EEEN20060 Communication Systems

Introduction

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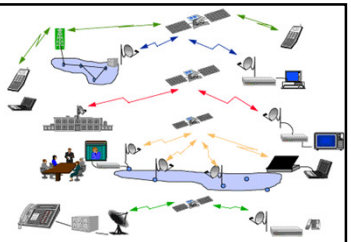
Scoil na hInnealtóireachta Leictrí, Leictreonaí agus Cumarsáide UCD

What is a Communication System ?



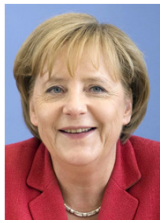
- Communication ?
  - transfer of information
    - (word has other meanings)
- Telecommunication ?
  - communication at a distance
- Our focus
  - electronic communication systems
  - using electrical signals
  - using electromagnetic waves

Example Communication Systems




- Consider the application
  - what type of information is transferred?
  - for what purpose?
- Consider the system
  - the infrastructure that makes it possible
  - we design a communication system to facilitate the application ?
  - applications develop because the system exists ?

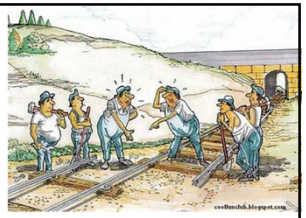
How to Communicate?



message

- Angela wants to get a message to François
  - what does she do?
  - what must be decided or known?
- What if no communication systems exist?
  - have to start from zero?

Communication Protocols



- Protocol = set of rules
  - things that must be agreed so that we can communicate reliably
- Many issues, at different levels
  - what electrical signals will we use?
    - in digital system, minimum 2, to represent 1 and 0
  - what language are we using?
  - how do we represent letters of the alphabet?
  - how do I know you want to connect?
    - and how do you know I accept?
  - . . .

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Standards

- Early days – private standards
  - one telephone company – can use any signals
  - one (mainframe) computer manufacturer – can interconnect computers any way it wants
  - proprietary protocols – owned by one company
- But soon need to agree standard protocols
  - international telephone calls
  - competing telephone companies must interconnect
  - connect computers from different manufacturers
  - use any mobile phone on any network…

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Attempt at Open Standard

- Developed by ISO in late 1970s
  - International Organisation for Standardization
  - aim: "Open Systems Interconnection" (OSI)
  - connect computers from any manufacturers
- Divides problem into 7 layers
  - each layer has separate, well-defined function
  - uses services provided by layer below
  - provides defined services to layer above
  - allows change to one aspect of system without re-design of other layers…
- Used as a reference model in designs
  - ideas adopted in various ways
  - not fully used in any popular network…

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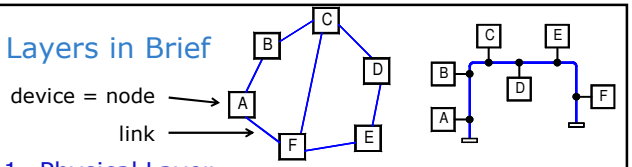
Layers in Brief



1. Physical Layer
   - deals with transfer of bits – knows nothing else
   - operates on a link – directly connected devices
   - moves bits from A to B, reasonably reliably
2. (Data) Link Layer
   - organises stream of bits, makes link reliable
   - on a shared link, arranges sharing...
3. Network Layer
   - makes devices and links work as a network
   - finds routes from source to destination
   - deals with congestion

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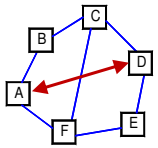
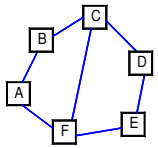
Layers continued...



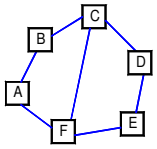
4. Transport Layer
   - operates end-to-end, across network
     - between communicating devices
   - makes network appear reliable
5. Session Layer
   - controls dialogue between processes
   - authentication, restoration if connection lost...
6. Presentation Layer
   - concerned with meaning of data
     - lower layers only carry blocks of bits
   - ensures data is understood at each end
   - translation, encryption...

Layers continued...



7. Application Layer
   - does what is actually wanted
   - examples:
     - send e-mail
     - transfer a file to another computer
     - get a web page from a web server
- Notes
  - lower layers point-to-point
  - higher layers end-to-end
  - only network layer knows network topology
  - lower layers usually in hardware
  - higher layers usually in software

ISO model for Open Systems Interconnection



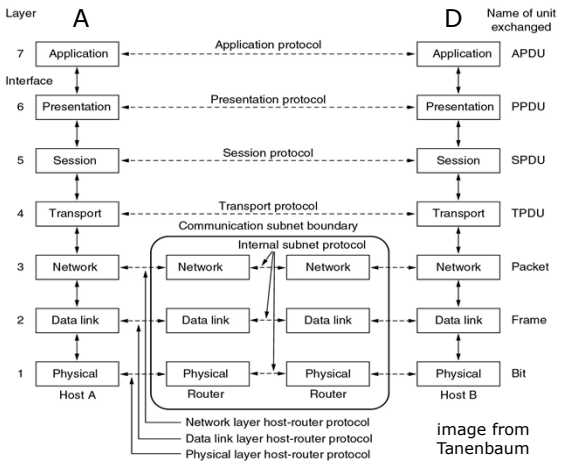
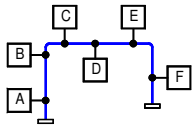


image from Tanenbaum

Comparison of Protocols



Internet	OSI model
Application	Application
	Presentation
	Session
Transport	Transport
Network	Network
	Data Link
	Physical

Shared link: Need extra sub-layer to control access to shared medium

Ethernet

Data Link
Medium Access Control
Physical

Module Outline

- Introduction
  - basic concepts
- Physical Layer Introduction
  - just the key issues – more later
  - details in Communication Theory modules
- Link Layer – providing reliable links
  - problems, possible solutions, examples
  - analysis and design of protocols
- Medium Access Control sub-layer
  - method of sharing the communication path
  - analysis of efficiency

Module Outline (sequence may change)

- Network Layer
  - topology, switching methods, routing
  - problems, possible solutions, examples
- Physical Layer revisited
  - more details, practical channels, analysis
- Transport Layer (if time permits)
  - problems, possible solutions
  - focus on Internet examples: TCP, UDP
- Application Layer (in passing)
  - some common Internet examples
  - illustrated in lab assignment

Practical Work

- Lab each week, Eng.329 – 3 offerings
  - Thursday 11:00 to 13:00
  - Friday 11:00 to 13:00
  - Friday 15:00 to 17:00
  - starting week 1
- Assignments
  - mostly computer-based, using C
  - write software to implement protocols
  - e.g. design & implement a link-layer protocol
  - e.g. communicate over the Internet
- Problem-based learning
  - independent learning will be expected

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Assessment

- Lab work and Assignments – 40%
  - some short – one day
  - others longer – design assignments
  - reports graded and returned with comments
- Open-book Exam – 60%
  - bring your lecture notes and one textbook
  - questions on design, problem solving
  - assess your understanding of the topics
    - not your memory!
  - assess your ability to apply your knowledge
    - solve a problem that you have not seen before

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Books

- Tanenbaum and Wetherall
  - *Computer Networks*, 5th edition, international
  - Pearson, 2013, ISBN-13: 978-1292024226
  - or e-book, 2014, 978-1292031668
  - bottom-up approach
- Kurose and Ross
  - *Computer Networking*, 6th edition, international
  - Pearson, 2012, ISBN-13: 978-0273768968
  - or e-book, 2013, 978-0273784876
  - top-down approach
- Many others available
  - but not called "Communication Systems"
    - that usually maps to Communication Theory

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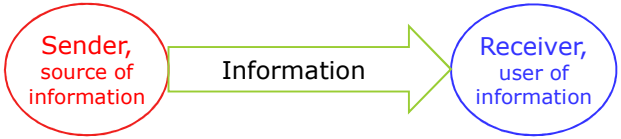
Communication System Concepts



- One-way communication
  - one sender, one receiver
  - one sender, many receivers (broadcast)
  - many senders, one receiver
- Two-way communication
  - users or devices can send and receive
  - one way at a time or both ways at same time ?
  - two users communicate at a time or many ?

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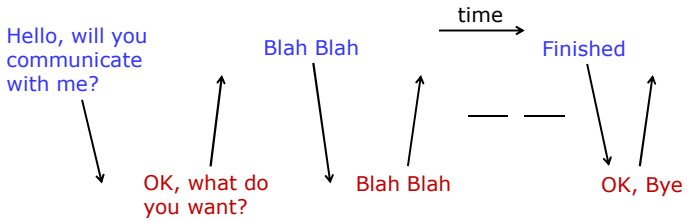
Connections ?



- Some systems use "connection" idea
  - first set up connection with another user
  - communicate as required, then clear connection
  - allows better reliability, security…
- Other systems are "connection-less"
  - just send message to desired user
  - simpler, quicker to get started…

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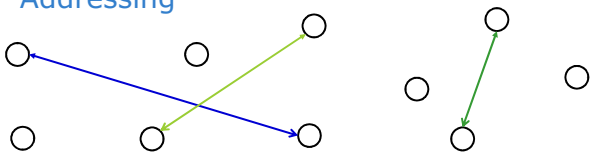
Addressing



- Arises in systems with many users or devices
  - often communicating one-to-one at any time
- Need some way of identifying users/devices
  - specify who/what you want to connect to
  - or specify destination for message
- Names or numbers
  - examples ?

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Client-Server Model

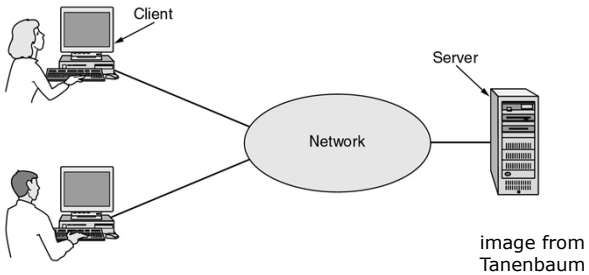

image from Tanenbaum

- Client initiates all communication
  - requests some service or information
- Server responds to requests
  - provides service or information requested

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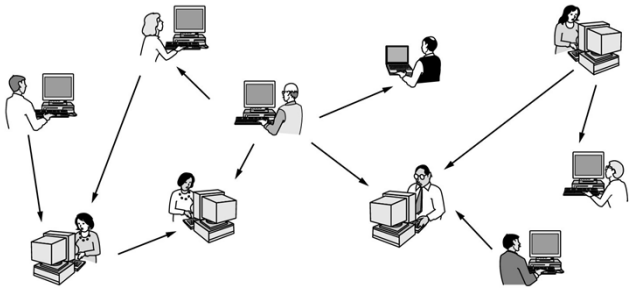
Peer-to-Peer Model

image from Tanenbaum



- All users or devices are equal
  - may act as either client or server
  - or concept might not arise

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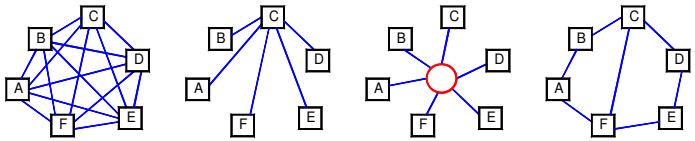
Network Topology (or Structure)



- First consider point-to-point links
  - usually bi-directional (two way)
- Mesh network - one extreme possibility
  - direct link from every device to every other
  - for N devices, need $\frac{1}{2}N(N-1)$ two-way links
- Star network – at the other extreme
  - connect every device to one "hub" node
  - need N or $N-1$ bi-directional links

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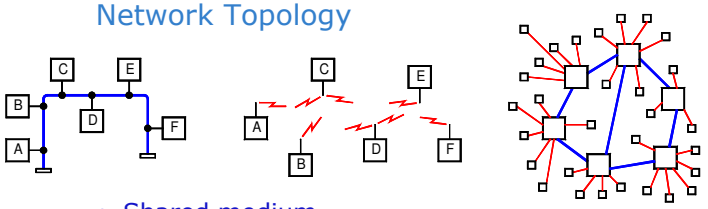
Network Topology



- Shared medium
  - all devices connect to same cable
  - all devices transmit on same radio frequency
  - all devices hear all messages?
  - usually only for relatively small areas
- Large networks
  - mix of ideas – different at edge and inside…
  - special equipment handling messages
  - end-users only at the edges

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