

Causal Ordering of Messages

**SES Protocol for Unicast and
Multicast**

Schipper-Eggli-Sandoz Protocol

- The goal of this protocol is to ensure that messages are given to the receiving processes in order of sending.
- Unlike the Birman-Schipper-Stephenson protocol, it does not require using broadcast messages.
- Each message has an associated vector that contains information for the recipient to determine if another message preceded it. Clocks are updated only when messages are sent.

Notations used in SES Protocol

- n processes
- P_i process
- C_i vector clock associated with process P_i ; j th element is $C_i[j]$ and contains P_i 's latest value for the current time in process P_k
- t^m vector timestamp for message m (stamped after local clock is incremented)
- t^i current time at process P_i
- V_i vector of P_i 's previously sent messages; $V_i[j] = t^m$, where P_j is the destination process and t^m the vector timestamp of the message; $V_i[j][k]$ is the k th component of $V_i[j]$.
- V^m vector accompanying message m

SES Protocol

P_i sends a message to P_j

- P_i sends message m , timestamped t^m , and V_i , to process P_j
- P_i sets $V_i[j] = t^m$

SES Protocol

P_j receives a message from P_i

- When $P_j, j \neq i$, receives m , it delays the message's delivery if both:
 - $V^m[j]$ is set; and
 - $V^m[j] < t^j$
- When the message is delivered to P_j , update all set elements of V_j with the corresponding elements of V^m , except for $V_j[j]$, as follows:
 - If $V_j[k]$ and $V^m[k]$ are uninitialized, do nothing.
 - If $V_j[k]$ is uninitialized and $V^m[k]$ is initialized, set $V_j[k] = V^m[k]$.
 - If both $V_j[k]$ and $V^m[k]$ are initialized, set $V_j[k][k'] = \max(V_j[k][k'], V^m[k][k'])$ for all $k' = 1, \dots, n$
- Update P_j 's vector clock.
- Check buffered messages to see if any can be delivered.

SES Protocol

