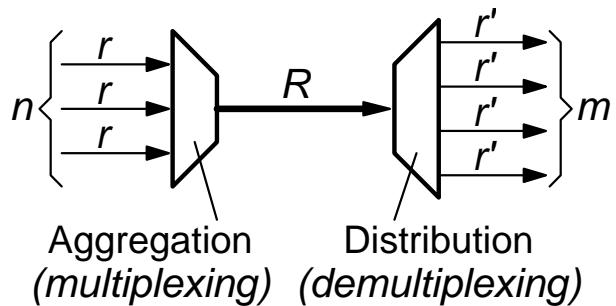


### 1.3 Multiplexing, Time-Switching, Point-to-Point versus Buses

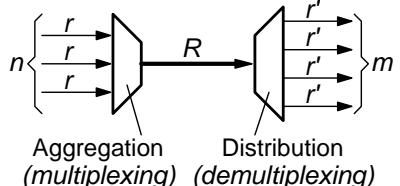


- Simplest Networking, like simplest programming:  
Sequential !

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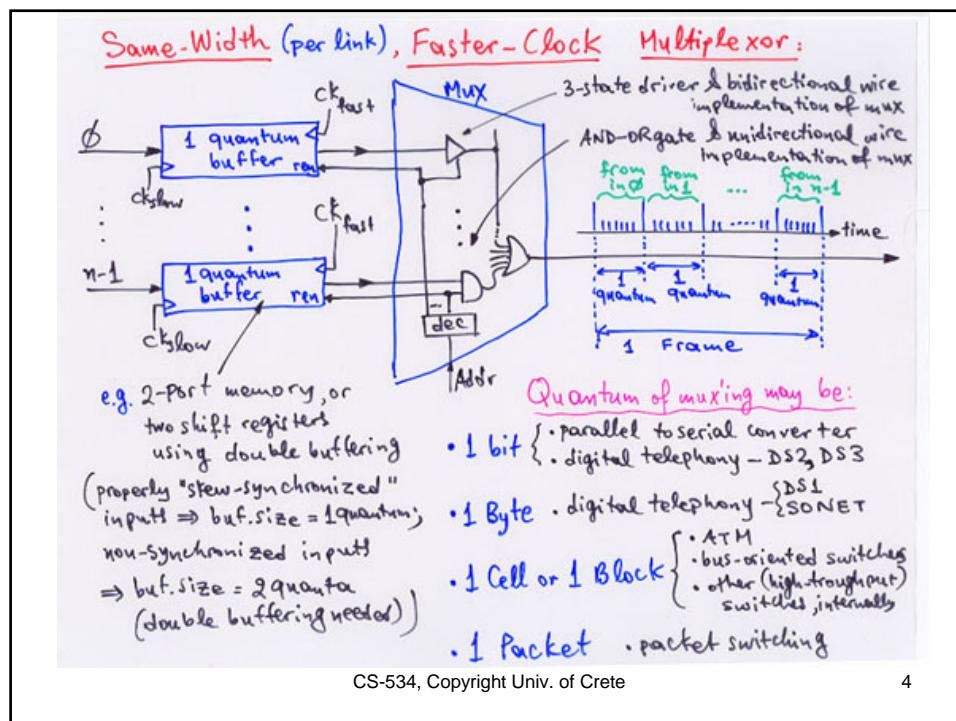
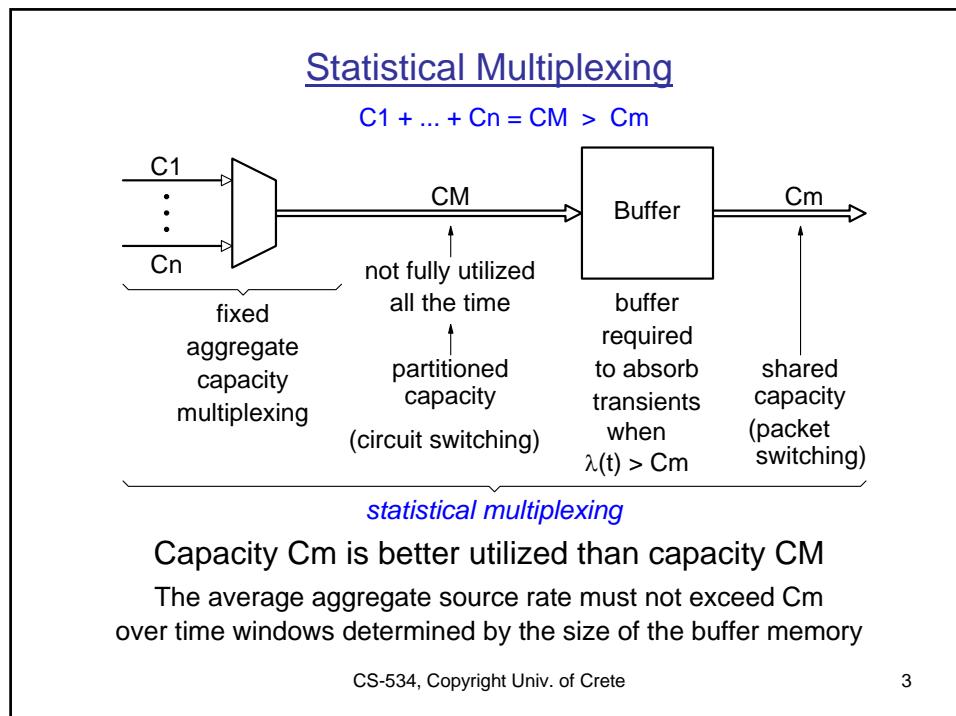
#### Time-Switching

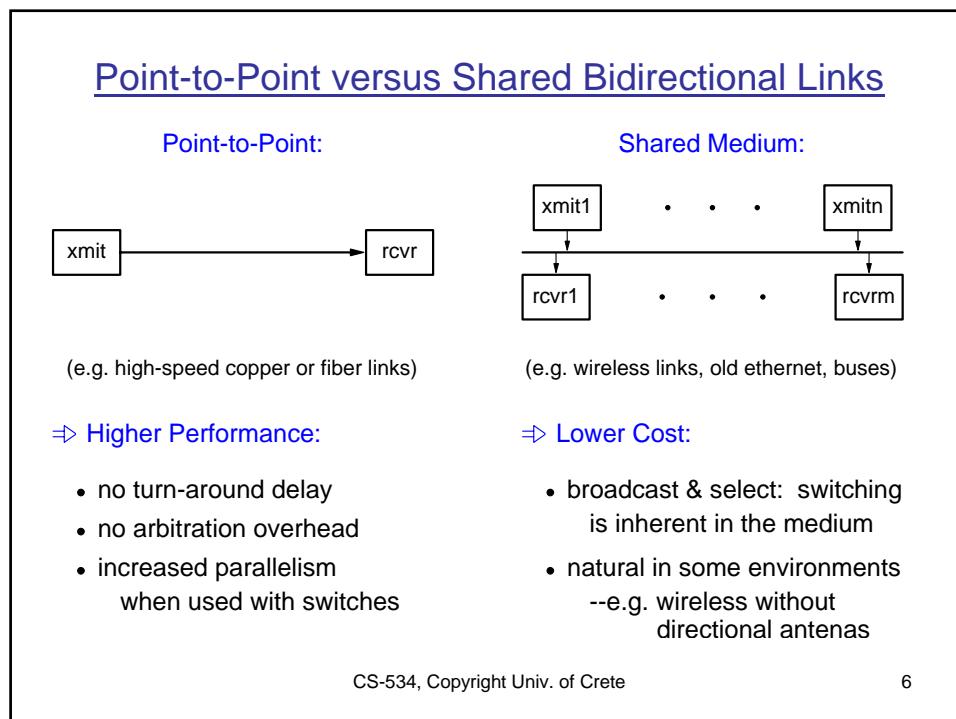
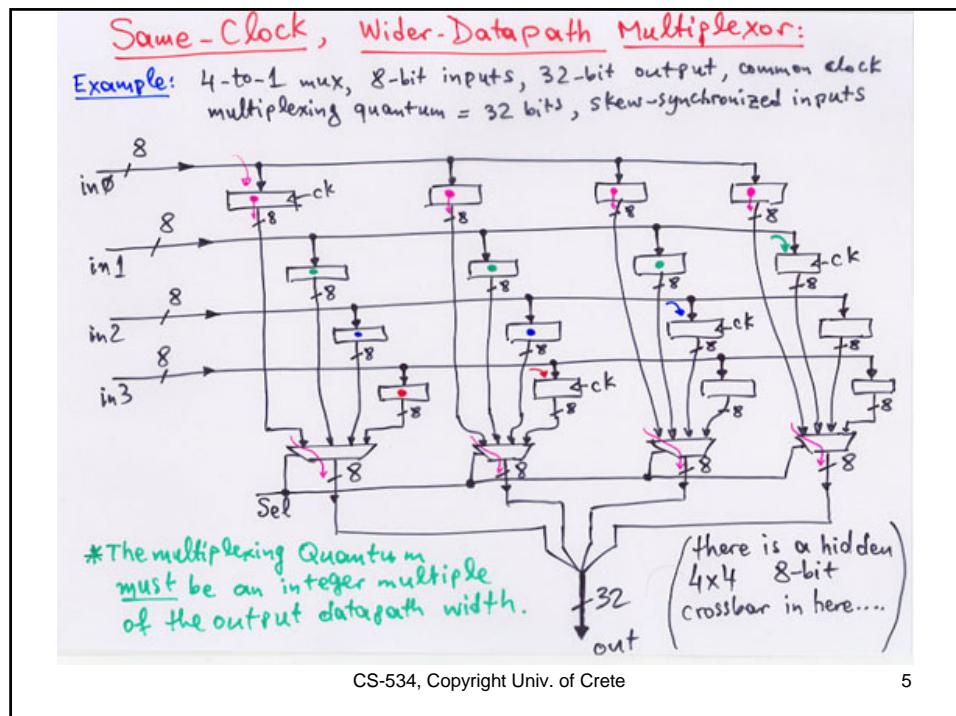


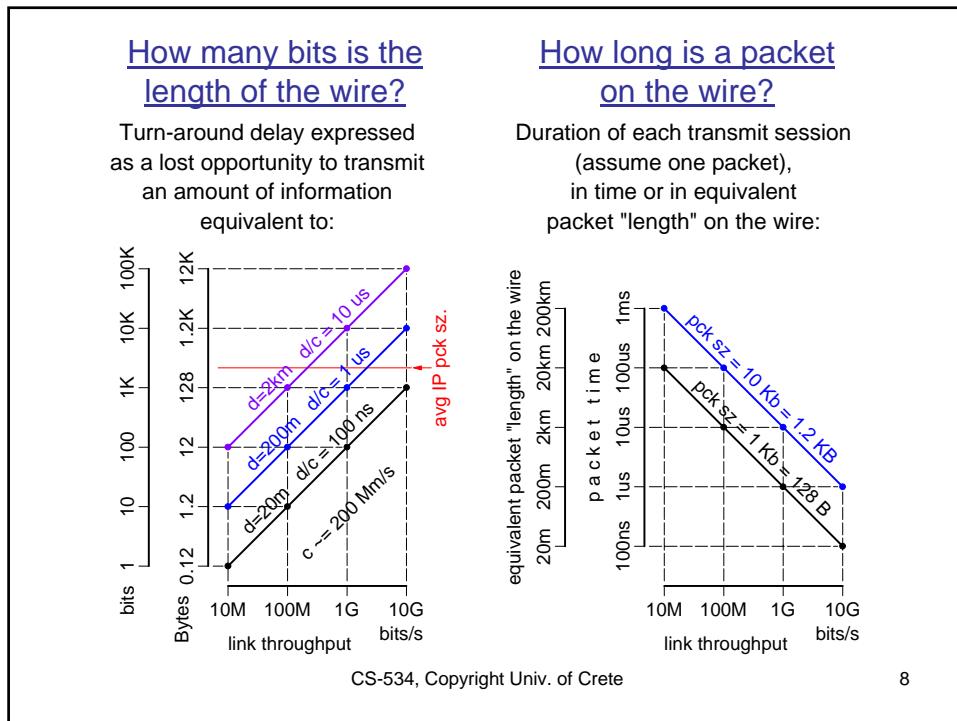
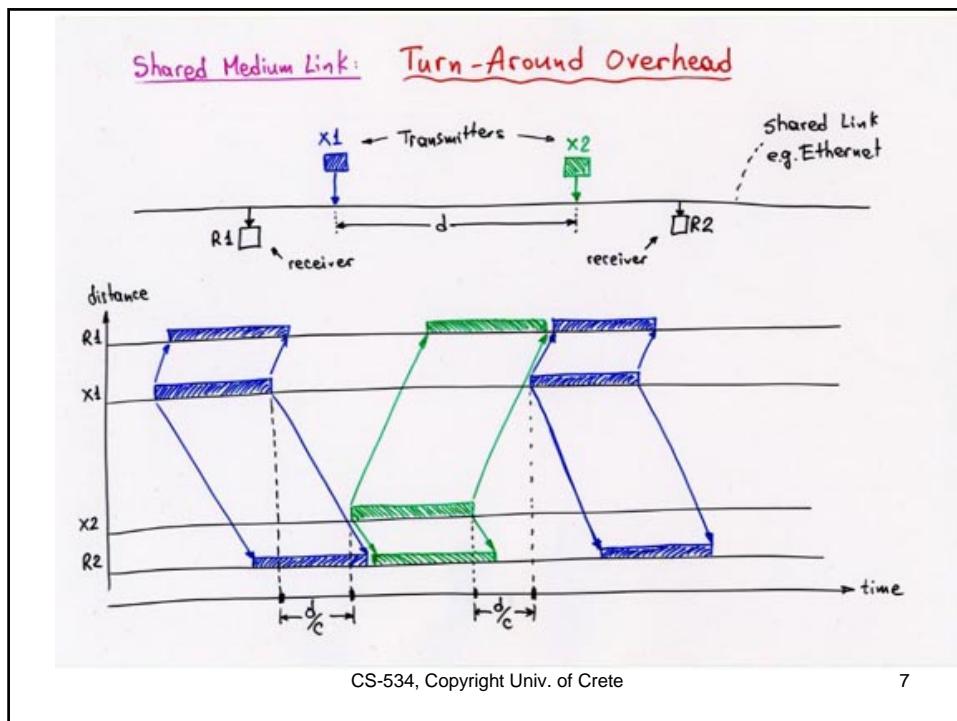
- Shared Medium Communication
- Demultiplexor determines where each piece of information is routed to by selecting the time at which each output receives information from the shared medium
- Simplicity: one thing at a time – no parallelism
- Non-scalable! – cannot increase  $R$  indefinitely
- Full-capacity ( $R = n \cdot r$ ) or Statistical Multiplexing ( $R < n \cdot r$ )
- Implementation issues, point-to-point links versus bidirectional, shared physical medium

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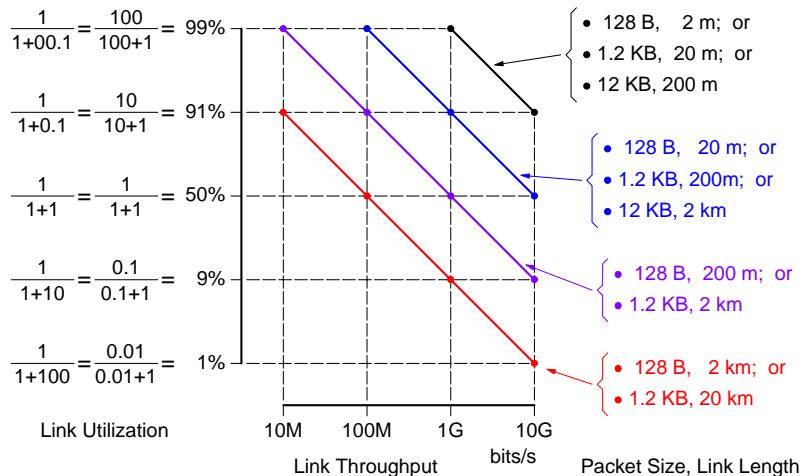






### Link Utilization = f(Packet Length, Wire Length, Throughput)

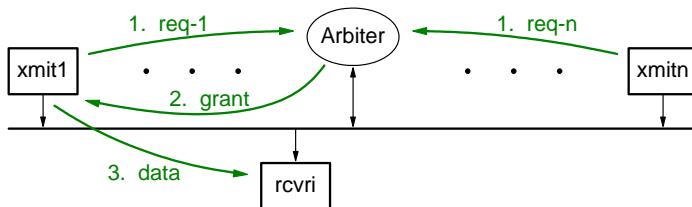
$$\text{Link Utilization} = \frac{\text{packetSize}}{\text{packetSize} + \text{turnAroundBitEquiv}} = \frac{\text{packetTime}}{\text{packetTime} + \text{turnAroundDelay}}$$



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### Arbitration Overhead in Shared Media



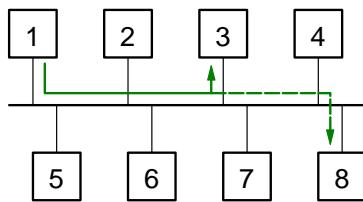
- Separate medium for requests and grants?  
→ increased media cost, increased latency.
- Shared medium for all of request, grant, and data?  
→ reduced throughput, increased latency.
- Optimistic arbitration (CDMA/ethernet style) ?  
→ limited peak throughput, very high latency at high loads.

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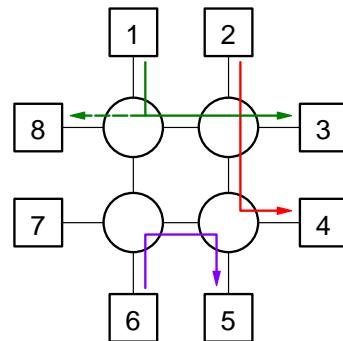
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### Sequential versus Parallel Transmissions

Shared Medium:



Point-to-Point Links + Switches:



*Single transmission at a time*

*Multiple transmissions in parallel*

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### This Course: Point-to-Point Links

- Throughput in shared media is rather low
  - time switching (simpler), protocols usually in software, with little, if any, & simple H/W support
- Shared media in modern networking: almost expelled, except in wireless
  - wireless MAC protocols are a major topic in other courses, and differ significantly from the hardware architecture of high-speed switches

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