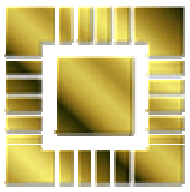
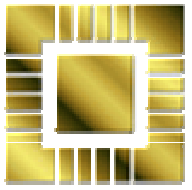


Electronics and Computer Science
University of Southampton

CM214-COMP2008
Data Communications and Networks

Links Between Networks

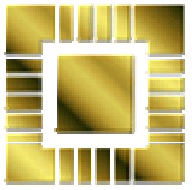
Karl R. Wilcox
krw@ecs.soton.ac.uk



Objectives

- The Theory of Packet Switching
  - To link similar networks
- The Hardware of Packet Switching
  - (Covered in Unit 4)

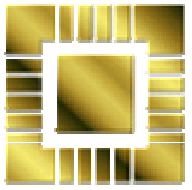
- (Peterson & Davie, Section 3.1, 3.2, 3.4)



Review

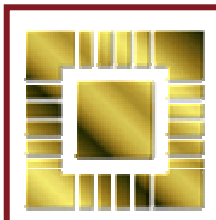
- In previous lectures we looked at Ethernet and other networking technologies

- Ethernet Limitations:
  - Performance on shared media
    - (Although we can use switched connections)
  - Geography
    - 2,500m, repeaters (and power!) every 500m



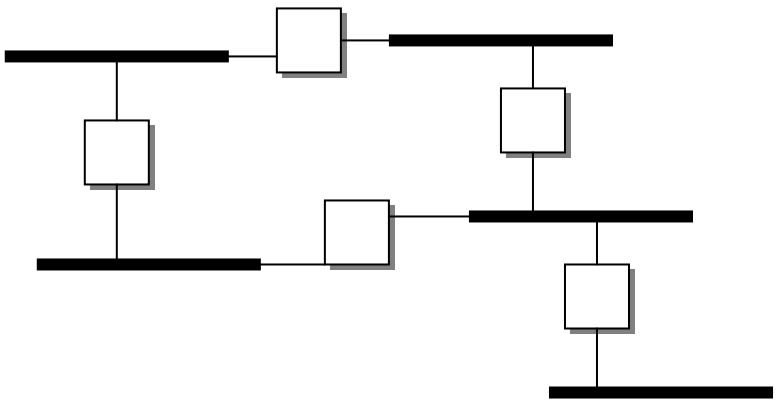
Ethernet Bridges

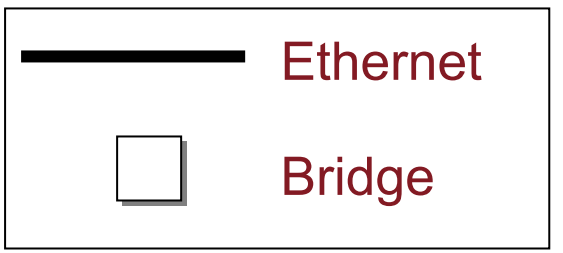
- Connect two (separate) ethernets
- Could work like a repeater
  - packet in = packet out on other interface
- More intelligently, build a forwarding table
- Use source address in packet header
  - Table build dynamically
  - Entries “lifed” to take account of moves



LANS with Loops

- Could have many Ethernets and bridges
- This could result in network loops

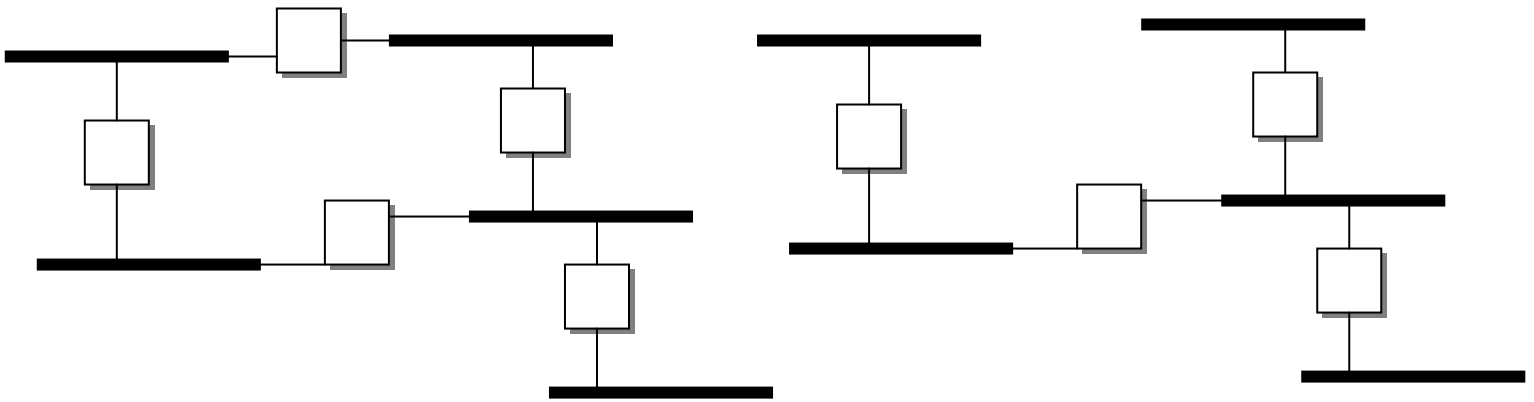


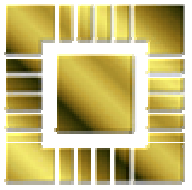


- Packets could loop forever
  - With simple dynamic table building

Spanning Tree Algorithm

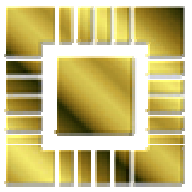
- Must construct tables that do not contain the loop
- Spanning Tree Algorithm
  - (See P&D Section 3.2.2 for full discussion)
  - Turns: Into:





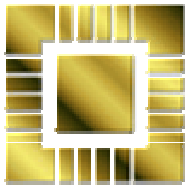
Spanning Tree Characteristics

- Good points
  - Dynamic reconfiguration
  - Takes account of moved / new hosts & bridge failures
- Bad points
  - “redundant” links are not used
  - No traffic management, busy bridges are not routed around (see lectures 7 & 8)



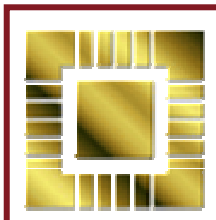
Bridges & Broadcast Packets

- To handle broadcast packets, bridges act like repeaters, send packet on all outbound ports
- Does not scale well
  - Where should broadcast stop?
- Can use “virtual LANs” (VLANS) to “break” network into smaller sections, broadcast only to the same section



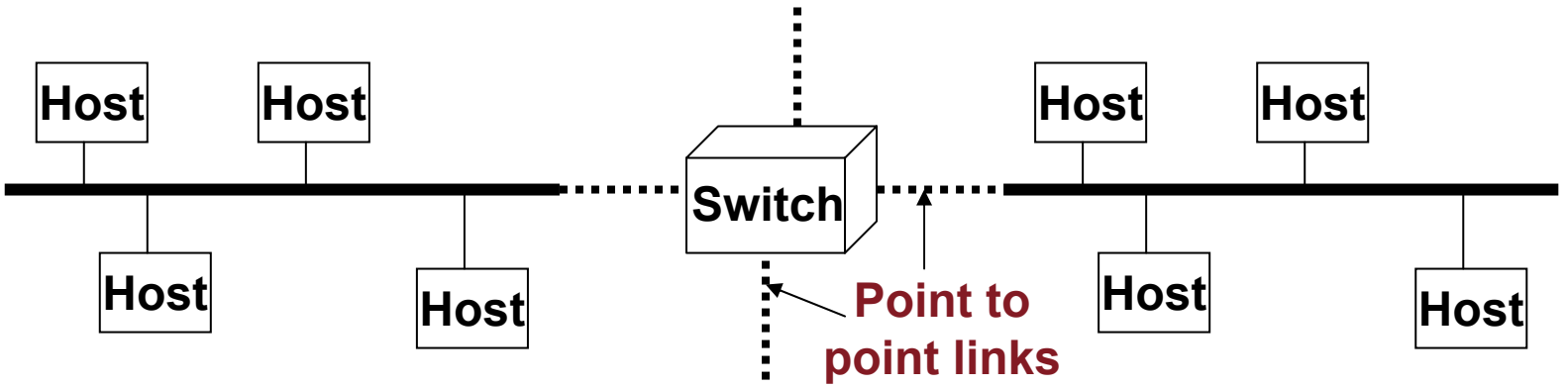
Limitations of Bridges

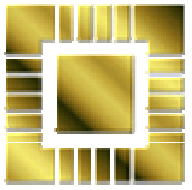
- Cannot scale indefinitely
- Difficult to mix network types
- Needs same address format throughout
- Bridges work at the frame level of the network
- Bridges increase network latency
  - End to end round trip time



Linking Ethernets

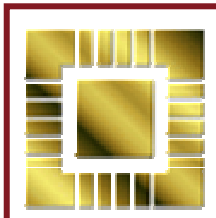
- We could connect Ethernets using bridges
  - Not feasible due to 500m segment length
- We must use some sort of point-to-point link such as optical fibre or telephone





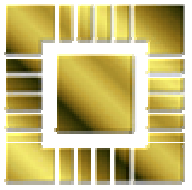
Switch Characteristics

- Ideally, we would like our switch to:
  - Provide multi-way connections
    - To avoid expense & complexity of linking every network with every other by a point-to-point link
  - Be able to connect to other switches
    - For redundancy and scalability
  - Not impose too much of a performance limitation on traffic
    - Keep all the (expensive) p-t-p links busy



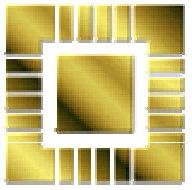
Switch Actions

- Receive packets on inbound links
- Send packets on outbound links
- Route packets between links
  - Datagram routing
  - Virtual circuit routing
  - (Source routing)



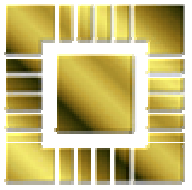
Datagram Routing

- Requires globally unique addressing
- Requires routing tables
  - Created manually or dynamically
- Manual routing tables require consistent tables across switches
- Dynamic routing tables require “smart” algorithms and cooperation between switches



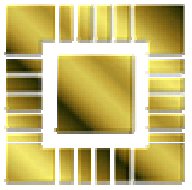
Datagram Characteristics

- Packets are <u>independent</u>
  - Sent at any time
  - No acknowledgement
    - (although higher level protocol may do so)
  - May arrive not in order sent
  - Routing is dynamic



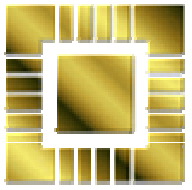
Virtual Circuit Switching

- Must be “setup” and dismantled
- An explicit route is created between the end points
- Uses a “virtual circuit identifier” (VCI)
- Switches know how to route packets
- VCIs meaningful only within switch
  - Can use different VCIs at each switch



Virtual Circuit Characteristics

- Setup required
  - Takes time
    - BUT
  - Guarantees connection
  - Can reserve buffer space etc.
  - Can provide quality of service guarantees
  - Failures require whole route to be rebuilt
  - Must “break up” closed circuits to recover resources



Summary

- To link geographically separate networks we must use point to point links
- This generates routing problems
  - And various solutions
- And decisions about packet handling
  - Switched or virtual circuit