C340 Concurrency: Transactions

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Outline

- Motivation
- Transaction Concepts
  - Atomicity
  - Consistency
  - Isolation
  - Durability
- Nested Transactions
- Centralized vs. Distributed Transactions
- Summary

Motivation

- ***What happens if a failure occurs during modification of resources?***
- ***Which operations have been completed?***
- ***Which operations have not (and have to be done again)?***
- ***In which states will the resources be?***

Transaction Concepts

1 ACID Properties
- ***Atomicity***
- ***Consistency***
- ***Isolation***
- ***Durability***

2 Transaction Commit vs. Abort

3 Flat vs. Nested Transactions

4 Central vs. Distributed Transactions

Atomicity

- *Transactions are either performed completely or no modification is done.*
- *Start of a transaction is a continuation point to which it can roll back.*
- *End of transaction is next continuation point.*

Consistency

- *Shared resources should always be consistent.*
- *Inconsistent states occur during transactions:*
  - *hidden for concurrent transactions*
  - *to be resolved before end of transaction.*
- *Application defines consistency and is responsible for ensuring it is maintained.*
- *Transactions can be aborted if they cannot resolve inconsistencies.*

Isolation

- Each transaction accesses resources as if there were no other concurrent transactions.
- Modifications of the transaction are not visible to other resources before it finishes.
- Modifications of other transactions are not visible during the transaction at all.
- Implemented through:
  - two-phase locking or
  - optimistic concurrency control.

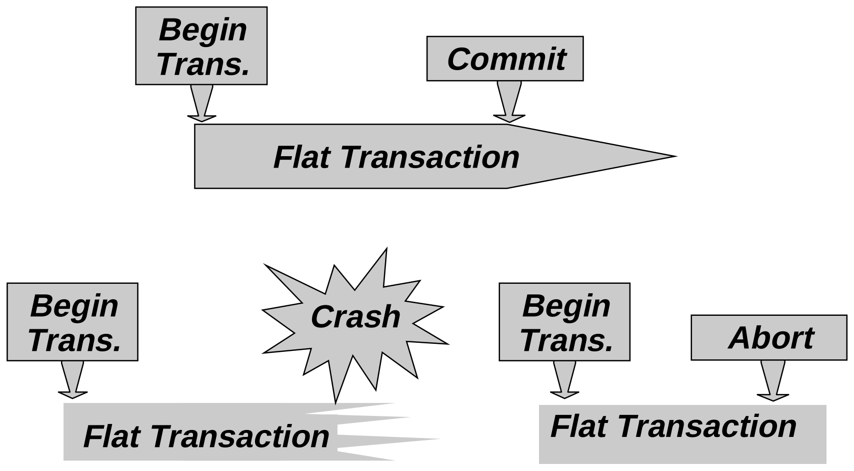
Durability

- A completed transaction is always persistent (though values may be changed by later transactions).
- Modified resources must be held on persistent storage before transaction can complete.
- May not just be disk but can include battery-backed RAM or Flash RAM.

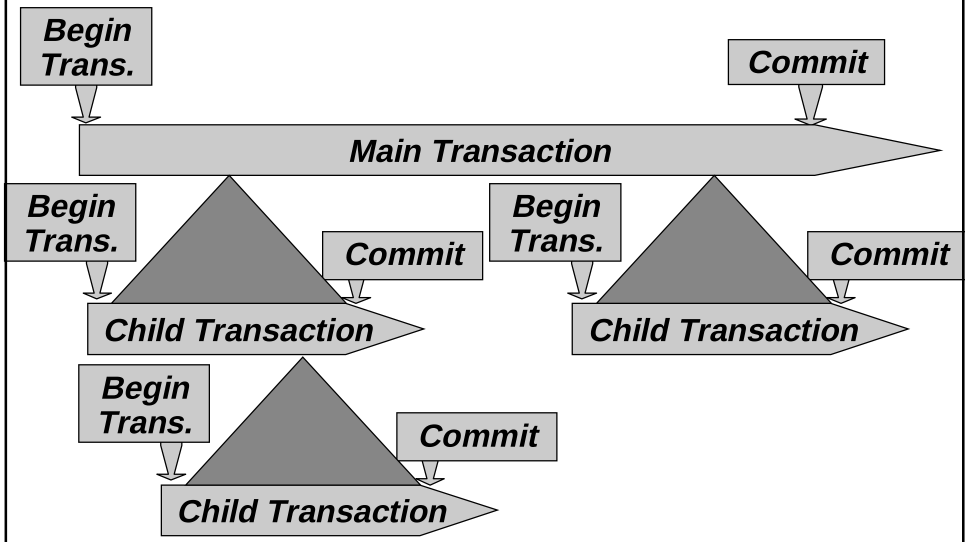
Transaction Commands

- **Begin:**
  - *Start a new transaction.*
- **Commit:**
  - *End a transaction.*
  - *Store changes made during transaction.*
  - *Make changes accessible to other transactions.*
- **Abort:**
  - *End a transaction.*
  - *Undo all changes made during the transaction.*

Flat Transactions



Nested Transactions



Central vs. Distributed Transactions

- **Transactions in a Database**
  - Centralized
  - DBMS controls transaction execution
  - DBMS implements concurrency control
  - Transaction processing transparent to application developers
- **Problem occurs if:**
  - Data kept in different databases or
  - Distributed objects do not use a database
  - Transaction processing not transparent to application developers

Summary

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- ■ *Transaction Concepts*
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  - *Consistency*
  - *Isolation*
  - *Durability*
- ■ *Nested Transactions*
- ■ *Centralized vs. Distributed Transactions*
- ■ *Summary*