SQLintersection

Session: Thursday, 11:30 am - 12:45 pm

Temporal Tables In Depth

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Overview

- What are Temporal Tables
- Reasons to Entertain Use
- How does it work?
- In Memory OLTP Use
- Anonymous Type, Default Type, Custom Type
- Adding to an Existing Table
- Testing For Performance

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Temporal Tables Introduction

- SQL Server 2016 Feature
- No triggers needed
- Many questions but answers are harder to get
- No restore needed to get the data back

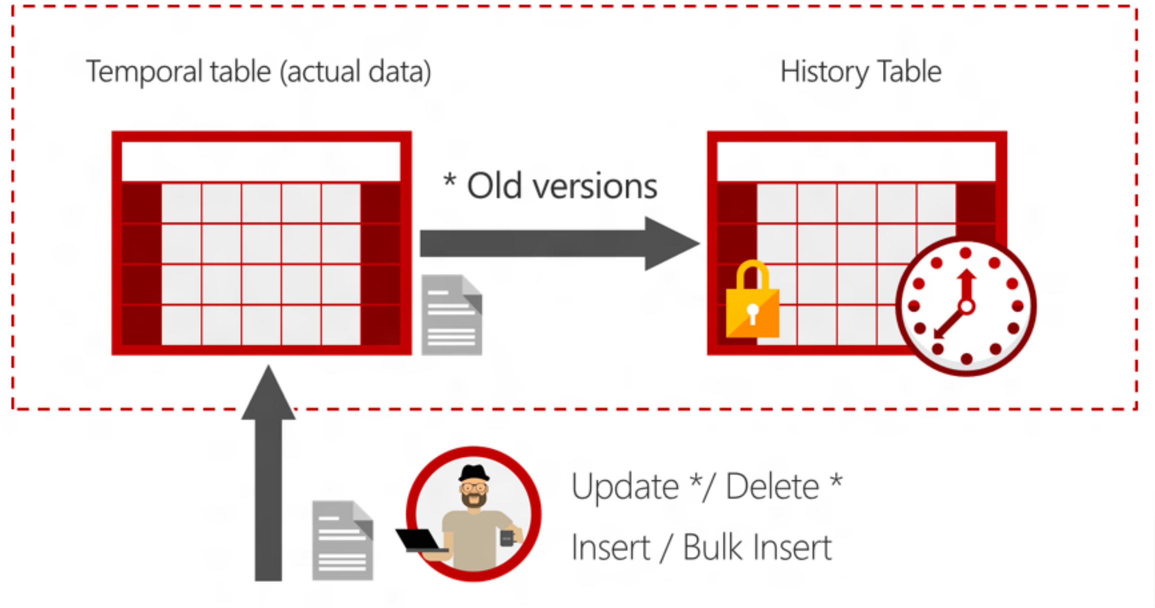
What are Temporal Tables

- **Classic Problem**
  - I have a table or tables
  - Need to know what changes have been made
  - Need to know what the data was a day ago
  - Need to have a log of changes made to the data over time
- **Solution**
  - System Versioned tables
  - Each modification is added to the history table and dated with Start and End times

Reasons to Entertain Use

- Auditing all data changes and performing data forensics when necessary
- Reconstructing state of the data as of any time in the past
- Calculating trends over time
- Maintaining a slowly changing dimension for decision support applications
- Recovering from accidental data changes and application errors

How Does it Work?



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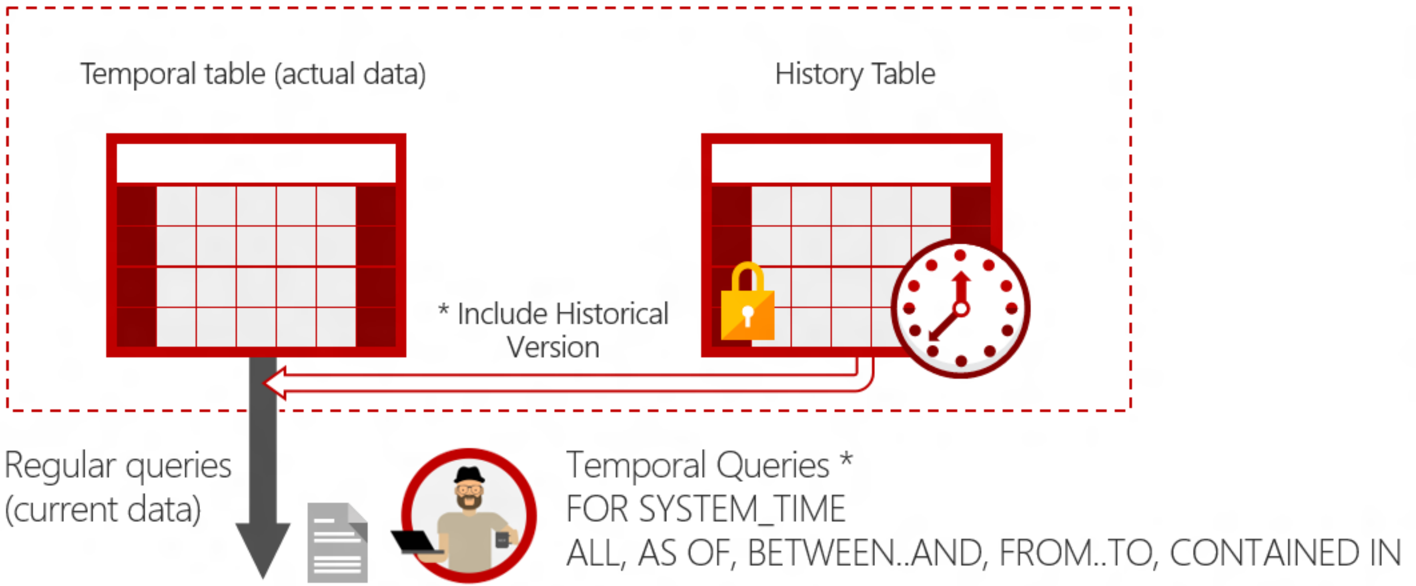
How Does it Work?

- **INSERTS**
  - Establish SysStartTime in the main table as the start time of the transaction
  - SysEndTime is assigned max value of 9999-12-31 which marks the row as Open
- **UPDATES**
  - System stores previous values of the row(s)
  - Sets SysEndTime as the start time of the transaction in UTC time (system clock) which marks the row as closed
  - Sets the main tables SysStartTime with the start time of the transaction in UTC time (System Clock)

How Does it Work?

- **DELETES**
  - Stores previous values of the row in the History table
  - Sets SysEndTime as the start time of the transaction in UTC time (system clock)
  - Marks the row as closed with a period of which the previous row was valid
  - Main table has the row removed
- **NOTE**
  - All SysStartTime, SysEndTime and Period are in DateTime2 column types
  - Dates are in UTC

Querying the History Table



Temporal table (actual data)

History Table

* Include Historical Version

Regular queries (current data)

Temporal Queries *
FOR SYSTEM_TIME
ALL, AS OF, BETWEEN..AND, FROM..TO, CONTAINED IN

Querying the History Table

- **AS OF start**
  - Beginning date to start and goes to now
- **FROM start TO end**
  - Does not include dates EXACTLY on the FROM or EXACTLY on the TO
- **BETWEEN start AND end**
  - Same as FROM/TO but INCLUDES those that are EXACTLY on the End

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Querying the History Table

- **CONTAINED IN (start, end)**
  - All rows Opened AND Closed in the boundaries including those EXACTLY on the boundary
- **ALL**
  - Returns UNION of rows that belong to the main table and the history table

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In Memory OLTP Tables

- **Only SCHEMA_AND_DATA tables supported**
- **FOR SYSTEM TIME not supported in Native Compiled SP**
- **History Table must be disk based**
- **Temporary Staging table created in memory and uses memory**
  - Data is flushed to the disk based History table asynchronously
  - sys.dm_xtp_memory_consumers
  - Can flush manually sp_xtp_flush_temporal_history @schema_name, @object_name
- **SYSTEM_VERSIONING=OFF or ALTER TABLE**
  - Staging table must be flushed to the disk based table

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How IMOLTP Staging Table Works

- **Table Name for the Staging table**
  - Memory_Optimized_History_Table_OBJECTID
- **Table replicates the schema in the current table + 1 BIGINT column**
  - Format for the bigint column (Change_ID[_suffix]) in case there is a column named Change_ID in the table
- **Max row size reduces by 8 bytes to 8052 because of the extra column**
- **You will NOT see this table in the Object Explorer**
- **Meta data about this is in the sys.internal_tables**

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Data Flush

- **Data movement starts when memory consumption of the internal staging table reaches 8% of memory consumption by the Main table**
- **Data Flush task is activated on a schedule**
  - Could be as often as 5 seconds and infrequent as 1 minute
- **One thread is used for each staging table that needs to be flushed**
- **Data flush deletes rows in staging table that are older than the oldest currently running transaction and moves them to the disk based history table**
- **Manually flush**
  - sp_xtp_flush_temporal_history @schema_name, @object_name

Data Retention Options (2017+)

- **Option to Set Retention**
  - HISTORY_RETENTION_PERIOD
- **Available Options**
  - DAYS, WEEKS, MONTHS, and YEARS
- **Retention Setting lost when setting System Versioning OFF**
- **Not specifying Retention Explicitly means INFINITE**
- **Finite Retention requires a Clustered Index on at least ValidTo**

Data Retention (2017+) Syntax

```
SELECT is_temporal_history_retention_enabled, name
FROM sys.databases

ALTER DATABASE <myDB>
SET TEMPORAL_HISTORY_RETENTION  ON
```

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```
CREATE TABLE dbo.WebsiteUserInfo
(
    [UserID] int NOT NULL PRIMARY KEY CLUSTERED
    ,[UserName] nvarchar(100) NOT NULL
    , [PagesVisited] int NOT NULL
    , [ValidFrom] datetime2 (0) GENERATED ALWAYS AS ROW START
    , [ValidTo] datetime2 (0) GENERATED ALWAYS AS ROW END
    , PERIOD FOR SYSTEM_TIME (ValidFrom, ValidTo)
 )
 WITH
 (
     SYSTEM_VERSIONING = ON
     (
        HISTORY_TABLE = dbo.WebsiteUserInfoHistory,
        HISTORY_RETENTION_PERIOD = 6 MONTHS
     )
 );
```

Important Notes

- A primary key must be defined.
- The table option SYSTEM_VERSIONING must be set to ON.
- Two DATETIME2 columns must be defined for the start and end date.
- LIMIT: Temporal and history table cannot be FILETABLE.
- LIMIT: INSTEAD OF triggers are not allowed. AFTER triggers are only allowed on the current table.
- LIMIT: The history table cannot have any constraints.
- LIMIT: Data in the history table cannot be modified.
- Full List: http://bit.ly/2pNEMMO

Ways to Enable Temporal History Tables

- Anonymous History Tables
- Default History with Specified Table
- Custom History Table
- Add Versioning to an Existing Table

End Result

- Table with automatic history
- No more triggers
- Data History for many use cases
- Solution Realized

Review

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Questions?

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Thank you!

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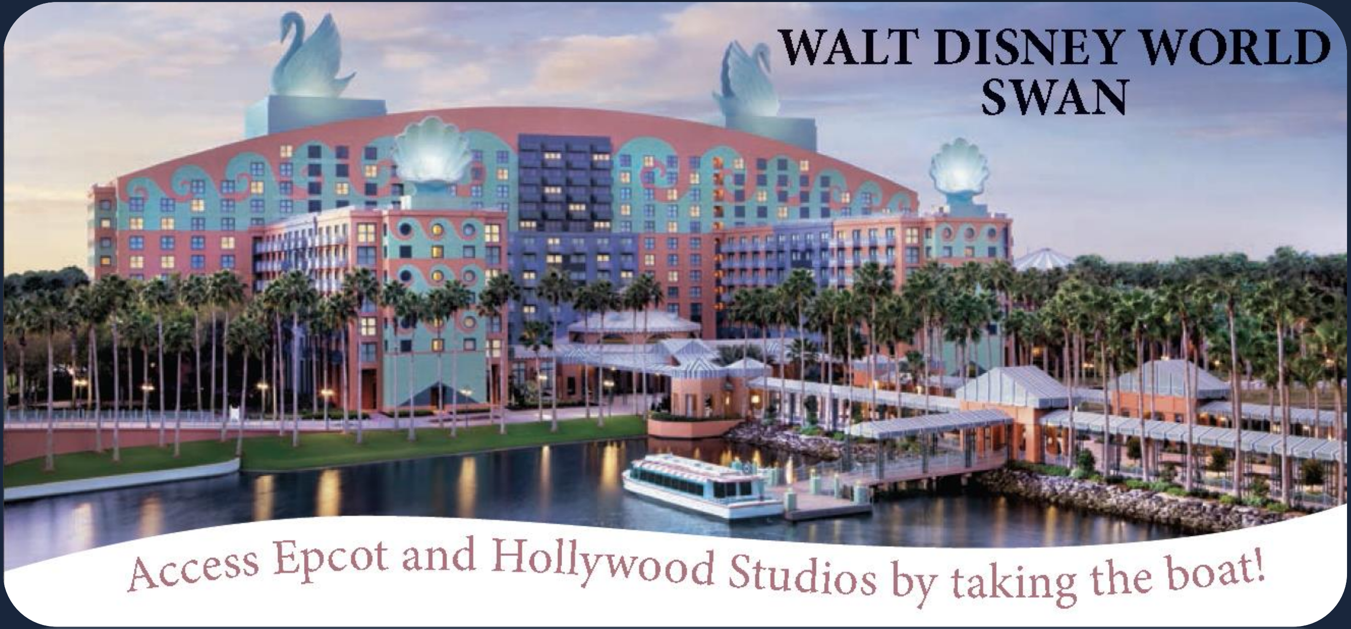

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