Database Recovery

Introduction: A computer system is an electromechanical device subject to failures of various types. The reliability of the DB system is linked to the reliability of the computer system on which it runs.

The Types of failures that the computer system is likely to be subjected to include failures of components or subsystems, software failures, power outage, accidents, unforeseen situations and natural or manmade disasters. DB recovery techniques are the methods of making the DB fault tolerant. The aim of the recovery scheme is to allow database operations to be resumed after a failure with minimum loss of information at an economically justifiable cost.

1. **Need for Recovery:** The process of Recovery is needed to handle the problems of DB failures.

The following are some of the failures occur in a DB system:

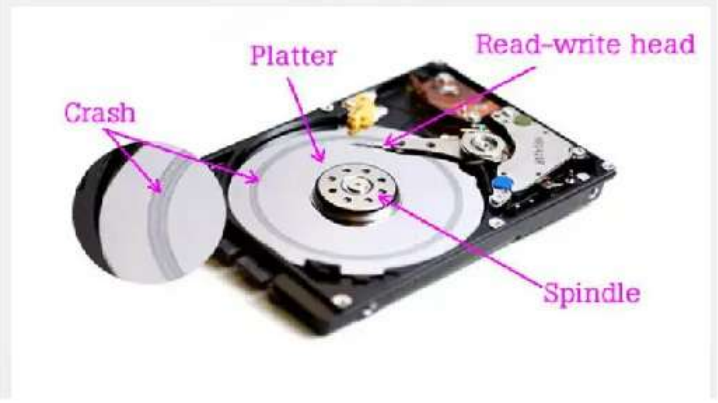
(i) **Transaction Failure:** There are two types of errors that may cause a transaction to fail:

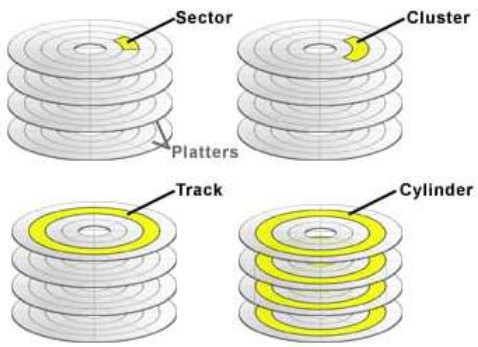
a) **Logical Error:** The transaction can no longer continue with its normal execution because of some internal condition such as incorrect input, Division by zero, integer overflow etc. Certain exceptional conditions that are not programmed correctly may also result in transaction cancellation.

b) System Error: The system has entered an undesirable state (Eg. Deadlock). As a result of this undesirable state, the transaction cannot continue with its normal execution. This type of transaction can be re-executed at a later time.

(ii) System Crash: Any hardware malfunction or a bug in the database software or the operating system that causes the loss of the content of volatile storage (RAM) and brings transaction processing to a halt. The contents of non-volatile storage (Hard disk) is not corrupted.

(iii) Disk Failure: A disk block loses its content as a result of either a head crash or failure during a data transfer operation. These errors may occur during read/write operations. Copies of the data on other disks or archival backups on storage media.





(iv) Physical Problems and Natural Disasters:

Problems like Data theft, Fire accident, overwriting of secodary storage comes under Physical Problems where as Problems like Earthquake, Floods, Tsunami comes under Natural Disasters. Both may result in the Loss of Data.

4) Transactions and Recovery: A transaction is the basic unit of recovery in DB system. The software which deals with DB recovery is Recovery Manager. The recovery manager has to ensure that on recovery from failure, all the effects of a given transaction are permanently recorded in the DB or none of them are recorded.

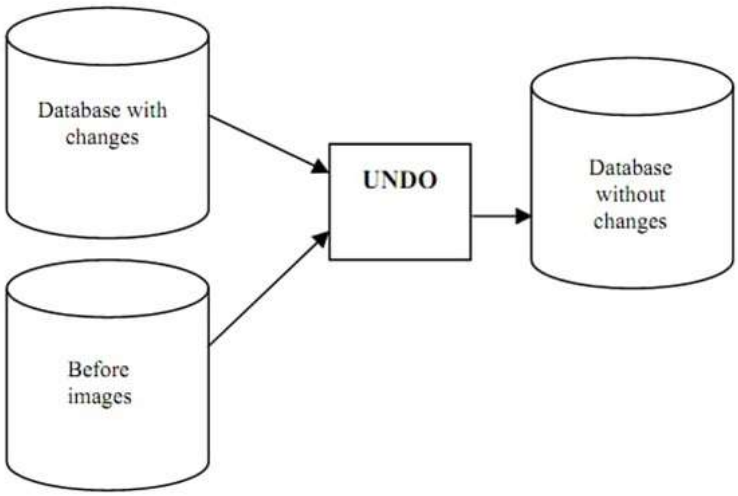
A transaction always begin with a successful execution of BEGIN TRANSACTION statement and it ends with successful execution of COMMIT statement.

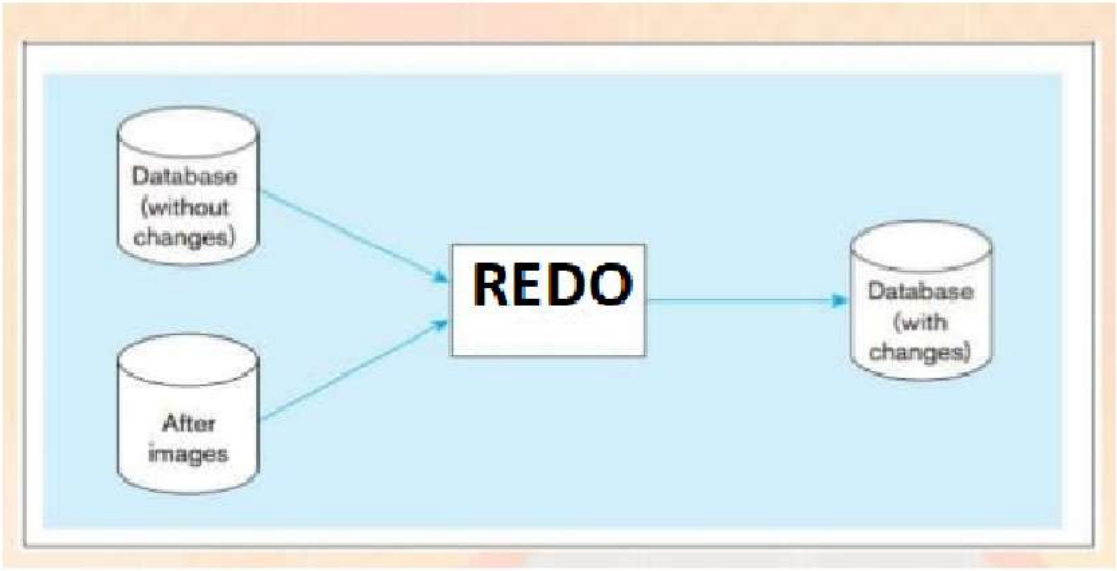
There are two types of Transaction Recovery

(i) Forward Recovery
(ii) Backward Recovery

Forward Recovery (REDO): Forward Recovery is the recovery procedure which is used in case of physical damage (Eg. Failure of Secondary storage while writing of data to DB).

Backward Recovery (UNDO): Backward Recovery is a recovery procedure which is used in the case of an error occurred in the middle of normal execution of a transaction. The recovery manager must undo the transaction when an error occurred in the middle of execution of a transaction.





III. DBMS Recovery Facilities:

A DBMS should provide the following facilities:

(i) Backup facilities: Every DBMS must backup periodic copies of the DB.

(ii) Logging facilities: It helps in keeping track of the current state of Transaction and DB changes

(iii) Checkpoint facilities: It enables updates to the database that are in progress to be made permanent.

(iv) Recovery Manager: It allows the system to restore the DB to a consistent state in case of failure.

IV. Recovery Techniques:

Recovery Techniques can be categorized into three types:

(i) Log-Based Recovery: The most widely used structure for recording database modifications is the Log. The Log is a sequence of Log Records. (Log Record maintains all the update activities in the DB).

An update log contains the following fields:

a) Transaction identifier: It is the unique identifier of the transaction that performed the write operation

b) Data-item identifier: It is the unique identifier of the data item written. Typically, It is the location on disk of the data item.

(iii) old value: It is the value of the data item prior to the write

(iv) New value: It is the value of the data item will have after the write.

→ The log based recovery technique is further classified into Two types:

1. Deferred update: The deferred update ensures transaction atomicity by recording all database modifications in the log, but deferring the execution of all write operations of a transaction until the transaction is successfully completed. Data changes recorded in the log file are applied to the database on commit. If a transaction fails before reaching its commit point, there is no need to undo any operation because the transaction has not affected the database on disk in any way.

(2) Immediate Update: The immediate update allows database modifications to be output to the database while the transaction is still in the active state. i.e, when a transaction issues an update command the database can be updated immediately without any need to wait for the transaction to reach its commit point. On commit, all changes made to the DB are made permanent and the records in the log file are discarded. On rollback, old values are restored into the database using the old values stored in the log file and all the changes made by the transaction to the DB are discarded.

(ii) Checkpoints:

This technique is used to solve the problem by upcoming the difficulties in Log-Based Recovery technique.

The two major difficulties with Log-Based approach:

a) The search process is Time Consuming.

b) Most of the transactions need to be redone have already written their updates into the DB. Although redoing them will cause no harm, it will nevertheless cause recovery to take longer.

A Checkpoint is a snapshot or copy of DB at a particular moment in time. Typically, a checkpoint involves recording a certain amount of information so that if a failure occurs, the database server can restart at that established point.

A checkpoint operation is performed periodically by the system as follows:

. A start of checkpoint record giving the identification, that is, checkpoint along with the date and time of the checkpoint.

. All log information from the buffers in the volatile storage is copied to the log on the stable storage.

. All database updates from the buffers in the volabile storage are written to the disk.

(iii) **Shadow Paging:** The shadow paging technique is different from the log-based recovery techniques in a way that it doesn't require the use of log in an environment where only one transaction is active at a time. The log is mandatory where multiple concurrent transactions are executing.

Shadow paging is based on making copies of the database. In this recovery scheme, the database is partitioned into fixed-length blocks referred as PAGES. These pages are mapped into physical blocks of storage with the help of page table called directory. These pages do not need to be stored in any particular order on disk. The main idea behind this technique is to maintain two page tables:

(i) Current page table or Current Directory
(ii) Shadow page table or Shadow Directory.