Microsoft

SQL Server to Azure Synapse Migration Process, Modules and Scripts

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Contents

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1   Design Principles and Programming Styles

1.1   Overview

What do the Scripts do?
- ✓ Translate SQL Server Table DDLs into Azure Synapse DDLs (Create Table Statements) and execute Table DDLs in Azure Synapse
- ✓ Export SQL Server tables to .csv or .parquet files
- ✓ Upload .csv or .parquet files into Azure Storage
- ✓ Extract SQL Server Code (Views, Stored Procedures and Functions) and perform database and schema mapping
- ✓ Generate Polybase Export T-SQL Scripts.
- ✓ Execute Polybase Export T-SQL Scripts – Export data directly into Azure Storage from SQL Server
- ✓ Generate T-SQL Copy Into Import Scripts.
- ✓ Execute T-SQL Copy Into Scripts - Import Data into Azure Synapse from Azure Storage.

Reusability

Module 1, 1A, and 1B are designed for code translation; Module 2, 2A, and 2B are for SQL Server data export. Only these modules are specific to SQL Server.

Module 3, 4, 5 are reusable for other types of migrations, for example, Netezza or Teradata or Exadata or Oracle to Azure Synapse migrations. After the code is translated, and data is exported out of source systems, the rest of the tasks are the same. Therefore module 3-5 can be utilized for any of those migrations.

1.2   Design Principles

We adhere to below design principles:

- ✓ **Modular**: Modules that run _independently_ but can use output from other modules
- ✓ **Consistent**: All driver programs are written in PowerShell Scripts.
- ✓ **Simple**: Only one PowerShell Program (scripts) for each module.
- ✓ **Configurable**: Each module has an easy way to config parameters.
- ✓ **User Friendly**: Users are prompted for config file name only. Well documented configuration parameters. Strong error handling mechanism to provide friendly messages. Sample config files are provided. Manual work is minimalized. Utilities are provided to generate config file(s) that involves a list of tables.
- ✓ **Reusable**: Module 1, 1A, and 1B are designed for code translation; Module 2, 2A, and 2B are for SQL Server data export. Only these modules are specific to SQL Server. _Modules 3-5 are reusable for any migration into Azure Synapse, the sources can be: Netezza, Teradata, Exadata, Oracle, DB2, Snowflake, Redshift, Google Big Query, etc., once the code is translated and data is exported out of source system._

1.3 Best Practices in Programming Styles

We adopt below best practice as our programming style:

- ✓ Being Protective - No hardcoded security information anywhere. We will ask you to provide security such as username and password.
- ✓ Being Assertive – We will ask you to specify the location of needed software such as **BCP** or **Azcopy**.
- ✓ Being Friendly - We prompt you for your information with sample values. We also provide utilities to generate configuration files.

2   Overview – Modules and Scripts

There are nine modules that contain PowerShell Scripts and T-SQL Scripts designed to accomplish key task(s) that are relevant to SQL server to Azure Synapse migration.

The modules are summarized as below:

1_TranslateTableDDLs: Translate SQL objects (DDLs) from source system format to Azure Synapse format. The output is stored as .sql files in specified file folder (configurable).

1A_ExtractCodeDDLs: Script out SQL Objects (Views, Functions, Stored Procedures, and Triggers) and write each object into a seperate .sql file.

1B_MapDatabasesAndSchemas: Map SQL Server Database & Schema into Synapse Database and Schema. In addition, unsupported data types in the code are mostly discovered and counted.

2_ExportSourceDataWithBCP: Export SQL Server Tables into data files stored in predefined structure and format (.csv or .txt).

2B_ExportSourceDataToParquet: Export SQL Server Tables into data files stored in .parquet files.

2A_GeneragePolybaseExportScripts: Generate Polybase Export T-SQL Script for each table. Polybase export set up examples are provided in subfolder "Utilities" inside this module.

3_LoadDataIntoAzureStorage: Load exported data files into specified container in Azure Storage (Blob Storage or Azure Data Lake Store).

4_GenerateCopyIntoScripts: Generate "COPY Into" T-SQL Scripts that will move data from Azure Storage into Azure Synapse SQL Pool tables, once executed.

5_RunSqlFilesInFolder: Run all T-SQL Scripts defined in .sql files stored in a specified file folder. The T-SQL Scripts can be DDL, DML, Data Movement Scripts (such as Copy Into scripts or Polybase Export Scripts), or any other scripts such as create/update statistics or indexes. In fact, this module is designed to run any SQL scripts in a folder.

The organization of the modules, output folder, and documentations is illustrated in Figure 1. Modules are stored in the "modules" directory. "output" is designed to store output of the modules. You can use a different folder as you wish. It is configurable.
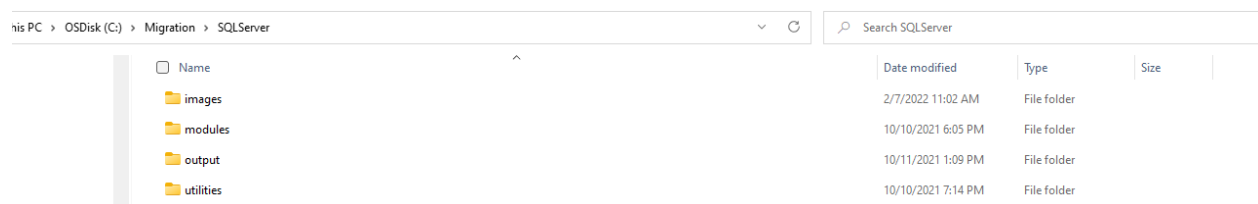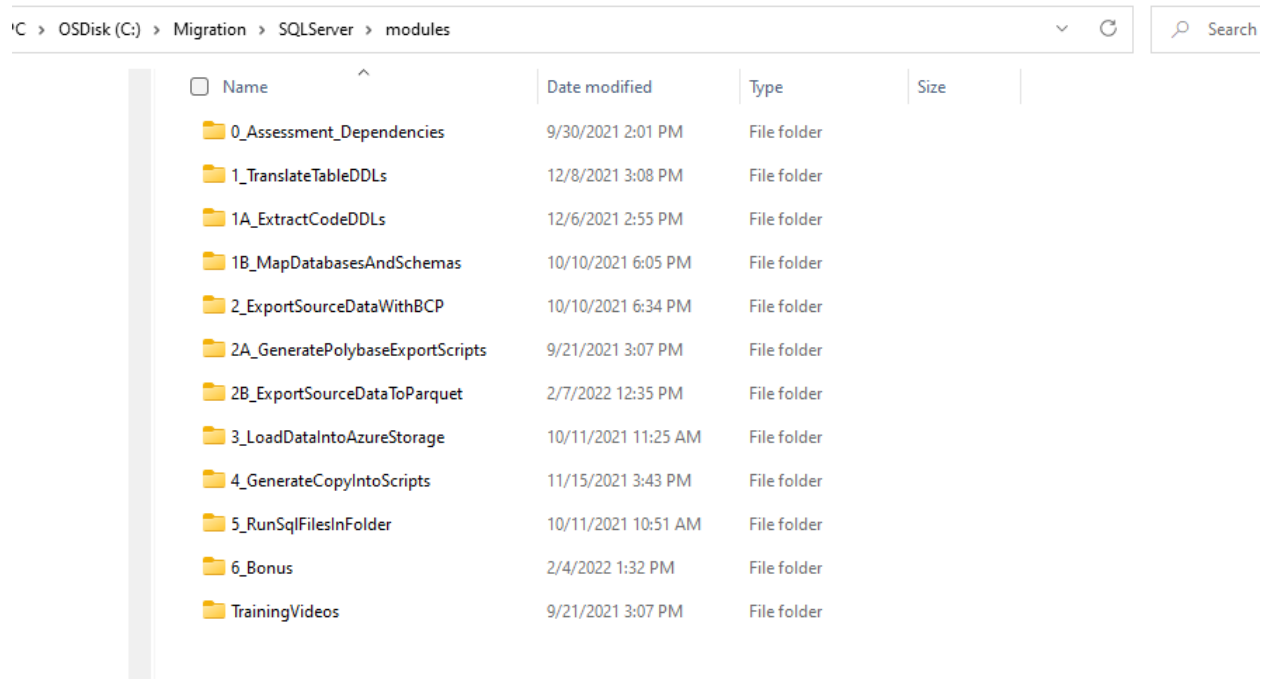

Figure 1 File Structures and Documentations

Inside the "modules" directory, there multiple modules, as illustrated in Figure 2.

Name	Date modified	Type	Size
📁 0_Assessment_Dependencies	9/30/2021 2:01 PM	File folder	
📁 1_TranslateTableDDLs	12/8/2021 3:08 PM	File folder	
📁 1A_ExtractCodeDDLs	12/6/2021 2:55 PM	File folder	
📁 1B_MapDatabasesAndSchemas	10/10/2021 6:05 PM	File folder	
📁 2_ExportSourceDataWithBCP	10/10/2021 6:34 PM	File folder	
📁 2A_GeneratePolybaseExportScripts	9/21/2021 3:07 PM	File folder	
📁 2B_ExportSourceDataToParquet	2/7/2022 12:35 PM	File folder	
📁 3_LoadDataIntoAzureStorage	10/11/2021 11:25 AM	File folder	
📁 4_GenerateCopyIntoScripts	11/15/2021 3:43 PM	File folder	
📁 5_RunSqlFilesInFolder	10/11/2021 10:51 AM	File folder	
📁 6_Bonus	2/4/2022 1:32 PM	File folder	
📁 TrainingVideos	9/21/2021 3:07 PM	File folder	

Figure 2 Organization of Modules, output folder and documentations

3 What Do I Need to Do to Run the PowerShell Scripts?

This section provides instructions to download and set up the Scripts.

3.1 Download the Code from GitHub

Go to the public repository site:

[microsoft/AzureSynapseScriptsAndAccelerators (github.com)](https://github.com)

Download the repository, as illustrated in Figure 3, you will receive a zip file in your own download directory.
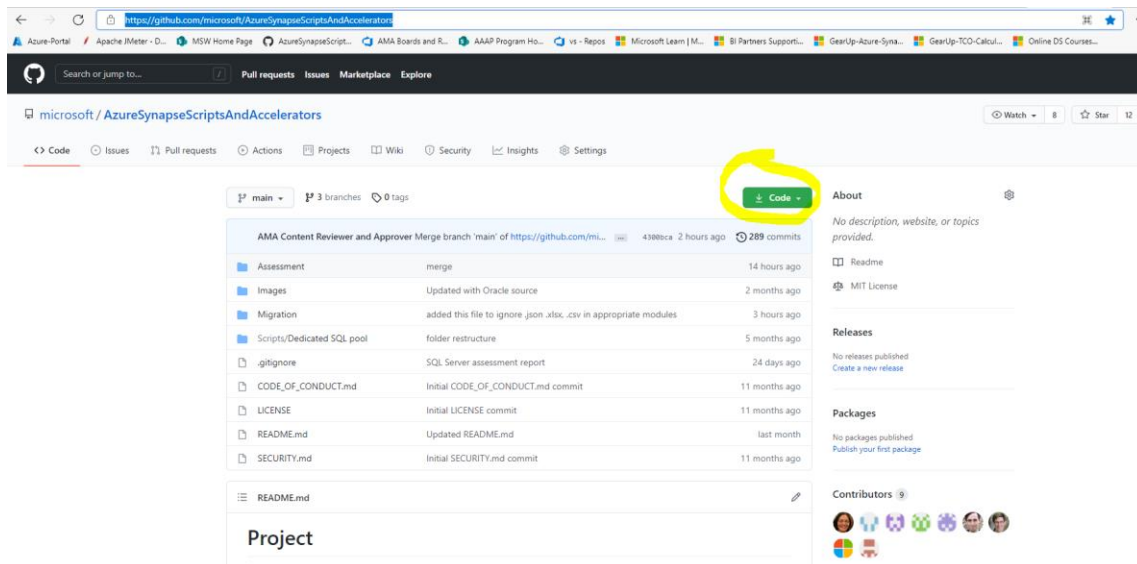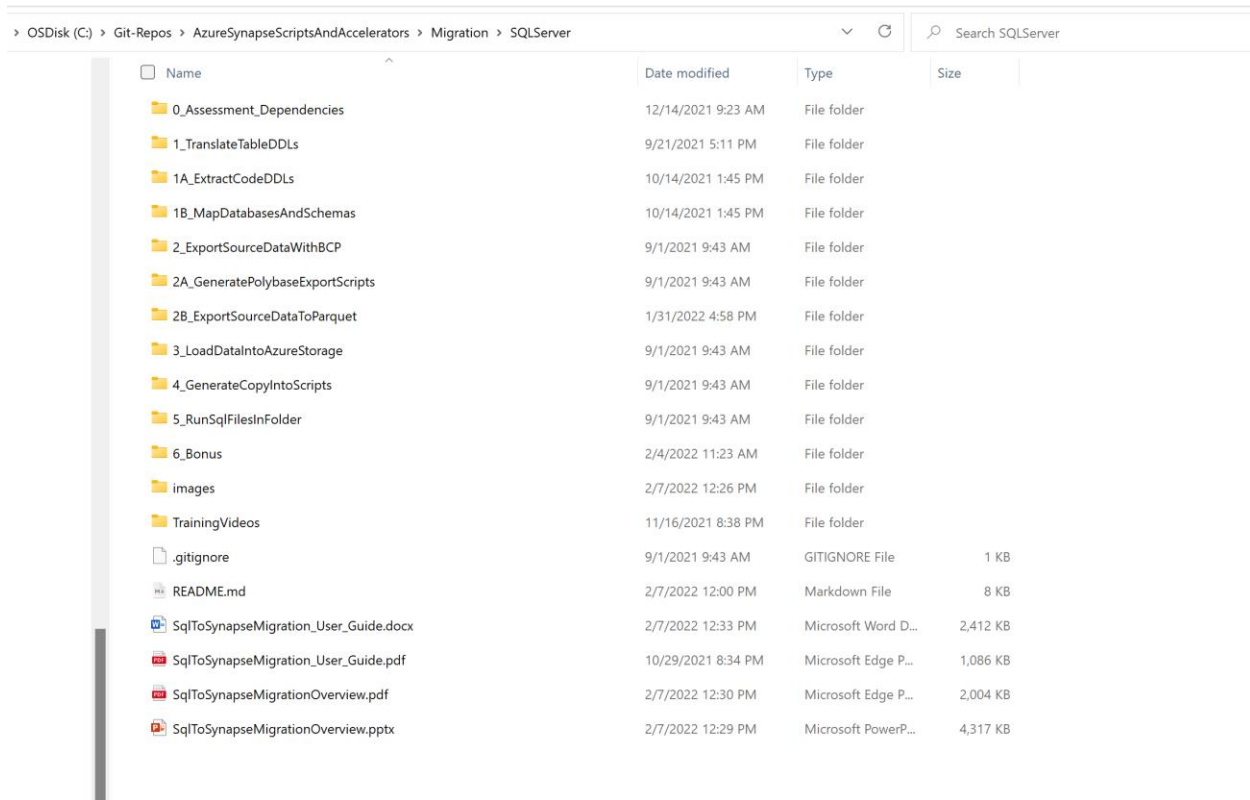

Figure 3 Download the Code from the Public Repository

Unzip the file, and you will find this folder below. Inside the SQLServer Folder, you will have all the code, including this document, as illustrated in Figure 4.

Figure 4 SQL Server to Synapse Migration Code Location

SQL Server to Azure Synapse Migration Process and Scripts Draft
Prepared by Gaiye "Gail" Zhou

3.2   Set up the Necessary Tools/Utilities

Choose One of the Environments:

1. Windows PowerShell ISE (preferred)
2. Visual Studio Code (with PowerShell Extension Installed)

PowerShell Modules required:

(1) Install-Module (Import-module) -name SqlServer

(2) Install-Module (Import-module) -name ImportExcel

(3) Install-Module (Import-module) -Name Az –AllowClobber

PowerShell Permissions (Permissions may be denied if the Scripts are from GitHub or Email):

Use one of the options to set Powershell permissions (examples):

Set-ExecutionPolicy Unrestricted -Scope CurrentUser

Unblock-File -Path C:\migratemaster\modules\1_TranslateTableDDLs\TranslateTables.ps1

Download and Install AzCopy (Only if you will be using BCP Export Method). This task can be skipped if you will be using other methods to upload data into Azure Storge such as Azure Data Box Gateway or Azure Data Explore).

Copy or move data to Azure Storage by using AzCopy v10 | Microsoft Docs

4 How Migration Tasks are Modularized

Migration process is illustrated in Figure 5 for BCP export option, and Figure 6 for Polybase Export Option.

The numbers specify the module numbers, not the execution sequence.
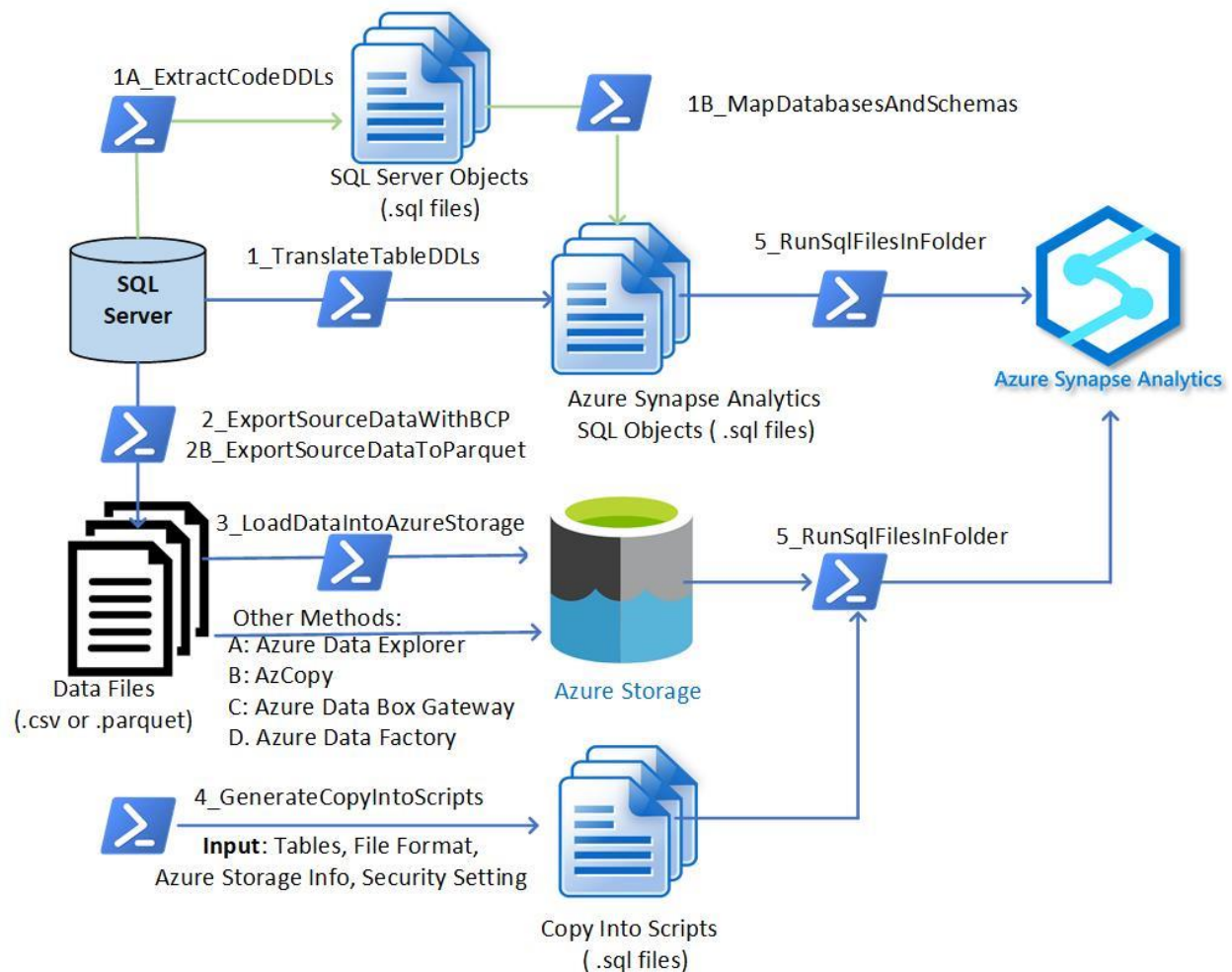

Figure 5 Migration Modules are Applied for the Migration Process (Export Tables into Local Files)
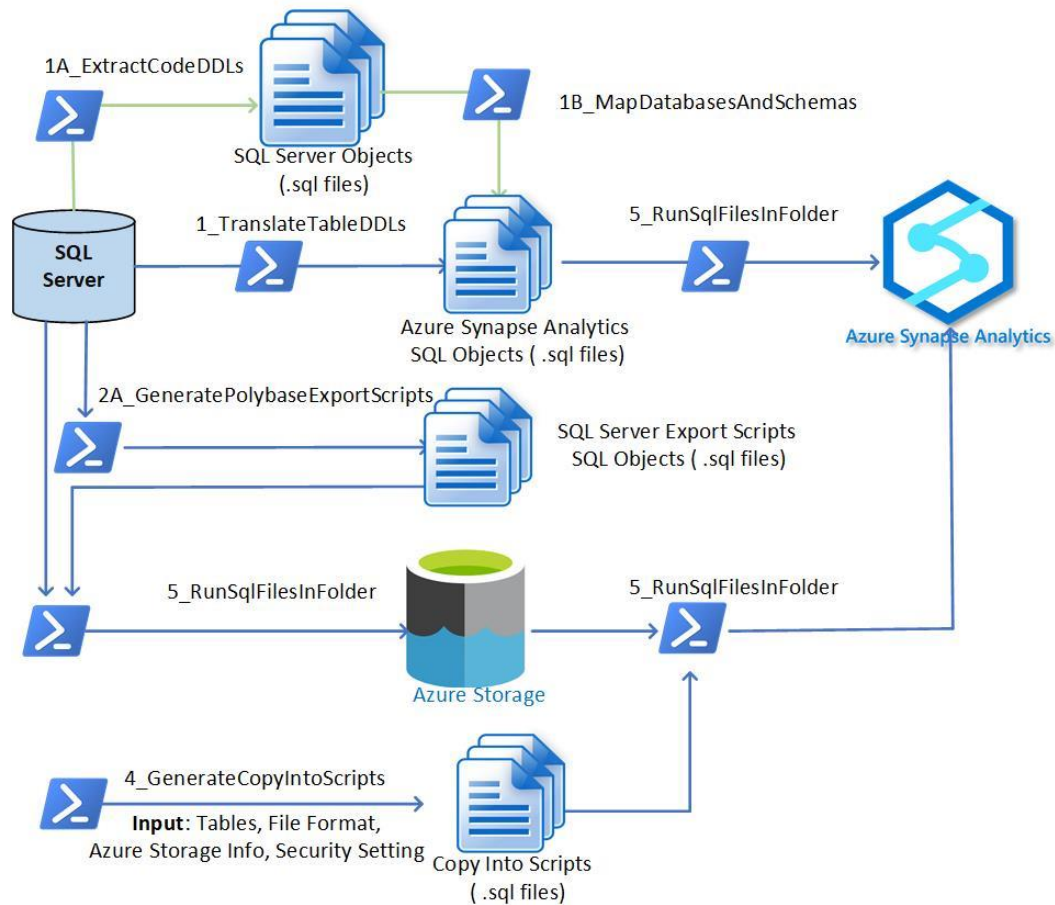
Figure 6 Migration Modules are Applied for the Migration Process (Polybase Export Option)

Source System Tasks (SQL Server):

- Use **1_TranslateTableDDLs** to translate and save results into .sql files
- Use **1A_ExtractCodeDDLs** and **1B_MapDatabasesAndSchemas** for Code Conversion (Stored Procs, Views, Functions)
- Use **2_ExportSourceDataWithBCP** to export source data and save results into local storage using BCP as .csv or .txt files.
- Use **2_ExportSourceDataToParquet** to export source data and save results into local storage in. parquet files.
- Use **2A_GeneratePolybaseExportScripts** to generate SQL Server Polybase Export T-SQL Scripts.

Data Movement Tasks:

- Use **3_LoadDataIntoAzureStorage** to load exported data into Azure Storage. Optionally you can use AzCopy or Azure Data Box Gateway to complete the task. Azure Data Box Gateway is a good choice if the volume of data is very large, for example, 50TB+.
- Use **4_GenerateCopyIntoScripts** to prepare "Copy Into" T-SQL Scripts
- Use **5_RunSqlFilesInFolder** to execute "Copy Into" T-SQL Scripts or Polybase Export T-SQL Scripts

Target System Tasks (Azure Synapse):

- Use **5_RunSqlFilesInFolder** to execute Azure Synapse T-SQL Scripts prepared by **1_TranslateMetadata,** to create meta data (tables) in Azure Synapse.
- Use **5_RunSqlFilesInFolder** to execute "Copy Into" T-SQL Scripts prepared by 4_**GenerateCopyIntoScripts,** to move data from Azure Storage into Synapse

5 Step-by-Step Migration Guide (Export to Local files and upload to Azure Storage)
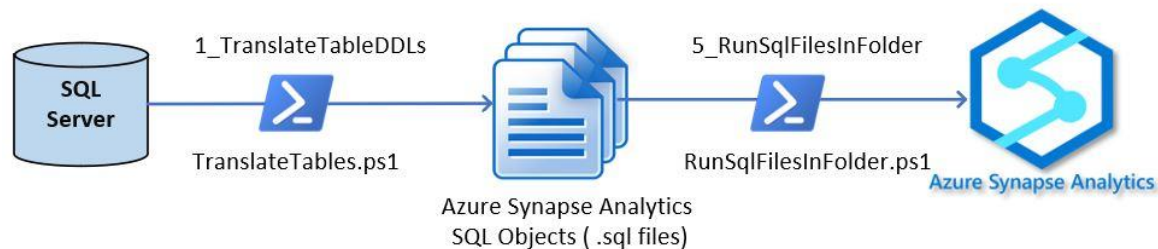
Although some of the modules can be run in parallel, we have designed a simple sequence for your Migration Journey.

5.1 Step 1 - Table DDLs Migration

Tables migration process is illustrated in Figure 7.

Figure 7 Step 1: Code (DDLs) Migration

Step 1: Code (DDLs) Migration – Translate SQL Server Tables and create them in Azure Synapse

Task 1

Execute PowerShell Scripts "TranslateTables.ps1" (Inside folder 1_TranslateTableDDLs folder)

Output: Azure Synapse Create Table Statement (DDLs) stored in .sql format.

Config Files needed (Samples are provided):

SourceToTargetTablesConfig.xlsx

translate_config.json

Note 1: Need to access SQL Server for this. "db_datareader" role permission is needed

Note 2: Look for T-SQL Scripts "GenerateSourceToTargetConfig.sql" in the Utilities Subfolder to create starter SourceToTargetTablesConfig.xlsx.

Task 2

Execute PowerShell Scripts"RunSqlFilesInFolder.ps1" (Inside folder 5_RunSqlFilsInFolder)

Input: Azure Synapse Table DDL files (.sql) stored in one file folder, which were generated by Task 1.

Output: Timestamped log files in the "Log" subfolder where you run this PowerShell Scripts.

Results: Tables will be created in Azure Synapse Dedicated SQL Pool.

Config File(s) needed (Samples are provided):

sql_synapse.json

Note: Need "Create Schema" and "Create Table Permission" in Azure Synapse SQL Pool.

5.2 Step 1A – Extract Code DDLs

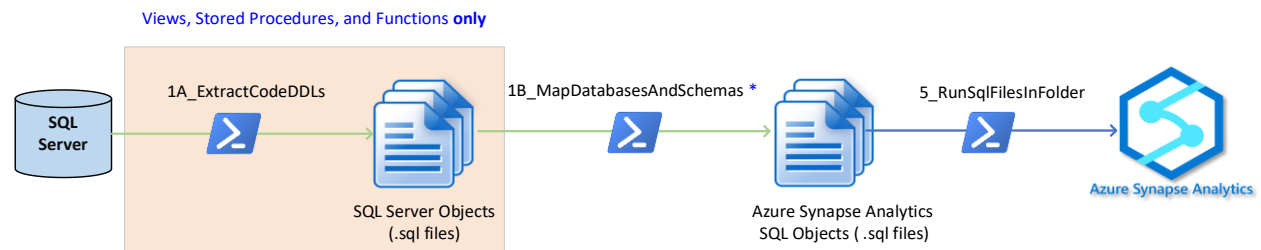Extract Code DDLs process is illustrated in Figure 8.

Views, Stored Procedures, and Functions **only**

Figure 8 Step 1A: Extract Code DDLs

Task 1

Execute PowerShell Script "**ExtractCodeDDLs.ps1**" (Inside folder 1A_ExtractCodeDDLs folder)

Output: Azure Synapse code DDLs (CREATE VIEW, CREATE PROCEDURE, CREATE FUNCTION statements) stored in separate SQL-script files.

Config Files needed (Samples are provided):

      DatabasesList.csv

      ExtractCodeDDLs_config.json

Note 1: Need to access SQL Server for this. VIEW ANY DEFINITION permission is required.

5.3 Step 1B – Map Databases and Schemas

Map Databases and Schemas process is illustrated in Figure 9.

Views, Stored Procedures, and Functions **only**
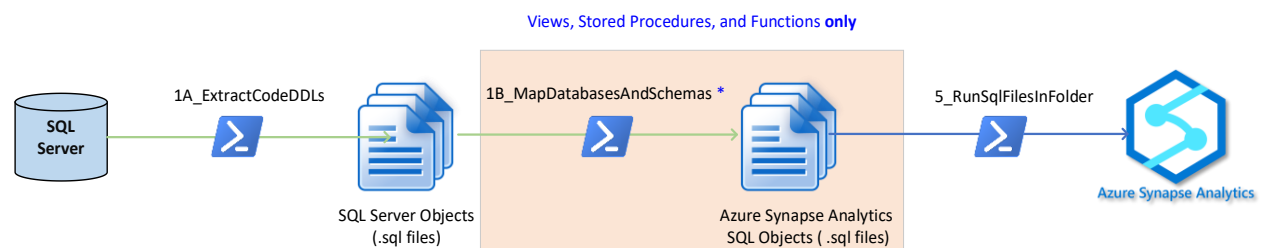
Figure 9 Step 1B: Map Databases and Schemas

Task 1

Execute PowerShell Script "**MapDatabasesAndSchemas.ps1**" (Inside folder 1B_MapDatabasesAndSchemas folder).

Output: Azure Synapse code DDLs (CREATE VIEW, CREATE PROCEDURE, CREATE FUNCTION statements) stored in separate SQL-script files which are updated according to schema mapping provided as input.

Config Files needed (Samples are provided):

      cs_dirs.csv

      schemas.csv

Note: The script does not connect to SQL Server instance, hence no SQL Server permissions required.

5.4   Step 2 - Export SQL Server Tables into Local Files (.csv or .parquet)

Exporting SQL Server data process is illustrated in Figure 10.

Figure 10 Step 2: Export SQL Server Data as .csv or .parquet

Task

Execute PowerShell Scripts "ExportSourceData.ps1" (Inside 2_ExportSourceDataWithBCP).
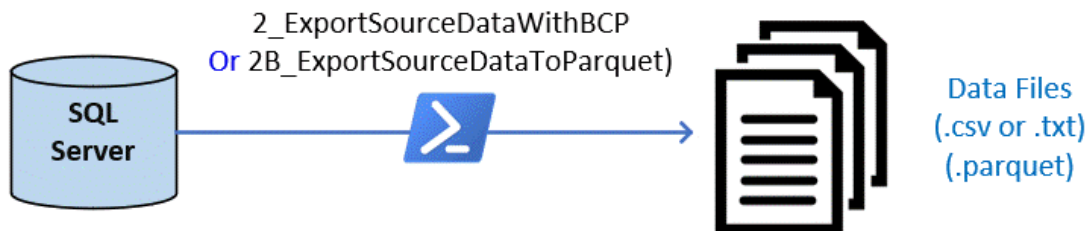
Output: Data files in .csv format are produced and saved into local storage.

Config Files needed (Sample(s) are provided):

        ExportTablesConfig.csv

        sql_bcp.json

Note 1: Need to access SQL Server for this. "db_datareader" role permission is needed

Note 2: You need bcp utility (bcp.exe) for this. If you have SQL server installed, you may find it in this location: C:\Program Files\Microsoft SQL Server\Client SDK\ODBC\130\Tools\Binn

If you are not able to find bcp.exe, you can download a copy from

https://docs.microsoft.com/en-us/sql/tools/bcp-utility?view=sql-server-ver15

If you are using Module 2B_ExportSourceDataToParquet, please refer the readme.md file in this section:

AzureSynapseScriptsAndAccelerators/Migration/SQLServer/2B_ExportSourceDataToParquet at main · microsoft/AzureSynapseScriptsAndAccelerators · GitHub

5.5 Step 3 – Upload Data into Azure Data Lake Store or Blob Storage

Uploading data into Azure Storage process is illustrated in Figure 11.
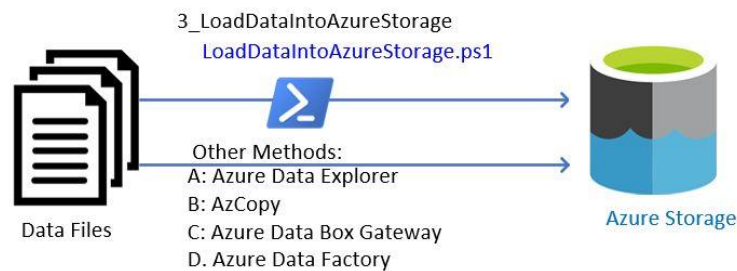
Figure 11 Step 3: Upload Data into Azure Storage

Task (If using 3_LoadDataIntoAzureStorage)

Execute PowerShell Scripts "LoadDataIntoAzureStorage.ps1" (inside folder 3_LoadDataIntoAzureStorage)

Output: None

Results: Data in Data Files are uploaded to Azure Storage (Data Lake Store or Blob Storage)

Config File(s) needed (Samples are provided):

 sql_bcp.json

Note: The user needs to have the permission of "Storage Blob Data Contributor"

5.6 Step 4: Generate COPY T-SQL Scripts

The process of generating COPY T-SQL Scripts is illustrated in Figure 12.

After executing each of the generated T-SQL Copy Script in the format of .sql files, the corresponding data will be imported into Azure Synapse. The execution step is carried out in next step, Step 5.

This step only generates T-SQL Scripts, it does not execute any T-SQL Scripts.

Figure 12 Step 4: Generate T-SQL COPY Into T-SQL Scripts

Task

Execute PowerShell Scripts "GenerateCopyIntoScripts.ps1" (inside folder 4_GenerateCopyIntoScripts)

Output: T-SQL COPY Script for Each Table (in the form of .sql files)

Config Files needed (samples are provided)

(1) csv_mi.json or parquet_mi.json (recommended) or csv_key.json (this requires Storage Account Key, not recommended but can be used for quick testing)

(2) TablesConfig.csv: This is a table list with information needed for each T-SQL Copy script.

Note 1: If using csv_mi.json or parquet_mi.json file, and the Azure Storage was created independently (not as part of the Azure Synapse Workspace Creation), you will need to set up Azure Synapse Workspace as a managed instance, for the Scripts to work. See instruction in top of the "GenerateCopyIntoScripts.ps1". In addition, you can find sample PowerShell script "SetManagedIdentity.ps1" (inside subfolder Utilities) to set up Managed Instance.

Note 2: Sample configuration files are provided for data file formats other than CSV: parquet and orc. However, these file formats are not tested.

5.7   Step 5: Import Data into Azure Synapse (SQL Pool)

The process of generating COPY T-SQL Scripts is illustrated in Figure 13. You will utilize the 5_RunSqlFilesInfolder to execute all the COPY T-SQL Scripts generated.

After this step, the data stored in Azure Storage will be imported into Azure Synapse SQL pool. The program also produces a log file, itemizing the results of each T-SQL Scripts. If there is errors, the errors will be found in the log file.

Figure 13 Step 5: Import Data into Azure Synapse SQL Pool

Task: Execute PowerShell Scripts "**RunSqlFilesInFolder.ps1**" (Inside folder 5_RunSqlFilsInFolder)

Input: T-SQL script (Copy Into) generated by **GenerateCopyIntoScripts.ps1** (Inside Module 4_GenerateCopyIntoScripts) stored in one file folder.

Output: Timestamped log files in the "Log" subfolder where you run this PowerShell Scripts.

Results: Data is imported to Azure Synapse Tables (Dedicated SQL Pool).

Config File(s) needed: sql_synapse.json

Note: Need "Write Data" Permission" in Azure Synapse SQL Pool.

6 Step-by-Step Migration Guide (with Polybase Export)

6.1 Step 1 - Code (DDLs) Migration

The work to be done in this step is the same as Step 1 – Code (DDLS) Migration with BCP Export. Please refer to this Section 5.1, Step 1 - Table DDLs Migration.

6.2 Step 1A – Extract Code DDLs

The work to be done in this step is the same as Step 1A – Extract Code DDLs with BCP Export. Please refer to the Section 155.2, Step 1A – Extract Code DDLs.

6.3 Step 1B – Map Databases and Schemas

The work to be done in this step is the same as Step 1B – Map Databases and Schemas with BCP Export. Please refer to the Section 155.3, Step 1B – Map Databases and Schemas.

6.4   Step 2A – Generate Polybase Export T-SQL Scripts

In this step, you will generate the Polybase Export T-SQL Scripts. Please note this step just generates the code, not execute it. The process of generating Polybase Export T-SQL Scripts is illustrated in Figure 14.

Figure 14 Step 2A Generate Polybase Export T-SQL Scripts

Task

Execute PowerShell Scripts "**GenerateExportTablesScripts.ps1**" (Inside 2A_GeneratePolybaseExportScripts).

Output: Polybase Export T-SQL Scripts (Create External Table) for each table in the format of .sql.

Config Files needed (Sample(s) are provided):

       ExportTablesConfig.csv

       export_tables_config.json

Note 1: Need SQL Server Permissions for create schema, create/drop table, read data. **Note 2:** You will need to set up Polybase export functions in SQL Server. Sample T-SQL Scripts are provided in the subfolder Utilities.

6.5   Step 3A – Export SQL Server Tables Data to Azure Storage

The process of Exporting SQL Server Tables Data into Azure Storage is illustrated in Figure 15. You will utilize the 5_RunSqlFilesInfolder to execute all the Polybase Export T-SQL Scripts generated in Step 2A.
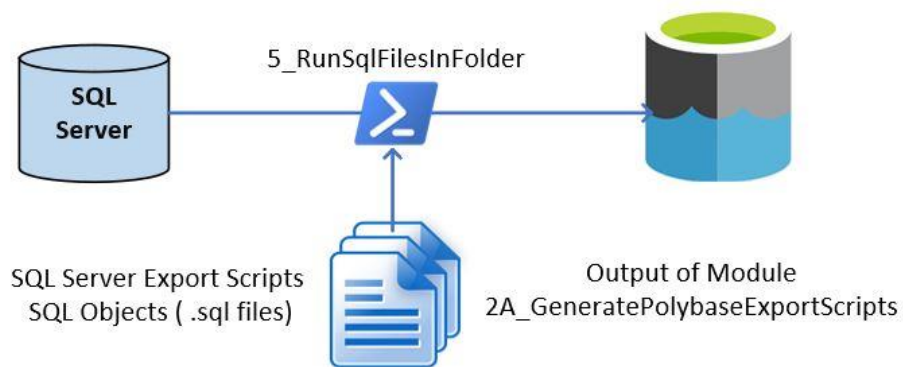

Figure 15 Step 3 (3A) Export SQL Server Tables Data into Azure Storage

Task: Execute PowerShell Scripts"**RunSqlFilesInFolder.ps1**" (Inside folder 5_RunSqlFilsInFolder)

Input: T-SQL script (Polybase Export) generated by **GenerateExportTablesScripts.ps1** (Inside Module 2A_GeneratePolybaseExportScripts), stored in one file folder.

Output: Timestamped log files in the "Log" subfolder where you run this PowerShell Scripts.

Results: Data is exported to Azure Storage from SQL Server Tables

Config File(s) needed: sql_sql.json

Note:

(1) Need Blob Storage Contributor Role in Azure Storage

(2) Permissions from SQL Server for Create Schema, Create Table, Read Data.

(3) Polybase Export is set up in SQL Server. External Data Source and File Format are created. See samples inside subfolder Utilities.

6.6   Step 4: Generate COPY T-SQL Scripts

The work to be done in this step is exactly the same as Step 4 using BCP export method. Please refer to Section 5.6, Step 4: Generate COPY T-SQL Scripts.

6.7   Step 5: Import Data into Azure Synapse (SQL Pool)

The work to be done in this step is exactly the same as Step 5 using BCP export method. Please refer Section: 5.7, Step 5: Import Data into Azure Synapse (SQL Pool).