Recap

- Strict execution of transactions?
  - Delay both their read and write operations on an object until all transactions that previously wrote that object have either committed or aborted

- Two phase locking?
  - Growing phase
  - Shrinking phase

- Strict two phase locking?
  - Release locks only at either commit() or abort()
Atomic Commit Problem

- Atomicity principle requires that either all the distributed operations of a transaction complete, or all abort.
- At some stage, client executes commit(). Now, atomicity requires that either all participants (remember these are on the server side) and the coordinator commit or all abort.
- What problem statement is this?
  - Consensus
  - Failure model
    - Arbitrary message delay & loss
    - Crash-recovery with persistent storage

Atomic Commit

- We need to ensure safety in real-life implementation.
  - Never have some agreeing to commit, and others agreeing to abort.
- First cut: one-phase commit protocol. The coordinator communicates either commit or abort, to all participants until all acknowledge.
- What can go wrong?
  - Does not allow participant to abort the transaction, e.g., under deadlock.
  - Does’t work well with failures (e.g., when a participant crashes before receiving this message). Need to have some extra mechanism.

Two-Phase Commit (Handling Abort)

- First phase
  - Coordinator collects a vote (commit or abort) from each participant (which stores partial results in permanent storage before voting).
- Second phase
  - If all participants want to commit, coordinator multicasts commit message
  - If any participant has aborted, coordinator multicasts abort message to all participants

Two-Phase Commit

- Communication

Dealing with Failures

- To deal with server crashes
  - Each participant saves tentative updates into permanent storage, vote before replying yes/no in first phase. Retrievable after crash recovery.
- To deal with canCommit? loss
  - The participant may decide to abort unilaterally after a timeout (coordinator will eventually abort)
- To deal with Yes/No loss, the coordinator aborts the transaction after a timeout (pessimistic). It must announce doAbort to those who sent in their votes.
- To deal with doCommit loss
  - The participant may wait for a timeout, send a getDecision request (retries until reply received) – cannot abort after having voted Yes but before receiving doCommit/doAbort!

Problems with 2PC

- It’s a blocking protocol.
- Scalability & availability issues
**Summary**

- Increasing concurrency
  - Non-exclusive locks
  - Two-version locks
  - Hierarchical locks
- Distributed transactions
  - One-phase commit cannot handle failures & abort well
  - Two-phase commit mitigates the problems of one-phase commit
  - Two-phase commit has its own limitation: blocking

**Acknowledgements**

- These slides contain material developed and copyrighted by Indranil Gupta (UIUC).