# Change Tracking and Temporal Tables

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## Agenda

- Change detection overview
- Change detection methods
- Change tracking
- Temporal tables

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## About

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**Tyleris Data Solutions**

- Data architecture
- Business intelligence
- Data warehousing
- ETL
- Analytics
- Tyleris.com

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# CHANGE DETECTION OVERVIEW

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## Change Detection Overview

*Change detection is the filtering of data, at the source or the destination, to only process data that is new or changed (or possibly deleted) since the last load.*

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## Change Detection Overview

Why change detection?
- Performance
- Historical record

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## Change Detection Overview

At the source
- Limit the retrieved data to only new or changed records
- Dependent on a reliable method at the source for detecting new/changed records

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## Change Detection Overview

At the destination
- Filtering of insert/update is done at the destination prior to load
- Performance can be a concern
  - Volume of data

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## Change Detection Overview

Change detection tools
- SQL Server tools, including change tracking and temporal tables
- T-SQL merge
- SSIS data flow components
- Third party tools

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# CHANGE DETECTION METHODS

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## Change Detection Methods

Timestamp
- Source-side change detection via row-level update timestamp
- Works well in theory
- Consistency is a concern

| CustomerID | Transaction Type | Transaction Amount | Employee ID | Transaction Time | Row Timestamp |
|---|---|---|---|---|---|
| BN144 | REFUND | 74.17 | 37 | 2012-09-26 19:15:51.827 | 2012-09-27 20:18:56.373 |
| PK248 | SALE | 1021.11 | 84 | 2012-09-26 20:37:11.127 | 2012-09-27 21:18:57.450 |
| RR100 | SALE | 92.90 | 84 | 2012-09-26 15:04:23.527 | 2012-09-27 21:18:57.450 |
| LM87 | SALE | 172.13 | 60 | 2012-09-26 15:24:03.150 | 2012-09-27 21:18:57.450 |

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## Change Detection Methods

Row hashing
- Destination change detection
- Creates binary hash for entire row
- The hash is then used for comparison

AA011239
John
Smith                          0x54 0xa4 0x9b…

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## Change Detection Methods

Row hashing
- Hash is stored in the destination table
- Calculate source hash on the fly
- Usually less performance impact than column-by-column comparison

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## Change Detection Methods

Brute force
- Column-by-column comparison
- Has the fewest assumptions
- Also the most tedious to set up and maintain
- Performance can be an issue

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## Change Detection Methods

ETL tools change detection
- Tools such as SSIS, ADF, and others
- Can make use of DB engine change detection methods
- Source or destination comparison
- Can be more flexible and more complex than using SQL Server directly

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## Change Detection Methods

Change data capture
- Source-side change detection
- Full change history
- Asynchronous, based on transaction log
- SQL Server Agent jobs

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## Change Detection Methods

Change data capture
- Prior to SQL Server 2016 SP1, requires Enterprise Edition
- More complex than change tracking or temporal tables

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## Change Detection Methods

Change tracking
- Lightweight, synchronous source-side mechanism for marking changed rows
- Based on primary key column(s) of tracked table
- Even tracks deletes
- Identifies changed rows only, not full history

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## Change Detection Methods

Change tracking
- All editions of SQL Server (including Express)
- Enabled at database level
- Tracks at table level
- Can identify individual columns as changed

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## Change Detection Methods

Change tracking
- Requires primary key on tracked tables
- Otherwise, change tracking is transparent to other processes

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## Change Detection Methods

Change tracking
- Tracks changes to a particular version number
- Version is at the batch level, not necessarily at the row level

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## Change Detection Methods

Change tracking
- Common functions:
  - CHANGE_TRACKING_CURRENT_VERSION()
  - CHANGETABLE()
  - CHANGE_TRACKING_IS_COLUMN_IN_MASK()

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## Change Detection Methods

Change tracking
- Common design pattern:
  - Store the version number for each load iteration in a table or other variable.
  - Store the current change tracking version number for a fixed ending point
    - That becomes the starting point for the next load

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# DEMOS – CHANGE TRACKING

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## Change Detection Methods

Temporal tables
- System-versioned tables
- Each update stores the old version in a history table
- Full history * of changes
- Date stamped versioning

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## Change Detection Methods

Temporal tables
- SQL Server 2016 or newer
- Any edition

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## Change Detection Methods

Temporal tables
- A "time machine" for a single table
- See current data, or how it existed at any point in its tracked history

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## Change Detection Methods

Temporal tables
- Not truly an auditing mechanism
- … but, very useful if you need full data history

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## Change Detection Methods

Temporal tables
- Requires a primary key on the tracked table
- Requires two new columns for identifying valid periods
- Otherwise, this is transparent to users of the table
- CRUD operations work exactly as before

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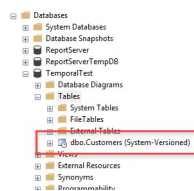
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## Change Detection Methods

Temporal tables
- No GUI! T-SQL only
- Create new tracked table, or add temporal functionality to existing table



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## Change Detection Methods

Temporal tables
- Creates a new physical table for historical rows
- Can inherit from existing history table *
- History table can be queried directly
  - Direct modifications are not allowed

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## Change Detection Methods

Temporal tables
- FOR SYSTEM_TIME functions for time-based queries
  - FOR SYSTEM_TIME AS OF <UTC datetime2>
  - FOR SYSTEM_TIME BETWEEN <x> AND <y> (includes the <x> time)
  - FOR SYSTEM_TIME FROM <x> TO <y> (wholly within <x> and <y>)
  - FOR SYSTEM_TIME CONTAINED IN (<x>, <y>, …)
  - FOR SYSTEM_TIME ALL

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# DEMOS – TEMPORAL TABLES

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## Final Thoughts

- Change tracking
  - Ideal for scenarios when you need to know what has changed, but not full history
  - Lightweight, transparent
- Temporal tables
  - Useful when you need full history
  - Mostly transparent

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## Thanks!

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