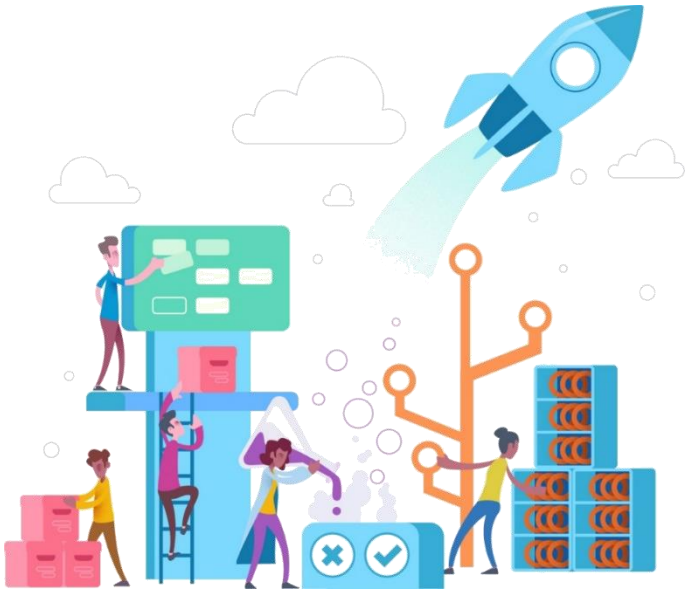
monkey consultancy

MonkeyDWH™

A monkey-proof DWH architecture



Version 2020-10-30

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1 Introduction & context

With today's tight labor market, every hour spend on development has to count. It can easily takes a Data Engineer hours or even days to add additional source tables to a DWH with manual development.

The lack of experienced engineers within a company, or employees leaving a company, raise a risk on any DWH project. Let alone, keeping up with the fast pace of changes within the Azure data landscape, demands discipline and regular training.

2 What is MonkeyDWH™

The MonkeyDWH™ generator tool quickly generates all the required Azure SQL database objects and Data Factory (ADF) objects (pipelines and datasets) that enables a company to quickly setup a Data Warehouse (DWH) on Azure in a matter of days.

It is able to ingest different kind of sources and process deltas fast and reliable.

3 Benefits of MonkeyDWH™

Future proof

By exclusively using native Azure Data Factory pipelines and activities, and thus without the use of an SSIS Integration Runtime (SSIS-IR), MonkeyDWH™ is easily adaptable to newly added ADF features or (code) changes in the future. MonkeyDWH™ uses Azure's own resource API's, which eliminates any custom PowerShell code or Runbooks to manage resources.

Fast data processing in the cloud

Due to the use of a single Azure SQL database within the architecture, temporary in-memory storage and local lookups (from Facts to Dimensions), MonkeyDWH™ is able to reduce processing time. Less time is spent on validations and other kinds of overhead, since it doesn't require a SQL Server Integration Services Runtime (SSIS-IR.

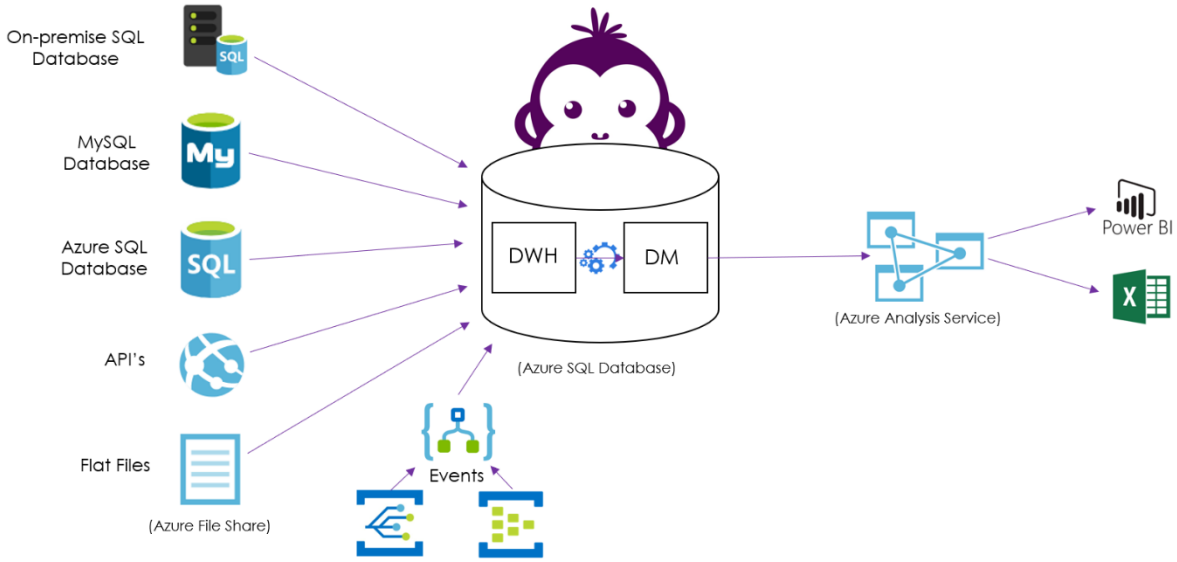
Low runtime costs

Thanks to its architectural design, runtime costs are kept low due to the lack of expensive resources which are billed per month and can't be paused automatically. The DWH and Data Mart (DM) for example, use a single (Serverless) Azure SQL Database for which automatically pauses after an hour. Azure Data Factory (ETL) activities are billed per execution and can be grouped by executions per hour or per day, executing these pipelines only when needed.

Maintenance updates and support

The solution will be kept in good shape, thanks to regular maintenance updates. And with the help from technical support, any concerns or issues regarding your DWH will be attended to.

4 A monkey-proof architecture

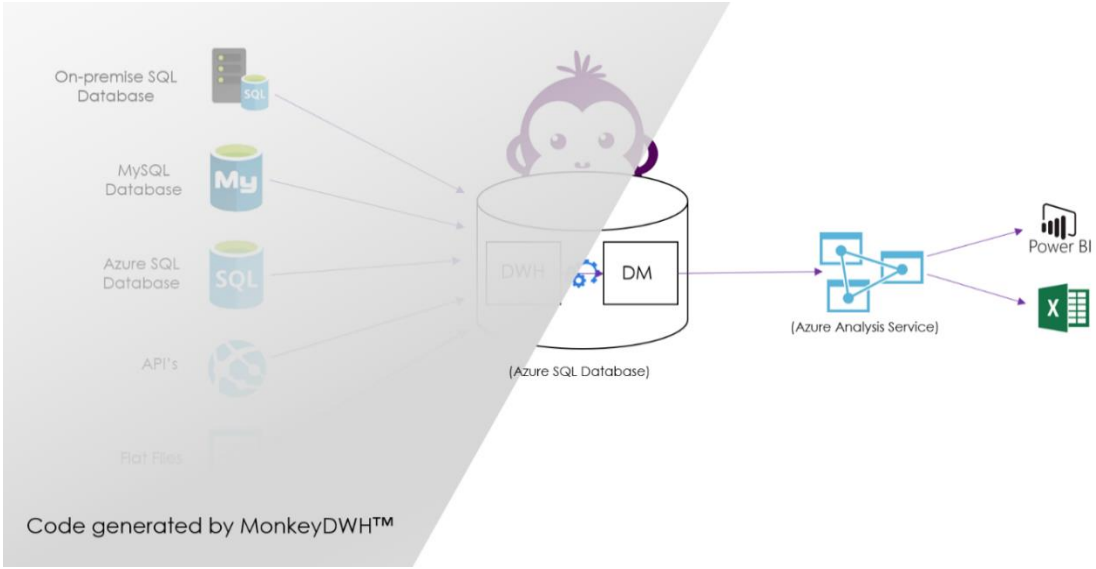


The overall architectural design is seen here, including all supported sources.

From left to right, data from different kind of sources is extracted and stored in staging-tables, and in case of (valid) changes, deltas will be loaded into the DWH. The Data Mart (in short 'DM') contains the dimensional model and will be populated by using stored procedures inside the same Azure SQL database. Once the DM is ready, the Azure Analyses Services Tabular Model will be processed and made available for end-users.

End-users will use Excel PivotTables and Power BI dashboards to analyze the facts, dimensions and KPI's within the Tabular Model. Data Scientists are able to directly query the 'raw' data inside the DWH tables (which are identical to the source tables) or analyze prepared data inside the DM or Tabular Model.

The maximum compressed data volume for the DWH on Business Critical is 4,0TB, but with Hyperscale up to 100TB of storage can be allocated.



The MonkeyDWH™ generates all Azure SQL database- and Data Factory objects needed to extract data from different kind of sources and store data historically inside the DWH.

Due to this feature, a Data Engineer doesn't have to spend his/her precious development time on this 'prepping-phase'. He/she is able to fully focus on creating insights, designing an Analysis Service tabular model (also known as a 'cube') and creating Power BI dashboards for the business.

The DWH project would be delivering results (as in usable insights via Power BI dashboards) within a single month, a high ROI with low budgetable costs.

5 Azure Resource Groups

An example of an Azure Resource Group can be seen below. This is how the architecture will look like within the Azure Portal:

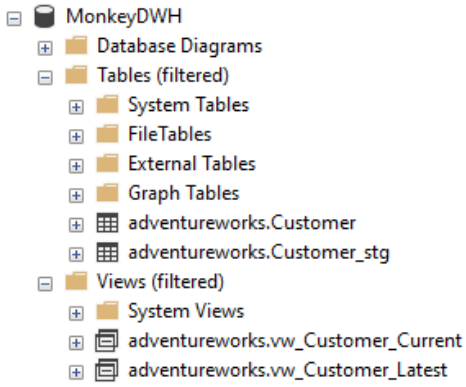
Resources
MonkeyDWH-PROD

MoveFiles	Logic app
SendEmail	Logic app
MonkeyDWH-PROD-ADF	Data factory (V2)
azurefile	API Connection
monkeydwhprod	SQL server
MonkeyDWH-PROD	SQL database
MonkeyDWH_MetaData	SQL database
CheckForDeletedRecords	Logic app
monkeydwhprodaas	Analysis Services
monkeydwhprodstorage	Storage account
office365-1	API Connection
sql	API Connection

6 Data Warehouse (DWH) objects

A DWH can be seen as sort of a flight recorder, it searches for changes in the data and records it. Each change will be recorded with full history (inserts, updates and optionally also deletes).

Example DWH objects for 'Customer' can be seen here:



The database contains a lot of database objects per source table (such as 'customer'):

- Two tables for each source table
- Two views to (quickly) analyze todays current- or latest -state of the data
- Several logging objects

The generated views provide quick insights on all historical changes. They also include start- and end-dates, and booleans for IsCurrent, IsLatest and IsDeleted as shown below:

Results Messages

	CustomerID	Territory	Group	LOADDATE	FILENAME	STARTDATE	ENDDATE	ISCURRENT	ISLATEST	ISDELETED
1	1	もしもし	North America	2019-08-30 14:09:46.147	Customer_20190106112233.txt	2019-08-30 14:09:46.147	2019-08-30 14:10:18.109	0	0	0
2	1	Northwest	South Africa	2019-08-30 14:10:18.110	Customer_20190107112233.txt	2019-08-30 14:10:18.110	2019-08-30 14:10:38.592	0	0	0
3	1	Northwest	Europe	2019-08-30 14:10:38.593	Customer_20190108112233.txt	2019-08-30 14:10:38.593	2019-08-30 14:11:37.037	0	1	1
4	2	お元気ですか	North America	2019-08-30 14:09:46.147	Customer_20190106112233.txt	2019-08-30 14:09:46.147	2019-08-30 14:10:18.109	0	0	0
5	2	Northwest	South Africa	2019-08-30 14:10:18.110	Customer_20190107112233.txt	2019-08-30 14:10:18.110	2019-08-30 14:10:38.592	0	0	0
6	2	Northwest	Europe	2019-08-30 14:10:38.593	Customer_20190108112233.txt	2019-08-30 14:10:38.593	2019-08-30 14:11:37.037	0	1	1
7	3	素敵な過食	North America	2019-08-30 14:09:46.147	Customer_20190106112233.txt	2019-08-30 14:09:46.147	2019-08-30 14:10:18.109	0	0	0
8	3	Southwest	South Africa	2019-08-30 14:10:18.110	Customer_20190107112233.txt	2019-08-30 14:10:18.110	2019-08-30 14:10:38.592	0	0	0
9	3	Southwest	Europe	2019-08-30 14:10:38.593	Customer_20190108112233.txt	2019-08-30 14:10:38.593	2019-08-30 14:11:37.037	0	1	1
10	4	寿司はおいしいです	North America	2019-08-30 14:09:46.147	Customer_20190106112233.txt	2019-08-30 14:09:46.147	2019-08-30 14:10:18.109	0	0	0
11	4	Southwest	North America	2019-08-30 14:10:18.110	Customer_20190107112233.txt	2019-08-30 14:10:18.110	9999-12-31 00:00:00.000	1	1	0
12	5	Southwest	North America	2019-08-30 14:09:46.147	Customer_20190106112233.txt	2019-08-30 14:09:46.147	9999-12-31 00:00:00.000	1	1	0
13	6	Southwest	North America	2019-08-30 14:09:46.147	Customer_20190106112233.txt	2019-08-30 14:09:46.147	9999-12-31 00:00:00.000	1	1	0
14	7	Northwest	North America	2019-08-30 14:09:46.147	Customer_20190106112233.txt	2019-08-30 14:09:46.147	9999-12-31 00:00:00.000	1	1	0
15	8	Southeast	North America	2019-08-30 14:09:46.147	Customer_20190106112233.txt	2019-08-30 14:09:46.147	9999-12-31 00:00:00.000	1	1	0
16	9	Southeast	North America	2019-08-30 14:09:46.147	Customer_20190106112233.txt	2019-08-30 14:09:46.147	9999-12-31 00:00:00.000	1	1	0
17	10	Canada	North America	2019-08-30 14:09:46.147	Customer_20190106112233.txt	2019-08-30 14:09:46.147	9999-12-31 00:00:00.000	1	1	0

Within the DWH database, two logging tables are available. One for recording all ADF Copy activities while reading and copying data into the staging-tables. Invalid records are skipped by default, but are still recorded in this logging-table (see '*RowsSkipped*'):

Results Messages

	LogId	SourceName	ObjectName	Status	StartDateTime	EndDateTime	Duration	RowsRead	RowsCopied	RowsSkipped	FileName
1	11	AdventureWorks	SalesOrderHeader	Succeeded	2019-08-30 14:24:22.3...	2019-08-30 14:24:53....	00:00:31	31465	31465	0	SalesOrderHeader_20190106112233.txt
2	10	AdventureWorks	SalesOrderDetail	Succeeded	2019-08-30 14:13:59.2...	2019-08-30 14:16:29....	00:02:30	121317	121317	0	SalesOrderDetail_20190106112233.txt
3	9	Star Wars	Planets	Succeeded	2019-08-30 14:13:12.1...	2019-08-30 14:13:21....	00:00:09	61	61	0	Planets_20190820112233.csv
4	8	AdventureWorks	Product	Succeeded	2019-08-30 14:12:36.3...	2019-08-30 14:12:44....	00:00:08	504	504	0	Product_20190106112233.txt
5	7	AdventureWorks	Customer	Succeeded	2019-08-30 14:10:48.0...	2019-08-30 14:10:55....	00:00:07	1328	1328	0	Customer_20190116112233.txt
6	6	AdventureWorks	Customer	Succeeded	2019-08-30 14:10:26.2...	2019-08-30 14:10:35....	00:00:09	1334	1334	0	Customer_20190108112233.txt
7	5	AdventureWorks	Customer	Succeeded	2019-08-30 14:10:04.9...	2019-08-30 14:10:11....	00:00:07	1334	1334	0	Customer_20190107112233.txt
8	4	AdventureWorks	Customer	Succeeded	2019-08-30 14:09:34.4...	2019-08-30 14:09:40....	00:00:06	1334	1334	0	Customer_20190106112233.txt
9	3	Star Wars	People	Succeeded with rows skipped	2019-08-30 14:07:53.6...	2019-08-30 14:07:59....	00:00:06	87	83	4	People_20190820112233.csv
10	2	AdventureWorks	Customer	Failed	2019-08-30 14:06:39.1...	2019-08-30 14:06:45....	00:00:06	0	0	0	Customer_20190106235999.txt
11	1	Star Wars	Movies	Succeeded with rows skipped	2019-08-30 14:06:29.1...	2019-08-30 14:06:38....	00:00:09	15	7	8	Movies_20190820112233.csv

Failed ADF Copy activities are also recorded properly:

Results Messages

	LogId	SourceName	ObjectName	Status	Duration	RowsRead	RowsCopied	RowsSkipped	FileName	ErrorMessage
1	14	AdventureWorks	Customer	Failed	00:00:07	0	0	0	Customer_20190106235999.txt	ErrorCode=UserErrorInvalidColumnMappingColumnNotFound,'

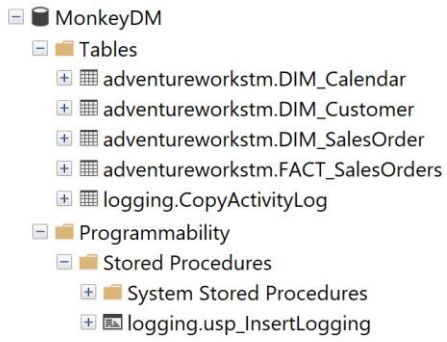
The other logging-table records the output from each 'processing stored procedure'. Each insert, update and delete is properly recorded:

Results Messages

	LogId	SourceName	ObjectName	Status	FileName	StartDateTime	EndDateTime	Duration	NumberOfInserts	NumberOfUpdates	NumberOfDeletes
1	12	AdventureWorks	SpecialOffer	Success	SpecialOffer_20190107112233.csv	2019-08-30 14:28:55.263	2019-08-30 14:28:55.263	00:00:00	0	1	0
2	11	AdventureWorks	SpecialOffer	Success	SpecialOffer_20190106112233.txt	2019-08-30 14:28:55.263	2019-08-30 14:28:55.263	00:00:00	16	0	0
3	10	AdventureWorks	SalesOrderHeader	Success	SalesOrderHeader_20190106112233.txt	2019-08-30 14:26:48.170	2019-08-30 14:27:14.170	00:00:26	31465	0	0
4	9	AdventureWorks	SalesOrderDetail	Success	SalesOrderDetail_20190106112233.txt	2019-08-30 14:21:38.273	2019-08-30 14:23:23.273	00:01:45	121317	0	0
5	8	Star Wars	Planets	Success	Planets_20190820112233.csv	2019-08-30 14:13:34.960	2019-08-30 14:13:35.960	00:00:01	61	0	0
6	7	AdventureWorks	Product	Success	Product_20190106112233.txt	2019-08-30 14:13:00.793	2019-08-30 14:13:00.793	00:00:00	504	0	0
7	6	AdventureWorks	Customer	Success	Customer_20190116112233.txt	2019-08-30 14:11:37.037	2019-08-30 14:11:46.037	00:00:09	0	0	6
8	5	AdventureWorks	Customer	Success	Customer_20190108112233.txt	2019-08-30 14:11:37.037	2019-08-30 14:11:43.037	00:00:06	0	3	0
9	4	AdventureWorks	Customer	Success	Customer_20190107112233.txt	2019-08-30 14:11:37.037	2019-08-30 14:11:41.037	00:00:04	0	4	0
10	3	AdventureWorks	Customer	Success	Customer_20190106112233.txt	2019-08-30 14:11:37.037	2019-08-30 14:11:39.037	00:00:02	1334	0	0
11	2	Star Wars	People	Success	People_20190820112233.csv	2019-08-30 14:08:22.767	2019-08-30 14:08:23.767	00:00:01	83	0	0
12	1	Star Wars	Movies	Success	Movies_20190820112233.csv	2019-08-30 14:06:52.743	2019-08-30 14:06:52.743	00:00:00	7	0	0

7 Data Mart (DM) objects

The DM objects will look like this:



The logging-table inside the DM database records all ADF Copy activities while populating the Data Mart. Invalid records are skipped, but recorded in this logging-table (see '*RowsSkipped*'):

Results Messages

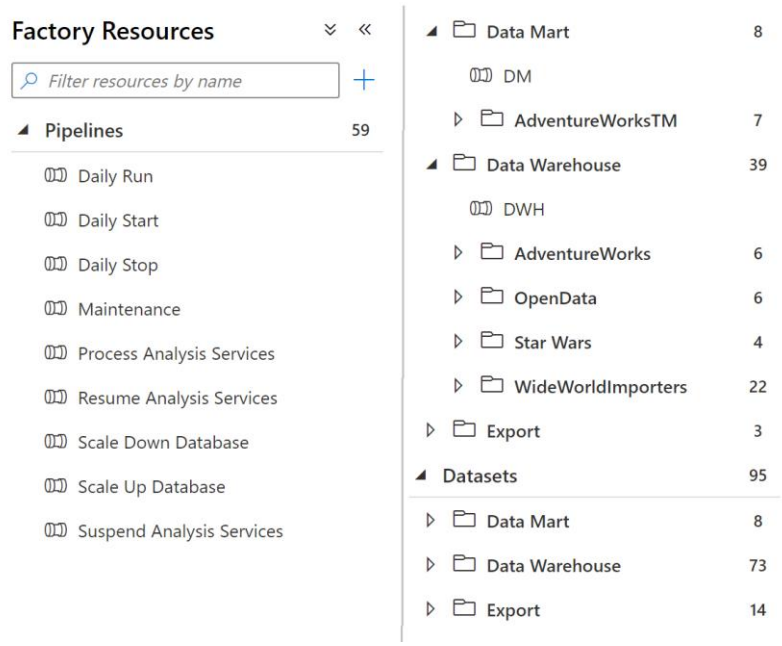
	LogId	SourceName	ObjectName	Status	StartDateTime	EndDateTime	Duration	RowsRead	RowsCopied	RowsSkipped
1	4	AdventureWorksTM	FACT_SalesOrders	Succeeded	2019-08-30 14:37:14.4466667	2019-08-30 14:40:35.4466667	00:03:21	31465	31465	0
2	3	AdventureWorksTM	DIM_SalesOrder	Succeeded	2019-08-30 14:36:16.2100000	2019-08-30 14:36:59.2100000	00:00:43	31465	31465	0
3	2	AdventureWorksTM	DIM_Customer	Succeeded	2019-08-30 14:35:51.3633333	2019-08-30 14:35:59.3633333	00:00:08	1341	1341	0
4	1	AdventureWorksTM	DIM_Calendar	Succeeded	2019-08-30 14:32:21.4700000	2019-08-30 14:35:33.4700000	00:03:12	10959	10959	0

8 Azure Data Factory

Azure Data Factory (ADF) is responsible for copying and processing all data in the Azure architecture.

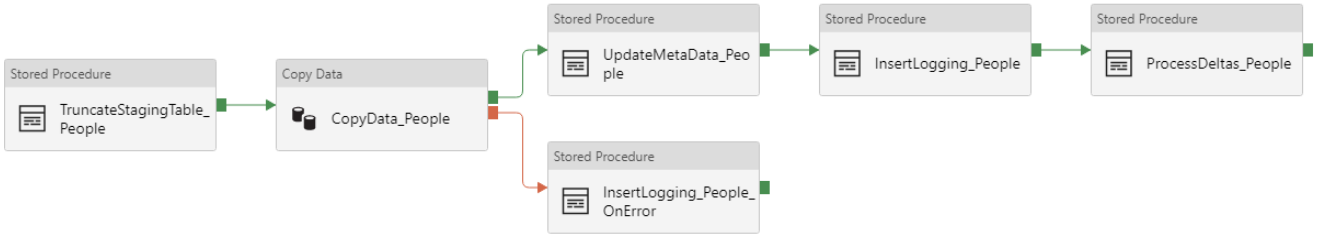
Over 80+ different types of so called 'connectors' are natively supported by ADF, but in most cases, only a handful are used. MonkeyDWH™ supports CSV-files, JSON-files, API's, Azure SQL databases, on-premise SQL databases and MySQL databases. Other types of sources can be added on request.

In the screenshot below, pipelines for DWH are generated for three different sample databases, namely PerformanceTest, Star Wars and WideWorldImporters. Pipelines for the AdventureWorks flat files (both CSV and TXT combined) are also included. The Data Mart (DM) contains a Fact and three Dimensions, all based upon four stored procedures as a source:



Database as a source

In comparison, the pipeline below shows the required activities to pull data out of a source database and process it properly in the DWH:

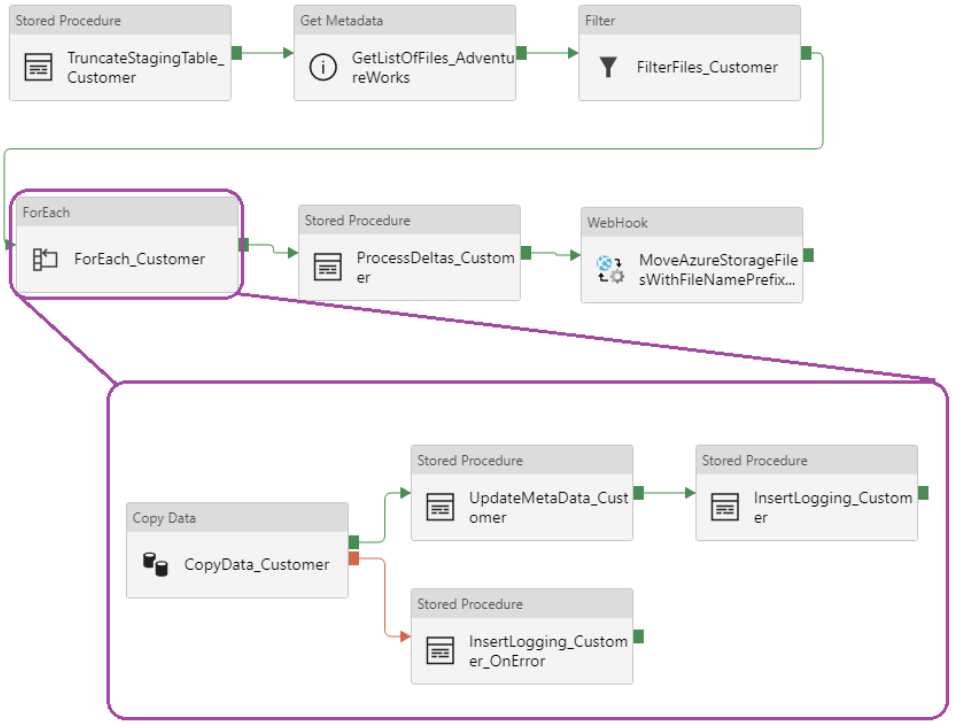


Event as a source

Event-driven architectures are becoming more and more mainstream, and processing such events within the Azure landscape, is also support by the MonkeyDWH™ solution. Events send by for example an Event Hub, Webhook or Event Grid Topic, will be handled by customized Logic Apps

Flat File as a source

An inside view of an ADF pipeline can be seen below. This pipeline consists of only native ADF activities and processes flat files:



9 Benchmark

The DWH has four processing methods (configurable per source table), namely:

- Bulk Import
- Inserts Only
- Inserts & Updates
- Inserts, Updates & Deletes

During this benchmark, a total of 44 million records were ingested from an Azure SQL database on a different SQL Server and Resource Group. Eight ADF pipelines ran in parallel, copying the data from to source to the sink tables and processing the data depending on the different methods. It took no more than 28 minutes and 55 seconds:

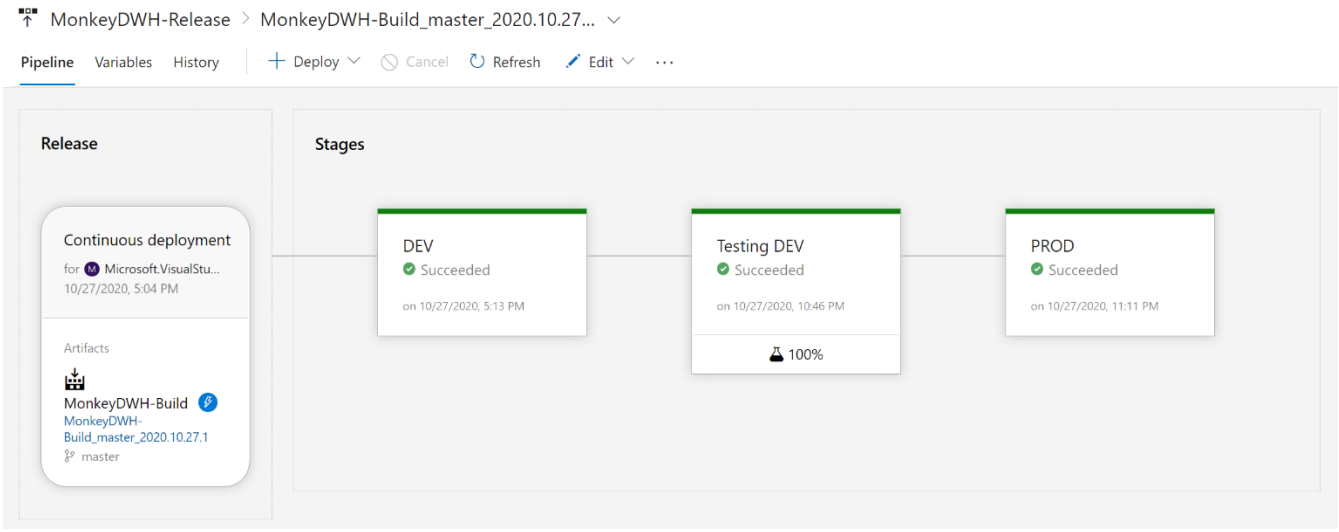
	1 million records		10 million records	
	Processing time	Total duration	Processing time	Total duration
Bulk Import	01:02	02:10	14:31	26:21
Inserts Only	00:59	02:15	12:33	24:25
Inserts & Updates	01:00	02:09	12:39	23:34
Inserts, Updates & Deletes	01:11	02:21	16:31	28:55

(Running in parallel on Gen5 - *General Purpose - GP_S_Gen5_4)*

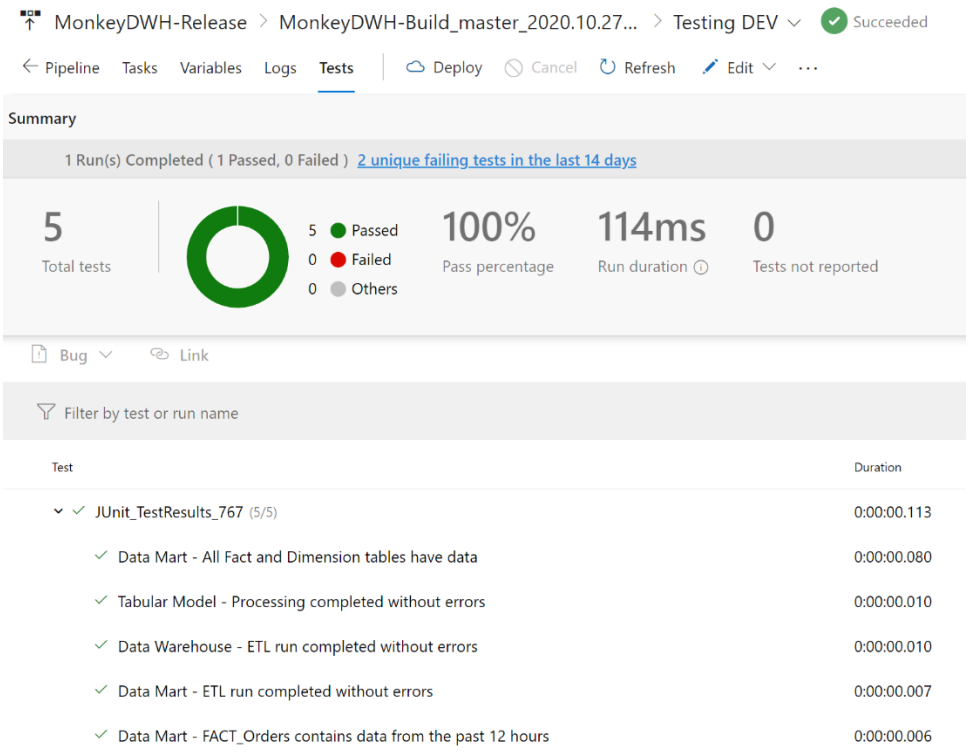
10 Azure DevOps (CI&CD) with automatic unit testing

The MonkeyDWH™ will be configured using Azure DevOps with Continuous Integration, Continuous Delivery or Continuous Deployment (CI/CD). Thanks to our automatic unit testing, we're able to implement Continuous Deployment to a Production-environment as seen below.

Azure DevOps Release Pipeline, including a stage for unit tests on the Development-environment:



The results of the unit tests:



11 Tooling

A solution which is future-proof and cloud native, means creating a solution which solely uses T-SQL coding in combination with meta-data, to generate all database- and ADF-objects.

Here's an overview of all tools:

About these tools:

- SQL Server is used locally for hosting the model database (for DWH and DM)
- Visual Studio will contain both database projects and also a project for the Analysis Services Tabular Model. This in combination with Git for code versioning
- Azure DevOps is used for building and releasing new code automatically (CI&CD)

12 License

The MonkeyDWH comes with a single license, namely:

MonkeyDWH™ perpetual license
This perpetual license for the MonkeyDWH™ (automation) framework allows the licensee to use all the generated Azure Data Factory and SQL Database objects.

13 Pricing

About the amount of peanuts…

License:

- MonkeyDWH™ perpetual license	€ 24.995,- (ca. € 695,- per month over 3 years)
- Azure & DevOps scripts	€ 4.995,-

Monthly costs:

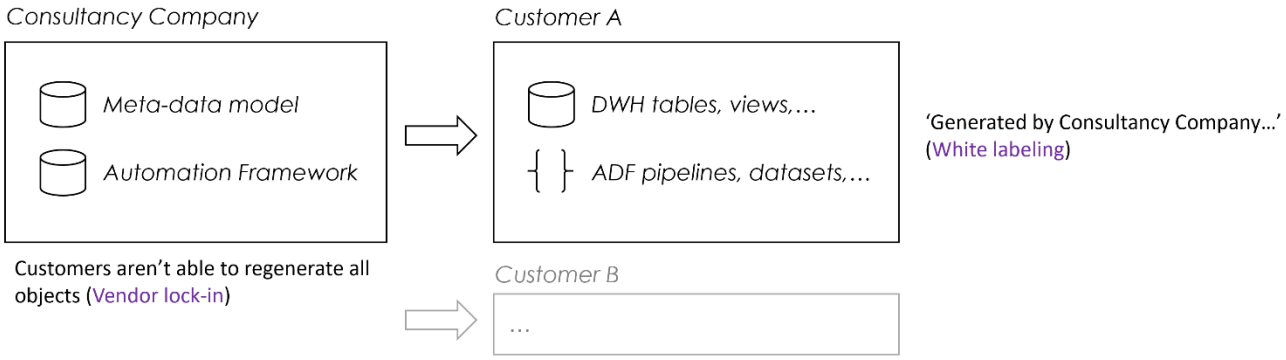
- Azure running costs (PROD & DEV)	€ 1.400,- *

Additional consultancy services:
- Custom development or configuration
- Daily morning checkups
- Azure & DevOps training courses and workshops

* This estimation is based on two environments (DEV & PROD) with 50GB of compressed data in the DWH, a daily load of 5GB and an Azure Analysis Service (PROD) scaled at Standard S0.

14 White labeling

MonkeyDWH™ is available for consultancy firms as a white label, in which the end product (in this case ADF- and database objects) are rebranded:



More info about white labeling can be found here (Dutch).

15 Planning

Within a week, the new Azure & DevOps architecture is fully configured with sample data(bases):

Week 1:
- Setting up and configuring Azure
- Implementing Azure DevOps Build- and Release-pipelines for CI&CD
- Adding the first source to the MonkeyDWH™

Week 2:
- Adding additional sources to the MonkeyDWH™

Week 3:
- Creating the first Facts and Dimensions for the Dimensional Model (DataMart) and cube

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Initial setup of Azure & DevOps															
Adding Source #1															
Adding Source #2															
Adding Source #3															
Adding Source #4															
Creating the first Fact's and Dim's															
Training internal employees															

Knowledge and Skill Requirements:
Minimum set of skills to operate: common BI/DWH knowledge
(e.g. DWH, SCD, Dimensional modelling, Business Keys, T-SQL and Hashes)

16 Questions & Answers

Q) Why use a SQL database resource instead of Azure Synapse on Azure?

A) Most of our customers have far less than 100GB of compressed data. An Azure SQL database is ideal for these type of volumes, when looking at supported database features and low runtime costs. Azure Synapse Analytics (also known as an Azure SQL DWH) is more practical when dealing with at least 2,0TB of compressed data[1].

Q) When our compressed data volume exceeds 2,0TB, are we able to switch to Synapse Analytics instead?

A) Yes, but the current version of the MonkeyDWH™ solution doesn't natively support Azure Synapse Analytics. Different objects (especially indexes, partitions and queries) will need to be generated.
An important fact is that the maximum compressed data volume for the DWH on Business Critical is 4,0TB, but with Hyperscale up to 100TB of storage can be allocated.

Q) Are we able to export data from the DWH to flat files?

A) Yes, the MonkeyDWH™ solution has an export functionality, which extracts data from various database source types (e.g. Azure SQL-, On-premise SQL- and MySQL- databases) and export this data to flat files. This functionality can be configured to export data from the DWH to CSV-files stored on an Azure File Share for example.

Q) Is it possible to include a Data Lake in the architecture?

A) Yes, with use of the export functionality (mentioned above), you're able to export data directly to a Data Lake. Importing data from Azure Data Lake Storage is possible with minimal custom development using Azure Data Factory Data Flows for example.

Q) Does the MonkeyDWH™ solution support the generation of a Data Vault 2.0 model?

A) No, not by default, but this would be possible with custom development.

Q) Where are all business- and transformation-rules located within the DWH?

A) The Data Factory pipelines execute stored procedures, which extract 'raw' data from the DWH tables and apply business- and transformation-rules towards a dimensional model.

Q) Is it possible to add an additional source type?

A) Yes, this is very much possible with minimal custom development.

[1] For more info, please visit: https://stackify.com/azure-sql-database-vs-warehouse/ and https://www.blue-granite.com/blog/is-azure-sql-data-warehouse-a-good-fit-updated/

17 About Monkey Consultancy B.V.

http://www.monkeyconsultancy.nl/

Monkey Consultancy is specialized in designing, generating and managing Data Warehouse (DWH) architectures on Azure. Especially combining these new architectures with Azure DevOps for being able to automatically build and release new versions of code. All Azure environments, combined with fully operational Azure DevOps (CI&CD) processes will be handed over to new customers in just a few weeks.

Over the past few years, we've shared our passion via the Monkey Update, a monthly newsletters about SQL Server, Microsoft BI, Azure, Azure DevOps and Power BI. Currently having 295 opt-in subscribers, a proud achievement.

With over 13 years of experience within the Microsoft BI competence, we've done business with:

18 Contact information

Questions or interested in a live demo?
Please feel free to contact:

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