Distribution in Databases

CS 451 Lecture
ACID Properties of Transactions

- Atomicity
- Consistency
- Isolation
- Durability
Atomicity

• Wrt failures
  – Either all or none of a transaction is performed
  – Transaction aborted by user
    • Transaction recovery
  – Transaction failed due to system crashes
    • Crash recovery
Consistency

- Transaction does what it’s supposed to do
  - Responsibility of the transaction programmer
  - Guarantee preconditions and postconditions
Isolation

• Atomicity wrt concurrent executions
  – Incomplete transactions does not reveal its intermediate results to other Trs.
  – Needed to avoid cascaded aborts

• Concurrency control
Durability

• Once the transaction commits, no system failure should result in loss of the event that this transaction took place

  – Database recovery
Serializability

- If several transactions are executed concurrently, the effect is the same as that of executing them in some serial order

- The process of guaranteeing serializability is concurrency control
Supporting Atomicity

• 2 Phase Commit

• Phase 1:
  – Coordinator asks all participants to prepare for commit
  – Each participant sends READY/ABORT
  – Coordinator also uses timeout

• Phase 2:
  – Coordinator sends the decision
  – All participants Acknowledge
Logging States

- Coordinator:
  - Write PREPARE before sending PREPARE to all participants
  - Write COMMIT/ABORT decision after receiving local decisions
  - Write COMPLETE after receiving ACKs

- Participant:
  - Write local decision before sending it to coordinator
  - Write received decision after it is communicated by the coordinator and before sending the ACK
Participant Failure Analysis

• Participant fails before writing the ready record locally
  – What was the global decision taken?

• Participant fails after having taken the ready decision
  – What was the global decision taken?
Coordinator Failure Analysis

• Coordinator fails after writing PREPARE record but before making the decision
  – What was the global decision taken?

• Coordinator fails after having taken a decision
  – What was the global decision taken?
2-PC state diagram

Coordinator

participant

Note: ACK messages are not shown
Terminating the transaction

• Can the transaction be terminated by all participants when failure of coordinator occurs?

• Possible in these cases:
  – At least one of the sites has received decision
  
  – None has received the decision, but only the coordinator has crashed
Blocking in 2 PC

• Termination impossible when
  – Case1:
    – No alive participant has received the decision
    – At least one participant failed and coordinator failed

• All must wait till coordinator/or the failed participant comes up
3-PC state diagram

Note: ACK messages are not shown