

ORDERED MESSAGE DELIVERY

81

81

FIFO Order

- FIFO Delivery Rule:
 - $\text{send}(m) \text{ on } i \rightarrow \text{send}(m') \text{ on } i$
implies that
 $\text{deliver}(m) \text{ on } k \rightarrow \text{deliver}(m') \text{ on } k$

82

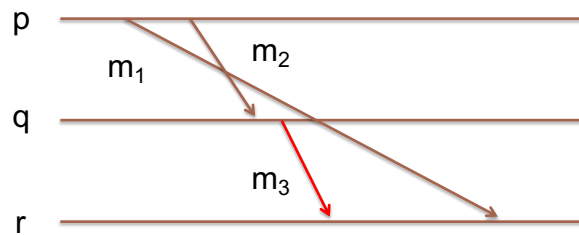
82

Causal Order

- Causal Delivery Rule:
 - $\text{send}(m) \text{ on } i \rightarrow \text{send}(m') \text{ on } j$
implies that
 $\text{deliver}(m) \text{ on } k \rightarrow \text{deliver}(m') \text{ on } k$
- FIFO Order not sufficient to ensure Causal Order

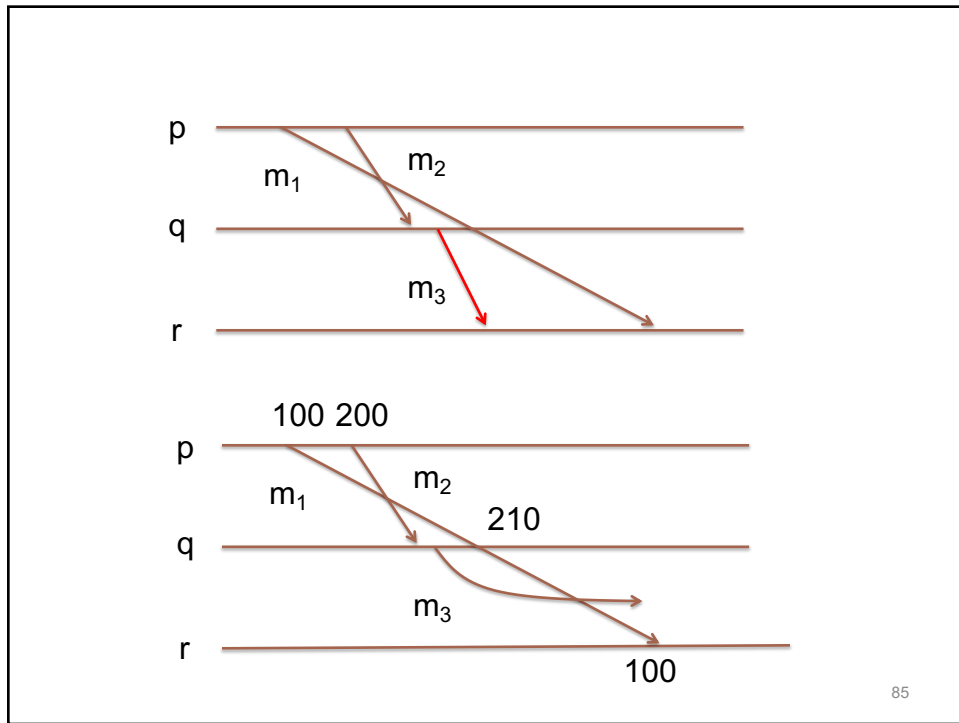
83

83



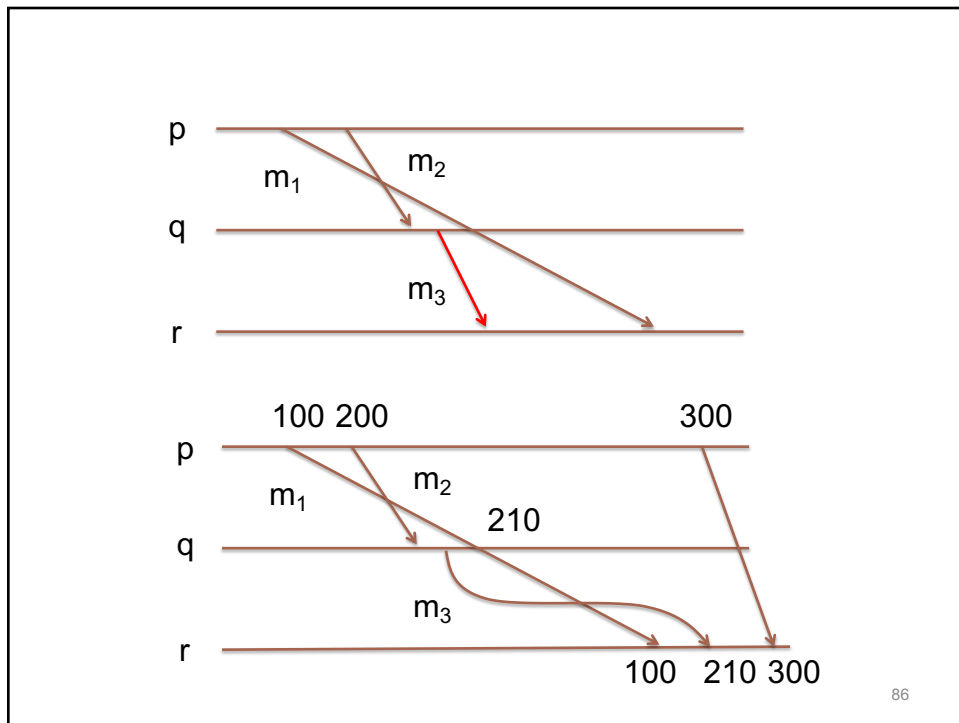
84

84



85

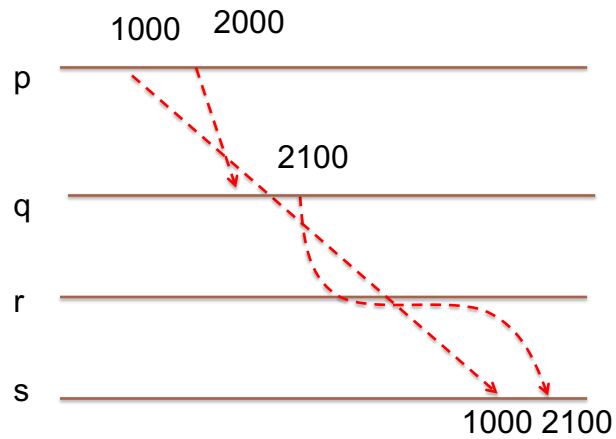
85



86

86

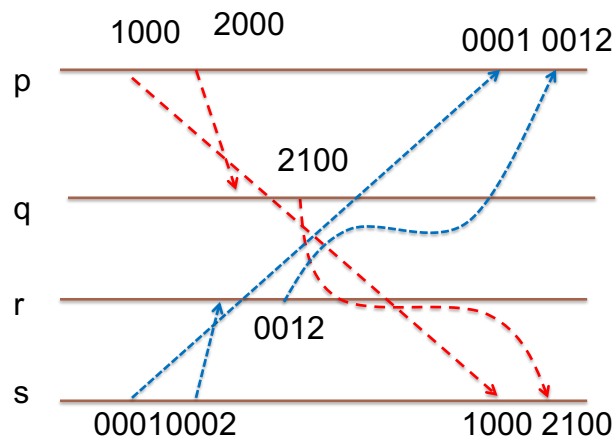
Causal Point-to-Point May Deadlock



87

87

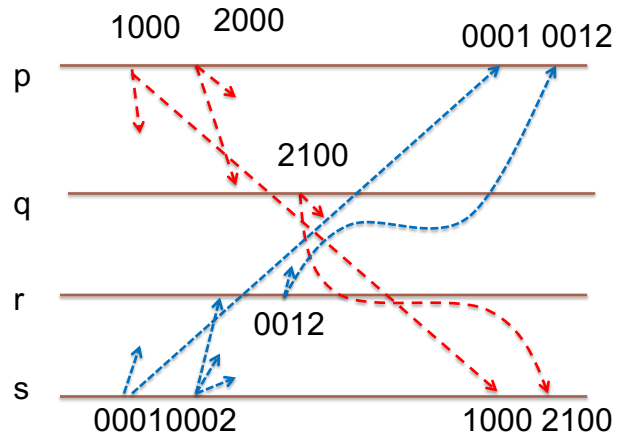
Causal Point-to-Point May Deadlock



88

88

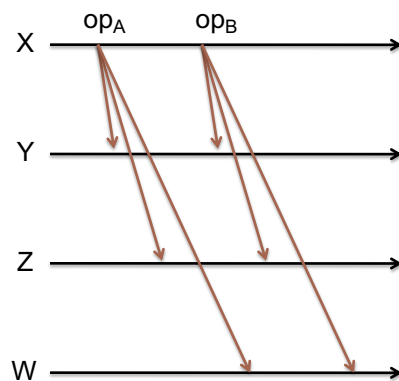
Causal Multicast avoids Deadlock



89

89

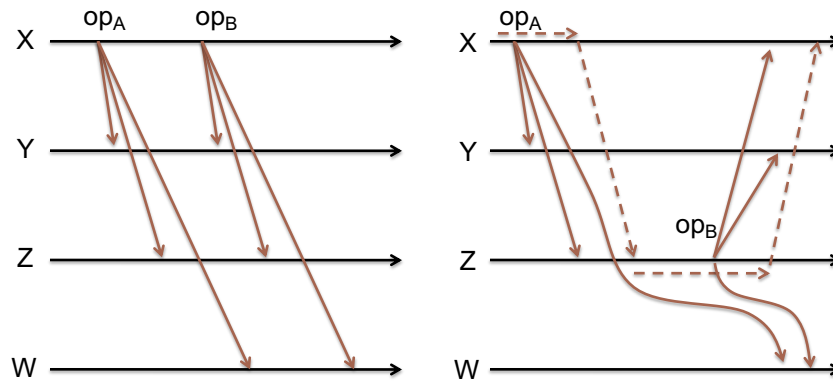
FIFO With One Sender



90

90

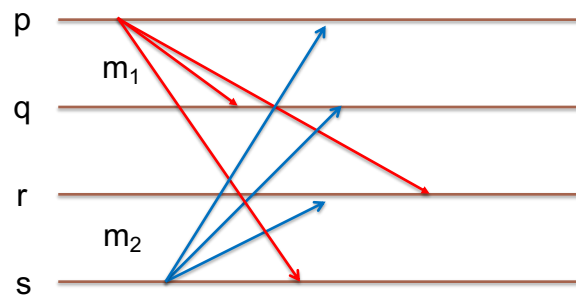
Causal with One Thread



91

91

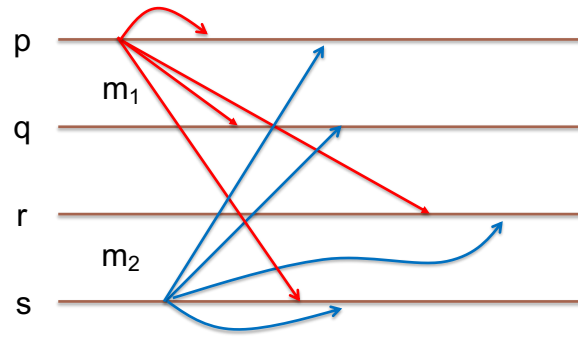
Causal but not Total



92

92

Total Ordered Multicast



93