## Chapter 6.3 Redo Logging

*Defect About Undo Logging File:*

Before all Data Modifications have been updated to the Disk, we can not COMMIT current Transaction. However, makes the Database Modifications only exist in the Main Memory can help us save Disk I/O. As long as there has Logging File which can help repair Logging File, then this is safe.

Definition:

*Undo Schema:*

Prevent the need to write back any Database Element before COMMIT the Transaction.

*Main Difference between Redo and Undo Logging File:*

1. Undo Logging Record eliminates any influences from unfinished Transaction and neglect any submitted Transactions; While Redo Logging File is to neglect any unfinished Transaction and repeat the procedure to submit all changes for commit Transactions.
2. Undo Logging Record asks us to update all Database Elements to the Disk before COMMIT Logging Record reaches the Disk. While Redo Logging File is to ask Update all COMMIT Logging Records to the Disk and after that update all Database Element Changes to the Disk.

*Conclusion:*

* When using Undo Schema to obey Rule U1 and U2, then we need to use *OLD Value of Database Elements* to revert all changes in the Main Memory and Disk.
* When using Redo Schema, then we need to use *New Value of Database Elements* to update to the Main Memory and Disk.

Chapter 6.3.1 Redo Logging Rule

*Principle:*

In Redo Logging Record, Logging Record <T, X, v> means ‘Update the New Value v for Variable X’, in this record, you can tell that there has no Old Value. Each time when Transaction T tries to modify Database Element X, we must write one Record just as <T, X, v>.

*Rule:*

For Redo Logging File, we can tell that Database Data and Logging File Record can be used by ‘Redo Rule’ to describe the Sequence under which Data and Logging Record reach the Disk - which is called *Logging - Rule - Write - First*.

*R1: Before any Database Data X modifications reach the Disk, first ensure to write one Logging Record about modify all Logging Records, including Update Statement <T, X, v> and <COMMIT T>, they need to show up in the Disk. After that any modifications about Database Element Modifications can show up in the Disk.*

Logging Record <COMMIT T> appears in Logging File only after Transaction finishes, so real updates about Database Data to Disk would take effect. *The Execution Sequence about Transaction when using Redo is:*

1. *Point in the Logging File that includes any Changed Elements.*
2. *COMMIT Logging Record.*
3. *Submit changes of Database Elements to the Disk.*

*Example:*

Consider the Same Transaction before, below gives a possible series Events.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *Step* | *Action* | *t* | *M - A* | *M - B* | *D - A* | *D - B* | *Logging* |
| *1* |  |  |  |  |  |  | *<START T>* |
| *2* | *READ(A, t)* | *8* | *8* | *8* | *8* | *8* |  |
| *3* | *t := t \* 2* | *16* | *8* | *8* | *8* | *8* |  |
| *4* | *WRITE(A, t)* | *16* | *16* | *8* | *8* | *8* | *<T, A, 16>* |
| *5* | *READ(B, t)* | *8* | *16* | *8* | *8* | *8* |  |
| *6* | *t := t \* 2* | *16* | *16* | *8* | *8* | *8* |  |
| *7* | *WRITE(B, t)* | *16* | *16* | *16* | *8* | *8* | *<T, B, 16>* |
| *8* |  |  |  |  |  |  | *<COMMIT T>* |
| *9* | *FLUSH LOG* |  |  |  |  |  |  |
| *10* | *OUTPUT(A)* | *16* | *16* | *16* | *16* | *8* |  |
| *11* | *OUTPUT(B)* | *16* | *16* | *16* | *16* | *16* |  |

*Difference:*

* At first, in Forth and Seventh Line, New Data has been updated to Logging File, but not the OLD Data.
* Second, we notice that the Logging Record <COMMIT T> appears early in the Logging File, it appears in the Eighth Line.
* Logging File has been Flushed and all other updates about Transaction T appears in the Logging File.
* Any modifications about Variable A and B appear in the Logging File Record.

Chapter 6.3.2 Recovery by using Redo Logging File

The First Deduction of Rule R1 is As long as there has no corresponding <COMMIT T> Logging Record in the Logging File, we can know that any updates about Transaction T to Database have not written back to the Disk. Therefore, during Recovery, we can just treat those Unfinished Transaction as never happen. However, there exist New Value in the Logging Record that we need most. We can write the New Value to the Disk but let any updates of the Database Element on the Main Memory alone. Before do any recovery in the Crash, we need to do the following job:

1. Make sure already committed Transactions.
2. Scan Logging File from Top. For each pair Logging Record <T, X, v>:
3. For each unfinished Transaction T, write <ABORT T> Logging Record into the Logging File and flushed Logging file.

*Example:*

Consider after different steps and if crash happens, what would happen.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *Step* | *Action* | *t* | *M - A* | *M - B* | *D - A* | *D - B* | *Logging*  *(Main Memory)* |
| *1* |  |  |  |  |  |  | *<START T>* |
| *2* | *READ(A, t)* | *8* | *8* | *8* | *8* | *8* |  |
| *3* | *t := t \* 2* | *16* | *8* | *8* | *8* | *8* |  |
| *4* | *WRITE(A, t)* | *16* | *16* | *8* | *8* | *8* | *<T, A, 16>* |
| *5* | *READ(B, t)* | *8* | *16* | *8* | *8* | *8* |  |
| *6* | *t := t \* 2* | *16* | *16* | *8* | *8* | *8* |  |
| *7* | *WRITE(B, t)* | *16* | *16* | *16* | *8* | *8* | *<T, B, 16>* |
| *8* |  |  |  |  |  |  | *<COMMIT T>* |
| *9* | *FLUSH LOG* |  |  |  |  |  |  |
| *10* | *OUTPUT(A)* | *16* | *16* | *16* | *16* | *8* |  |
| *11* | *OUTPUT(B)* | *16* | *16* | *16* | *16* | *16* |  |

1. *Crash happens after Ninth Step - At that time, <COMMIT T> has been flushed to the Disk.* Then Recovery System would think that Transaction T would be one Committed Transaction. *At that time, traced back the Logging File, find Logging Record <T, B, 16> and <T, A, 16> would make the Recovery Management to help write the data 16 into Disk for Variable A and B.*

*(We can tell that in Tenth Step, the variable 8 has not been updated in Disk. But under this kind of situation, this would be fine, since Recovery Management would help update all 16 in both variables A and B.)*

1. *Crash happens between Eighth Step and Ninth Step, although Logging Record <COMMIT T> has been updated in Logging File, but it may has not reached to the Disk.* If the record has reached Disk, then Recovery would take place just as situation 1. However, if Logging Record <COMMIT T> has not reached to the Disk, then the Recovery would happen just same as the Situation 3 below.
2. If Crash happens before Eighth Step, then we can sure that <COMMIT T> has not reached to the Disk since it has not been updated to the Main Memory. Therefore, Transaction T would be treated as an unfinished Transaction.

Chapter 6.3.3 Checkpoint for Redo Logging File

Chapter 6.3.4 Recovery by using Redo Logging File with Checkpoint