Question 1

Suppose a database system reboots after a crash and finds that both A and B on disk have the value 10. The log is found to be:

\[
\begin{align*}
\text{<START T1>} \\
\text{<START T2>} \\
\text{T1, A, 5>} \\
\text{<COMMIT T1>} \\
\text{T2, B, 5>} \\
\text{T2, A, 15>} \\
\text{[CRASH]}
\end{align*}
\]

1. If the system is using UNDO logging, give the initial state of the database before T1 and T2 began executing (i.e., what were the initial values of A and B on the disk?).

2. If the system is using UNDO logging, what will be the final state of the database after recovery (i.e., what will be the values of A and B on the disk after the recovery process has finished?).

3. If the system is using REDO logging, give the initial state of the database before T1 and T2 began executing (i.e., what were the initial values of A and B on the disk?).

4. If the system is using REDO logging, what will be the final state of the database after recovery (i.e., what will be the values of A and B on the disk after the recovery process has finished?).

Solution

1. A=5, B=5; As the Undo logging stores the initial values, A and B will have the values of the first entry in the log.

2. A=15, B=5; During the recovery, only the uncommitted T2 will be undone.

3. A=10, B=10; Since Redo logging stores the new values and no log contained the final disk value of 10, it means that the changes of the log were not reflected on the hard disk, i.e. 10 was the initial value.

4. A=5, B=10; During the recovery, only the committed T1 will be redone.
Question 2

Assume that a database system using UNDO/REDO logging and nonquiescent checkpointing crashes with the log records on disk given below. Record $< T, X, v, w >$ means that transaction T changed the value of database element X; its former value was v, and its new value is w.

$\langle \text{START } T1 \rangle$
$\langle T1, X, 14, 28 \rangle$
$\langle T1, Y, 15, 5 \rangle$
$\langle \text{START } T2 \rangle$
$\langle T2, Z, 20, 10 \rangle$
$\langle \text{COMMIT } T1 \rangle$
$\langle \text{START CHKPT (T2)} \rangle$
$\langle T2, W, 4, 7 \rangle$
$\langle \text{START } T3 \rangle$
$\langle \text{END CHKPT} \rangle$
$\langle T3, X, 28, 17 \rangle$
$\langle \text{COMMIT } T2 \rangle$

1. What are all of the possible values on disk for each of the database elements W, X, Y and Z?
2. Which, if any, transactions will need to be redone in the recovery process?
3. How would your answers to parts (1) and (2) change if $\langle \text{END CHKPT} \rangle$ were not present in the log?

Solution

1. For element W: 4, 7
   For element X: 17, 28
   For element Y: 5
   For element Z: 10
2. Transactions to Redo: T2
3. For element W: 4, 7
   For element X: 14, 17, 28
   For element Y: 5, 15
   For element Z: 10, 20
   Transactions to Redo: T1, T2

Question 3

Consider the following transaction log from the start of the run of a database system that is capable of doing UNDO/REDO logging with checkpointing:

1) $\langle \text{START } T1 \rangle$
2) $\langle T1, A, 45, 10 \rangle$
3) $\langle \text{START } T2 \rangle$
4) $\langle T2, B, 5, 15 \rangle$
5) $\langle T2, C, 35, 10 \rangle$
6) $\langle T1, D, 15, 5 \rangle$
7) $\langle \text{COMMIT } T1 \rangle$
8) $\langle \text{START } T3 \rangle$
9) $\langle T3, A, 10, 15 \rangle$
10) $\langle \text{START CHKPT (T2, T3)} \rangle$
11) $\langle T2, D, 5, 20 \rangle$
12) $\langle \text{COMMIT } T2 \rangle$
13) $\langle \text{END CHKPT} \rangle$
14) <START T4>
15) <T4, D, 20, 30>
16) <T3, C, 10, 15>
17) <COMMIT T3>
18) <COMMIT T4>

Assume the log entries are in the format <Tid, Variable, Old value, New value>. What are the values of the data items A, B, C, and D on disk after recovery:

1. If the system crashes just before line 6 is written to disk?
2. If the system crashes just before line 10 is written to disk?
3. If the system crashes just before line 12 is written to disk?
4. If the system crashes just before line 13 is written to disk?
5. If the system crashes just before line 16 is written to disk?
6. If the system crashes just before line 18 is written to disk?

Solution

1. A=45, B=5, C=35, D=15;
2. A=10, B=5, C=35, D=5;
3. A=10, B=5, C=35, D=5;
4. A=10, B=15, C=10, D=20;
5. A=10, B=15, C=10, D=20;
6. A=15, B=15, C=15, D=20;