Concurrency Control w/o Locking

Use timestamps $TS(T_i)$ indicating start time of T_i

Want that if a_i of T_i is operation that conflicts w/ a_j of T_j then if $TS(T_i) < TS(T_j)$ a_i occurs before a_j. Otherwise, abort transaction

To get this to work, every object O is given a read timestamp $RTS(O)$ (timestamp of last reader) and a $WTS(O)$. If T wants to read O and $TS(T) < WTS(O)$ then abort T and restart w/ larger timestamp. If $TS(T) > WTS(O)$, T reads O and $RTS(O)$ is set to larger of $RTS(O)$ and $TS(T)$

If T wants to write if $TS(T) < RTS(O)$ abort

If $TS(T) < WTS(O)$ might abort but don't — if follow Thomas Write rule in w/c case write and update $WTS(O)$

Otherwise T writes O & updates $WTS(O)$

Fact: using Thomas Write Rule can lead to unrecoverable schedules

Crash Recovery

Recovery manager — responsible for atomicity and durability of transactions

- ↓ undo transactions that don't commit
- ↓ makes sure all committed transactions survive crashes

ARIES — popular recovery algorithm
uses steal - no force approach (not force write commit)
objects can be written to disk before commit

Phases after a crash

① Analysis — identifies dirty pages in buffer pool as well as active transactions at time of crash.

② Redo: Repeats all actions, starting from an appropriate point in the log to get DB into state at time of crash.

③ Undo: Undoes actions that did not commit.

Ex

Log Sequence Number (LSN) — LOG

Log File

10	update T1 writes P5
20	update T2 writes P3
30	T2 commit
40	T2 end
50	update: T3 writes P1
60	update: T3 writes P3
	✕ crash

T1 & T3 were active at time of crash, T2 committed

3 Main Principles of Aries

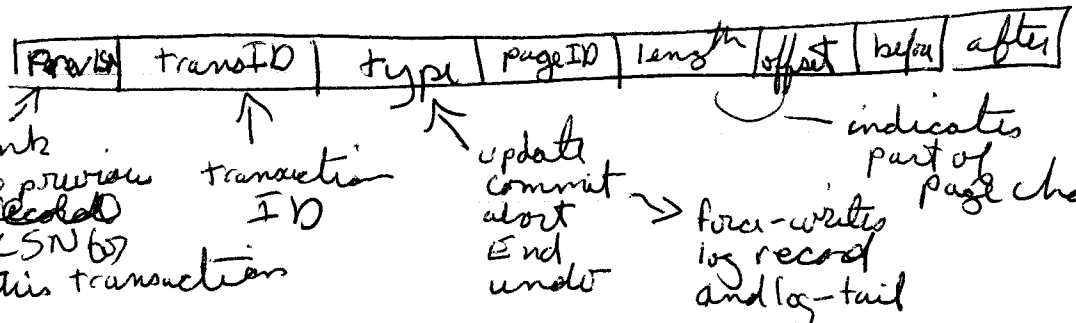
- Write ahead logging: Any change to DB must first record to the log. This record must be on disk or tape before the change to the DB written to disk

- Repeating History During Undo: Repeating operations up to point of crash then undo ops as necessary

allows record level locking

- Logging Changes During Undo: Changes made while undoing transactions are logged to ensure such an action is not repeated if crash while recovering.

What does a log entry look like?



Compensation Log Record (CLR)

- a log record for undoing an operation written when a transaction aborted and start undoing its operation
  Also written during undo phase of crash recovery.