

Topic 2 : Introduction to Networking

Lectures 3 and 4

P & D: Pages 2-27 + others...

"Computer Networks - A Systems Approach", 3rd edition", Larry L. Peterson and Bruce S. Davie, Morgan Kaufman, £34.99.

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Goals of the Networking Lectures...

- Provide you with a basic understanding of key networking issues: requirements, managing connectivity, network architecture, including layering and protocol issues.
- Gain a basic understanding of the Internet packet switched network and the rational for the design choices taken when developing/defining the Internet architecture and common services.

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Computer Networks...

- Compare with other networks...
 - Phone network
 - Specialised for carrying voice traffic
 - Cable TV network.
 - Used to transfer video signals
- Computer Network...
 - 'Generality'
 - Built from general purpose hardware
 - Deliver 'messages' between connected network devices
 - Not optimised for one particular application
 - Messages might be to do with all sorts of things...
 - This is certainly the case with the Internet...

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Applications...

- Consider the diversity of Internet based applications...
 - Web
 - Downloading a file, e.g. latest patch for windows XP
 - **Client** requests file from **server** (e.g. www.microsoft.com/...)
 - Want reliable transfer...
 - Networked Multimedia
 - Streaming audio/video
 - **Source** generates/sends an audio/video stream
 - **Sink** presents the stream of data as it arrives
 - Video conferencing,
 - Tight timing constraints...
 - » Audio + Video frames
 - » Frames can be sent as separate messages...
 - But -it's OK to lose some data!



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Video...

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Network Components...

- Wide diversity...



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Serial and Parallel Communications

- Serial communications
 - e.g. USB, RS232C...

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Serial and Parallel Communications

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- Parallel communications.



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Serial and Parallel Communications

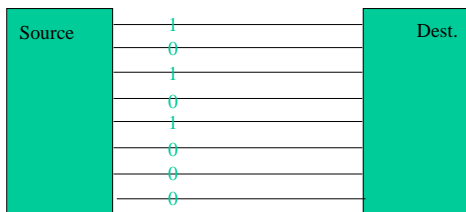
- Parallel communications.



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Serial and Parallel Communications

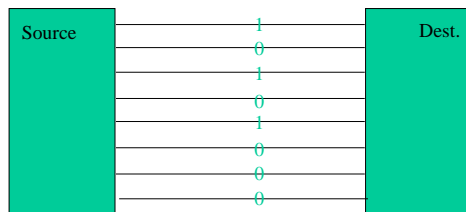
- Parallel communications.



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Serial and Parallel Communications

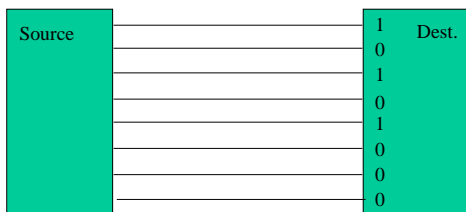
- Parallel communications.



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Serial and Parallel Communications

- Parallel communications.



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The Network Interface

- This is the connection between the computer and the physical network.
- Interface defines, for example, the signals and voltage levels applied to the network.
- In the case of high-speed networks a dedicated card is used.
- For networks requiring analogue signals we use a modem.

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Frequency Modulation

- Change frequency to represent changes in data.



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Frequency Modulation

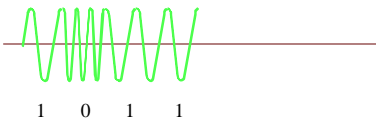
- Change frequency to represent changes in data.



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Frequency Modulation

- Change frequency to represent changes in data.



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Amplitude Modulation

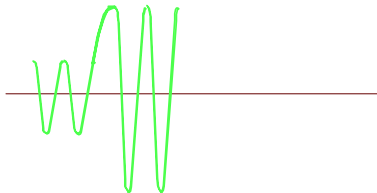
- Change the volume of the signal to represent changes in data,.



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Amplitude Modulation

- Change the volume of the signal to represent changes in data,.



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Network Components...

- Wide diversity...
 - Bandwidth/throughput
 - 9.6 Kbps –
 - 10000 Mbps (10 Gigabit)
 - Latency (delay)
 - One way vs. RTT
 - 330ms max speech
 - Satellite
 - At least 240 ms
 - Reliability
 - BER
 - EMR etc...
 - Predictability...



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What design choices would you make?

- Want generality
 - Cope with wide range of application requirements!
 - Cope with wide range of underlying network components!
- So designers made basic functionality as simple as possible
 - Build on this functionality to meet more stringent requirements

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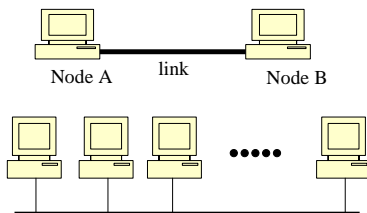
Designing for diversity...

- Simple basic functionality/service...
 - Unreliable message transfer service!
 - Supported by almost (any) underlying communications components
 - Fine for our video conferencing application (providing throughput is sufficient)
- Build on this basic functionality to meet more stringent requirements...
 - Reliable service...
 - Better for downloading our windows XP patch!

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Connectivity...

- Network must provide connectivity among a set of computers!
- Networks such as the Internet designed to be able to grow...
 - **Nodes, Direct Links, and Clouds**



- Point-to-point...
 - e.g. serial cable, microwave link etc...
- Multiple access...
 - e.g. wireless cell, copper fibre, Ethernet

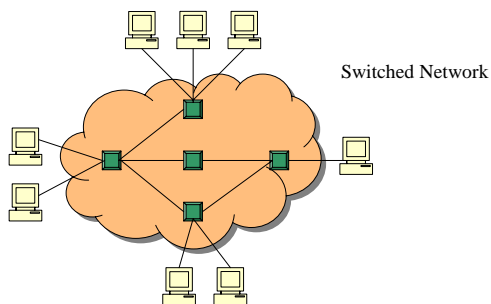
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Want Scalability... but how do we avoid this?



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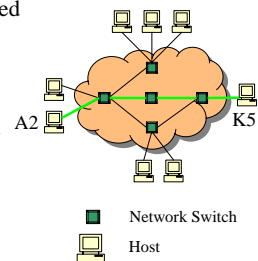
Indirect links... the switched network



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Cloud model cont...

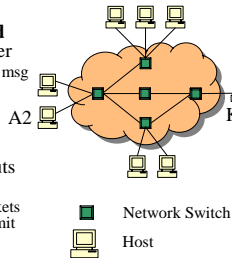
- Nodes attached to >1 link run s/w that forwards data received on one link to another - **switches**.
- **Cloud model** distinguishes between
 - Nodes that *implement* network
 - Nodes that *use* the network
- Switched network
 - Circuit switched
 - Telephone system
 - Packet switched



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Packet switched networks...

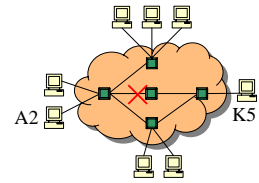
- Focus of our study...
- Nodes (i.e. hosts and switches) **send discrete blocks of data** to each other
 - Messages (Packets), e.g. part of e-mail msg
 - Store-and-forward
 - Receive whole packet
 - Store in internal memory
 - Forward complete packet to next node
- Switches have fixed number of inputs and fixed number of outputs
 - Main role of a switch is to receive packets on one of its (inbound) links and transmit them on one of its (outbound) links



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Packet switched...

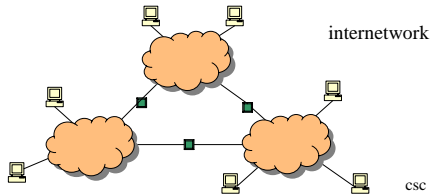
- Robustness...
 - Resilience to failure
 - Link/node



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internetwork (internet for short– n.b. small ‘i’)

- Cloud icon denotes any type of network
 - Single point-to-point, multiple access link or a switched network...
 - Note recursive nature of definition
 - internetwork can be built from an interconnection of independent internetworks (clouds)!



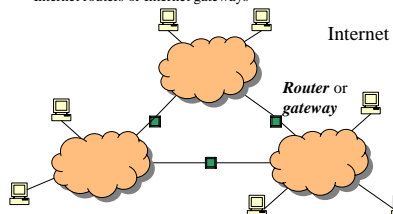
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Questionnaires...

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Internet – n.b. capital ‘I’

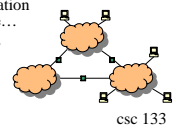
- Term given to the global internetwork that utilises the TCP/IP protocol (more on this later...)
 - Node connected to 2 or more networks...
 - Internet routers or Internet gateways



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Addressing in packet switched networks...

- Need to assign an address to each node...
- Addresses
 - Byte string identifier (e.g. 148.88.8.6)
 - Addresses both the particular network and the node on particular network
- Basic Algorithm for delivering packet (unicast)...
 - If destination node NOT directly connected to sending node then switches and routers use address to decide how to forward packet towards destination
 - basically consult a routing or forwarding table...
 - Process of determining how to do this known as **routing**
- Also notion of **Broadcasting** and **Multicasting**...



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Traceroute...

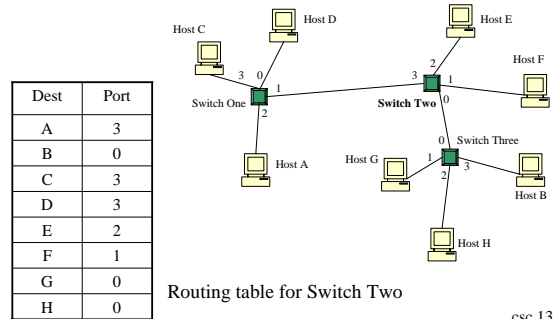
- Tryout for yourself...

```

C:\WINDOWS\System32\cmd.exe
Trace complete.
C:\Documents and Settings\chouret\Desktop>tracert 148.88.157.188
Tracing route to 000.000010.lance.ac.uk [148.88.157.188]
over a maximum of 30 hops:
  0  23 ms  26 ms  25 ms  101-bhai.th.eclipse.net.uk [212.104.130.141]
  1  24 ms  25 ms  24 ms  qe1-2-core3.th.eclipse.net.uk [81.5.191.37]
  2  24 ms  24 ms  23 ms  lin-out-ja.net [194.66.254.151]
  3  24 ms  24 ms  22 ms  n14-0-load-ocr2.ja.net [146.97.35.125]
  4  25 ms  25 ms  25 ms  po7-0-load-ocr3.ja.net [146.97.31.72]
  5  26 ms  25 ms  26 ms  po6-0-load-ocr.ja.net [146.97.31.131]
  6  30 ms  30 ms  29 ms  po1-0-ocsp-ocr.ja.net [146.97.31.54]
  7  32 ms  32 ms  32 ms  po8-0-8.lancaster-har.ja.net [146.97.35.98]
  8  32 ms  31 ms  31 ms  146.97.40.10
  9  32 ms  32 ms  32 ms  174.81.46.2
 10  32 ms  33 ms  32 ms  gw-lance0.lance.ac.uk [174.88.32.64]
 11  32 ms  33 ms  32 ms  gw-lance0.lance.ac.uk [174.88.32.64]
 12  34 ms  33 ms  81 ms  000.000010.lance.ac.uk [148.88.157.188]
Trace complete.
C:\Documents and Settings\chouret\Desktop>
    
```

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Routing (forwarding) tables?



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