Microsoft

SQL Server 2016 CTP2 Temporal HOL

Contents

Overview and setup

Estimated time to complete lab is 40-45 minutes.

Overview

Data is rarely static. Sometimes it can be very valuable to see how data has evolved over time, or to query data as of a particular point in time. While traditional databases store the data that is considered to be valid at the current time only, SQL Server 2016 CTP2 Temporal features provide correct information about stored facts at any point in time.

Each Temporal table (or 'system-versioned' temporal table) consists of two tables actually – one for the current data and the other one for the historical data. Additional querying constructs are provided to hide this complexity from users.

Common scenarios for using Temporal data include:

- Querying data as of a particular point in time to examine the state of the data at that time;
- Providing regulatory compliance and perform auditing;
- Implementing slowly changing dimensions; and
- Reverting a table to "last good known state" without downtime;

This hands on lab will familiarize you with the new Temporal data structures and queries and help you understand how to implement them. In particular, you will learn:

1. How to create temporal tables;
2. How to explore temporal data and metadata;
3. How to run temporal queries;
4. How to manage and maintain temporal indexes.

This lab has four parts. The first part demonstrates scenarios for creating temporal tables or adding temporal functionality to existing tables. The second part involves examining temporal data and metadata. The third part of the lab looks at several scenarios for querying temporal data. Finally, we will investigate how to manage and maintain temporal indexes. At the end of this lab, you will have worked through several of the most common scenarios involved with the new Temporal features in SQL Server 2016 CTP2.

Setting up your environment

1. The script file that contains the scripts to be used in this lab is located in the **C:\SQL Server 2016 CPT2 HOLs\Temporal** folder.

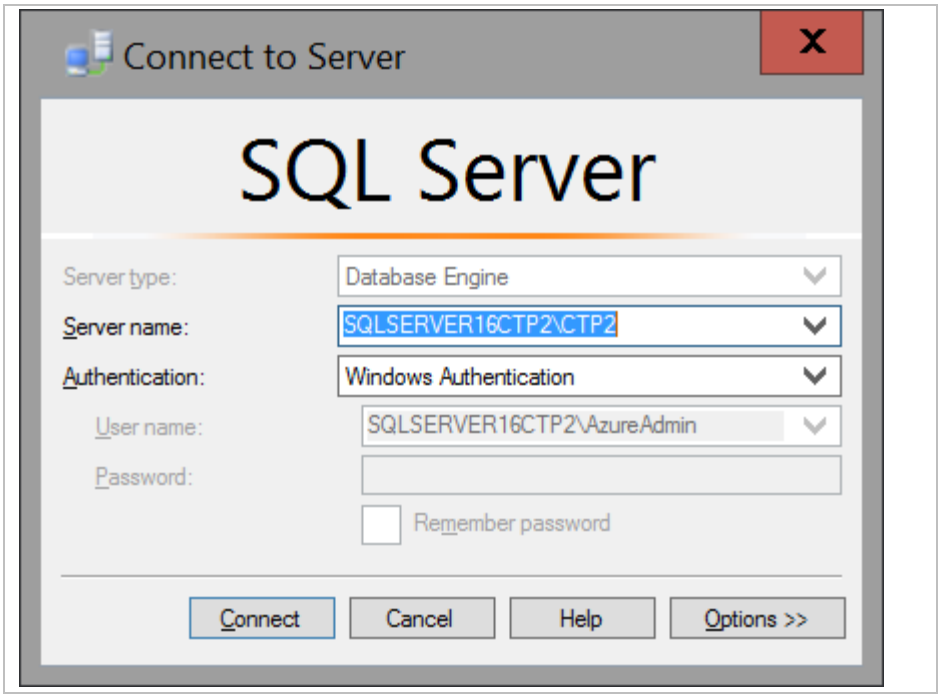
2. Open **Notepad.exe**. You will use **Notepad** as a scratchpad tool for copy and paste of text elements.

Create temporal tables

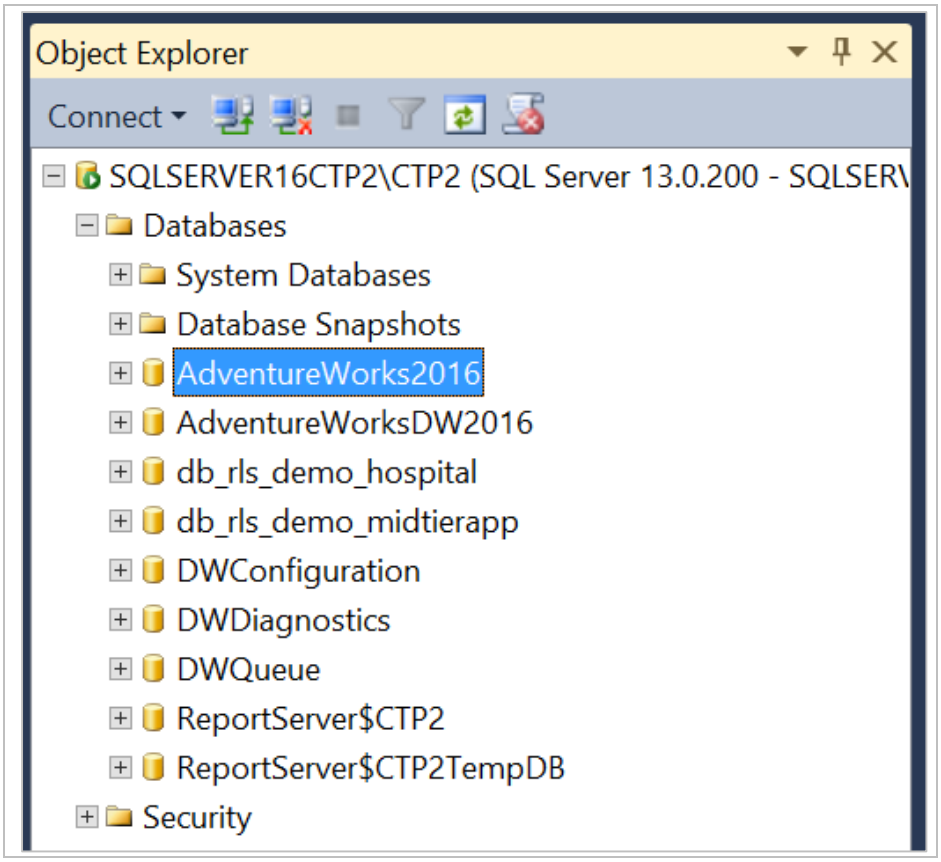
In this lab, we will explore creating temporal tables and to add temporal system versioning to existing tables. Let's get started!

Create a new temporal table using history table defaults

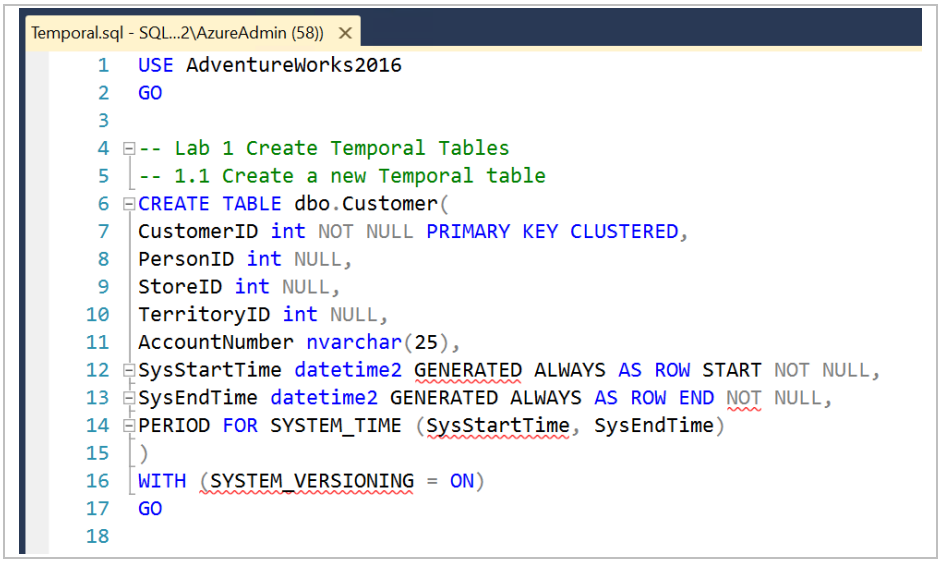
1. Open up **SQL Server Management Studio** and connect to the **SQLSERVER16CTP2\CTP2** Database Engine instance.



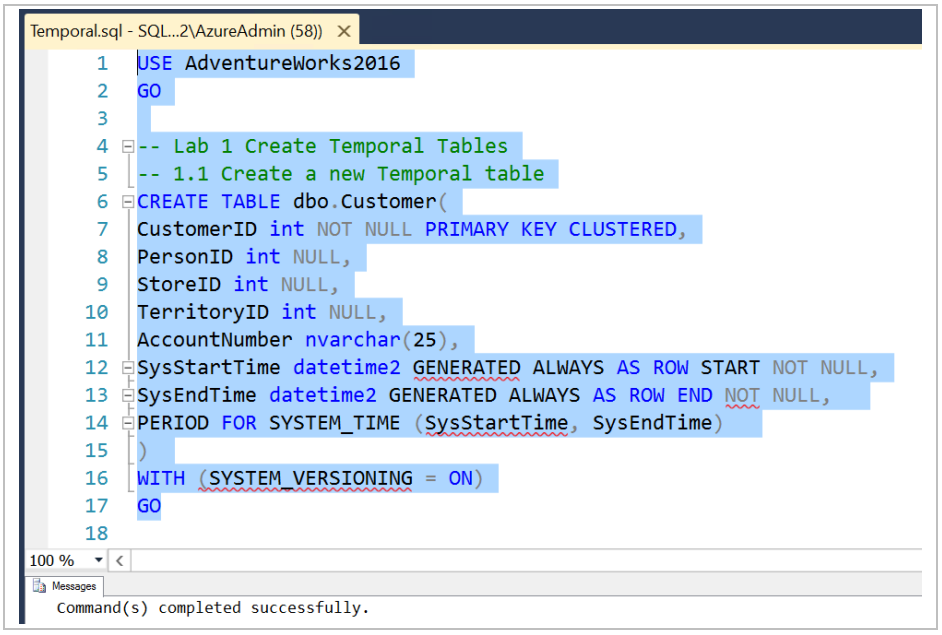
2. Expand the **Databases** folder in **Object Explorer** and click on **AdventureWorks2016** to select it.



3. Press **Ctrl+O** and open the file **C:\SQL Server 2016 CPT2 HOLs\Temporal\Temporal.sql**.

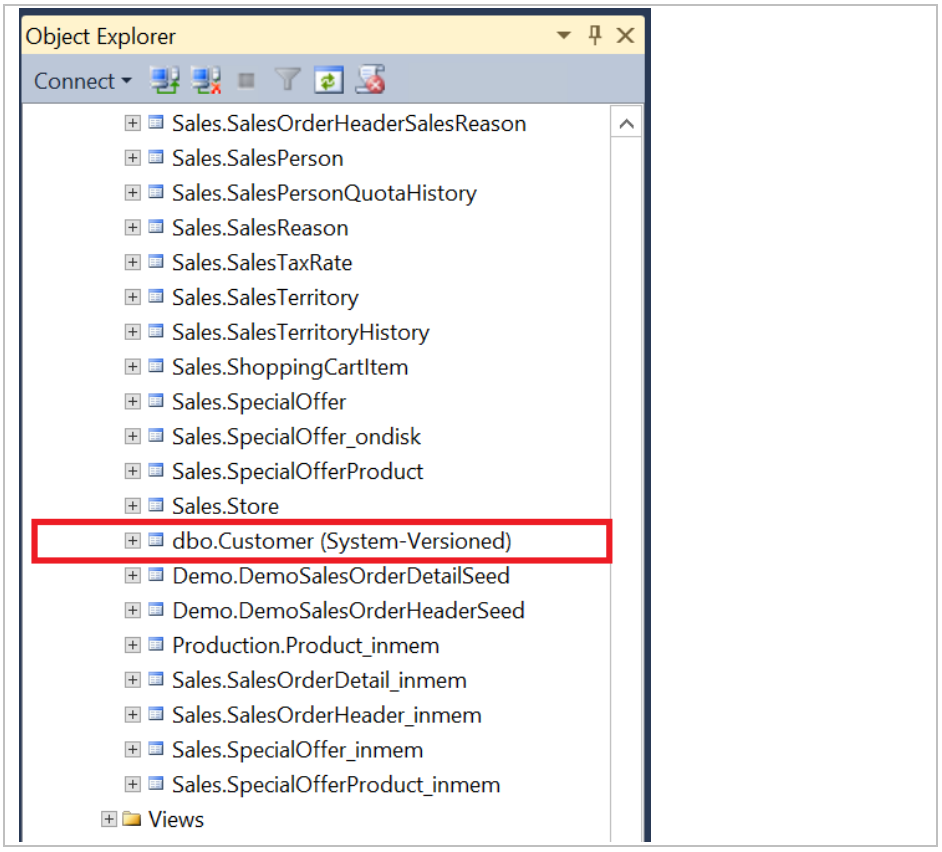


4. Select the **USE AdventureWorks2016** and **CREATE TABLE dbo.Customer** statements and press **F8** to create the new **b** table in the **dbo** schema within **AdventureWorks2016**.



Note that the table must use datetime2 as the data type for the temporal fields.

5. Expand out the list of **Tables** in the **Object Explorer** and scroll down the list until you see the new **dbo.Customer (System-Versioned)** table.



Add temporal features to an existing table

We will manually add temporal to the Person.BusinessEntityContact table in AdventureWorks2016.

*Note, the following SQL Statements are included in the **C:\SQL Server 2016 CPT2 HOLs\Temporal\Temporal.sql** script.*

1. First, create a history table that mirrors the table you want to add temporal features to. Add **SysStartTime** and **SysEndTime** columns.

```
CREATE TABLE Person.BusinessEntityContactHistory(
BusinessEntityID int NOT NULL,
PersonID int NOT NULL,
ContactTypeID int NOT NULL,
rowguid uniqueidentifier ROWGUIDCOL  NOT NULL,
ModifiedDate datetime NOT NULL,
--Add new columns
SysStartTime datetime2 NOT NULL,
SysEndTime datetime2 NOT NULL
)
```

Note that a default history table can be created automatically, using the script in #3, immediately below. You can create one manually, as here, but the history table must be identical to its 'parent' table in terms of its columns and datatypes. The history table cannot contain any triggers, unique or foreign keys, or constraints and cannot contain Filestream data. However, the history table could contain indexes, compression, or even a columnstore index.

2. Add the new columns to the table we want to make temporal for the period boundaries.

```
ALTER TABLE Person.BusinessEntityContact
ADD SysStartTime datetime2 GENERATED ALWAYS AS ROW START
      CONSTRAINT P ValidFromConstraint DEFAULT
SYSUTCDATETIME() NOT NULL,
      SysEndTime datetime2 GENERATED ALWAYS AS ROW END
      CONSTRAINT P_ValidToConstraint DEFAULT CONVERT
(DATETIME2, '9999-12-31 23:59:59.9999999') NOT NULL,
      PERIOD FOR SYSTEM_TIME (SysStartTime, SysEndTime)
```

3. Alter the non-temporal table to enable system-versioning and make a link to the new history table we created above.

```
ALTER TABLE Person.BusinessEntityContact
SET (SYSTEM_VERSIONING = ON (HISTORY_TABLE =
Person.BusinessEntityContactHistory))
```

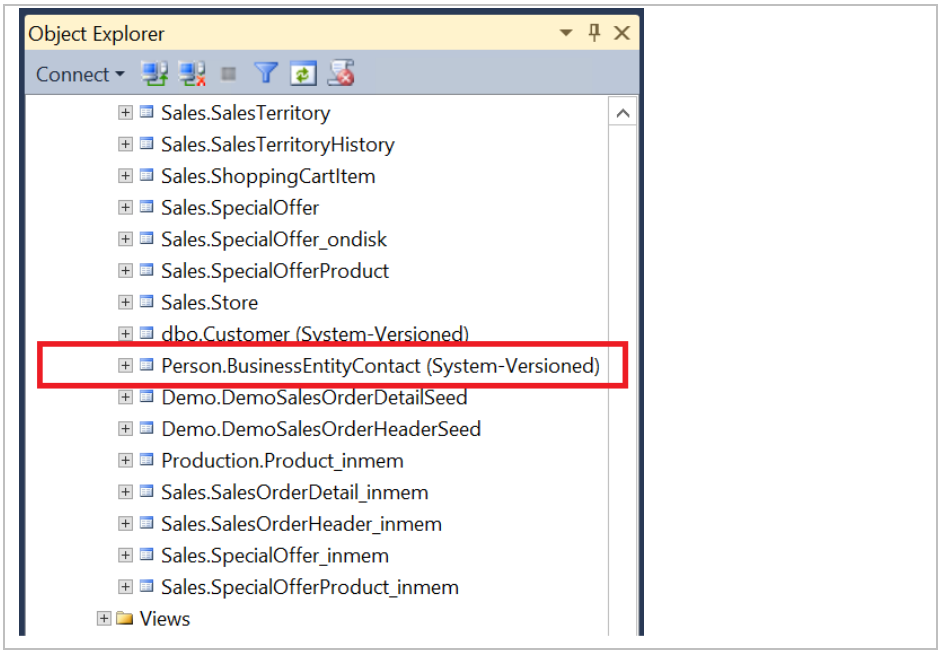
Explore temporal data and metadata

In this exercise, we will look at how temporal tables show up in SSMS and also take a look at the metadata for these tables.

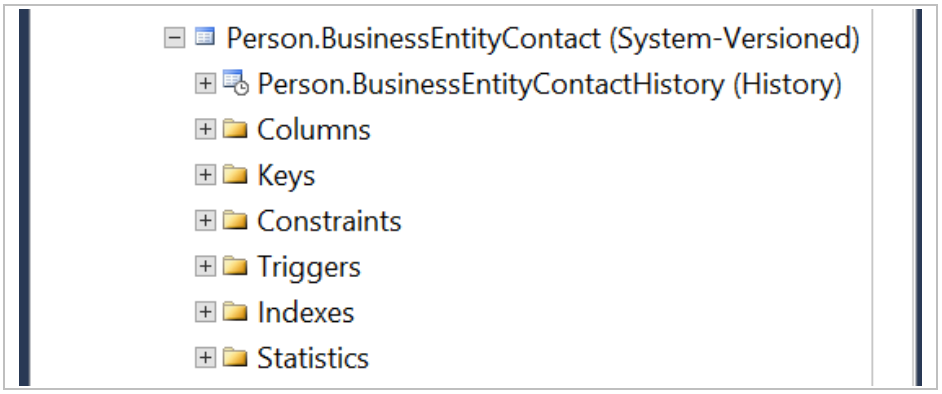
View temporal table in SSMS

1. In **Object Explorer**, refresh the tables by right clicking on **Tables** and selecting **Refresh**.

2. Notice that **Person.BusinessEntityContact** is now listed with "**(System-Versioned)**" after its name in Object Explorer and that it is listed below the non-temporal tables.



3. Also notice that the **Person.BusinessEntityContactHistory** table that we created above is not immediately visible in Object Explorer. To see the history tables, expand the plus sign next to the temporal table's name. Note that the history table is listed "inside" its temporal parent table in Object Explorer.

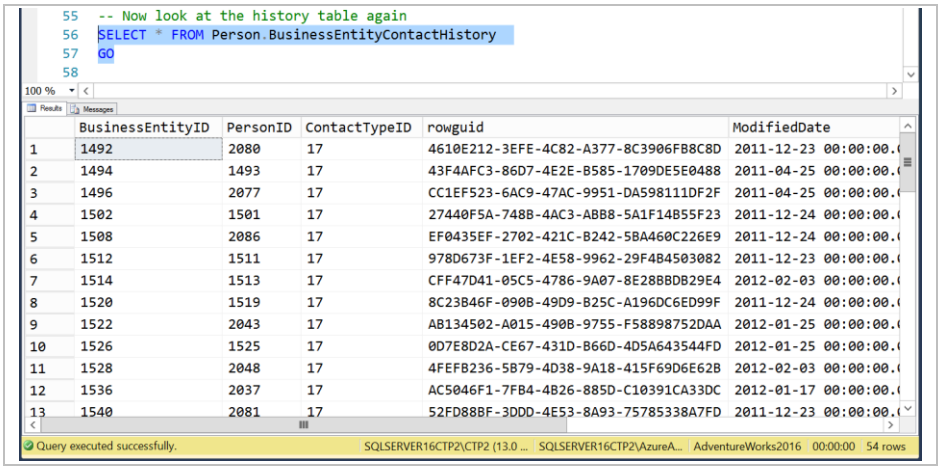


4. SELECT * FROM Person.BusinessEntityContactHistory and note that there are not yet any records in the history table.

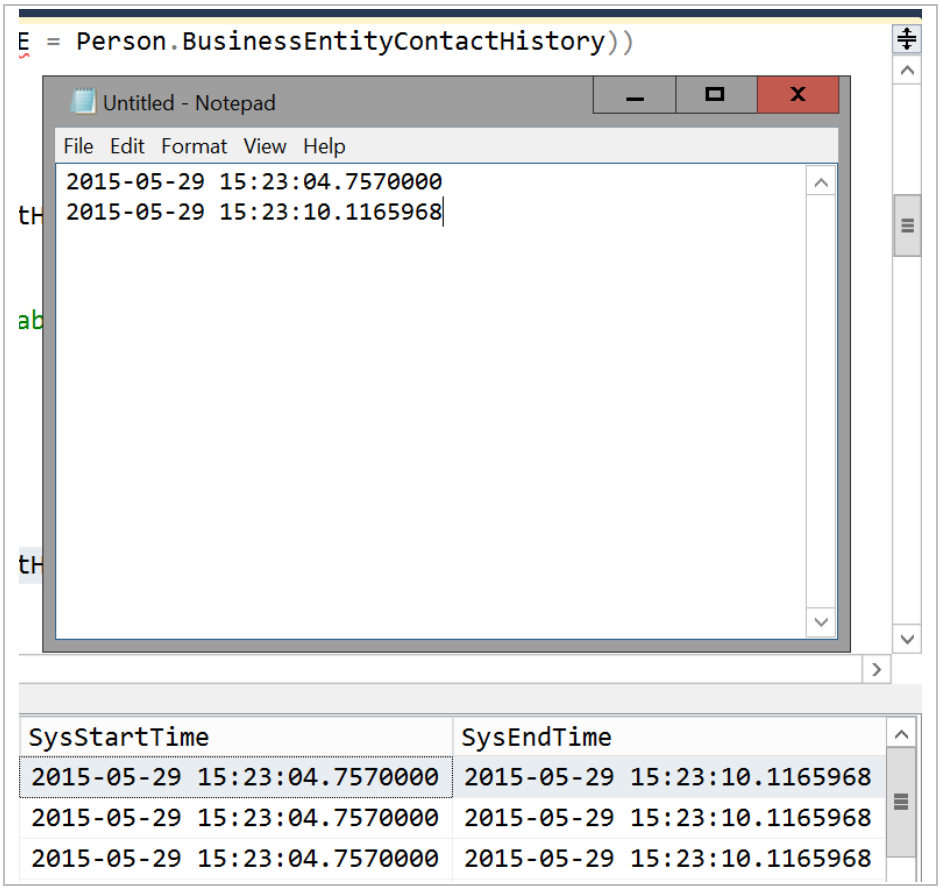
5. Update some rows.

```
UPDATE Person.BusinessEntityContact
SET ContactTypeID = 19
WHERE ContactTypeID = 17
```

6. Now SELECT * FROM Person.BusinessEntityContactHistory and notice that the pre-updated data is stored in the history table.



7. Copy the value from one of the rows for the SysStartTime and paste that UTC time value into Notepad.exe. Also copy the SysEndTime and paste on a new line in Notepad. We will use both times in a later part of this lab.



View metadata about temporal tables

1. Execute the following query to view information about the temporal tables and their associated history tables.

```
SELECT T1.name as TemporalTableName,
SCHEMA_NAME(T1.schema_id) AS TemporalTableSchema,
 T2.name as HistoryTableName, SCHEMA_NAME(T2.schema_id)
AS HistoryTableSchema,
 T1.temporal_type_desc
 FROM sys.tables T1
 LEFT JOIN sys.tables T2
 ON T1.history_table_id = T2.object_id
 WHERE T1.temporal_type <> 0
 ORDER BY T1.history_table_id DESC
```

```
59   -- 2.3 Get full information about temporal tables, including referenced history tables
60  SELECT T1.name as TemporalTableName, SCHEMA_NAME(T1.schema_id) AS TemporalTableSchema,
61  T2.name as HistoryTableName, SCHEMA_NAME(T2.schema_id) AS HistoryTableSchema,
62  T1.temporal_type_desc
63  FROM sys.tables T1
64  LEFT JOIN sys.tables T2
65  ON T1.history_table_id = T2.object_id
66  WHERE T1.temporal_type <> 0
67  ORDER BY T1.history_table_id DESC
68  GO
```

	TemporalTableName	TemporalTableSchema	HistoryTableName	HistoryTableSchema	temporal_
1	BusinessEntityContact	Person	BusinessEntityContactHistory	Person	SYSTEM_VE
2	Customer	dbo	MSSQL_TemporalHistoryFor_1028198713	dbo	SYSTEM_VE
3	MSSQL_TemporalHistoryFor_1028198713	dbo	NULL	NULL	HISTORY_T
4	BusinessEntityContactHistory	Person	NULL	NULL	HISTORY_T

2. Execute the following query to view information about the Periods and their associated start and end time columns.

```
SELECT P.name as PeriodName, T.name as
TemporalTableName, c1.name as StartPeriodColumnName,
c2.name as EndPeriodColumnName
 FROM sys.periods P
 INNER JOIN sys.tables T ON P.object_id = T.object_id
 INNER JOIN sys.columns c1 ON T.object_id = c1.object_id
      AND p.start_column_id = c1.column_id
 INNER JOIN sys.columns c2 ON T.object_id = c2.object_id
      AND p.end_column_id = c2.column_id
```

```
70   -- 2.4 Period and period columns
71  SELECT P.name as PeriodName, T.name as TemporalTableName,
72  c1.name as StartPeriodColumnName, c2.name as EndPeriodColumnName
73  FROM sys.periods P
74  INNER JOIN sys.tables T ON P.object_id = T.object_id
75  INNER JOIN sys.columns c1 ON T.object_id = c1.object_id
76      AND p.start_column_id = c1.column_id
77  INNER JOIN sys.columns c2 ON T.object_id = c2.object_id
78      AND p.end_column_id = c2.column_id
79  GO
80
```

	PeriodName	TemporalTableName	StartPeriodColumnName	EndPeriodColumnName
1	SYSTEM_TIME	BusinessEntityContact	SysStartTime	SysEndTime
2	SYSTEM_TIME	Customer	SysStartTime	SysEndTime

Create temporal queries

In this lab, we will explore how to query data using some of the temporal constructs. We'll look at querying at a single point in time, as well as two ways to view records that span 2 points in time.

Query the temporal table at a single point in time

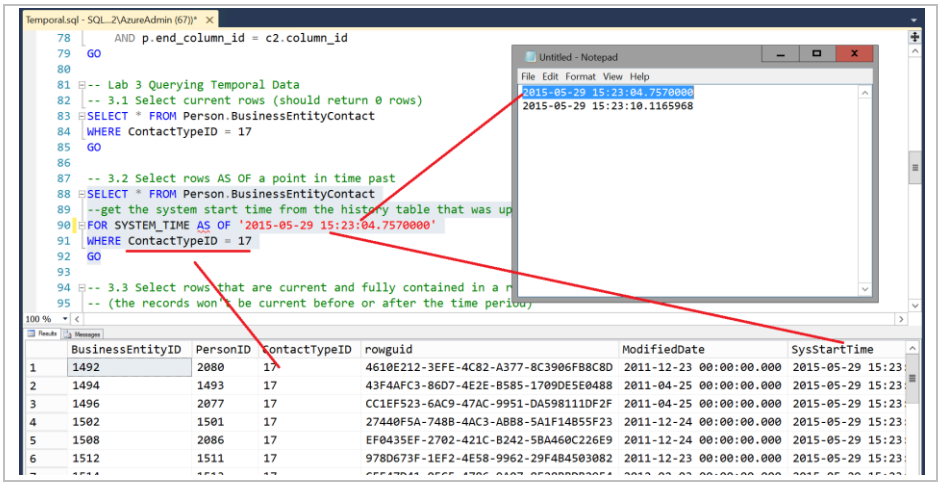
This uses the AS OF syntax to query the table at a single point in time.

1. Run the following select statement. You should see zero rows, because we updated all **ContactTypesIDs** that were 17 so that now they are now 19, above.

```
SELECT * FROM Person.BusinessEntityContact
WHERE ContactTypeID = 17
```

2. Now, we will run this same query again, but it will be as if we were running it before the update that we made to the ContactTypeIDs in the last part of the lab. Use the UTC start time value that you copied into Notepad in this query. It should return the rows with the ContactTypeID that had the value of 17 at that time.

```
SELECT * FROM Person.BusinessEntityContact
--get the system start time from the history table that
was saved to Notepad
FOR SYSTEM_TIME AS OF '2015-04-06 19:16:28.4126016'
WHERE ContactTypeID = 17
```



Note: Using the construct FOR SYSTEM_TIME AS OF @PointInTime will return rows where the @PointInTime is >= SysStartTime and < SysEndTime. If @PointInTime = SysEndTime those rows will not be returned. Make sure that the time you use is either equal to a start time or between the start and end time.

Query the table for rows that were contained between 2 points in time

This uses CONTAINED IN to return only those rows that are contained within a period without overlapping the beginning or the end. The record version must be opened and closed within the period contained within the two points and cannot extend before or after that period.

1. First use the SysStartTime and SysEndTime that you copied to Notepad to define the period.

```
-- Get these 2 values from the SysStartTime and
--SysEndTime from the history table in 2.2 above
DECLARE @Start datetime2 = '2015-04-06 23:14:33.2370000'
DECLARE @End datetime2 = '2015-04-06 23:15:03.4098982'
SELECT * FROM Person.BusinessEntityContact
FOR SYSTEM_TIME CONTAINED IN(@Start, @End)
WHERE ContactTypeID = 17
```

2. Now modify the starting time and make it greater than it was originally, but still before the end time. Now, when you re-run the query, it will return no rows because the life of the rows with a ContactTypeID of 17 began before the period that we are querying for.

   Note: You can think of CONTAINED IN as meaning that the full life of the rows as defined must have been 'born' and 'died' within the period. Any rows that were born before or that continued living after the period will not be returned.

Query the table for rows that were current between 2 points in time, including overlaps or that immediately succeed them

The BETWEEN syntax returns table records that were active or began to be active within a given period of time. Record versions may be opened before start of period and stay opened after end of period. We'll use the same scenario as for CONTAINED IN to see the difference

1. Again we will first use the SysStartTime and SysEndTime that you copied to Notepad to define the period.

```
-- Get these 2 values from the SysStartTime and
-- SysEndTime from the history table in 2.2 above
DECLARE @Start datetime2 = '2015-04-06 23:14:33.2370000'
DECLARE @End datetime2 = '2015-04-06 23:15:03.4098982'
SELECT * FROM Person.BusinessEntityContact
FOR SYSTEM_TIME BETWEEN @Start AND @End
WHERE ContactTypeID = 17
```

2. Again, just as for the CONTAINED IN scenario, modify the starting time and make it greater than it was originally, but still less than the end time. Now, however, when you re-run the query, it will still return the same rows because the life of the rows with a ContactTypeID of 17 is inside the period that we

are querying for, even if that life began before the period or if it extends after the end of the period.

Note: The BETWEEN construct will also return rows that begin at the end of the period. In other words, those rows will be returned if their life immediately succeeds the defined period. There is an additional construct using FROM … TO that is identical to BETWEEN, except that FROM … TO does not include rows that immediately succeed the period.

Query a view containing temporal tables

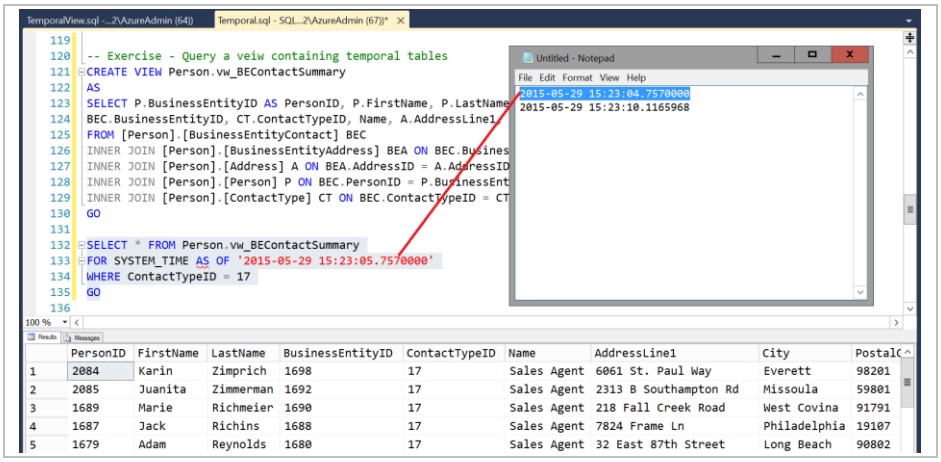
Creating a view that contains a temporal table is convenient for querying complex data that needs to be examined at various points in time.

1. Create a view that contains useful information related to the temporal table created earlier. Here we will look at information related to the business entity and their contacts.

```
CREATE VIEW Person.vw_BEContactSummary
AS
SELECT P.BusinessEntityID AS PersonID, P.FirstName,
P.LastName,
BEC.BusinessEntityID, CT.ContactTypeID, Name,
A.AddressLine1, A.City, A.PostalCode
FROM [Person].[BusinessEntityContact] BEC
INNER JOIN [Person].[BusinessEntityAddress] BEA ON
BEC.BusinessEntityID = BEA.BusinessEntityID
INNER JOIN [Person].[Address] A ON BEA.AddressID =
A.AddressID
INNER JOIN [Person].[Person] P ON BEC.PersonID =
P.BusinessEntityID
INNER JOIN [Person].[ContactType] CT ON
BEC.ContactTypeID = CT.ContactTypeID
```

2. Now query that view for a specific SYSTEM_TIME.

```
SELECT * FROM Person.vw_BEContactSummary
FOR SYSTEM_TIME AS OF '2015-04-06 23:14:33.2370000'
WHERE ContactTypeID = 17
```



3. Change the value for the SYSTEM_TIME to be a value after the end time that was copied into Notepad.exe and execute the query again. You should see no values.

Manage and maintain temporal indexes

In this exercise, we will explore how to conduct maintenance tasks on the temporal table to make sure that performance is kept at the optimal level. Note that the current and the history components of the temporal table are independently maintained. Some of these tasks can be done as with other tables, but if maintenance operations would change the content of history data, it will be possible only while system versioning is suspended.

Operations that can be run normally on temporal tables

1. Rebuild the indexes on both the current and history tables.

```
ALTER INDEX ALL ON Person.BusinessEntityContact REBUILD
GO
ALTER INDEX ALL ON Person.BusinessEntityContactHistory
REBUILD
GO
```

2. Create statistics on the history table

```
CREATE STATISTICS [BusEntContact_BusEnt]
ON Person.BusinessEntityContact([BusinessEntityID])
GO
```

3. Apply different compression on the history table

```
ALTER TABLE Person.BusinessEntityContact
REBUILD WITH (DATA_COMPRESSION = PAGE)
```

Operations that must be run with SYSTEM_VERSIONING = OFF

Any operation that moves data, such as a partition change, or updates, inserts, or deletes data from a history table can only be accomplished with SYSTEM_VERSIONING = OFF. Here, we'll assume that the DBA wants to move older history into a new history archive table.

1. First create the new archive table.

```
SELECT TOP 0 * INTO
Person.BusinessEntityContactHistoryArchive
FROM Person.BusinessEntityContactHistory
```

2. Disable the temporal features on the main (current) table

```
ALTER TABLE Person.BusinessEntityContact
      SET (SYSTEM_VERSIONING = OFF)
```

3. Run any data moving or changing operations with the temporal features turned off.

```
INSERT INTO Person.BusinessEntityContactHistoryArchive
SELECT * FROM Person.BusinessEntityContactHistory

DELETE FROM Person.BusinessEntityContactHistory
```

4. Enable the temporal features again and establish the link to the history table again.

```
ALTER TABLE Person.BusinessEntityContact
      SET (SYSTEM_VERSIONING = ON
(HISTORY_TABLE=Person.BusinessEntityContactHistory,
      DATA_CONSISTENCY_CHECK = OFF))
```

5. You can now close the lab environment.

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