Crash Recovery

- *Instructor*

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Need for Recovery

- Natural physical disasters
  - Fires, floods, earthquakes or power outage
- Sabotage
  - Intentional contamination or destruction of data, hardware, software facilities
- Carelessness
  - Unintentional contamination or destruction of data, hardware, software facilities
- Disk malfunctions
  - Head crashes, defective disks, unreadable tracks
- System crashes
  - Hardware malfunctions, resulting in loss of main and cache memory
- System software errors
  - Abnormal termination or destruction of DBMS
- Application software errors
  - Logical errors in program accessing database

Recovery Manager

- When a DMBS restarts after crashes, the recovery manager given control to must bring the database on a consistent state.
- Ensures atomicity by undoing the actions that do not commit.
- Ensures durability by making sure that all actions of committed transactions survive system crashes.

Recovery related steps during normal execution

- Log of all modifications saves on stable storage.
- Maintain multiple copies on different locations on nonvolatile storage devices.
- Write log entries in stable storage before the transaction commits.

ARIES

- **Analysis:** Identifies dirty pages in the buffer pool (i.e., changes that have not been written to disk) and active transactions at the time of the crash.
- **Redo:** Repeats all actions, starting from an appropriate point in the log, and restores the database state to what it was at the time of the crash.
- **Undo:** Undoes the actions of transactions that did not commit, so that the database reflects only the actions of committed transactions.

ARIES Principals

1. **Write-ahead logging (WAL):** Any change to a database object is first recorded in the log; the record in the log must be written to stable storage before the change to the database object is written to disk.
2. **Repeating history during Redo:** Upon restart following a crash, ARIES retraces all actions of the DBMS before the crash and brings the system back to the exact state that it was in at the time of the crash. Then, it undoes the actions of transactions that were still active at the time of the crash (effectively aborting them).
3. **Logging changes during Undo:** Changes made to the database while undoing a transaction are logged in order to ensure that such an action is not repeated in the event of repeated (failures causing) restarts.

Log/Trail/Journal

- Log record is written for each of following actions:
  - Updating a page
  - Commit
  - Abort
  - End
  - Undoing an update

Recovering from a System Crash

- Analysis:
  - It determines the point in the log at which to start the Redo pass.
  - It determines (a conservative superset of the) pages in the buffer pool that were dirty at the time of the crash.
  - It identifies transactions that were active at the time of the crash and must be undone.
- Redo:
  - The logged actions are reapplied.
  - The page is set redone log record.
- Undo
  - Scan backward from end of log.
  - Undo actions of transactions active lastly.

ARIES Exercise 1

LSN	LOG
00	begin
10	update: T1 writes P5
20	update: T2 writes P3
30	T1 aborts
40	CLR: Undo T1 LSN10, T1 end
50	update:T3 writes P1
60	update: T2 writes P5
CRASH, RESTART	
70	?
80	?
CRASH, RESTART	
90	?

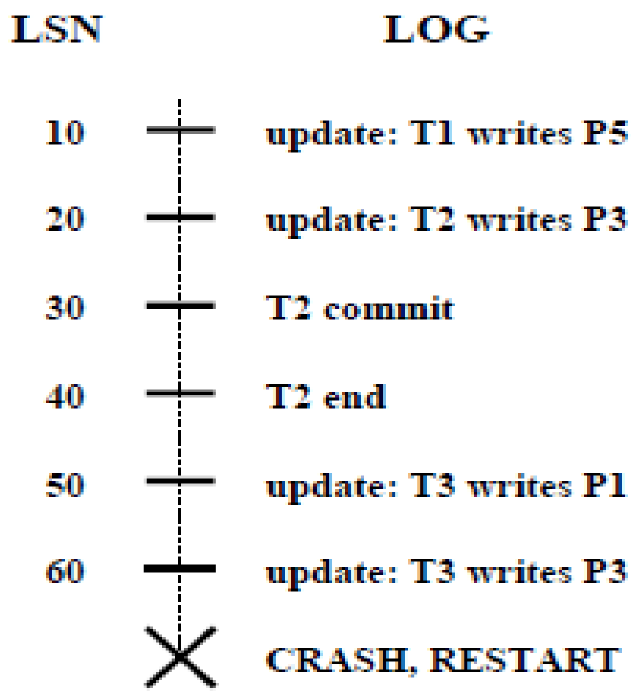
ARIES Exercise 1

LSN	LOG
00	begin
10	update: T1 writes P5
20	update: T2 writes P3
30	T1 aborts
40	CLR: Undo T1 LSN10, T1 end
50	update:T3 writes P1
60	update: T2 writes P5
	CRASH, RESTART
70	CLR: Undo T2 LSN60
80	CLR: Undo T3 LSN50, T3 end
	CRASH, RESTART
90	CLR: Undo T2 LSN20, T2 end

ARIES Exercise 2

LSN	LOG
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, RESTART

ARIES Exercise 2



LSN	LOG
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, RESTART
70	CLR: Undo T3 LSN 60
80	CLR: Undo T3 LSN 50, T3 end
90	CLR: Undo T1 LSN 10, T1 end