

COURSE : DATABASE MANAGEMENT SYSTEMS

TOPIC : CONCURRENCY CONTROL-3

COURSE CODE: 23AD2102A

Session - 6

AIM OF THE SESSION



To familiarize students with the Basic concepts about Concurrency Techniques and Locking Protocols

INSTRUCTIONAL OBJECTIVES



This Session is designed to:

1. Discuss about Terminology of Concurrency and Locking Protocols.
2. Describe the Locking Protocols.
3. Describe Two phase locking with suitable example.
4. Discuss about Deadlock prevention in locking .

LEARNING OUTCOMES



At the end of this session, students should be able to:

1. Review of Cascading Rollback & Cascade less Schedule
2. Concurrency Control: Lock based Protocols

SESSION OBJECTIVE

- At the end of the session the students will understand about
- ***Time Stamp based Protocols***
- ***Thomas Write Rule***

REVIEW OF GRAPH BASED PROTOCOLS & DEADLOCK HANDLING

- Graph-based locking protocols impose restrictions on the order in which items are accessed, and can thereby ensure serializability without requiring the use of two-phase locking, and can additionally ensure deadlock freedom.
- Various locking protocols do not guard against deadlocks. One way to prevent deadlock is to use an ordering of data items, and to request locks in a sequence consistent with the ordering.
- Another way to prevent deadlock is to use preemption and transaction rollbacks. To control the preemption, we assign a unique timestamp to each transaction. The system uses these timestamps to decide whether a transaction should wait or roll back.
- If a transaction is rolled back, it retains its old time stamp when restarted.

REVIEW OF GRAPH BASED PROTOCOLS

- If deadlocks are not prevented, the system must deal with them by using a deadlock detection and recovery scheme.

To do so, the system constructs a wait-for graph.

- A system is in a deadlock state if and only if the wait-for graph contains a cycle.
- When the deadlock detection algorithm determines that a deadlock exists, the system must recover from the deadlock.
- It does so by rolling back one or more transactions to break the deadlock.

TIME STAMP BASED PROTOCOLS

- Also called as Timestamp Ordering Protocols
- The Timestamp Ordering Protocol is used to order the transactions based on their Timestamps. The order of transaction is nothing but the ascending order of the transaction creation.
- The priority of the older transaction is higher that's why it executes first. To determine the timestamp of the transaction, this protocol uses system time or logical counter.
- The lock-based protocol is used to manage the order between conflicting pairs among transactions at the execution time. But Timestamp based protocols start working as soon as a transaction is created.

TIME STAMP BASED PROTOCOLS

- Let's assume there are two transactions T1 and T2. Suppose the transaction T1 has entered the system at 007 times and transaction T2 has entered the system at 009 times. T1 has the higher priority, so it executes first as it is entered the system first.
- The timestamp ordering protocol also maintains the timestamp of last 'read' and 'write' operation on a data

WORKING OF BASIC TIMESTAMP ORDERING PROTOCOL

1. *Check the following condition whenever a transaction T_i issues a Read (X) operation:*

- If $W_TS(X) > TS(T_i)$ then the operation is rejected.
- If $W_TS(X) \leq TS(T_i)$ then the operation is executed.
- Timestamps of all the data items are updated.

2. *Check the following condition whenever a transaction T_i issues a Write(X) operation:*

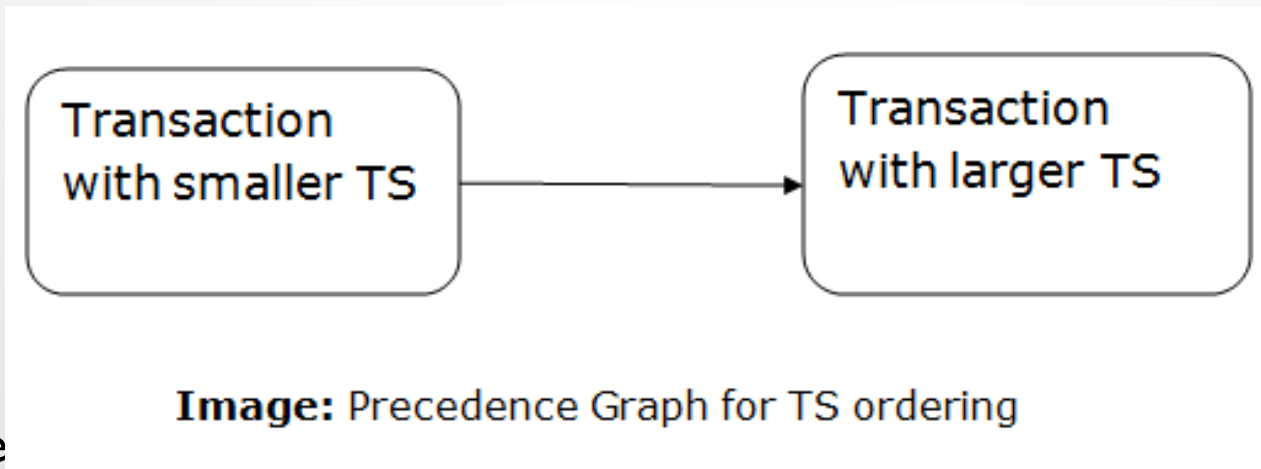
- If $TS(T_i) < R_TS(X)$ then the operation is rejected.
- If $TS(T_i) < W_TS(X)$ then the operation is rejected and T_i is rolled back otherwise the operation is executed.

HERE,

- **TS(Ti)** denotes the timestamp of the transaction T_i .
- **R_TS(X)** denotes the Read time-stamp of data-item X .
- **W_TS(X)** denotes the Write time-stamp of data-item X .

ADVANTAGES AND DISADVANTAGES OF TIME ORDERING PROTOCOL

- TO protocol ensures serializability since the precedence graph is as follows:



- TS protocol ensures serializability since the precedence graph is as follows: never waits.
- But the schedule may not be recoverable and may not even be cascade- free.

VALIDATION BASED PROTOCOL

- In the validation based protocol, the transaction is executed in the following three phases:
 - 1. Read phase:** In this phase, the transaction T is read and executed. It is used to read the value of various data items and stores them in temporary local variables. It can perform all the write operations on temporary variables without an update to the actual database.
 - 2. Validation phase:** In this phase, the temporary variable value will be validated against the actual data to see if it violates the serializability.
 - 3. Write phase:** If the validation of the transaction is validated, then the temporary results are written to the database or system otherwise the transaction is rolled back.

VALIDATION BASED PROTOCOL

- Here each phase has the following different timestamps:
- ***Start(T_i)***: It contains the time when T_i started its execution.
- ***Validation (T_i)***: It contains the time when T_i finishes its read phase and starts its validation phase.
- ***Finish(T_i)***: It contains the time when T_i finishes its write phase.

VALIDATION BASED PROTOCOL

- This protocol is used to determine the time stamp for the transaction for serialization using the time stamp of the validation phase, as it is the actual phase which determines if the transaction will commit or rollback.
- Hence $TS(T) = \text{validation}(T)$.
- The serializability is determined during the validation process. It can't be decided in advance.
- While executing the transaction, it ensures a greater degree of concurrency and also less number of conflicts.
- Thus it contains transactions which have less number of rollbacks.

THOMAS WRITE RULE

- Thomas Write Rule provides the guarantee of serializability order for the protocol. It improves the Basic Timestamp Ordering Algorithm.
- The basic Thomas write rules are as follows:
 - *If $TS(T) < R_TS(X)$ then transaction T is aborted and rolled back, and operation is rejected.*
 - *If $TS(T) < W_TS(X)$ then don't execute the $W_item(X)$ operation of the transaction and continue processing.*
 - *If neither condition 1 nor condition 2 occurs, then allowed to execute the WRITE operation by transaction T_i and set $W_TS(X)$ to $TS(T)$*

THOMAS WRITE RULE

If we use the Thomas write rule then some serializable schedule can be permitted that does not conflict serializable as illustrate by the schedule in a given figure:

T1	T2
R(A) W(A) Commit	W(A) Commit

Above figure shows , a Serializable Schedule that is not Conflict Serializable

THOMAS WRITE RULE

- In the previous figure, T1's read and precedes T1's write of the same data item. This schedule does not conflict serializable.
- Thomas write rule checks that T2's write is never seen by any transaction. If we delete the write operation in transaction T2, then conflict serializable schedule can be obtained which is shown in below figure.

T1	T2
R(A) W(A) Commit	Commit

The above figure shows Conflict Serializable Schedule

SUMMARY OF THE SESSION

- A time stamp-ordering scheme ensures serializability by selecting an ordering in advance between every pair of transactions. A unique fixed timestamp is associated with each transaction in the system. The timestamps of the transactions determine the serializability order.
- Thus, if the timestamp of transaction T_i is smaller than the timestamp of transaction T_j , then the scheme ensures that the produced schedule is equivalent to a serial schedule in which transaction T_i appears before transaction T_j . It does so by rolling back a transaction whenever such an order is violated.

SELF-ASSESSMENT QUESTIONS

A transaction is made to wait until all _____ locks held on the item are released

- (a) Compatible
- (b) Equivalent
- (c) Compatible
- (d) Executable

2. The protocol that indicates when a transaction may lock and unlock each of the data items is called as

- a) Locking protocol
- b) Unlocking protocol
- c) Granting protocol
- d) Conflict protocol

- 1. Explain different types of Locking Protocols
- 2. Describe the advantages and disadvantages of Two phase locking protocol
- 3. What do you mean by concurrency control techniques?
- 4. Explain the working of locking technique in concurrency control. What benefits does Rigorous two-phase locking provide? How does it compare with other forms of two-phase locking?