CS346 - Transaction Processing

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Textbook:
Jim Gray, Andreas Reuter
Transaction Processing - Concepts and Techniques
Morgan Kaufmann, 1992

These lecture notes closely follow the notes used by Prof Garcia-Molina in the previous years.
Introduction

TRANSACTION

Definition 1

- Operation consisting of multiple actions
- Actions access shared, persistent state
- Typically: relatively simple, pre-defined, few types
- Examples: banking, inventory control, airlines
Definition 2

• Collection of actions requiring the ACID properties
  \( T_1: a_1 a_2 a_3 \ldots a_n \)

A  Atomicity
C  Consistency
I  Isolation
D  Durability

Note: A, I, D properties guaranteed by the system
      C property of system AND transaction itself
Announcing the new MEGATRON 5000 TP SYSTEM

while TRUE do
    begin
        accept NewTransaction
        print "ABORTED ***"
    end;

Other possibility: MEGATRON 5000/32

while TRUE do
    begin
        accept NewTransaction
        print "System unavailable - try again later"
    end;
⇒ Need additional property:

A  Availability:
   At a given time there is a good chance that the transaction will complete successfully.
MEGATRON 6000 Series "All Natural"

Features:
• Your transaction handled by experienced craftsmen
• We only do one transaction at a time
• Your output hand chiseled on stone tablets

⇒ Need another additional property:

F  Fast
Homework assignment: Need new acronym

A  C  I  D  A  F

D:  Persistent, ...
F:  Performance, Rapid, High performance, ...

Other desired features?

S  secure
E  easy to use, program
Focus of course: How to achieve ACID-AF system

Examples:
Chapter 3    Fault tolerance    (CD-A)
Chapters 7, 8   Locking        (I)
Chapters 9, 10  Logging        (A)
All chapters   Logging        (F)

No chapter     (Easy)

Theme: Coping with

- Failures
- Concurrency
- Complexity
Transaction Processing System

Definition

• System that performs transactions.

Examples:
• traditional: banking, airlines, ...
• now: any DBMS
• trend: wider use, e.g. transactional RPC

other examples:
• UPS - tracing packages
• Walmart - data mining
• Office applications
Where does CS346 fit in? (old organization)

CS145  Models, Languages

CS245A  DB System Principles

CS346  TP
CS347  Distributed Databases
CS245B  DB Project
CS345A  Beyond Relational DB Systems
CS395  Indep. Project
CS545  DB seminar
Where does CS346 fit in? (new organization)

CS145 Models, Languages, Applications

CS245A DB System Principles

CS347 Transaction Processing and Distributed DB

CS245B DB System Implementation

CS345 Advanced Topics in DB

CS395 Independent Project

CS545 DB Seminar
The CS245 view of TP:

BEGIN TRANS;
READ (X);
WRITE (Y);
...
END TRANS;

DBMS: does locking, logging, ...
 guarantees **serializable** schedules
Questions:

1) user request \( \Rightarrow \) running program?
   (at ATM you do not say "BT; READ (X); ... ")

2) what is transaction code?
   SQL calls? C program? Menu choice?

3) what runs code?
   Process? Thread? System?

4) what are components? Interfaces?
   lock manager? log manager?
   \( \Rightarrow \) trend to open systems:

   ![Diagram](image)
More Questions:

5) how are transactions used in non-DB applications?  
   eg. transactional RPC

6) how to achieve F (fast)?  
   "tricks of the trade"

7) other parts of the picture:  
   - communications  
   - application writing  
   - system administration  
   - ...

** this is not just a DB course!!

DB    OS    distributed computing    fault tolerance    ...

TP
Claim:
30%-50% of all computing $ go to TP applications.

Plus:
TP technology $\Rightarrow$ new applications

$\Rightarrow$ TP important

but:
usually not covered in classes, textbooks
Gray & Reuter Book:

NOT a great textbook, BUT the only one!

- too many details sometimes
- not very precise sometimes
- "here is how things work in practice - don't ask why"
- organization could be better (⇒ use glossary)
- use bug report
- good glossary
Outline of the book:

1) Introduction
2) Base Terms
3) Fault Tolerance
4) Transaction Models
5) TP Monitors
6) "
7) Isolation
8) "
9) Logging & Recovery
10) "
11) "
12) Advanced TP Topics
13) Sample RM
14) "
15) "
16) System Surveys
## Reading Assignments

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<tr>
<th>Chapter</th>
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<tr>
<td>Ch. 1</td>
<td>all except 1.3 (skim)</td>
<td>try problems 1, 3, 6</td>
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<tr>
<td>Ch. 2</td>
<td>skim all, except skip 2.7</td>
<td>try problems 1, 10, 14</td>
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<tr>
<td>Ch. 3</td>
<td>all except skip 3.7.4</td>
<td>try problems 1, 5, 12, 22</td>
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<td>Ch. 4</td>
<td>skip all (for now)</td>
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<td>Ch. 5</td>
<td>all except skip 5.5.4</td>
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<tr>
<td>Ch. 6</td>
<td>all except skim 6.5.1, skip code in 6.4</td>
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<tr>
<td>Ch. 7</td>
<td>should already know 7.1 - 7.5; read 7.6, 7.7; should already know 7.8.1-7.8.3; read 7.8.4, 7.8.5; skip 7.8.6 - 7.8.8; read 7.9, 7.11; skip 7.10, skim 7.12</td>
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<td>Ch. 8</td>
<td>all except skim 8.5, 8.6</td>
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<td>Ch. 9</td>
<td>all</td>
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<td>Ch. 10</td>
<td>all except skim 10.3.7.2</td>
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<tr>
<td>Ch. 11</td>
<td>all, skip 1-bit RM</td>
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