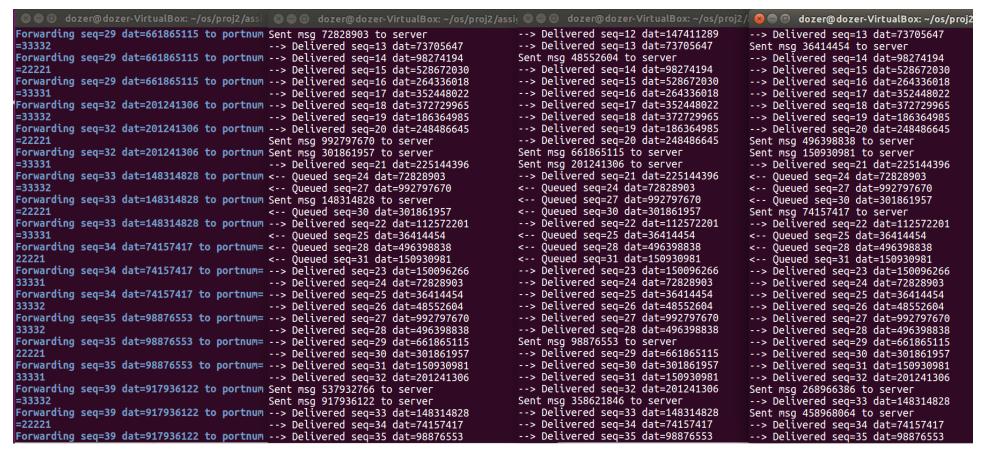
## **Ordered Delivery**

The output files for 2 worker processes. It can be seen that the messages are delivered in the same order. Running "diff out2 out3 | grep Delivered" confirms the order of delivery.

out2 out3 Process ID = 2Process ID = 3Listener Proc started listening on port 44444 Listener Proc started listening on port 44445 Sent msg 346997813 to server Sent msg 364458395 to server Sent msg 218063339 to server Sent msg 242972265 to server <-- Queued seq=2 dat=364458395 <-- Queued seq=2 dat=364458395 --> Delivered seq=1 dat=346997813 Sent msg 145375561 to server --> Delivered seq=2 dat=364458395 --> Delivered seq=1 dat=346997813 --> Delivered seq=2 dat=364458395 --> Delivered seq=3 dat=242972265 Sent msg 600544824 to server --> Delivered seq=3 dat=242972265 Sent msg 400363217 to server Sent msg 981091995 to server Sent msg 832605629 to server Sent msg 654061332 to server --> Delivered seq=4 dat=218063339 Sent msg 555070421 to server <-- Queued seq=8 dat=981091995 --> Delivered seq=4 dat=218063339 Sent msg 676436191 to server <-- Queued seq=8 dat=981091995 --> Delivered seq=5 dat=145375561 --> Delivered seq=5 dat=145375561 <-- Queued seq=9 dat=654061332 <-- Queued seq=9 dat=654061332 --> Delivered seq=6 dat=600544824 Sent msg 450957462 to server --> Delivered seq=6 dat=600544824 Sent msg 522254681 to server --> Delivered seq=7 dat=400363217 --> Delivered seq=7 dat=400363217 --> Delivered seq=8 dat=981091995 --> Delivered seg=8 dat=981091995 --> Delivered seq=9 dat=654061332 --> Delivered seq=9 dat=654061332 Sent msg 910420842 to server Sent msg 348169789 to server <-- Queued seq=16 dat=910420842 <-- Queued seq=16 dat=910420842 <-- Queued seq=17 dat=606947229 Sent msg 606947229 to server <-- Queued seq=12 dat=676436191 <-- Queued seq=17 dat=606947229 <-- Queued seq=12 dat=676436191 Sent msg 760381009 to server --> Delivered seq=10 dat=832605629 --> Delivered seq=10 dat=832605629 --> Delivered seq=11 dat=555070421 --> Delivered seg=11 dat=555070421 --> Delivered seq=12 dat=676436191 --> Delivered seq=12 dat=676436191 --> Delivered seq=13 dat=450957462 --> Delivered seq=13 dat=450957462 --> Delivered seq=14 dat=522254681 Sent msg 506920674 to server Sent msg 69207834 to server --> Delivered seg=14 dat=522254681 --> Delivered seq=15 dat=348169789 --> Delivered seq=15 dat=348169789 --> Delivered seg=16 dat=910420842 --> Delivered seq=16 dat=910420842 --> Delivered seg=17 dat=606947229 --> Delivered seg=17 dat=606947229 Sent msg 46138557 to server Sent msg 457186842 to server

Running 3 worker processes: the order of delivery is preserved across all processes.



When the server receives a message from a client it increments the global timestamp, appends it to the message and forwards the message to all the clients. When a client receives a multicast message from the server, it checks the message's timestamp, if it is one increment above the current time then it is delivered, otherwise it is queued. Whenever a message is delivered the queue is looped over and any message in the queue with a timestamp one increment above the message that was just delivered is popped from the queue and delivered.