

Router Construction

- Outline
 - Switched Fabrics
 - IP Routers
 - Extensible (Active) Routers



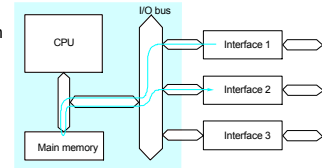
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Workstation-Based

- Aggregate bandwidth
 - 1/2 of the I/O bus bandwidth
 - capacity shared among all hosts connected to switch
 - example: 800Mbps bus can support 8 T3 ports
- Packets-per-second
 - must be able to switch small packets
 - 100,000 packets-per-second is achievable
 - e.g., 64-byte packets implies 51.2Mbps



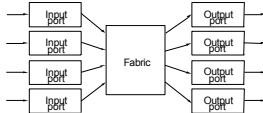
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Switching Hardware

- Design Goals
 - throughput (depends on traffic model)
 - scalability (a function of n)
- Ports
 - circuit management (e.g., map VCIs, route datagrams)
 - buffering (input and/or output)
- Fabric
 - as simple as possible
 - sometimes do buffering (internal)



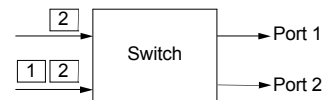
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Buffering

- Wherever contention is possible
 - input port (contend for fabric)
 - internal (contend for output port)
 - output port (contend for link)
- Head-of-Line Blocking
 - input buffering

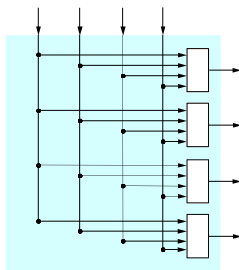


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Crossbar Switches



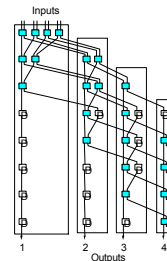
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Knockout Switch

- Example crossbar
- Concentrator
 - select 1 of n packets
- Complexity: n^2



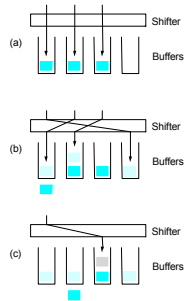
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Knockout Switch (cont)

- Output Buffer



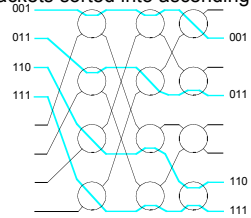
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Self-Routing Fabrics

- Banyan Network
 - constructed from simple 2×2 switching elements
 - self-routing header attached to each packet
 - elements arranged to route based on this header
 - no collisions if input packets sorted into ascending order
 - complexity: $n \log_2 n$



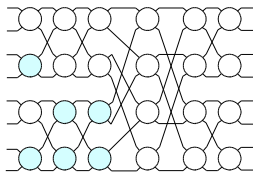
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Self-Routing Fabrics (cont)

- Batcher Network
 - switching elements sort two numbers
 - some elements sort into ascending (clear)
 - some elements sort into descending (shaded)
 - elements arranged to implement merge sort
 - complexity: $n \log_2^2 n$



- Common Design: Batcher-Banyan Switch



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High-Speed IP Router

- Switch (possibly ATM)
 - link interface
 - router lookup (input)
 - common IP path (input)
 - packet queue (output)
- Network Processor
 - routing protocol(s)
 - exceptional cases

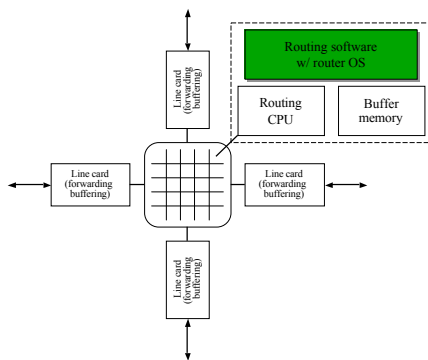


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High-Speed Router

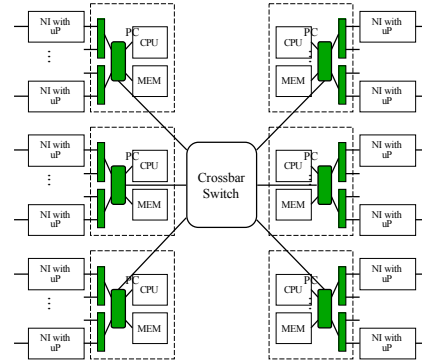


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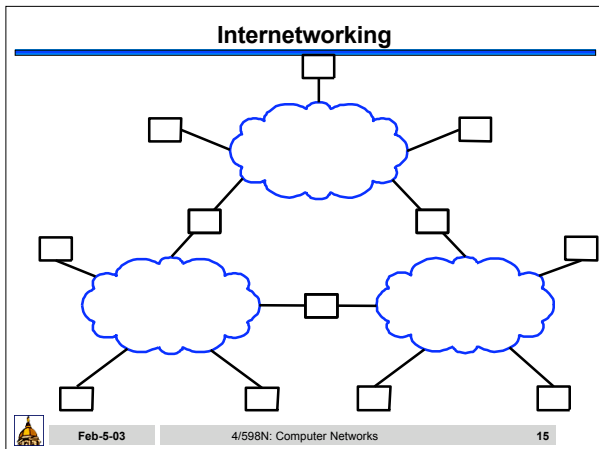
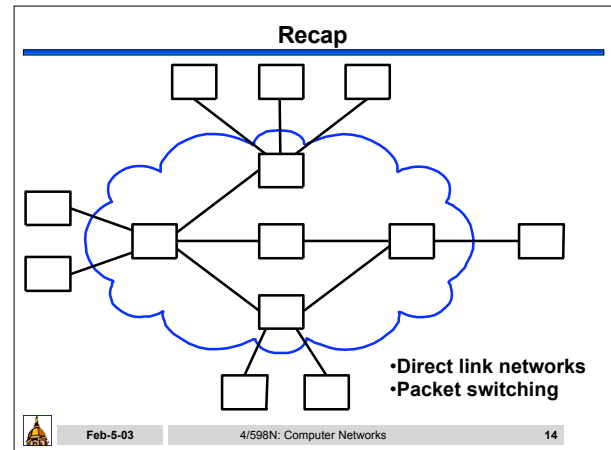
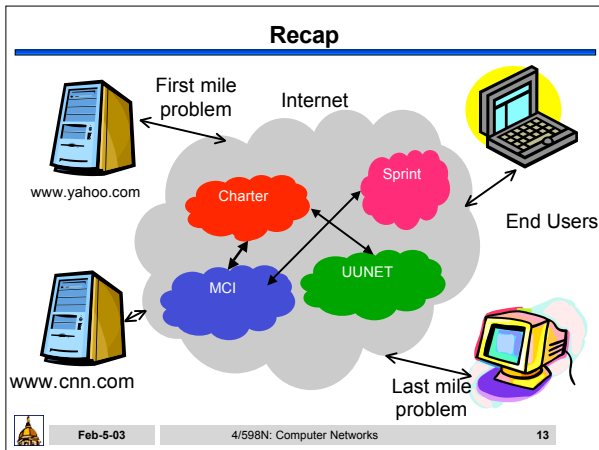
Alternative Design



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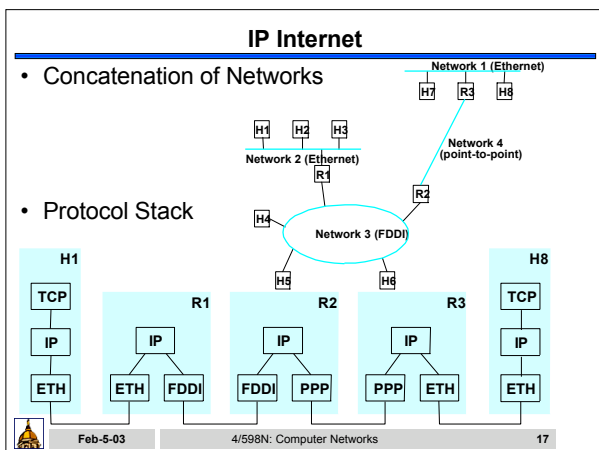
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Internetworking

- Outline
 - Best Effort Service Model
 - Global Addressing Scheme

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1. Service Model

- Connectionless (datagram-based)
- Best-effort delivery (unreliable service)
 - packets are lost
 - packets are delivered out of order
 - duplicate copies of a packet are delivered
 - packets can be delayed for a long time
- Datagram format

0		4		8		16		19		31	
Version		HLen		TOS		Length					
Ident		Flags		Offset							
TTL		Protocol		Checksum							
SourceAddr											
DestinationAddr											
Options (variable)										Pad (variable)	
Data											

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