Objectives

- To discuss the different message ordering paradigms.
- To discuss Raynal-Schiper-Toueg algorithm for causal ordering.
- To discuss 3-phase distributed algorithms for total ordering.

Place your
Webcam Video here
Size 100%

Message ordering paradigms

Place your
Webcam Video here
Size 38%

The order of delivery of messages in a distributed system is an important aspect of system executions.

- Because it determines the messaging behavior that can be expected of the distributed program.

1. Async / Non-FIFO
2. FIFO
3. Causal Order
4. Synchronous order

Group Communication

1. Causal Order
2. Total Order

$$\text{Sync} \subset \text{CO} \subset \text{FIFO} \subset \text{Async}$$

Implementing message ordering

Place your
Webcam Video here
Size 38%

- Summary of approaches to implement different message ordering paradigms.

Ordering Paradigm	Implementation approach
Async order	Lamport's Scalar clock
FIFO order	Sequence numbering along each channel
Causal order	Raynal-Schiper-Toueg algorithm*
Sync order	Mutual exclusion, agreement algorithms
Total order	Three Phase Distributed algorithm*

* Will be dealt next.

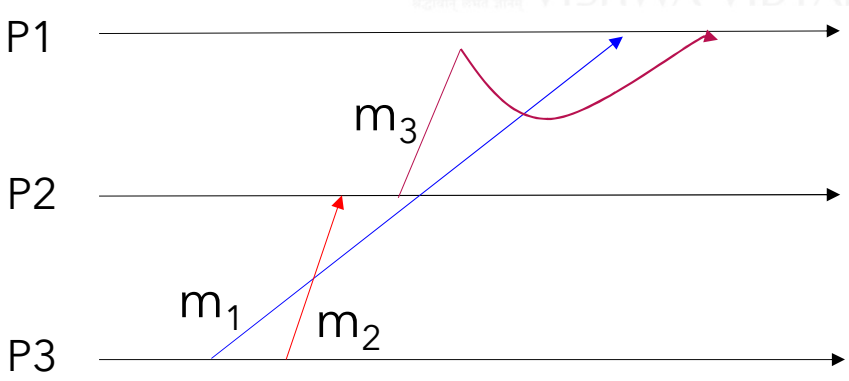
Implementing Causal Ordering

Place your
Webcam Video here
Size 38%

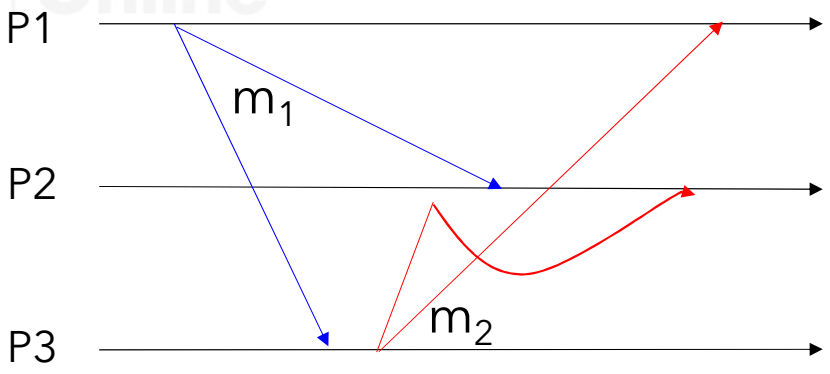
Recall causal order definition:

- Two causally related messages, arriving at the same destination, although along different links, are received in the correct order.

Causal Order in Unicast



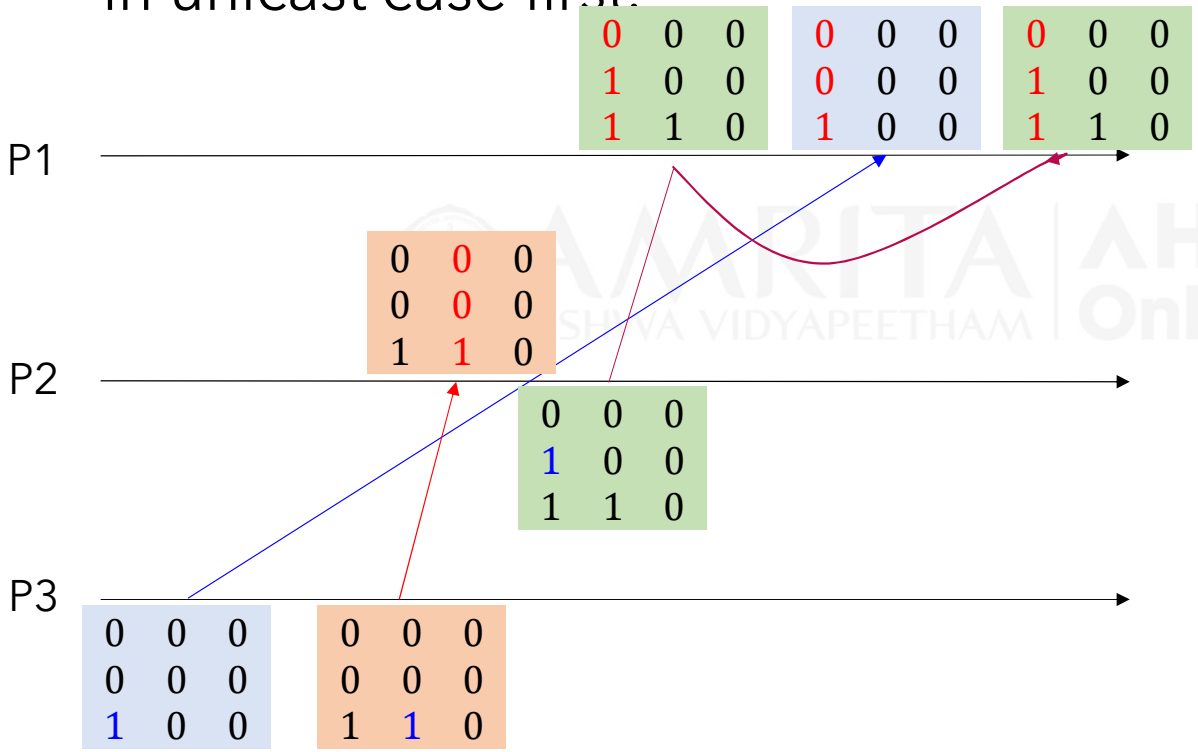
Causal Order in Multicast



Raynal-Schiper-Toueg Algorithm

Place your
Webcam Video here
Size 38%

- How it works when messages arrive in wrong order in unicast case first.



Messages from 1

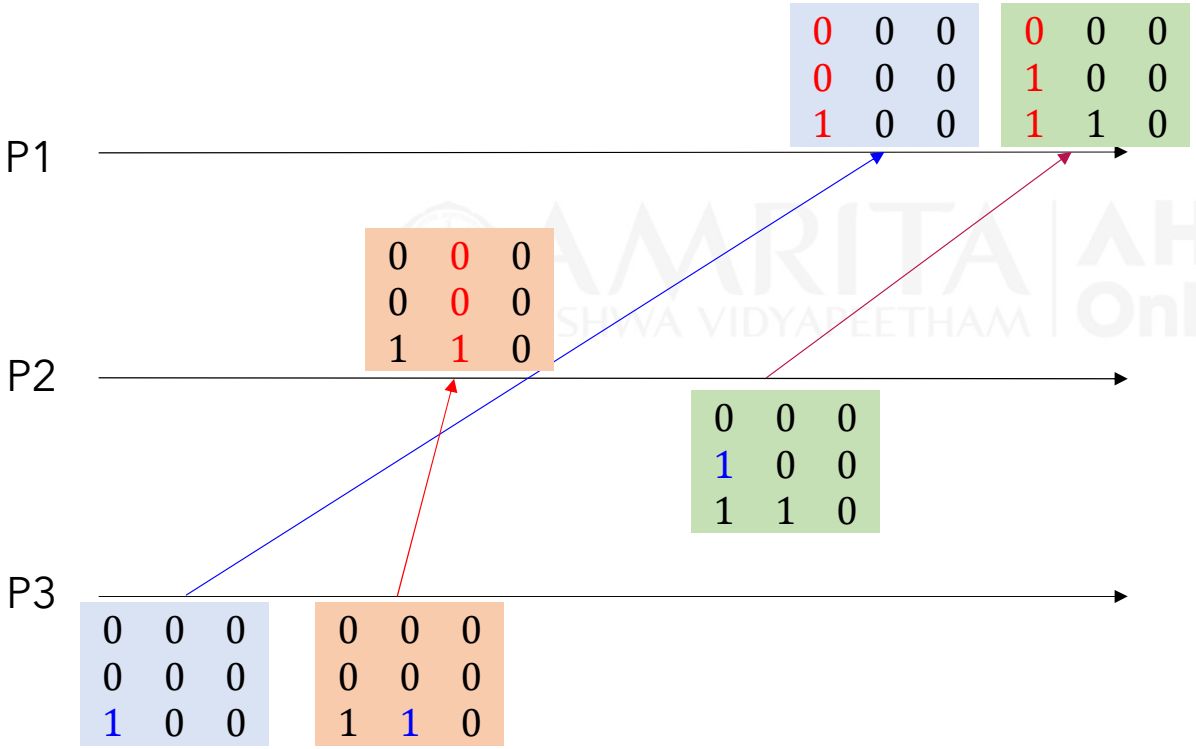
$1 \rightarrow 1$	$1 \rightarrow 2$	$1 \rightarrow 3$
$2 \rightarrow 1$	$2 \rightarrow 2$	$2 \rightarrow 3$
$3 \rightarrow 1$	$3 \rightarrow 2$	$3 \rightarrow 3$

Messages to 1

Raynal-Schiper-Toueg Algorithm

Place your
Webcam Video here
Size 38%

- How it works when message arrive in correct order.

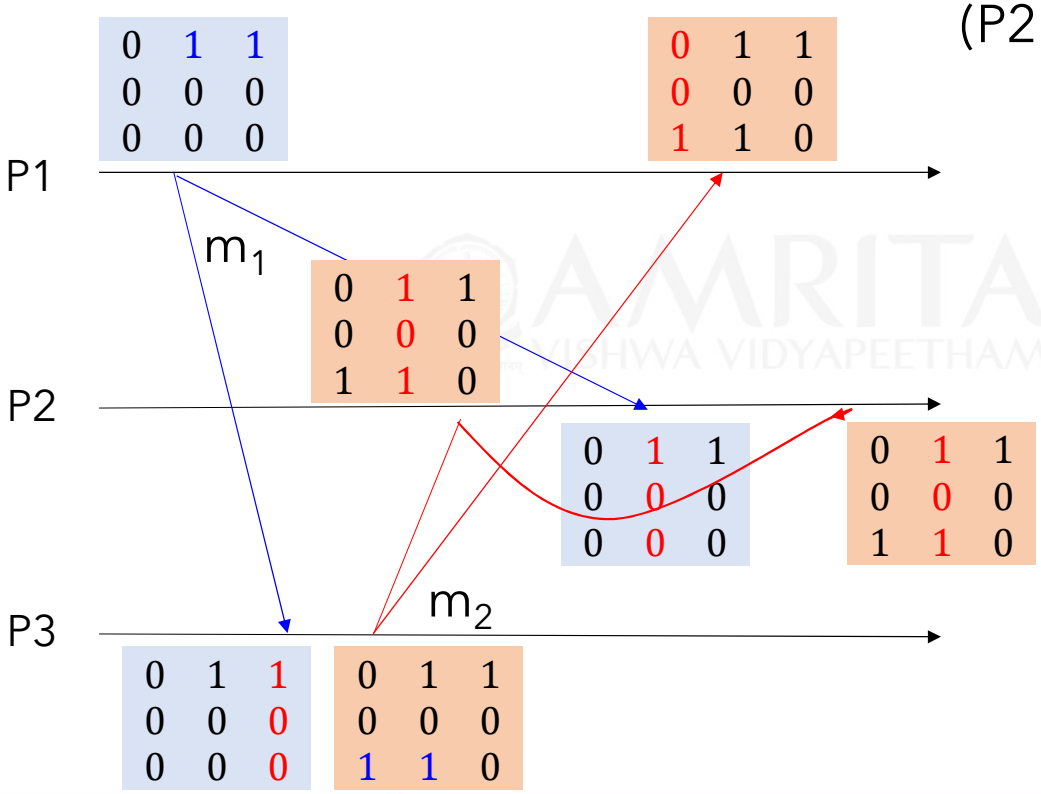


Apply R-S-T Algorithm for Multicast

Place your
Webcam Video here
Size 38%

- Consider the case of not causally ordered multicast.

(P2 receives m_2 before m_1)



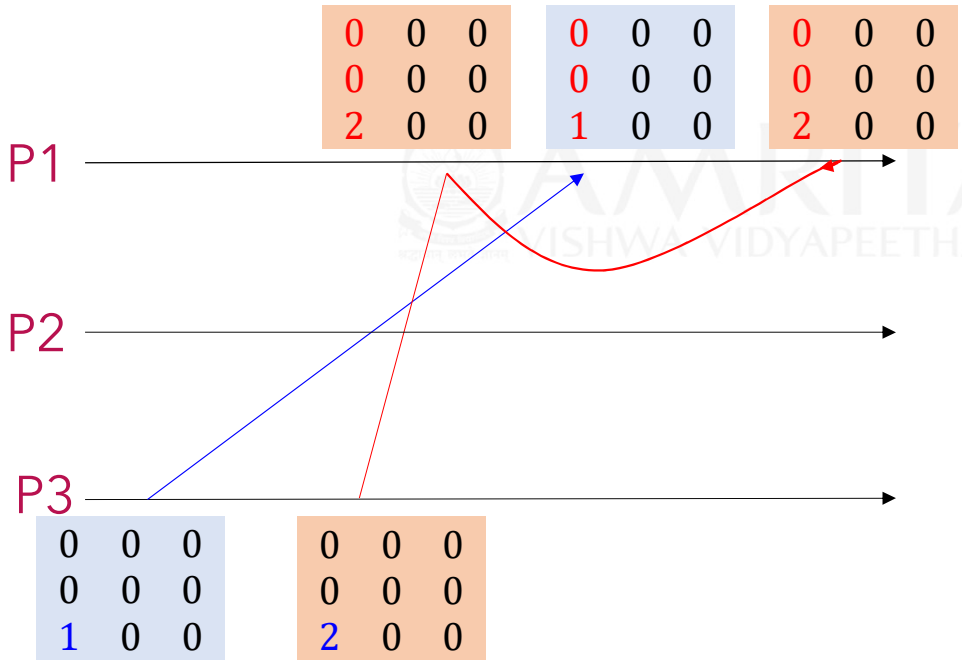
Bottomline

Raynal-Schiper-Toueg algorithm ensures causal order is maintained.

R-S-T Algorithm ensures FIFO

Place your
Webcam Video here
Size 38%

- Two messages along the same channel arrive out of order. Sent order: m1, m2. Received order: m2, m1.



Bottomline

- If you need CO, implement R-S-T algorithm. FIFO is taken care automatically.
- If you need only FIFO, go for sequence number as it involves less work.

Applications of Causal Order

Place your
Webcam Video here
Size 38%

- Replicated data
- Allocating requests in fair manner
- Synchronizing multi-media streams

Conclusion

- We discussed different message ordering paradigms.
  - Async, FIFO, Causal, Sync
- Multicast communication
  - Causal order, Total order
- Causal ordering by Raynal-Schiper-Toueg algorithm.
- Three phase total ordering algorithm.

Place your
Webcam Video here
Size 100%