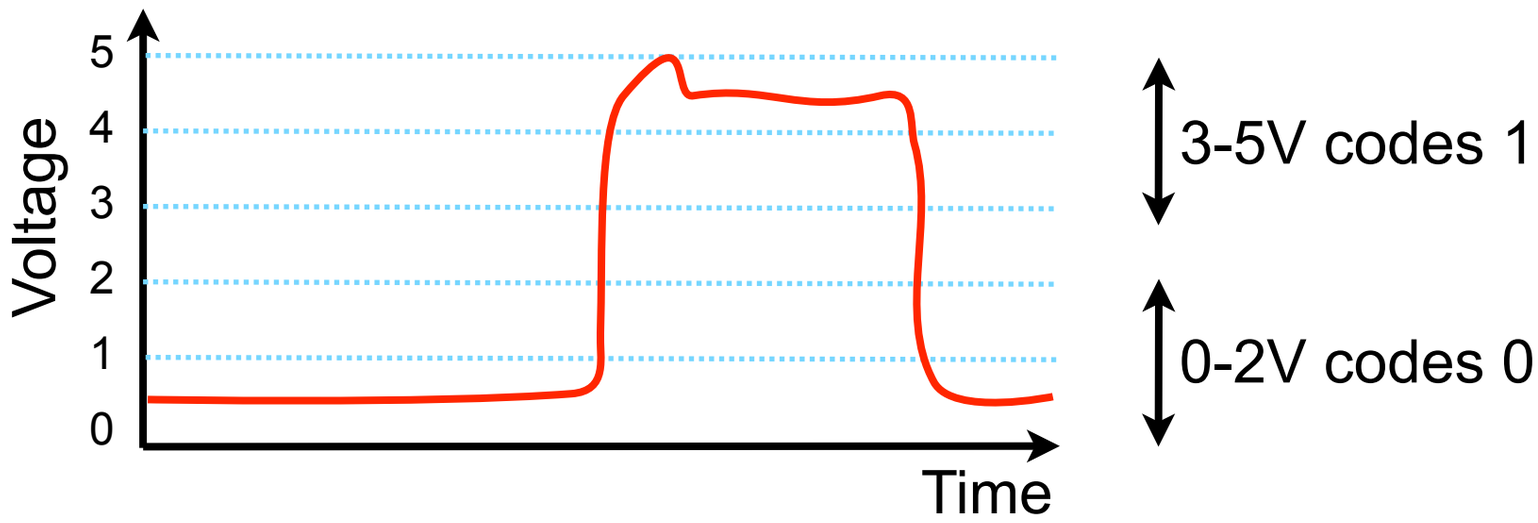


Analogue data can be digitally coded by *sampling* at a suitable rate, *quantising* to the nearest allowable discrete value, and then converting to digital representation (PCM)

0101
0111
1001
1001
1000
...

Digital Signals

- Digital signals comprise a sequence of discrete symbols – fixed alphabet, not arbitrary values
- But underlying channel is almost always *analogue*
  - Coding maps analogue signal ranges to digital symbols



Baud Rate

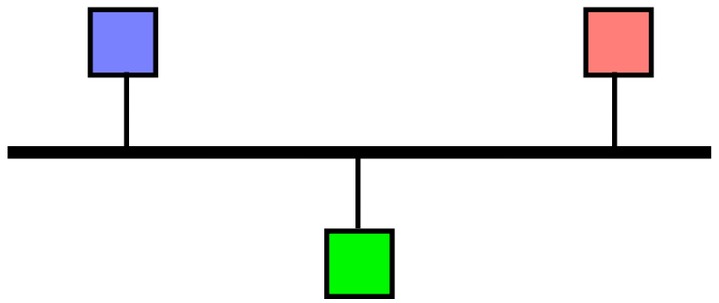
- Number of symbols transmitted per second is the *baud rate*
  - *Binary* codes common, using two distinct symbols
  - This is *not* a requirement – radio communications and ADSL modems often use non-binary codes
    - E.g. Quadrature Amplitude Modulation with 16 symbols → 4 bits per baud

Channels and Network Links

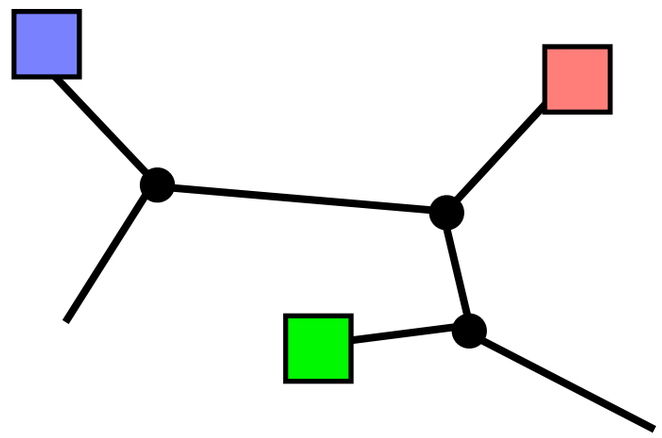
- A signal is conveyed via a channel
  - May be directly conveyed – electrical signals in a cable
  - May be modulated onto an underlying carrier – radio
- The combination of signal and channel forms a network link

From Links to Networks

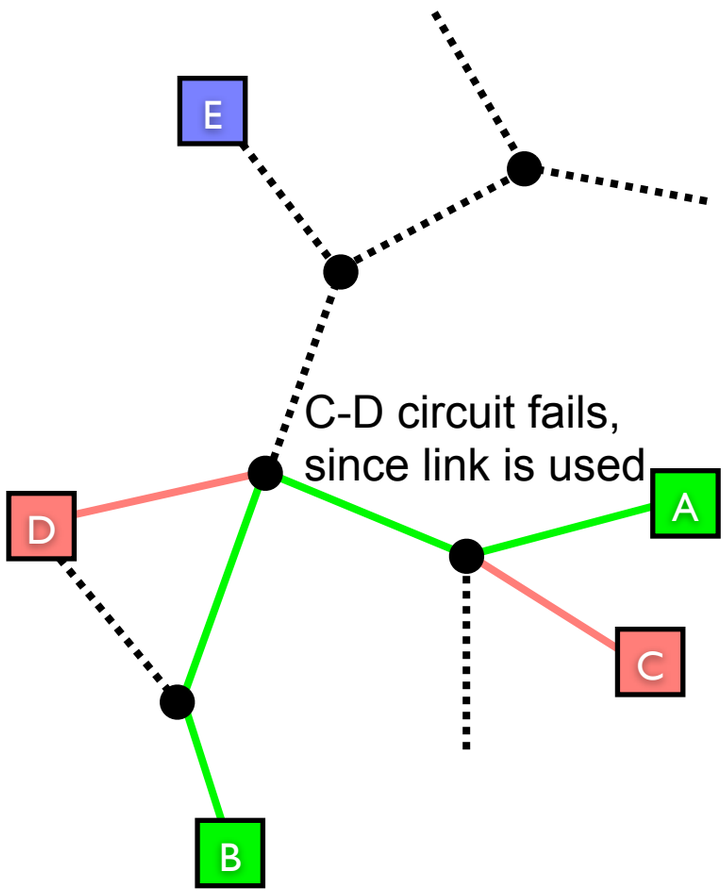
- A network link can directly connect one or more hosts



- Alternatively, hosts might be connected via intermediate switches or routers
  - Circuit switched *vs.* packet switched

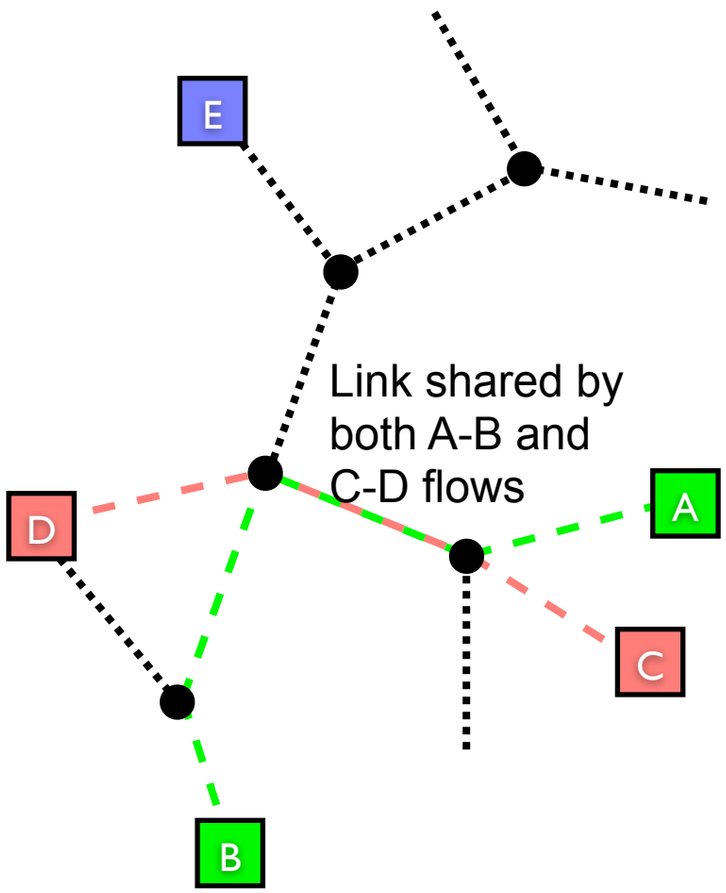


Circuit Switched Networks



- A dedicated *circuit* can be set up for A and B to communicate
- A and B exchange arbitrary length messages
- Guaranteed capacity once circuit is created
- But – the dedicated circuit can block other communications (e.g. the C to D path); the capacity of the network gives the blocking probability
- Example: traditional telephone network

Packet Switched Networks



- Alternatively, messages can be split into small *packets* before transmission
- Allows A-B and C-D to communicate at the same time, sharing the bottleneck link
- Connectivity guaranteed, but the available capacity varies depending how many other people are using the network
- Messages have size limits
- Example: the Internet

Networked Systems

- All networked systems built using these basic components:
  - Hosts – the source and destination(s)
  - Links – physical realisation of the channel, conveying messages
  - Switches and routers – connect multiple links
- Layered on top are *network protocols* which give meaning to the messages that are exchanged

Questions?