

Introduction to Networks (I)

Networked Systems Architecture 3
Lecture I



UNIVERSITY
of
GLASGOW

Lecture Outline

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- Introduction to Networks

Administrivia

Contact Details and Website

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Aims and Objectives

- To provide a solid understanding of the technologies that support modern networked computer systems
- To provide our undergraduates with the ability to see through the hype generated by telecommunications and computer networking vendors, and evaluate and advise industry on networking deployment

Intended Learning Outcomes

- Describe and 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		Introduction to Networks
2	Case Studies	Web Client (basic, file download only)	Socket Programming
3	Communications Theory		Physical Layer
4	Data Link Layer	Web Server (single connection)	Data Link Layer
5	Network Layer		Network Layer
6	Network Layer	Web Server (sequential, multiple connections)	Transport Layer
7	Transport Layer		Transport Layer
8	Applications	Web Server (concurrent, multiple connections)	Applications
9	Applications		Applications
10	Worked Example		

Labs and Assessment

- 8 weekly laboratory sessions
 - Network programming with C and pthreads on Linux
 - Practical work to complement theory from lectures
 - Students expected to attend all laboratory sessions
- No assessed course work: 100% Examination
 - Exam format: answer all three questions
 - Material covered in labs *will* be explicitly examined

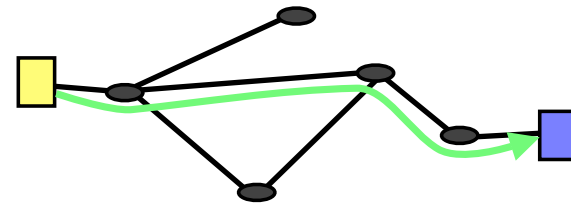
Required Reading

- Any good text on computer networks, e.g.:
 - Tanenbaum, *Computer Networks*, 4th Edition, Prentice Hall, 2002, ISBN 0130384887
 - Peterson and Davie, *Computer Networks: A Systems Approach*, 3rd Edition, Morgan Kaufman, 2003, ISBN 1558608338
 - Stallings, *Data and Computer Communications*, Prentice Hall, 2003, ISBN 0131833111

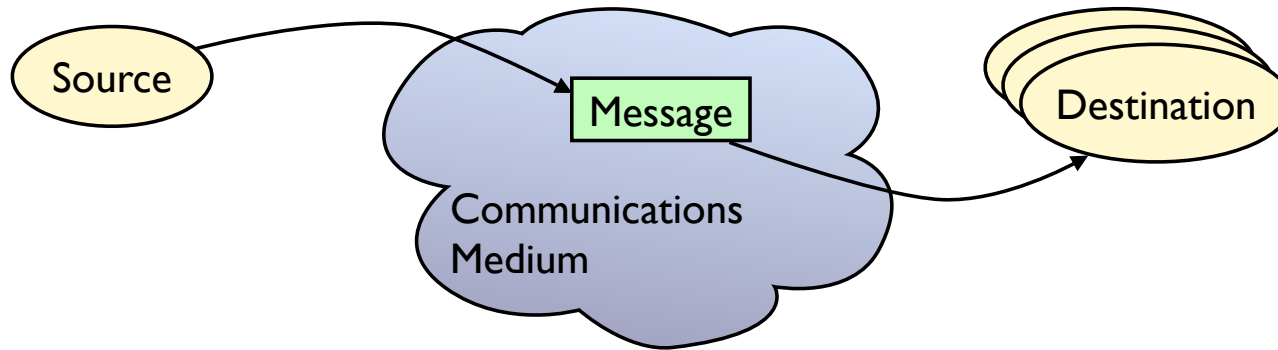
Introduction to Networked Systems Architecture

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

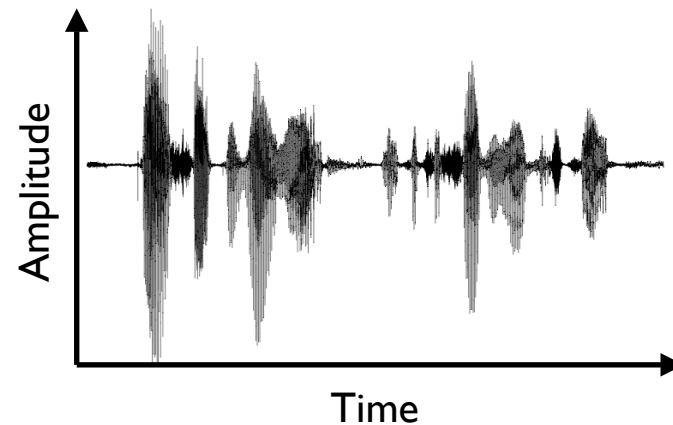
- Messages convey *information*
 - The amount of information in a message can be characterised mathematically – *Information Theory*
- Capacity of channels to convey information can also be modelled
 - How much? How fast? How much power used?
 - Physical limits exist on the capacity of a channel

Signals

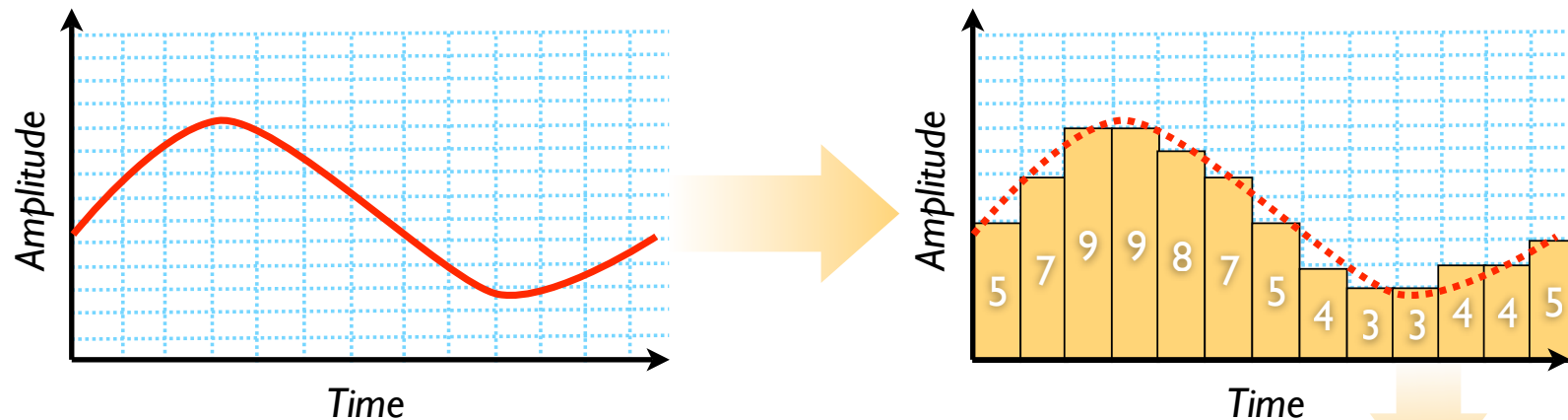
- Physical form of a message is a *signal*
 - May be a material object (carrier pigeon, CD, ...)
 - Usually a wave (sound, electrical signal, light, radio, ...)
- Signal may be analogue or digital
 - Analogue: a smooth continuum of values
 - Digital: a sequence of discrete *symbols*
 - Mapping information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

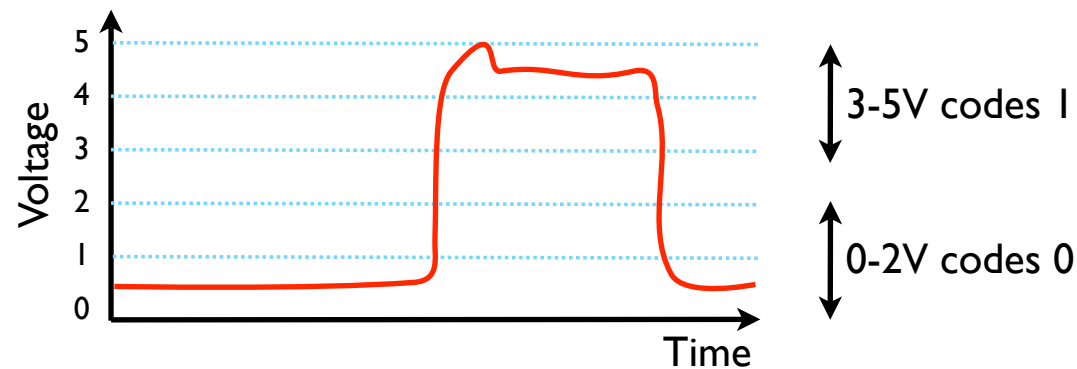


Analogue data can be digitally coded by *sampling* at a suitable rate, *quantising* to the nearest allowable discrete value, and then converting to digital representation (PCM)

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

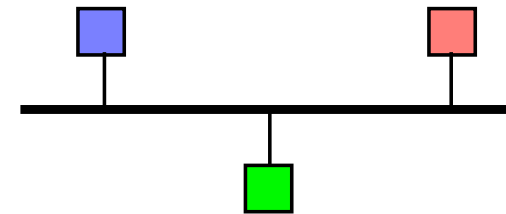
- Number of symbols transmitted per second is the *baud rate*
- *Binary* codes common, using two distinct symbols
- This is *not* a requirement – radio communications and ADSL modems often use non-binary codes
 - E.g. Quadrature Amplitude Modulation with 16 symbols \Rightarrow 4 bits per baud

Channels and Network Links

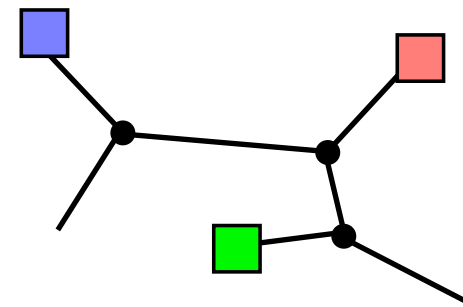
- A signal is conveyed via a channel
 - May be directly conveyed – electrical signals in a cable
 - May be modulated onto an underlying carrier – radio
- The combination of signal and channel forms a network link

From Links to Networks

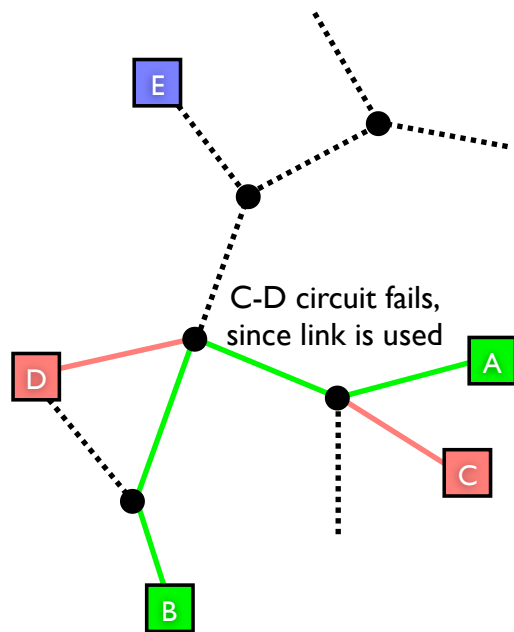
- A network link can directly connect one or more hosts



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

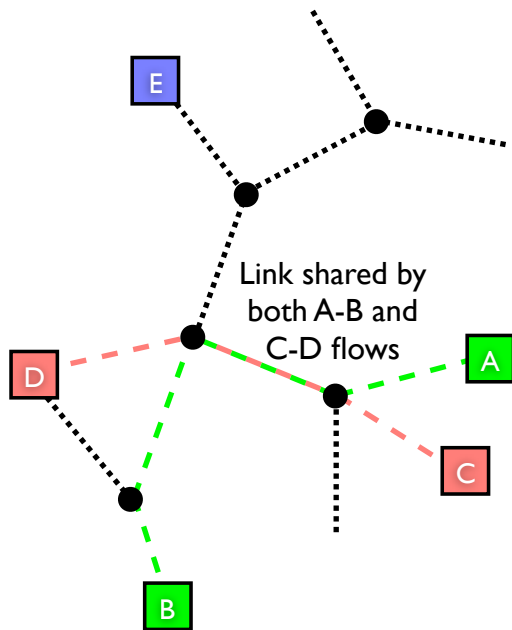


Circuit Switched Networks



- 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?