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Exploring Optimized Locking in SQL Server 2025

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Let’s Talk Objectives

Objectives

Current problems

Lock Refresher

Optimized Locking Components

How does it work

Limitations

Current Problems

ACID Compliance

Lock escalation

Long-term locking

Excessive blocking

Excessive memory utilization

Pessimistic vs Optimistic Locking

Pessimistic locking assumes conflicts are probable and explicitly locks data.

Optimistic locking assumes conflicts are rare and checks for conflicts only when committing changes.

What can be locked?

Resource Lock	Description
Key	Lock on a row in an index
Object	Lock on table, procedure, view, etc
Page	Lock on an 8-KB page
RID	Lock on a single row in a heap
Xact	Lock on a transaction

Locking Refresher

Lock	Purpose
IX/IU – Intent Lock	Establishes a lock hierarchy,
U – Update Lock	Used on resources that can be updated.
X – Exclusive Lock	Used for data-modification operations, such as INSERT, UPDATE, or DELETE.
S – Shared Lock	Used for read operations that do not change or update data

Lock Compatibility Matrix

Existing/Request Lock	IS	S	U	IX	X
Intent shared (IS)	Yes	Yes	Yes	Yes	No
Shared (S)	Yes	Yes	Yes	No	No
Update (U)	Yes	Yes	No	No	No
Intent exclusive (IX)	Yes	No	No	Yes	No
Exclusive (X)	No	No	No	No	No

How Traditional Locking Works

Update lock taken on rows
to allow for predicate evaluation

If **predicate** is satisfied, then
an **exclusive lock** is taken on the row

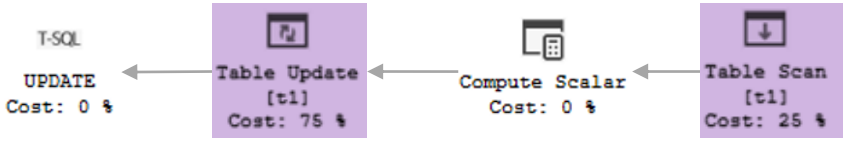
Locks are held until
the end of the transaction

Traditional Locking

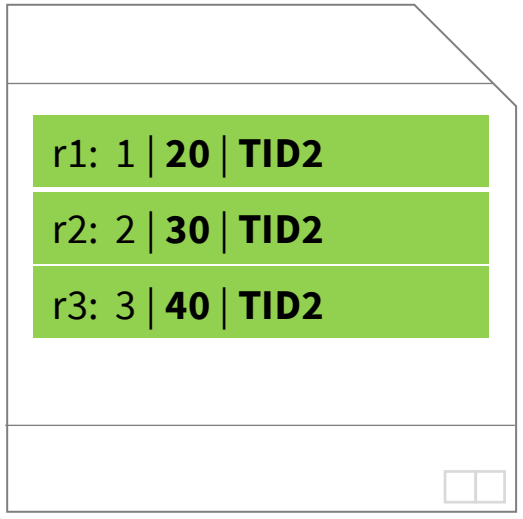
```
ALTER DATABASE [Locking] SET READ_COMMITTED_SNAPSHOT OFF;
SET TRANSACTION ISOLATION LEVEL READ COMMITTED;

CREATE TABLE t1 (a int, b int);
INSERT INTO t1 VALUES (1,10), (2,20), (3,30);

-- TID2: Increase b by 10
BEGIN TRAN UPDATE t1 SET b=b+10;
```



p1: Data Page for t1



Lock Manager

Lock Mode	Lock Type	Lock Resource
IX	OBJECT	t1
IX	PAGE	p1
X	RID	r1
X	RID	r2
X	RID	r3

Slide Credit: Perry Skountrianos/Prashanth Purnananda & the Microsoft team who brought you optimized locking

Old School

Updating 1 million rows might require 1 million exclusive (X) row locks held until the end of the transaction.

https://learn.microsoft.com/en-us/sql/relational-databases/performance/optimized-locking?view=azuresqldb-current

Optimized Locking Components

- Accelerated Database Recovery
- Transaction ID (TID)
- Lock After Qualification (LAQ)

Here's the **purr-scription:**

ADR Overview

Persisted Version Store (PVS) lives in user databases

In-row versions versus off-row versions (PVS)

Facilitates much faster rollback operations

Eliminates long-running transaction rollbacks

Transaction ID (TID)

A unique identifier

Each row will contain the TID that last modified it

Lock will be held on the transaction ID versus row key

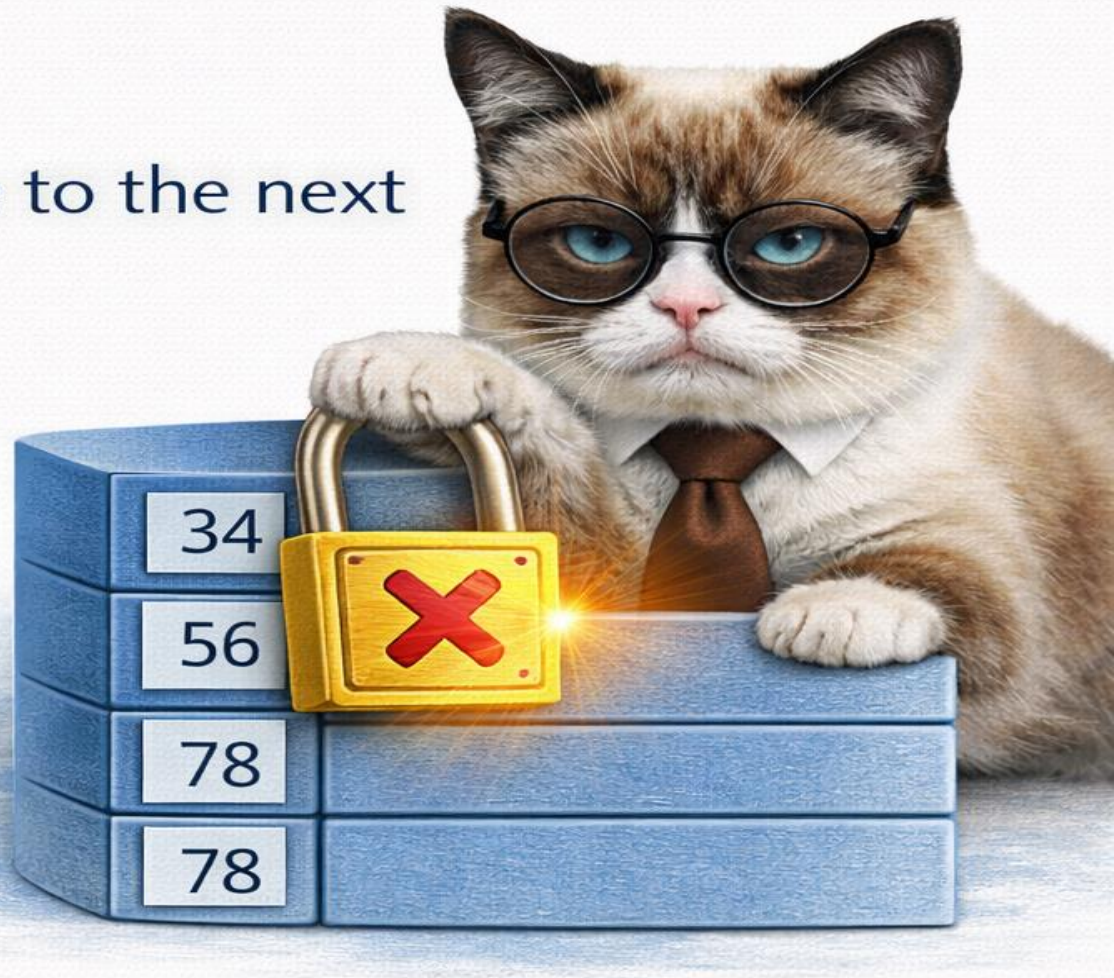
Lock After Qualification (LAQ)

Predicate is applied to the row using the latest version of the row

If the predicate is not satisfied, move to the next row

If the predicate is satisfied, an exclusive (X) lock is placed on the row

Can retry predicate evaluation as needed due to previous exclusive



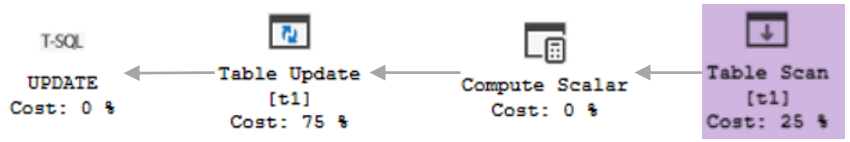
Traditional Blocking

```
ALTER DATABASE [db1] SET READ_COMMITTED_SNAPSHOT ON;
SET TRANSACTION ISOLATION LEVEL READ COMMITTED;

CREATE TABLE t1 (a int, b int);
INSERT INTO t1 VALUES (1,10), (2,20), (3,30);
```

```
-- TID2 [SESSION 1]: Increase b by 10 where a=1
BEGIN TRAN UPDATE t1 SET b=b+10 where a=1;
```


```
-- TID3 [SESSION 2]: Increase b by 10 where a=2
BEGIN TRAN UPDATE t1 SET b=b+10 where a=2;
```



p1: Data Page for t1

Row does not qualify

r1: 1 | **20** | **TID2** ✓

r2: 2 | 20 | TID1 ✗

r3: 3 | 30 | TID1 ✗

Row version store

r1: 1 | 10 | TID1

Lock Manager

Lock Mode	Lock Type	Resource	Owner	Status
IX	OBJECT	t1	TID2, TID3	GRANT
IX	PAGE	p1	TID2	GRANT
X	RID	r1	TID2	GRANT
IU	PAGE	p1	TID3	GRANT
U	RID	r1	TID3	WAIT

Slide Credit: Perry Skountrianos/Prashanth Purnananda & the Microsoft team who brought you optimized locking

🚫 Session 2 is blocked waiting for Session 1 to commit

Optimized Locking

```
ALTER DATABASE [db1] SET READ_COMMITTED_SNAPSHOT ON;
SET TRANSACTION ISOLATION LEVEL READ COMMITTED;

CREATE TABLE t1 (a int, b int);
INSERT INTO t1 VALUES (1,10), (2,20), (3,30);
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```
-- TID2 [SESSION 1]: Increase b by 10 where a=1
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-- TID3 [SESSION 2]: Increase b by 10 where a=2
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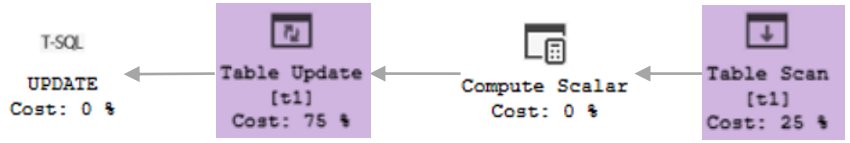

p1: Data Page for t1

Row does not qualify

r1: 1 | **20** | **TID2** ✓

r2: 2 | **30** | **TID3**

r3: 3 | 30 | TID1 ✗

Row version store

Row does not qualify

r1: 1 | 10 | TID1 ✗

r2: 2 | 20 | TID1

Lock Manager

Lock Mode	Lock Type	Resource	Owner	Status
X	XACT	TID2	TID2	GRANT
IX	OBJECT	t1	TID2, TID3	GRANT
IX	PAGE	p1	TID2	GRANT
IX	PAGE	p1	TID3	GRANT
X	RID	r2	TID3	GRANT

✓ Session 2 is not blocked by Session 1

Slide Credit: Perry Skountrianos/Prashanth Purnananda & the Microsoft team who brought you optimized locking

New School

Updating 1 million rows might require 1 million X row locks but each lock is released as soon as each row is updated,

Only one TID lock will be held until the end of the transaction.

https://learn.microsoft.com/en-us/sql/relational-databases/performance/optimized-locking?view=azuresqldb-current

Warning

“Even without LAQ, applications should not assume that SQL Server (under versioning isolation levels) will guarantee strict ordering, without using locking hints.”

https://learn.microsoft.com/en-us/sql/relational-databases/performance/optimized-locking?view=azuresqldb-current”

Best Practices & Troubleshooting

Locking hints will be honored but reduce the effectiveness of the optimized locking

Avoid locking hints
Make sure RCSI is enabled
New entries for Deadlock Graphs
New Waits introduced:

ONCE AGAIN FOR THOSE IN THE BACK,

NO LOCK IS NOT THE ANSWER!!!

Limitations of Optimized Locking

Required
Accelerated Database Recovery

SQL Managed Instance 2025 Policy ONLY

Repeatable Read & Serializable Isolation forces the lock to be held on the row or page until the end of the transaction

Summary

Better concurrency

Significantly reduced locking and lock memory

On by default in Azure SQL Database ADR/RCSI is enabled by default as well

Every SQL Server DBA should be watching this feature arrive to the box product

Resources

Optimized Locking - https://learn.microsoft.com/en-us/sql/relational-databases/sql-server-transaction-locking-and-row-versioning-guide?view=sql-server-ver16&source=recommendations

Article - https://www.red-gate.com/simple-talk/databases/sql-server/database-administration-sql-server/optimized-locking-in-azure-sql-database/ (Simple Talk - Aaron Bertrand)

Questions?
Answers!

How was the session?

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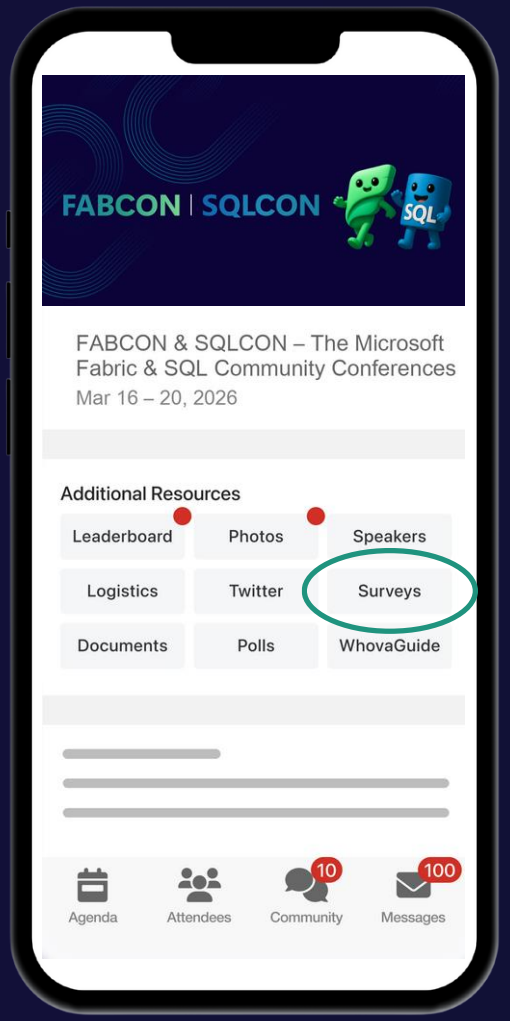

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