1. For any 2 operations, a and b, if $a \to b$ in one of the processes, $a \to b$ is true in all other processes.

2. def handle (~~evt~~ ~~event~~ event):

if ~~event~~ the event is a broadcast from ~~other processes~~ another process:

update local lamport clock according to event.time

add event into the priority queue with key = event.time and value = event.msg

if the event is a msg (not an acknowledgement):

broadcast_acknowledge (this.time, event.msg);

~~for all~~

find the first msg, msg1, in ~~pq~~ the priority queue (if any) // will be used in part 3.

if ~~msg1~~ the # of acknowledgement of msg1 in the priority queue is equal to the # of processes,

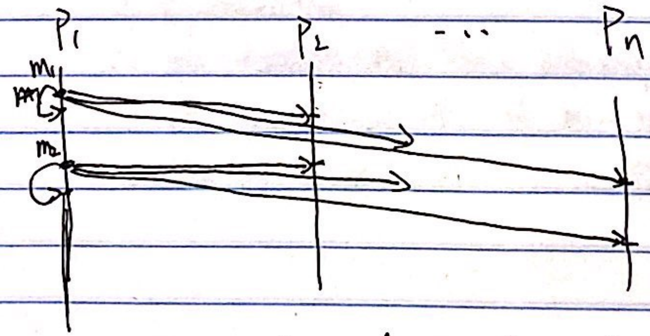
pop ~~and~~ msg1 frome the priority queue along with all its acknowledgement and execut msg1

if the event is a local event:

broadcast_msg (this.time, event.msg);

3. Assume there are n processes, $p_1, p_2, \cdots, p_n$.

Let p_1 ~~send~~ broadcast m1 and m2, where $m1 \to m2$



Since the broadcast of m1 is earlier than the broadcast of m2, and the FIFO rule applies, m_1 is received ~~and been~~ before m2 in all processes from p1 to pn. Since m1 is received and broadcasted earlier, ~~m1 is in the front of~~ m1 comes before m2 in the priority queue of every process. According to the pseudocode, if some msg is poped and executed, it has to be the first msg. So, if ~~all~~ all msgs execute on all processes, m1 must happen before m2.

4. Proof:

Assume there are n processes, p_1 to p_n

~~Assume As Let $m_1 \to m_2$ but m_2 in p_1 and~~

~~Assume~~

Let $m_1 \to m_2$ in p_a, for ~~a~~ $1 \le a \le n$

Assume $m_2 \to m_1$ in p_b, for ~~b≤~~ $1 \le b \le n$ ~~and b≠a~~.

Let t_a be the timestamp of m_1 and t_b be the timestamp of m_2.

$\because m_1 \to m_2$ in p_a

$\therefore$ the priority queue right before ~~executing~~ popping m_1 looks like:

t_b	...	t_a	...	t_2	t_1	time
m_2	...	m_1	...	...	...	msg

So, $t_a > t_b$

$\because m_2 \to m_1$ in p_b

$\therefore$ the priority queue right before popping m_2 looks like:

t_a	...	t_b	...	t_2	t_1	time
m_1	...	m_2	...	...	...	msg

So, $t_b > t_a$

$\because t_a > t_b$ and $t_b > t_a$

$\therefore$ Contradiction

$\therefore$ ~~we conclude that~~ Since assuming $m_2 \to m_1$ in p_b results in a contradiction, we can conclude that if $m_1 \to m_2$ in any process p_a, then $m_1 \to m_2$ is also true in any process p_b.

QED.