Group Communication

Group oriented activities are steadily increasing. There are many types of groups:

Open and Closed groups

Peer-to-peer and hierarchical groups

Important issues

Atomic multicast

Ordered multicast

Dynamic groups

Sometimes, certain features available in the infrastructure of a distributed system simplify the implementation of multicast. Examples are (1) multicast on an ethernet LAN (2) IP multicast

Atomic multicast

A multicast by a group member is called ***atomic***, when the message is delivered to **every correct** (i.e. functioning) member, or to **no member** at all. A simple implementation:

<u>**Sender's program**</u>	<u>**Receiver's program**</u>
i:=0;	**if** **m** is new □
do i ≠ n □	accept it;
send message to i;	multicast **m**;
i:= i+1	**m** is duplicate □ discard m
od	**fi**

Distinguish between ***basic*** and ***reliable*** versions. The basic version does not consider process crashes.

Ordered multicasts

Total order

Causal order

Local order (single source FIFO)

} definitions?

Why are they important?

Total order multicast is useful in the consistent update of replicated servers

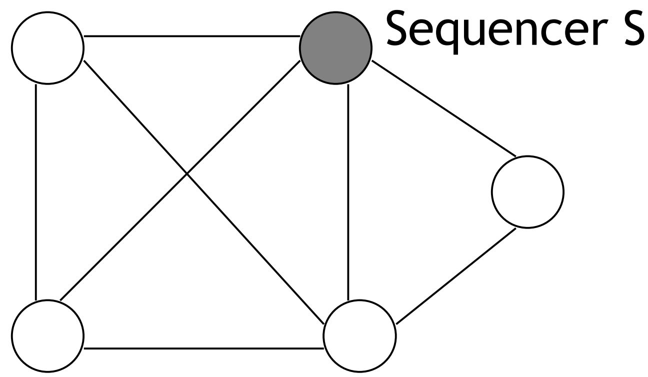
Causal order multicast is relevant in implementing bulletin boards

Local order multicast is useful in updating cache memories in multi-computers

Implementing ordered multicasts

(basic version)

Total Order Multicast using a sequencer



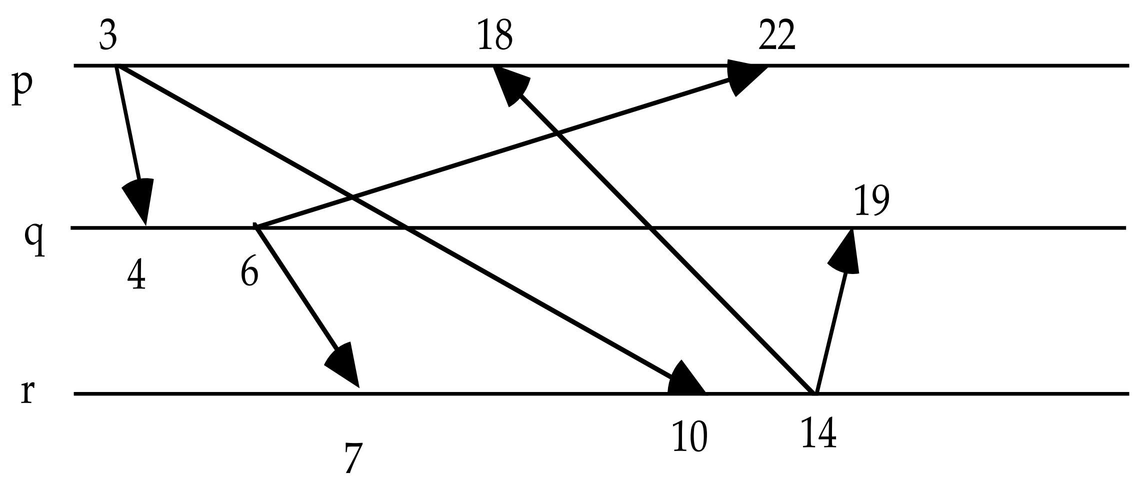
Every process forwards the data to the sequencer.

```
{The sequencer S}
define seq: integer (initially seq=0}
do  receive m →    multicast (m, seq); seq := seq+1;
                    deliver m
od
```

Every process accepts and delivers the messages in the increasing order of ***seq***.

Total order multicast without a sequencer

Uses the idea of *two-phase commit*.



Step 1. Sender **i** sends **(m, ts)** to all

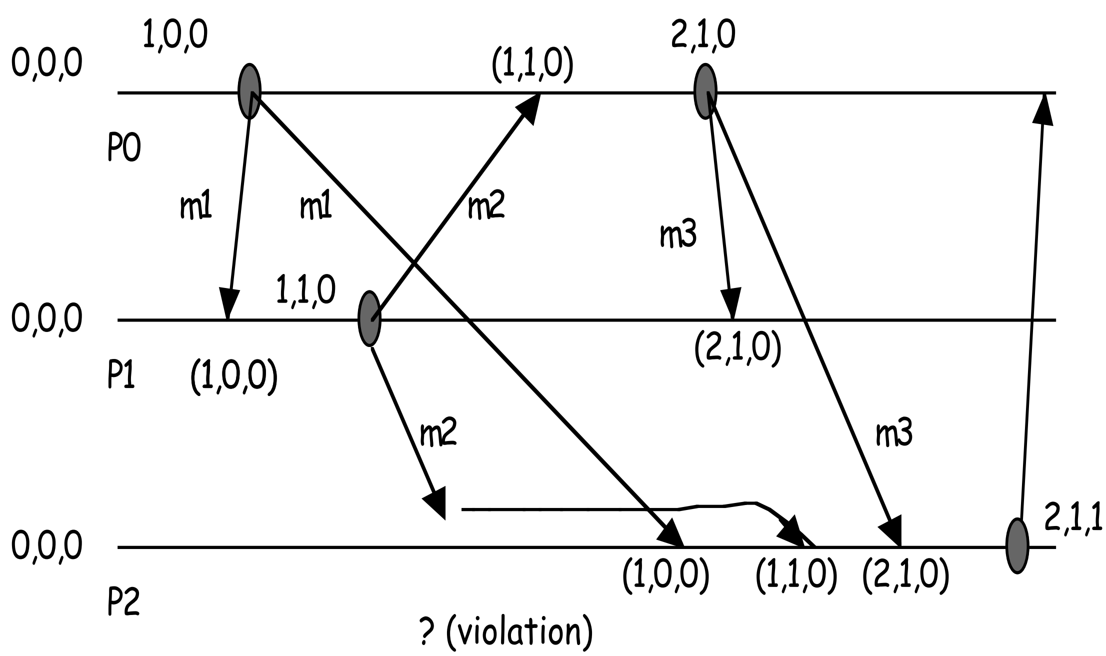
Step 2. Receiver **j** saves it in a *holdback queue*, and sends **(a, ts)**

Step 3. Receive all acks, and pick the largest ts. Then send **(m, commit)** to all.

Step 4. Receiver removes it from the holdback queue and delivers **m**.

<u>Implementing causal order broadcast</u>

Use vector clocks. (Note the difference from the classical model)



The recipient **i** delivers a message from **j** iff

1. $\mathbf{VC_j(j) = LC_j(i) + 1}$ {LC is the local vector clock}

2. $\mathbf{\square k: k \neq j :: VC_k(j) \leq LC_k(i)}$

What is the rationale behind these rules?

Dealing with open groups

Processes may join or leave a group, but life will be simpler, if everyone has a consistent view of the current membership. A list of the current members is called a ***view***.

Views should propagate in the same order to all.

Example.

Current view v0(g) = {0, 1, 2, 3}.

Let 1, 2 leave and 4 join the group concurrently.

These view change can be serialized in many ways:

> {0,1,2,3}, {0,1,3} {0,3,4}, OR
> {0,1,2,3}, {0,2,3}, {0,3}, {0,3,4}, OR
> {0,1,2,3}, {0,3}, {0,3,4}

Collected from local observations and send by a total order multicast.