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PASS

Optimized Locking: Improving SQL Server Transaction Concurrency

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- 25 years as a DBA
- Data Platform Women in Tech (WIT) Virtual UG, Co-leader
- WITspiration, Co-founder
- Redgate Community Ambassador
- Microsoft MVP, Data Platform
- In my spare time, I can usually be found doing something musical or something geeky with my husband, Andy, and our dog, Sebastian.

What's the problem we're trying to solve?

- Locking & Blocking!

Introducing Optimized Locking

- GA in Azure SQL DB in Feb 2023
- SQL Server 2025 Public Preview
- Writes not blocking Writes

Agenda – How it works

- Components used by Optimized Locking
  - Read Committed Snapshot Isolation Level (RCSI)
  - Accelerated Database Recovery (ADR)
- Lock Escalation
- Optimized Locking
  - Transaction ID Locking
  - Lock After Qualification

Pessimistic vs Optimistic Locking

- **Pessimistic Locking** – Preventing users from modifying data in a way that affects other users
  - Read Uncommitted
  - Read Committed
  - Serializable
  - Repeatable Read

Pessimistic vs Optimistic Locking

- **Optimistic Locking** – No locks when reading data but data is checked when modifying
  - Read Committed Snapshot Isolation
  - Snapshot Isolation
  - Optimized Locking

Read Committed Snapshot Isolation Level (RCSI)

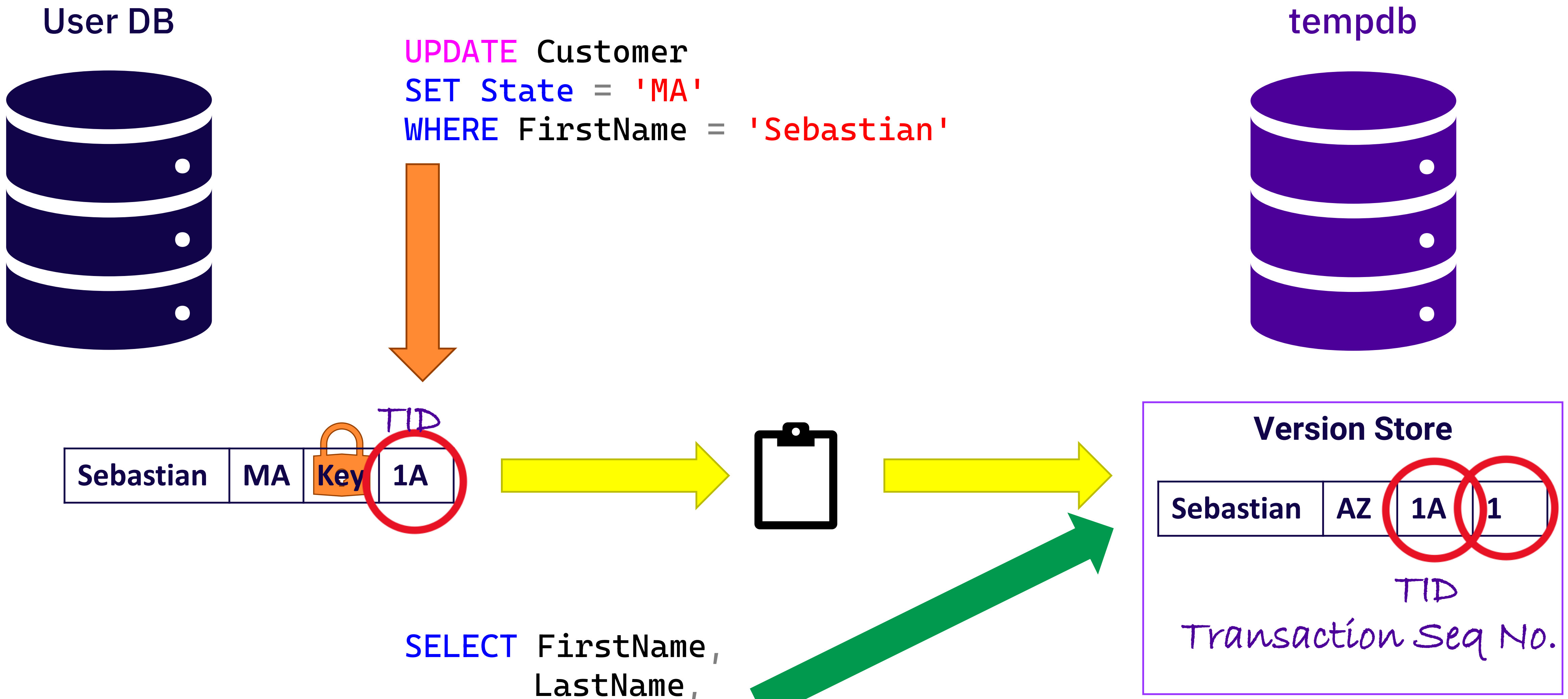
- Introduced with SQL Server 2005
- Writes and Reads don’t block each other
- Two database options for setting this:
  - SET READ COMMITTED SNAPSHOT ISOLATION – sets default for the database
  - ALLOW SNAPSHOT ISOLATION LEVEL – allows individual sessions\queries to use SNAPSHOT isolation levels even if read committed snapshot isolation is not set.

Read Committed Snapshot Isolation Level (RCSI)

- Every row in the database has a Transaction ID (TID)
- Keeps copies of the previously committed versions of the records in the Version Store in TempDB
- Only reading the committed version of the data

```
BEGIN TRAN 1A

UPDATE Customer
SET State = 'MA'
WHERE FirstName = 'Sebastian'
```



```
SELECT FirstName,
       LastName,
       State
FROM Customer
WHERE FirstName = 'Sebastian'
```

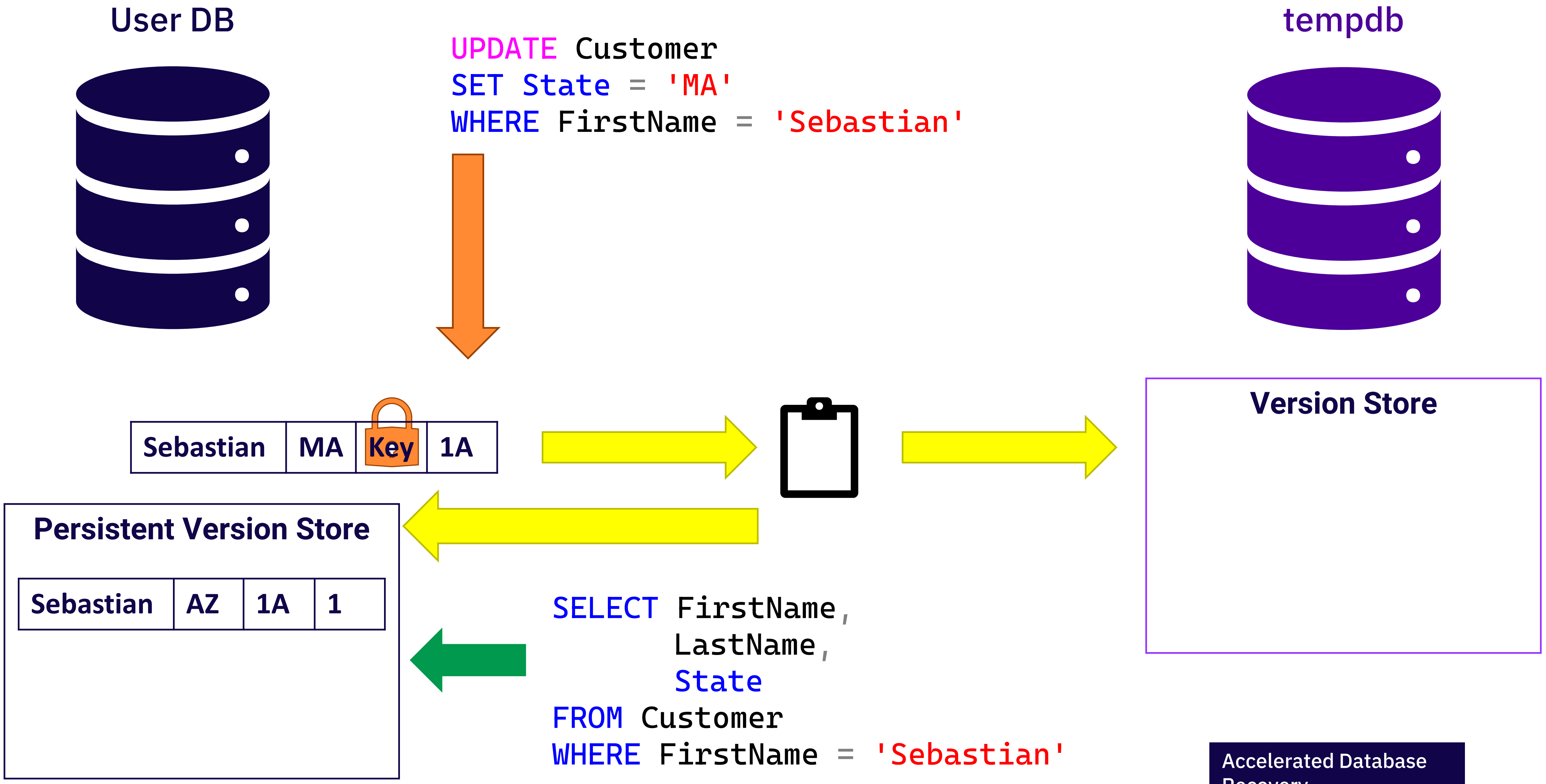
Read Committed
Snapshot Isolation

Accelerated Database Recovery (ADR)

- Introduced in SQL Server 2019
- Default for Azure SQL DB
  - Cannot be turned off
- Changes the way the transactions logs are read to be able to recover from long running transactions or just restore faster
- Uses a Persistent Version Store in Database rather than the Version Store in TempDB

```
BEGIN TRAN 1A

UPDATE Customer
SET State = 'MA'
WHERE FirstName = 'Sebastian'
```



```
SELECT FirstName,
       LastName,
       State
FROM Customer
WHERE FirstName = 'Sebastian'
```

Lock Escalation

- Threshold at which SQL Server will convert lower granularity locks to a higher level in order to manage a small number of locks
  - 5,000 on a table or index for a single statement
  - Each additional 1,250 locks taken in a transaction

Lock Granularity (from Microsoft)

Resource	Description
RID	A row identifier used to lock a single row within a heap.
KEY	A row lock to lock a single row in a B-tree index.
PAGE	An 8 kilobyte (KB) page in a database, such as data or index pages.
EXTENT	A contiguous group of eight pages, such as data or index pages.
HoBT	A heap or B-tree. A lock protecting a B-tree (index) or the heap data pages in a table that doesn't have a clustered index.
TABLE	The entire table, including all data and indexes.
FILE	A database file.
APPLICATION	An application-specified resource.
METADATA	Metadata locks.
ALLOCATION_UNIT	An allocation unit.
DATABASE	The entire database.
XACT	Transaction ID (TID) lock used in Optimized Locking

Lock Escalation (cont’d)

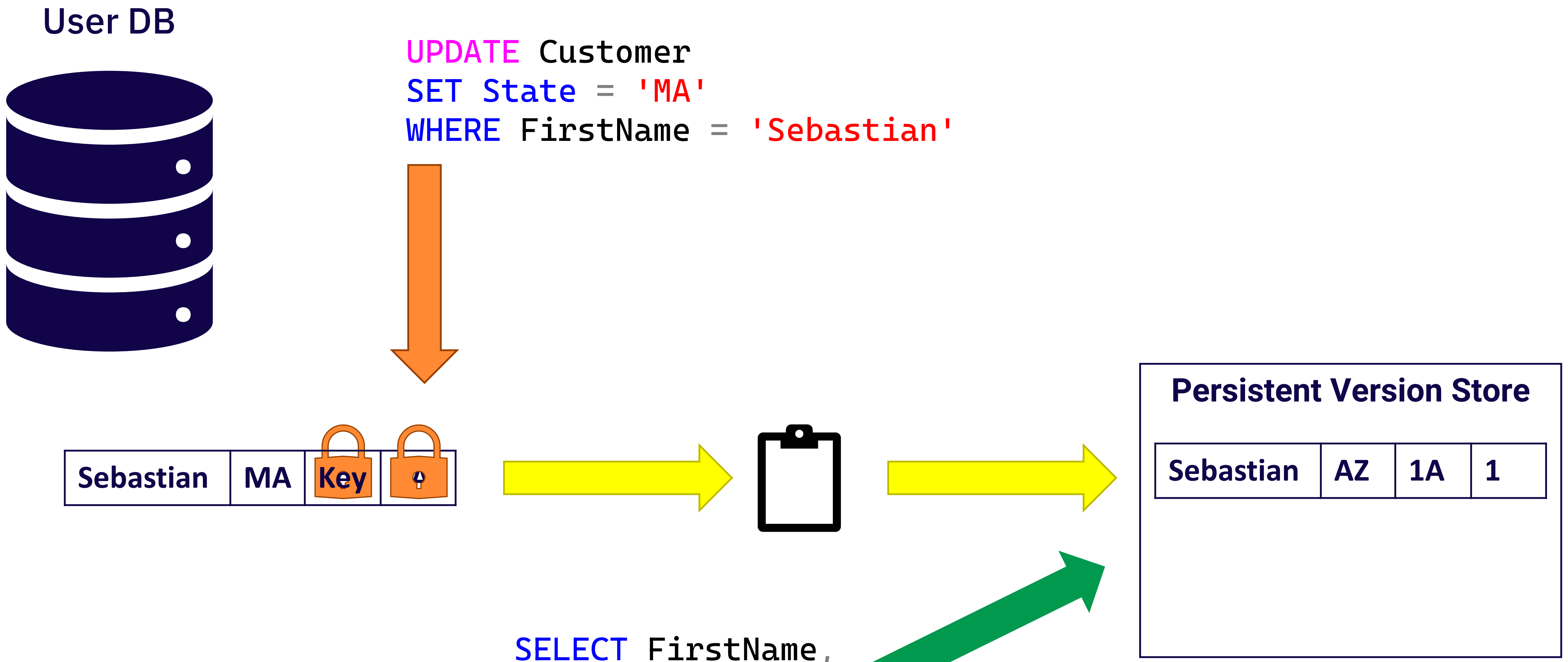
- Row and key locks escalate to table locks, not page locks
- “Queries Decide the Isolation Level” (Erik Darling)

Optimized Locking

- Changes to the locking mechanisms
  - Locks on the Transaction ID
  - Releases locks on other objects quickly
  - Minimizes lock escalation
- Accelerated Database Recovery is Required

```
BEGIN TRAN 1A

UPDATE Customer
SET State = 'MA'
WHERE FirstName = 'Sebastian'
```



```
SELECT FirstName,
       LastName,
       State
FROM Customer
WHERE FirstName = 'Sebastian'
```

Optimized Locking - Reads

Yeah, but that was just a SELECT statement…

Regular RCSI stuff.

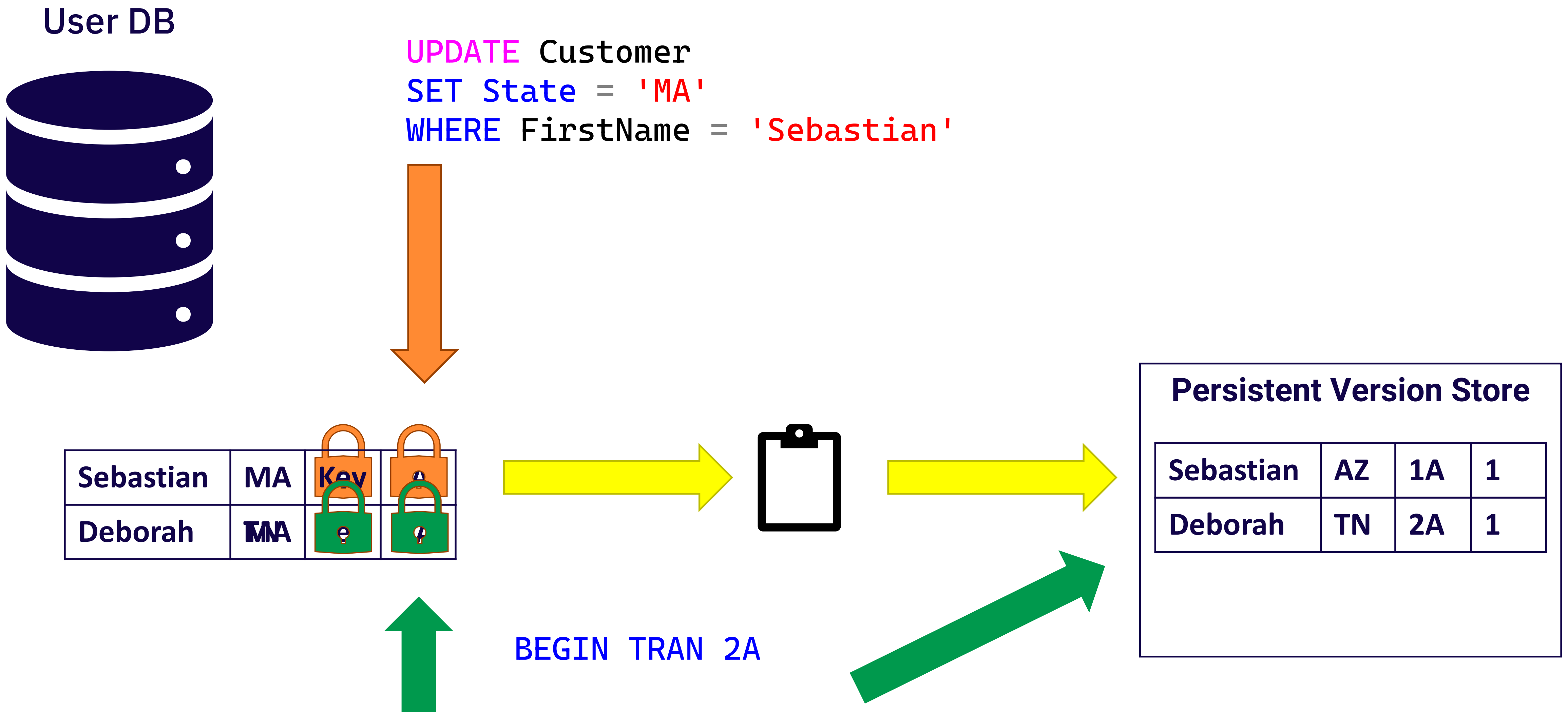
Now what about writes?

Transaction ID Locking

- As the lock is held on the Transaction ID, the next transaction can see when rows aren’t affected and update them without waiting.

```
BEGIN TRAN 1A

UPDATE Customer
SET State = 'MA'
WHERE FirstName = 'Sebastian'
```



Sebastian	AZ	1A	1
Deborah	TN	2A	1

```
BEGIN TRAN 2A

UPDATE Customer
SET State = 'MA'
WHERE FirstName = 'Deborah'
```

Optimized Locking - TID Locking

Lock After Qualification (LAQ)

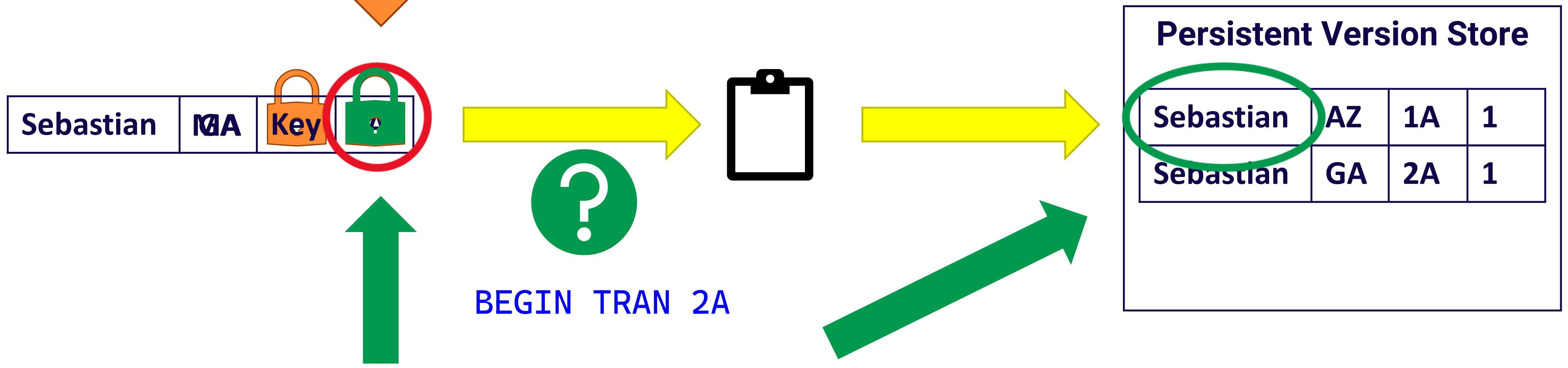
- RCSI is a requirement for this to work
- Looks to see if the previously committed version of the rows with TID locks would also be affected by the current transaction
  - If yes, transaction ***will wait*** for previous transaction to finish and include those columns as part of the change
  - If no, the transaction will update the rows that do match

User DB

```
BEGIN TRAN 1A

UPDATE Customer
SET State = 'GA'
WHERE FirstName = 'Sebastian'
```

```
COMMIT TRAN 1A
```



```
BEGIN TRAN 2A

UPDATE Customer
SET State = 'MA'
WHERE FirstName = 'Sebastian'
```

Persistent Version Store

Sebastian	AZ	1A	1
Sebastian	GA	2A	1

Optimized Locking - LAQ

Demos!

INDEXES ARE MAGIC
#SQLFamily
#DataWeekender
SQL SERVER
BONES COFFEE CO
SentryOne
Microsoft Most Valuable Professional
Assume she is technical and capable of breathing fire
How may I deny your request today?

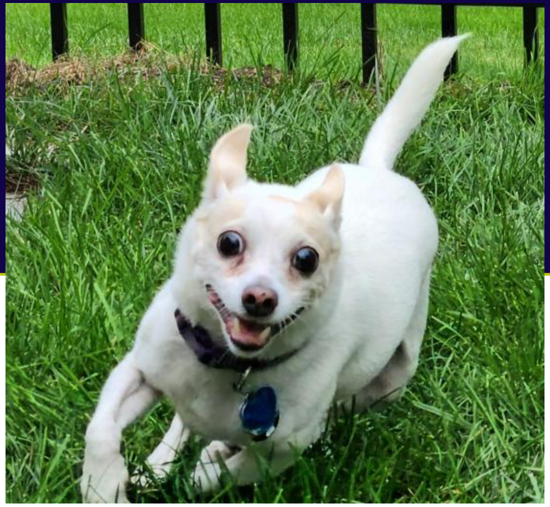
Be aware of

- Persistent Version Store
  - Make sure there is enough space available
    - When full, only reads can happen – no writes
  - Asynchronous Cleaner
    - Data remains until it’s no longer needed
  - Keep Transactions Fast

Be aware of

- Lock After Qualification
  - Blocking and waits can still occur
  - Be aware of multiple transactions that may change data for the same set of records

Recap



- Understand how RCSI & ADR are used for optimized locking
- Minimizes blocking but does not solve ALL situations
- Reduces the number of locks being held and the length they are held for
- Writes don’t block Reads OR Writes

Resources – Optimized Locking

- SQL Server Transaction Locking and Row Versioning Guide
- Optimized Locking
- Bob Ward's Github - Optimized Locking Demos
- Isolation Level Locking (Erik Darling)

Resources - Accelerated Database Recovery

- Soaring to New Heights with Accelerated Database Recovery (John Morehouse)
- Monitor and Troubleshoot Accelerated Database Recovery
- Why to Use Accelerated Database Recovery in SQL Server (Luis Lema)
- Constant Time Recovery in Azure SQL Database (whitepaper)

Your feedback is important to us

Evaluate this session at:

www.PASSDataCommunitySummit.com/evaluation

Thank you

Any Questions?

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