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FACULTY OF EGINEERING AND TECHNOLOGY

Distributed Systems(BCS-701)
LECTURE-08

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OUTLINE

- Logical clocks
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Logical clocks

Assign sequence numbers to messages

– All cooperating processes can agree on order of events

– vs. physical clocks: time of day

Assume no central time source

– Each system maintains its own local clock

– No total ordering of events • No concept of happened-when

Happened-before

- **Lamport's "happened-before" notation**
  - a -> b event a happened before event b
  - e.g.: a: message being sent, b: message receipt
- **Transitive:**
  - if a -> b and b -> c then a -> c

Logical clocks & concurrency

Assign “clock” value to each event

– if a->b then clock(a) < clock(b)

– since time cannot run backwards

If a and b occur on different processes that do not exchange messages, then neither a ->b nor b -> a are true

– These events are concurrent

Event counting example

- Three systems: P0 , P1 , P2
- Events a, b, c, …
- Local event counter on each system
- Systems occasionally communicate

Lamport's algorithm

- Each message carries a timestamp of the sender's clock
- When a message arrives:
  - if receiver's clock < message timestamp set system clock to (message timestamp + 1)
  - else do nothing
- Clock must be advanced between any two events in the same process

Summary

- Algorithm needs monotonically increasing software counter
- Incremented at least when events that need to be timestamped occur
- Each event has a Lamport timestamp attached to it
- For any two events, where a -> b:

  L(a) < L(b)

References

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