DATA SATURDAYS #64 PARMA 2024

SQL Server deadlocks: Techniques to identify and resolve them!

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Slide and demos: https://bit.ly/DataSatParma2024-sgovoni

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Agenda

- Transactions and concurrency models
- Misconceptions about deadlock
- Lock vs. deadlock
- Deadlock discovery
- Identifying deadlocks
- Best practices and prevention

Transactions and concurrency models

- A-C-**I**-D: The four properties of a transaction
- Pessimistic concurrency model
  - Uses blocking to avoid conflicts
  - Readers can block writers, and writers can block readers
- Optimistic concurrency model
  - Use row versioning
  - Readers cannot block writers, and writers cannot block readers, but the writer can block another writer

Pessimistic concurrency models

- Four isolation levels
  - Read Uncommitted
    - Allows the dirty read problem
  - Read Committed
    - We can only read committed data
  - Repeatable Reads
    - Acquires shared-lock until the end of the transaction
  - Serializable
    - Any transaction is waiting until the current transaction completes

Optimistic concurrency models

- Two isolation levels
  - Snapshot
  - Read Committed Snapshot
- These two isolation levels are based on row versioning

Lock modes

Lock mode	Description
Shared (`s`)	Used for read operations that do not change or update data, such as a `SELECT` statement.
Update (`u`)	Used on resources that can be updated. Prevents a common form of deadlock that occurs when multiple sessions are reading, locking, and potentially updating resources later.
Exclusive (`x`)	Used for data-modification operations, such as `INSERT`, `UPDATE`, or `DELETE`. Ensures that multiple updates cannot be made to the same resource at the same time.

https://learn.microsoft.com/sql/relational-databases/sql-server-transaction-locking-and-row-versioning-guide#lock_modes

Misconceptions about deadlock

Misconceptions about deadlocks

- Deadlocks in SQL Server are bugs
- Deadlocks cannot be prevented
- Using NOLOCK on all SELECTs will prevent deadlocks
- Adding covering indexes for every query prevents deadlocks
- Only very experienced SQL Server developers or administrators can troubleshoot deadlocks

Lock vs. deadlock

Difference between lock and deadlock

- Deadlocking is often confused with normal blocking
- When a transaction requests a lock on a resource locked by another transaction, the requesting transaction waits until the lock is released
  - The requesting transaction is blocked, not deadlocked
- By default, transactions don’t time out, unless LOCK_TIMEOUT is set

Difference between lock and deadlock

- Deadlocks are resolved almost immediately
- Blocking can, in theory, persist indefinitely

- Lock granularity and hierarchies

Resource locked by another transaction

Deadlock discovery

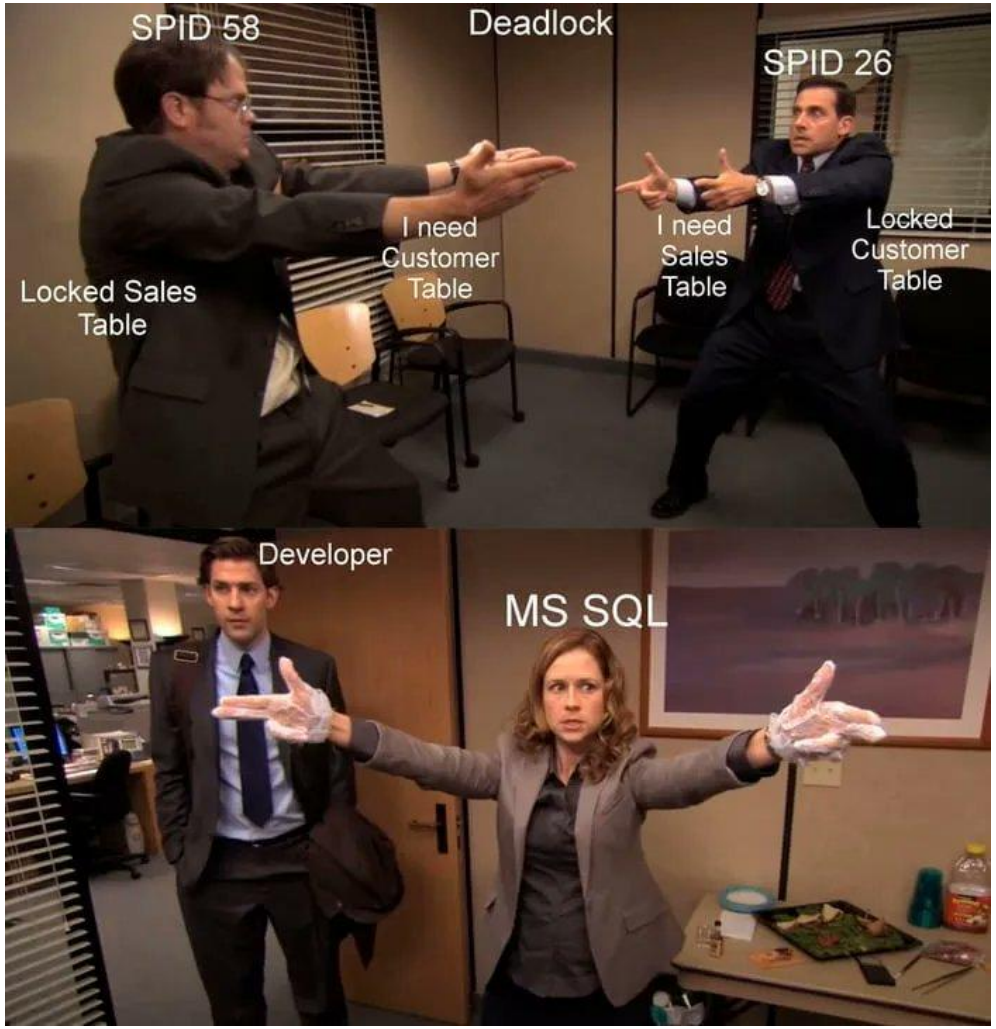
What is a deadlock?

A deadlock is a specific type of lock that occurs when two or more tasks permanently block each other, creating a **cyclic dependency** situation!

Cyclic dependency scenario

https://x.com/ladataplatform/status/1608859212053975040?s=46

Cyclic dependency scenario



https://x.com/ladataplatform/status/1608859212053975040?s=46

Deadlock discovery

- The lock monitor thread is tasked with deadlock discovery, conducting periodic scans to identify and resolve them
- During deadlock discovery, the lock monitor identifies blocked tasks and recursively searches the tasks to trace the blocking resource owners, uncovering cyclic blocking that forms a deadlock
- Each time a deadlock is discovered, the search interval reduces from a default of 5 seconds to as fast as 100 milliseconds, depending on the deadlock frequency on the server

Deadlock discovery

- If the monitor detects a cyclic dependency, it chooses one of the tasks as a **victim** and terminates its transaction with an error
  - This allows the other task to complete its transaction

- How is a deadlock victim chosen?

Deadlock priority

- Any user can set the DEADLOCK_PRIORITY session option to influence deadlock resolution behavior
  - It is impossible to prevent a user from setting DEADLOCK_PRIORITY, even with Resource Governor
- Assigning a higher DEADLOCK_PRIORITY to important transactions ensures they are not chosen as the deadlock victim when a deadlock occurs with a lower priority session

Deadlock victim selection

- When a deadlock is detected, the lock monitor ends it by choosing one of the threads as the deadlock victim
  - The deadlock victim is killed, rolling back its transaction
  - The client receives a 1205 error
- The deadlock victim is selected based on the following criteria:
  - The DEADLOCK_PRIORITY of the two session is compared, and the lowest priority session is selected ad the victim
  - If both session have the same DEADLOCK_PRIORITY value, the transaction that is least expensive to rollback, based on the log records that have been generated, is selected as the victim (default)

Identifying deadlocks

Deadlock information tools

- There are several tools that can be used to identify deadlocks:
  - Extended event (recommended)
  - SQL Profiler
  - Trace flags 1204, 1222
    - Avoid using trace flags 1204 and 1222 on workload-intensive systems that are experiencing deadlocks because these trace flags might introduce performance issue
    - How It Works: SQL Server Deadlock Trace Flag 1222 Output
  - Event notification

DEMO

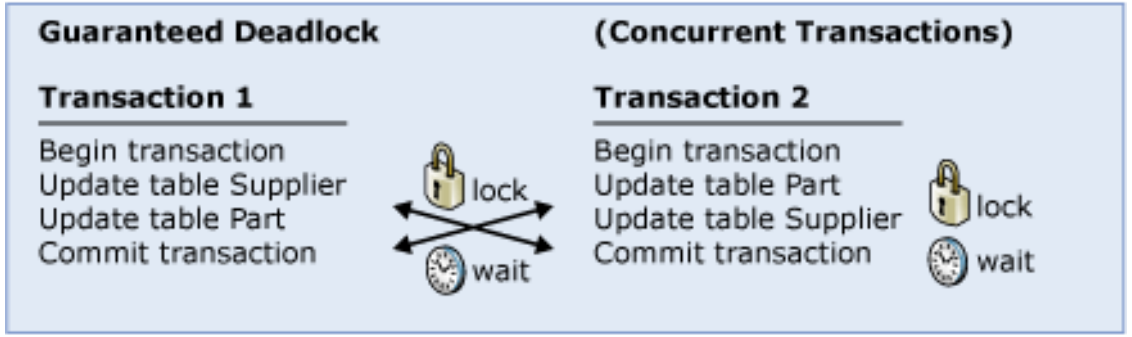
Best practices and prevention

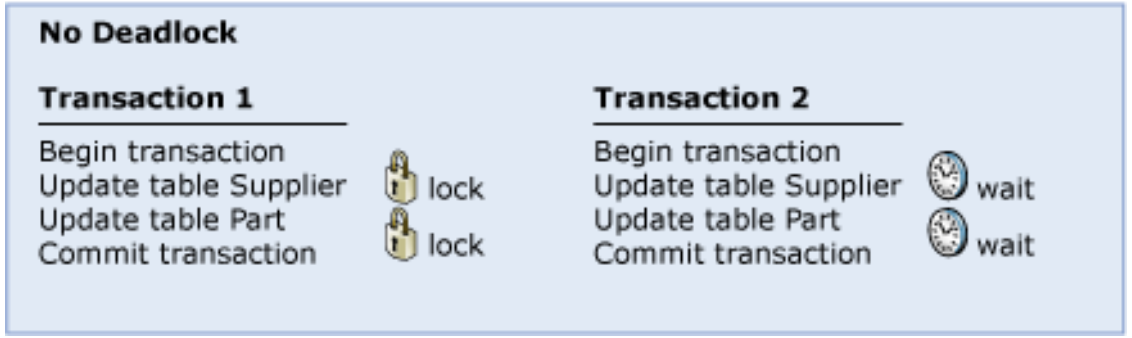
Best practices and prevention

- Deadlocks cannot be completely avoided; anyway, these coding conventions can minimize the chance of generating a deadlock:
  - Access objects in the same order
  - Avoid user interaction in transactions
  - Keep transactions short and in one batch
  - Use a lower isolation level
  - Use a row versioning-based isolation level
  - Use bound connections

Access objects in the same order

- If all concurrent transactions access objects in the same order, deadlocks are less likely to occur





Summary

- Deadlocks in SQL Server aren’t bugs but an outcomes of resource contention in multi-user environments
- To prevent deadlocks, focus on designing transactions carefully, using the same order when accessing resources, and use a row versioning-based isolation level (when it is possible)
- SQL Server tools like extended events, SQL Profile, Trace Flags and First Responder Kit can help you to identify and monitor deadlocks

Resources

- Deadlocks guide
- Analyze Deadlocks with SQL Server Profiler
- How It Works: SQL Server Deadlock Trace Flag 1222 Output
- Hands-On-Lab: SQL Server Deadlock Types
- SQL Server First Responder Kit by BrentOzar
  - sp_Blitz *

Thanks!!!