

# Lecture 26

- ❑ Administration
- ❑ Chapter 6 (section 1,2,3)

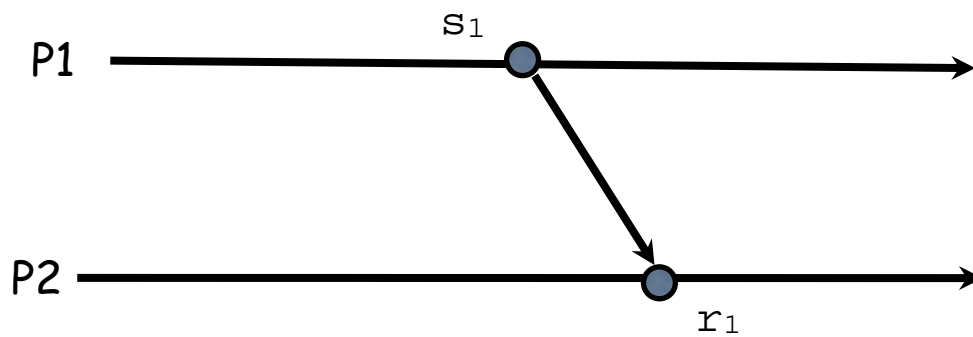
**Distributed Computing** Principles, Algorithms, and Systems  
Ajay D. Kshemkalyani and Mukesh Singhal

## □ Definitions:

$a \sim b$  , events  $a$  and  $b$  occur at the same process

$E_i$ , the events at process  $i$   $T = \{(s,r) \in E_i \times E_j\}$

$a \rightarrow b$ , event  $a$  happens before  $b$



$s_1 \rightarrow r_1$

□ FIFO messages:

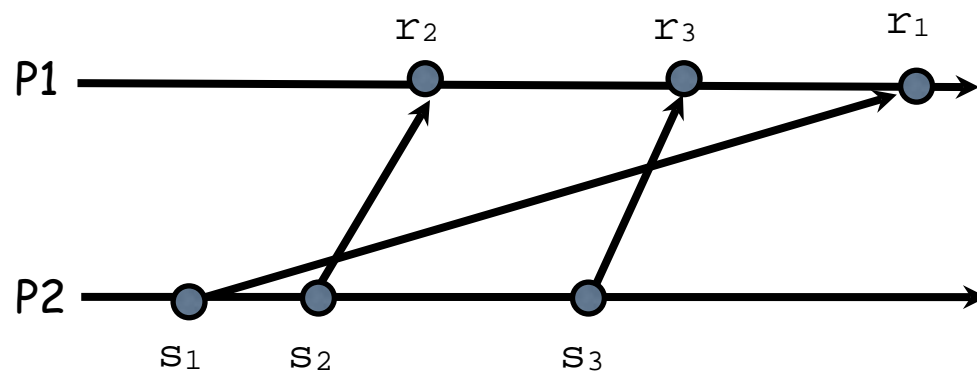
For all  $(s,r)$  and  $(s',r') \in T$ ,

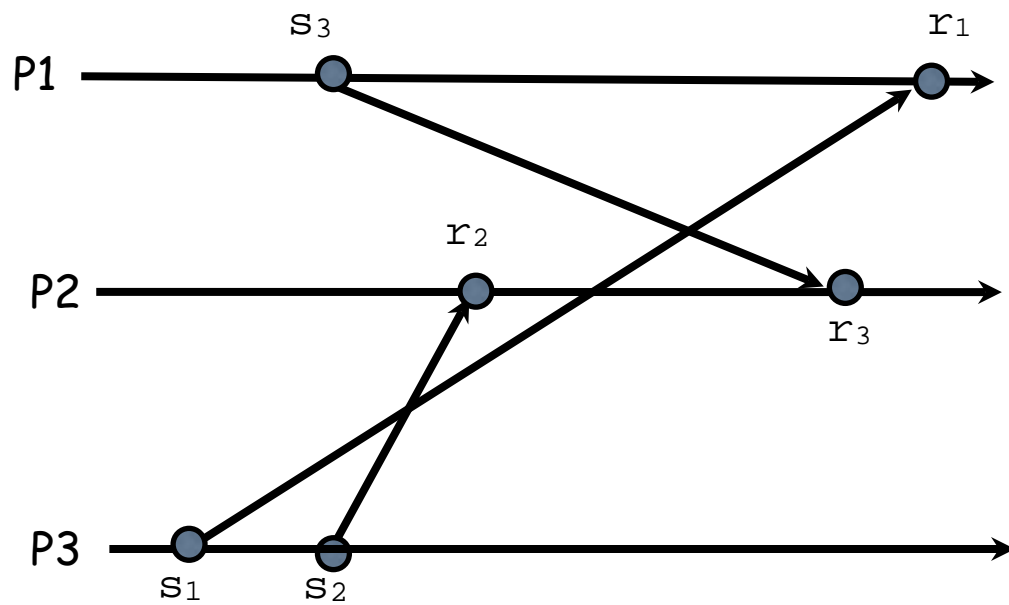
If  $s \sim s'$  and  $r \sim r'$  and  $s \rightarrow s'$  then  $r \rightarrow r'$

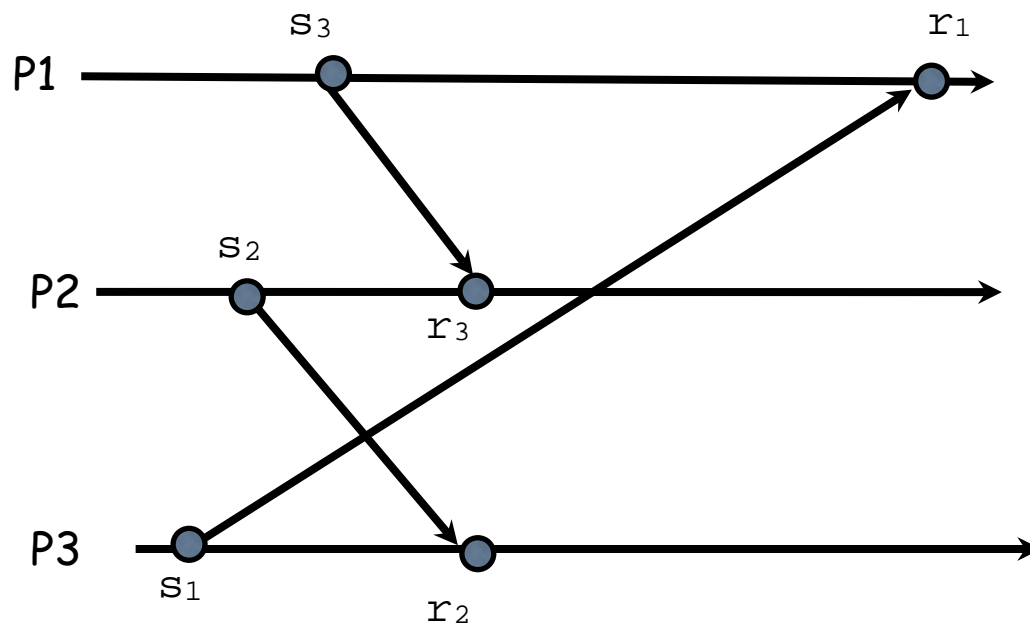
## □ Causal Ordered messages:

For all  $(s,r)$  and  $(s',r') \in T$ ,

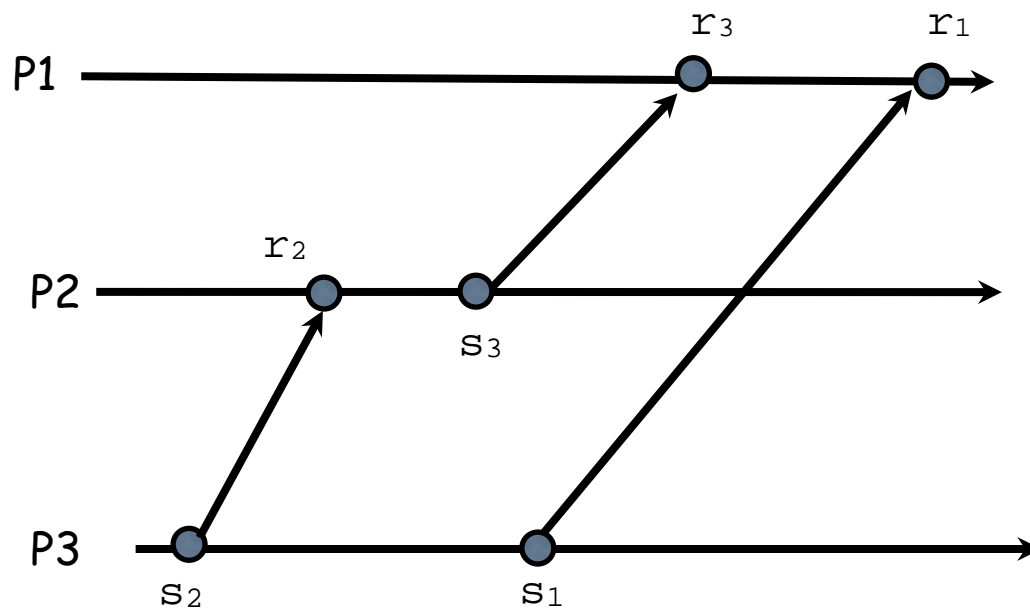
If  $r \sim r'$  and  $s \rightarrow s'$  then  $r \rightarrow r'$

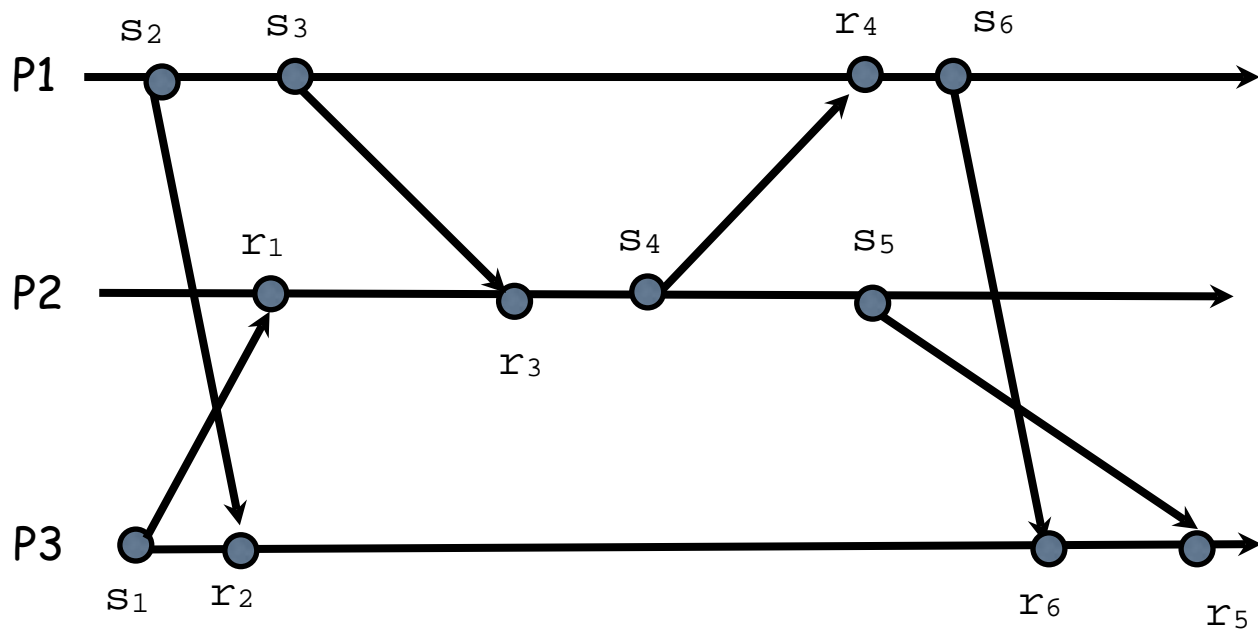


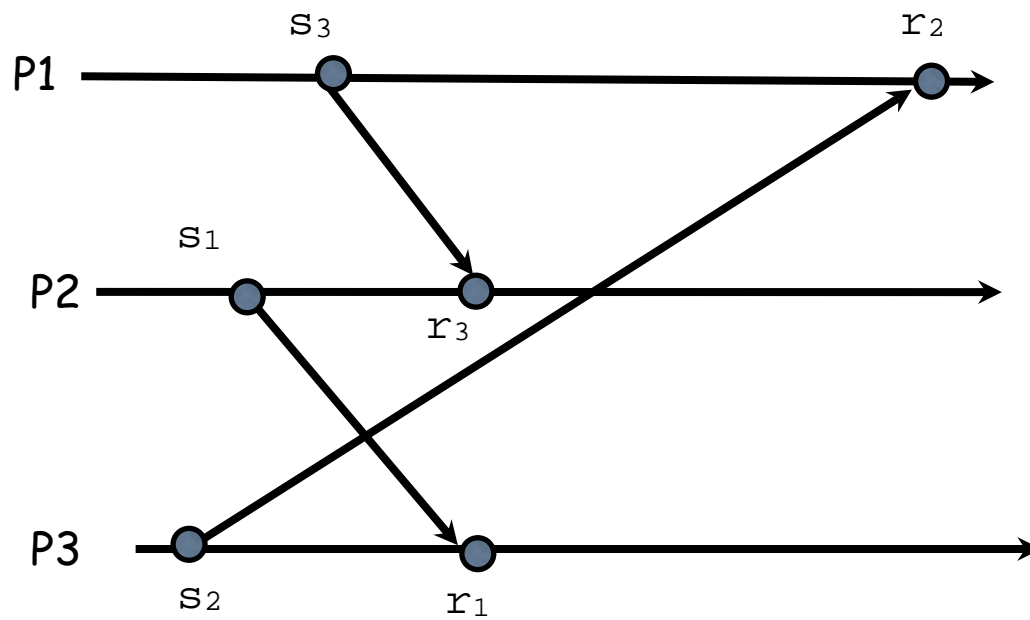












## Synchronous Execution:

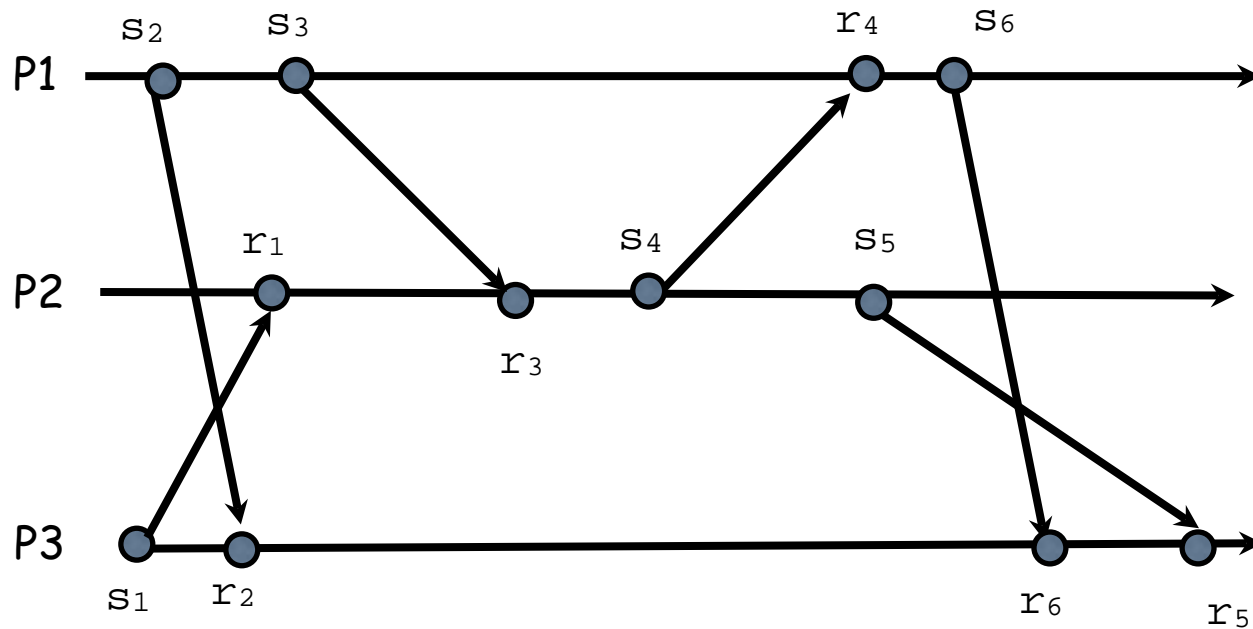
Given a relation  $\ll$  as defined below,  $E$  is a synchronous execution when  $(E, \ll)$  is a partial order over  $E$ .

If  $x \rightarrow y$  at the same process then  $x \ll y$ .

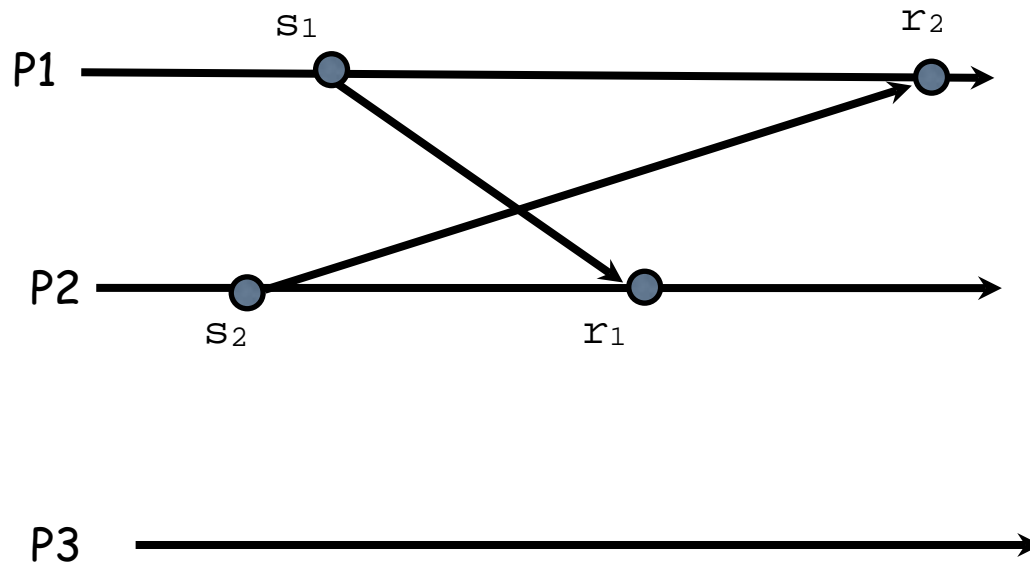
If  $(s, r) \in T$  for  $x \in E$ ,  $x \ll s \iff x \ll r$  and  $s \ll x \iff r \ll x$

$x \ll y, y \ll z, \Rightarrow x \ll z$  (transitive)

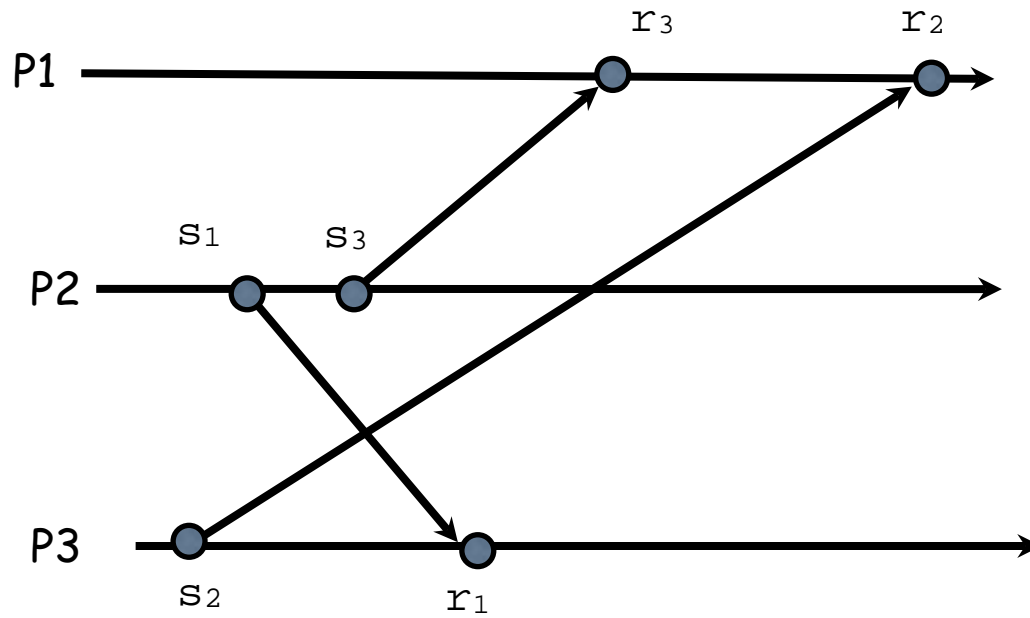
# Synchronous Communication



# Crown



# Crown



# Crown

