Global State Recording

Global State Collection

- Applications:
  - Checking "stable" properties, checkpoint & recovery

- Issues:
  - Need to capture both node and channel states
  - system cannot be stopped
  - no global clock

Notations

Some notations:

- LS_i: Local state of process i
- $send(m_{ij})$: Send event of message m_{ij} from process i to process j
- $rec(m_{ij})$: Similar, receive instead of send
- $time(x)$: Time at which state x was recorded
- $time(send(m))$: Time at which $send(m)$ occurred

Definitions

- $send(m_{ij}) \in LS_i$ iff $time(send(m_{ij})) < time(LS_i)$

- $rec(m_{ij}) \in LS_j$ iff $time(rec(m_{ij})) < time(LS_j)$

- $transit(LS_i, LS_j)$
  $$= \{ m_{ij} \mid send(m_{ij}) \in LS_i \text{ and } rec(m_{ij}) \notin LS_j \}$$

- $inconsistent(LS_i, LS_j)$
  $$= \{ m_{ij} \mid send(m_{ij}) \notin LS_i \text{ and } rec(m_{ij}) \in LS_j \}$$

Definitions

- Global state: collection of local states

    GS = {LS1, LS2,…, LSn}

- GS is consistent iff

    for all i, j, 1 ≤ i, j ≤ n,

    inconsistent(LSi, LSj) = Φ

- GS is transitless iff

    for all i, j, 1 ≤ i, j ≤ n,

    transit(LSi, LSj) = Φ

- GS is strongly consistent if it is consistent and transitless.

Chandy-Lamport's Algorithm

- Uses special marker messages.

- One process acts as initiator, starts the state collection by following the marker sending rule below.

- Marker sending rule for process P:
  - P records its state and
  - For each outgoing channel C from P on which a marker has not been sent already, P sends a marker along C before any further message is sent on C

Chandy Lamport's Algorithm contd..

- When Q receives a marker along a channel C:

    – If Q has not recorded its state then Q records the state of C as empty; Q then follows the marker sending rule

    – If Q has already recorded its state, it records the state of C as the sequence of messages received along C after Q's state was recorded and before Q received the marker along C

Notable Points

- Markers sent on a channel distinguish messages sent on the channel before the sender recorded its states and the messages sent after the sender recorded its state

- The state collected may not be any state that actually happened in reality, rather a state that "could have" happened

- Requires FIFO channels

- Message complexity $O(|E|)$, where E = no. of links