Info

• Quiz 5 will be Tuesday Nov. 10, 2015
• It will cover Byzantine Agreement and Paxos
  • I will provide pseudocode for both algorithms

• After quiz, we will discuss specs for project 2
  • Please prepare by brainstorming how you will use Paxos in the distributed Calendar application.

• Today
  • Review of Paxos
  • Transactions and Concurrency Control
Some Requirements for Project 2

• No conflicting appointment should be inserted into the log.
  • So there is no need for a conflict resolution protocol.

• Every event should appear in the log (at most) once.
  • Single event for all participants.

• No delete appointment event should appear in the log unless the create appointment event precedes it.
  • Do we really need/want this?
Brief Review of Paxos

- We need to store a log of events (decrees)

| Event 1 | Event 2 | Event 3 | Event 4 | Event 5 | … |

- Want to replicate this log at multiple sites.
  - Need the event to appear in the same order in every log.
  - Need every event to eventually appear in every log.

- Need to reach consensus for each log entry.
  - Use Synod algorithm for single consensus problem.
Review of Synod Algorithm (1)

- Proposers propose values by issuing proposals of the form \((\text{proposal\_number}, \text{proposal\_value})\)

- Acceptors may accept proposals.
  - An acceptor may accept more than one proposal (change its vote)
  - These proposals may have different values.

- A single proposal is chosen when a majority of acceptors accept that proposal.
  - In that case, the proposal’s value is also chosen
  - Multiple proposals may be chosen, but in this case, they all have the same value.
Requirements for Synod (Consensus)

- **Safety** – no bad things happen
  - Only a value that has been proposed may be chosen (decided as consensus value).
  - Only a single value is chosen.
  - A process never learns that a value has been chosen unless it actually has been (no changing a decision).

- **Liveness** – good things eventually happen (not guaranteed)
  - No precise requirement
  - Goal is that eventually some proposed value is chosen, and then eventually a process can learn the chosen value.
Review of Synod (2)

- Synod algorithm has 2 phases.
  - Phase 1 – Proposer identifies “safe” value to propose
    - Prepare and Promise messages
  - Phase 2 – Proposer tries to get a majority of acceptors to accept this safe value. If value chosen, it can be written in the log.
    - Accept, Ack, and Commit messages
Identifying a safe value to propose

• How does proposer identify safe value to send in accept messages?
Full Paxos Algorithm

- The Synod algorithm is used to determine consensus value for a single log entry.

- The Paxos algorithm is a sequence of Synod algorithms.
  - With some optimizations.
  - Use distinguished proposer (to guarantee liveness)
  - If leader is stable, it only needs to execute Phase 1 of Synod algorithm once.
Another Reference

TRANSACTION MANAGEMENT AND CONCURRENCY CONTROL

Concurrency Control and Recovery in Database Systems
Philip A. Bernstein, Vassos Hadzilacos, Nathan Goodman
Chapters 1, 2, 3