Application of state machines in transaction management

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Abstract: This thesis investigates the application of state machines for transaction management in distributed and database systems. Traditional transaction models often struggle with complex, long-running workflows, leading to challenges in error recovery, concurrency control, and maintaining atomicity. By modeling a transaction as a finite state machine, this research proposes a formal framework that explicitly defines all possible states (e.g., active, prepared, committed, aborted) and the valid transitions between them. This approach enables precise specification of transaction lifecycles, simplifies the implementation of compensation actions for rollbacks, and enhances the handling of partial failures. The study demonstrates how state machine semantics can enforce consistency constraints and improve the predictability of transaction outcomes. Through a prototype implementation and comparative analysis, the results indicate that the state machine model reduces complexity in error handling and provides a more robust mechanism for managing distributed transactions compared to conventional two-phase locking protocols. The findings offer a scalable and reliable alternative for modern transaction processing environments.

Keywords: state machine, transaction management, finite state machine, transaction processing