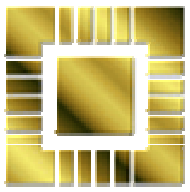

Electronics and Computer Science
University of Southampton

CM214-COMP2008
Data Communications and Networks

Networking Requirements

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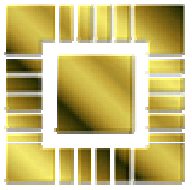
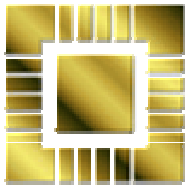


Objectives

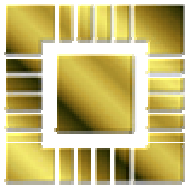
- To review basic networking technology
- To understand what is required to move data over a significant distance
  - I.e. more than a few metres

- (Peterson & Davie, Sections 1 & 2)



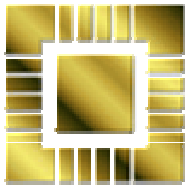
Data Transmission

- At the most fundamental level of the network, we need a means of transmitting a signal
  - A varying electrical voltage
    - In a wire
  - A varying electro-magnetic field
    - In open air / space
    - Confined in a medium (e.g. co-axial cable)
  - (In theory – anything else)



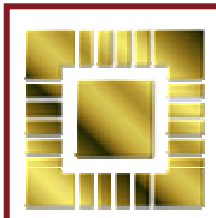
Data Encoding

- We also need a “mapping” between the varying signal and the (digital) data
  - This is the encoding
- Types of encoding (signal → binary digits)
  - NRZ, NRZI, Manchester, 4B/5B
  - There is more than one way!
  - (Almost) always implemented in hardware



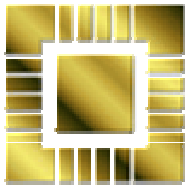
Data Framing

- The stream of bits must be split into meaningful units (frames)
- Need to indicate start (synchronisation)
- Sentinel approach
  - Use special bit sequences as markers
  - Need to “escape” markers in data
- Byte counting approach
- Clock based framing
  - Regularly repeated markets, no “escapes”



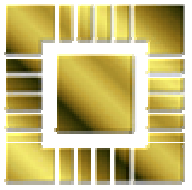
Data Errors

- Errors occur in data transmission due to
  - Thermal noise
    - No electrical system is perfect
  - Interference
    - Other sources of electro-magnetic radiation
  - Cosmic rays
    - Can affect buffers, memories
  - Other factors
    - JCB Operators, mice, cups of coffee…



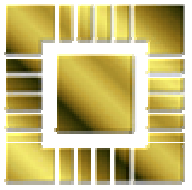
Error Detection

- There are techniques to detect errors
  - For a given probability of errors occurring we can ensure correct transmission with any level of confidence we require (but not 100%)
  - At the cost of “overhead” bits
- Examples
  - 2D Parity, Checksums, CRCs



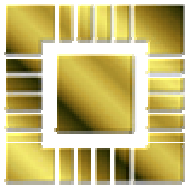
Error Correction

- With further overhead bits we can also correct (certain combinations of) errors
  - Hamming codes
- The overhead is quite high – error correction only worthwhile if the cost of retransmission is very high (or impossible)
  - E.g. Forward Error Correction (FEC) on satellite TV transmissions



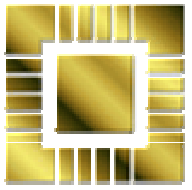
Lost Frames

- Most links are not error corrected
- Detected errors cause the frame to be discarded
- Frames may also get lost in transit
- Acknowledgements and timeouts can be used to cause lost / corrupt frames to be resent
  - Automatic Repeat Request (ARQ)



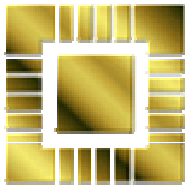
ARQ Algorithms

- Stop and Wait
  - 1 frame outstanding at any time
  - Needs 1 bit flag to detect duplicate frames
- Sliding Window
  - More than 1 frame outstanding
  - Various schemes for acknowledgement
  - Can also manage out of order frames



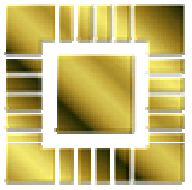
Terminology – 1

- Link – point to point connection between two nodes of a network
  - e.g. cable, leased line, optical fibre
- Node – some processing element on the network
  - e.g. general purpose computer, or network router



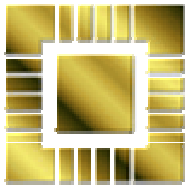
Terminology – 2

- Bandwidth – number of bits per second that can be sent over a link
  - e.g. Ethernet 10Mbps
- Throughput – the measured performance of a link
  - Typical Ethernet shared segment 3Mbps



Terminology – 3

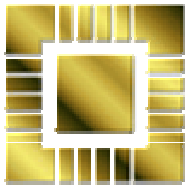
- Latency – The time taken by a packet to traverse a link
  - This is **not** the inverse of the bandwidth / bitrate
  - It depends on the propagation time of the medium
  - And any processing delays in the link
- Round Trip Time (RTT) – Time to send a packet there and back again



Terminology – 4

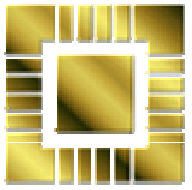
- Propagation delay – The time for one bit to traverse a link

- Delay x bandwidth – The “capacity” of a link, i.e. the outstanding data in the link
  - This is important for flow control
  - And for the efficient usage of the link



Terminology – 5

- Bitrate – rate at which digital bits are transmitted
- Baudrate – rate at which the signal varies
  - Although it is considered somewhat “nerdy” to point out this distinction…



Summary

- Networks consist of links and nodes
- We need to encode the digital data in some varying signal
- And group raw “bits” into frames
- And try to detect any errors in the frame
- While still using the link most efficiently
- And not confusing our terminology