Developing Flexible Database Replication Protocols: How to Integrate SI Replicas with Several Data Consistency Levels?

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Database Replication

- What is database replication?

- Why database replication?
  * High Availability
  * Performance

- Does database replication come “for free”??
Data Consistency

Bank Database

Bill

Account Balance: $1000

Cash Withdrawal

Account Balance: $0

Lucy

Account Balance: $200

Cash Withdrawal

Account Balance: $800

Account Balance: $??????
Data Consistency Levels Featured by Replication Protocols

- Replication Protocols order transactions by way of the total-order message delivery featured by Group Communication Systems.

- If we have DBMS replicas with serializable transaction isolation level:
  - One Copy Serializability (1CS):
    - The strongest correctness criterion.
    - The interleaved execution of a transaction is equivalent to a serial execution in a centralized setting.

- If we have SI DBMS replicas:
  - It is not straightforward to see the “latest” version.
  - Generalized Snapshot Isolation
    - Transactions may use an older snapshot instead of the latest one of SI (i.e. the one of the delegate replica).
  - One Copy Snapshot Isolation (1CSI):
    - Transactions must remain block for reading from the latest snapshot version in a replicated environment.
      - Sending a total order message at the beginning of the transaction.
    - It looses the advantage of conventional SI where read operations never block.
**k-Bound GSI**

- Our aim is to define a function that measures the distance between
  - The start of the transaction \((T.\text{start})\)
  - The delivery of the start message \((T.\text{begin})\)
  - \(d(T.\text{start}, T.\text{begin}) < k\)
    - \(k > 0\): Bound values for GSI level
    - \(k = 0\): SI level
    - \(k = -1\): Serializable level
    - \(k = \perp\): GSI level.

- In order to define such distance we have multiple possibilities:
  - Time, overall PC-WS –even not colliding–, number of colliding items in each writeset, number of times an item.
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