From SAS® Data Management to Big Data Appliances: How SAS/ACCESS® Makes Life Easier
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ABSTRACT

In the fast changing world of Data Management, new technologies to handle increasing volumes of (big) data are emerging every day. Many (large) companies are struggling in dealing with these technologies and more importantly on integrating them in their existing data management processes. Moreover, they also want to rely on the knowledge built by their teams in existing products and implementing change to learn new technologies can therefore be a costly procedure.

SAS® is perfectly fitting in this situation by offering a suite of software that can be set up to work with any third-party database through the usage of the corresponding SAS/ACCESS®. Indeed, for every new database technology SAS® is releasing a specific SAS/ACCESS® allowing users to develop and migrate SAS® solutions almost transparently. Only few techniques have to be known by your users to combine the power of SAS® with a third-party (big) database.

This paper will help companies on dealing with the integration of rising technologies in their current SAS® Data Management platform using SAS/ACCESS®. More specifically the focus will be on best practices, coming from project experiences, to succeed such an implementation integrating SAS® Data Management with the PureData for Analytics Appliance as an example.

INTRODUCTION

Volume of data to manage today is becoming bigger and bigger and its generation rate is increasing very rapidly. To illustrate this fact, we can tell that 90% of all the data in the world has been generated over the last 2 years¹. New technologies are developed to help companies handle this huge volume of data. Amongst them, the Massively Parallel Processing (MPP), enabling splitting data and queries across a large number of nodes in order to perform simultaneous computation.

MPP technology allows Extract-Transform-Load (ETL) processes and Analytics to run faster; solving the case when execution time is becoming too big for the windows time frame allowed. Furthermore, companies can now integrate new data generated outside their organization and combine them to their data warehouse that was historically containing inside generated data only. This integration enables companies to discover new business facts and opens new opportunities by analyzing data (e.g. recommendation system based on clickstream analytics, review engine to capture shopping experience,… ). Some current MPP technology available on the market are IBM PureData for Analytics appliance (previously named Netezza), Oracle Exadata, Teradata…, etc.

When companies are investing in this kind of technology, they want to switch system quickly without too much affecting what has already been done during the past years. SAS® is providing an easy way of migrating SAS® development between data sources: SAS/ACCESS® software. It is a way to read, write and update data stored on a third-party data source transparently as if it was a native SAS® source. Some best practices and specifics setup have to be applied to leverage the computing power of the third-party data source. This paper will explain them by using the PureData for Analytics appliance as an example (historically named Netezza).

¹ SINTEF: ScienceDaily. 22 May 2013 Available at https://www.sintef.no/en/news/big-data--for-better-or-worse/
IN-DATABASE PROCESSING – BEST PRATICE

When implementing in-database processing tasks, some specific aspects of the data flow have to be taken into account. Indeed, when you are working with a third-party database, you would like to avoid overwhelming your network with unnecessary data transfer, especially with big (volume of) data. By using the related SAS/ACCESS®, SAS® will automatically convert tasks into SQL code that is compliant with your third-party database.

In some condition, covered later on this paper, code cannot be converted. In this case, data will be downloaded on the SAS® server where the data transformation will take place before pushing-back the entire dataset to the third-party database.

To avoid these unnecessary Input/Output (I/O) the following best practices should be followed:

- Use an explicit pass-through SQL code when a task cannot be converted automatically into a database specific SQL code.
- Avoid unnecessary I/O between your SAS® server and your database: redirect your SAS® work by using a third-party database library, letting it to be the physical host of your datasets.
- Leverage the bulkload capabilities of your third-party database. Especially in case of a Big Data appliance like PureData for Analytics that is not optimized for single update or insert. Instead of doing a single update/insert, delete all rows that you want to update and append them using bulkload.
- While developing your tasks make sure that you use the database specific SQL functions.

Best practice to leverage in-database processing is to implement Extract-Load-Transform (ELT) flows instead of ETL (see Figure 1).

- Extract:
  - Access any data source or system.
  - Efficiently extract only the data needed.
- Load:
  - Stage data inside a database platform.
  - Utilize high-speed loaders to load data fast.
- Transform:
  - Transform inside the database.
  - Use database specific SQL, user defined functions, etc.
  - Leverage the database resources.

Figure 1: Processing differences between ETL and ELT using SAS/ACCESS®
SAS/ACCESS® USAGE IN SAS® BASE

SAS/ACCESS® has two faces using either an implicit pass-through or an explicit one based on the SAS® SQL pass through facility.

Implicit pass-through is automatically generating database specific SQL statements that which are submitted to the third-party database for processing. This is leveraged by the SAS® LIBNAME engine:

```
LIBNAME libref ENGINE <connection-options> <LIBNAME-options>;
```

Explicit pass-through allows SAS/ACCESS® to send SQL queries directly to the third-party database for processing. This is done by writing PROC SQL CONNECT, EXECUTE statements:

```
PROC SQL;
   CONNECT to ENGINE (<connection-options>);
   EXECUTE ( query ) BY ENGINE;
   DISCONNECT FROM ENGINE;
QUIT;
```

**IMPLICIT VS EXPLICIT PASS-THROUGH**

Implicit pass-through is the key component of a migration; it will automatically convert what has already been done into a database specific SQL statement. However not all SAS® functions and procedures can be converted. You must check the list of supported function and procedures related to your SAS/ACCESS® engine.

Explicit pass-through is not interpreted by SAS® and will be directly sent to the third-party database for execution. Therefore you cannot use any SAS® specifics statements in your code. Figure 2 summarizes existing differences between the two pass-through methods.

<table>
<thead>
<tr>
<th>Implicit pass-through</th>
<th>Explicit pass-through</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Use the LIBNAME engine.</td>
<td>• Use the PROC SQL CONNECT – EXECUTE statements.</td>
</tr>
<tr>
<td>• Use the various DBMS data types and translate them into SAS formats.</td>
<td>• The SQL query has to be able to work AS-IS in the database.</td>
</tr>
<tr>
<td>• SAS attempts to generate a database specific SQL query that will be executed in-database.</td>
<td>• Database will generates errors if a query contains anything SAS specifics:</td>
</tr>
<tr>
<td>• Not all SAS functions and procedures can be converted to DBMS-specific syntax. As example, Netezza engine supports:</td>
<td>• SAS formats.</td>
</tr>
<tr>
<td>• 48 SAS functions</td>
<td>• SAS functions.</td>
</tr>
<tr>
<td>• 7 SAS procedures</td>
<td>• DATE or DATETIME actual numeric values.</td>
</tr>
<tr>
<td></td>
<td>• INTO: macro variable.</td>
</tr>
<tr>
<td></td>
<td>• Dataset options</td>
</tr>
<tr>
<td></td>
<td>• Using multiple librefs.</td>
</tr>
</tbody>
</table>

Figure 2 Summary of differences between implicit and explicit pass-through
Explicit pass-through example – Stored Procedure

As shown on Figure 3, a useful use case of coding a SQL explicit pass-through is when you need to call a stored procedure.

![Figure 3 Example of a stored procedure call](image)

**LIBNAME OPTIONS**

Here is an example of PureData for Analytics libname statement:

```sql
LIBNAME nz NETEZZA DATABASE='SANDBOX' SERVER='XX.XX.XX.XXX' SCHEMA='admin' USER=admin PASSWORD='XXXXX';
```

Besides, we will see in the following sections some useful libname options which will be applied to each tables registered in this library.

**SQL functions**

By default, the implicit pass-through is converting a subset SAS® functions into a database specific SQL statement. Setting the libname option `SQL_FUNCTION=ALL` allows you to use all existing functions.

However, pay attention as this extended set of functions can work differently than expected. This is especially true for every date and time functions that could be handled differently depending of your third-party database.

**Unload data**

By setting the libname option `BULKUNLOAD=YES` you will leverage the external table facility which is the fastest way to unload data from PureData for Analytics.

Although, you want to process tasks in-database as much as possible, some of them will request to unload data to the SAS® server. Nevertheless, this option will optimize the unloading speed performances.

**Execute in-database**

`DIRECT_SQL=YES` libname option is pushing in-database processing all the generated SQL from PROC SQL statements that is the default behavior of the Netezza engine. Table 1 is showing the different values that can be passed to this libname option to prevent in-database processing. Therefore, the in-database execution of the generated SQL code can be fine-tuned depending of the situation.
NO or NOGENSQL | Generated SQL from PROC SQL is not passed for processing.
NONE | Generated SQL from PROC SQL, SAS functions, joins and WHERE is not passed for processing.
NOWHERE | WHERE clauses from SAS data step, generated and explicit PROC SQL are not passed for in-database processing.
NOFUNCTIONS | SQL containing functions are not passed.
NOMULTOUTJOINS | Multiple outer joins are not passed; other type of joins are still passed.

Table 1 DIRECT_SQL options

DATA STEP AND PROCEDURE OPTIONS

SAS/ACCESS® also allows users to specify options to be applied to specific tables only. The scope of these options is local to the table unlike to the libname ones having a global scope.

As shown on Table 2, local options are specified either in a SAS® data step or in a procedure.

<table>
<thead>
<tr>
<th>Data Step</th>
<th>PROC SQL</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATA tablename(&lt;options&gt;);</td>
<td>PROC SQL;</td>
</tr>
<tr>
<td>SET tablename;</td>
<td>CREATE TABLE tablename (&lt;options&gt;) AS</td>
</tr>
<tr>
<td>RUN;</td>
<td>SELECT *</td>
</tr>
<tr>
<td></td>
<td>FROM tablename;</td>
</tr>
<tr>
<td></td>
<td>QUIT;</td>
</tr>
</tbody>
</table>

Table 2 Usage of SAS® options in a data step or procedure

Loading data

Similarly to the bulkunload libname option, the dataset option BULKLOAD=YES leverages the bulkload facility by using external table to load data into the database at the fastest throughput allowed by your network.

The next sections will present the following other useful options to manage the loading and unloading behavior. Output 1 shows how the loading options are used during the in-database processing.

data nz.bulkload_nz_table(BULKLOAD=yes BL_USE_PIPE=NO BL_DELIMITER=',', BL_OPTIONS="maxerrors 100");

set sasdata.input_table;
run;

NETEZZA: COMMIT performed on connection 2.
NOTE: There were 366 observations read from the data set SASDATA.input_table.
NOTE: The data set nz.BULKLOAD_NZ_TABLE has 366 observations and 73 variables.

NETEZZA_3: Executed: on connection 2
INSERT INTO SANDBOX.ADMIN.BULKLOAD_NZ_TABLE SELECT * FROM EXTERNAL 'BL_INPUT_TABLE_8040E521-AC86-40C4-96C2-A0715672581B.dat' USING (DELIMITER ',', REMOTESOURCE 'ODBC' NULLVALUE '' maxerrors 100)

Output 1 In-database generated code
*Column delimiter*

The default delimiter used by the bulk(un)load facility differs between third-party databases. In the case of PureData for Analytics datasource the default delimiter used is the pipe symbol ("|").

As illustrated by Figure 4, an error occurs when your data contains the default character delimiter. To avoid this error, you will need to override it by using the dataset option `BL_DELIMITER='<char_delimiter>'`.

![Figure 4 Error due to the BL_DELIMITER default value in SAS® Data Integration Studio](image)

*Pipe usage*

By default, bulk(un)load facilities are using a named pipe to transfer data between SAS® and the third-party database. If your dataset can contain null values then you need to use the `BL_USE_PIPE=NO` option to avoid getting an error due to consecutives delimiter.

This option will force SAS/ACCESS® to use flat file to transfer data instead of a named pipe.

*Loading options*

The `BL_OPTIONS=` allows you to specify specific loading of options used by the third-party database. It’s used as the following: `BL_OPTIONS='option <…, option>'`.

Table 3 shows some of the most used loading of options for the PureData for Analytics appliance.

<table>
<thead>
<tr>
<th>Option</th>
<th>SQL</th>
</tr>
</thead>
<tbody>
<tr>
<td>AllowReplay</td>
<td>MAX_QUERY_RESTARTS</td>
</tr>
<tr>
<td>DateDelim</td>
<td>DATEDELIM</td>
</tr>
<tr>
<td>DateStyle</td>
<td>DATESTYLE</td>
</tr>
<tr>
<td>DecimalDelim</td>
<td>DECIMALDELIM</td>
</tr>
<tr>
<td>Encoding</td>
<td>ENCODING</td>
</tr>
<tr>
<td>MaxErrors</td>
<td>MAXERRORS</td>
</tr>
<tr>
<td>MaxRows</td>
<td>MAXROWS</td>
</tr>
</tbody>
</table>
Create table options

When creating tables via SAS/ACCESS®, some database specific options can be added to the generated create table statement. This is done by using the option `DBCREATE_TABLE_OPTS='<options>'`. For example, PDA is based on a MPP architecture, so to avoid data skew, while creating a table, it is essential to specify a distribution key. Table 4 shows how to use it.

<table>
<thead>
<tr>
<th>Data Step</th>
<th>PROC SQL</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATA nz.USER (BULKLOAD=YES DBCREATE_TABLE_OPTS='DISTRIBUTE ON (AGE)'); SET sasdata.USER; RUN;</td>
<td>PROC SQL; CREATE table nz.USER (BULKLOAD=YES DBCREATE_TABLE_OPTS='DISTRIBUTE ON (AGE)') as (select * from sasdata.USER); QUIT;</td>
</tr>
</tbody>
</table>

Table 4 Distribution key passed to PDA via a SAS® option

Additionally, a specific SAS/ACCESS® for Netezza option exists to specify directly the distribution key of a table: `DISTRIBUTE_ON='<key1, key2/ random>'`.

Handling null values

PDA is handling NULL values differently than SAS®. Indeed, for PDA two NULL values do not have the same internal representation and are therefore not equal. This behavior becomes an issue when joining tables having NULL values.

SAS/ACCESS® is providing two options to handles missing values: `NULLCHAR=` and `NULLCHARVAL=`. By setting `NULLCHAR=NO` it will force NULL values stored in SAS® datasets to be treated as a character or string specified in the option `NULLCHARVAL='<character>'`.

SYSTEM OPTIONS

SASTRACE and SASTRACELOC are very useful system options which enable a user to see what is really happening on the third-party database regarding the execution but also the submitted generated code.

```
OPTIONS SASTRACE=','",d' SASTRACELOC=SASLOG NOSTSUFFIX;
```

Output 2 shows an example of how an error can be interpreted by using the output of sastrace.

```
Netezza_20: Executed on connection 4
CREATE EXTERNAL TABLE '/tmp/tablename' using(DELIMITER '|' REMOTESOURCE 'ODBC' NULLVALUE '') AS SELECT ... ERROR: CLI open cursor error: ERROR: found delim '|' in a data field, specify escapeChar '\' option in the external table definition.
```

Output 2 SASLOG output generated by the SASTRACE system option
Explanation of the log: in-database processing cannot be executed, so an external table is created to download data on the SAS® server. The default delimiter (pipe) is used but this character is found in one of table columns.

To fix this use, if it is not possible to modify the code to push it for in-database processing, then data will have to be unloaded properly by using the bl_delimiter option to specify another character delimiter that does not exist in your data.

LEVERAGING SAS/ACCESS® IN SAS® DATA INTEGRATION STUDIO

SAS® Data Integration Studio is a visual design tool for building, implementing and managing data integration processes regardless of data sources, applications, or platforms.

In other words, it allows you to create ELT (or ETL) processes without having to write SAS® base code (or a minimal amount). This software will automatically generate specific database SQL statement based on the table library used at each step leveraging SAS/ACCESS® capabilities.

All the options seen in the previous sections are re-usable in this tool. This section focuses on how to set-up and leverage the best performances of SAS/ACCESS®.

BEST PRACTICES IMPLEMENTATION

As a reminder, best practice is to create ELT data flow by making sure that each step will be executed in-database. SAS® Data Integration Studio has a useful button to perform this check (Figure 5).

A little “N” (standing for Netezza) marks transformations that will be executed in-database on the upper right corner.

Figure 5 In-database processing check

The remainder of this section will focus on how to implement the ELT best practices with SAS® Data Integration Studio:

1. Redirecting the SAS® work to a third-party database library. The global option can be setup under Tools > Options > Code Generation tab and redirect the SAS® work to a third-party database

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2 http://support.sas.com/software/products/etls/
library (Figure 6).

Figure 6 Redirect the SAS® work

This redirection of the default SAS® work to a third-party database library will affect every transformation added to jobs. Intermediary results will be stored in an automatically created third-party table or view.

2. Leverage the bulkload capabilities of your third-party database. Do not perform single update or insert but instead delete all the rows that you want to update and append them using bulkload. The table loader transformation holds the little “N” showing that it will be executed in-database (Figure 7).

Figure 7 Implement bulkload instead of single update or insert
3. To push in-database processing the SQL generated code, use database specific SQL functions in the transformation as shown at Figure 8.

![Figure 8 select the database specifics functions](image)

4. When joining table make sure to push SQL join in database processing by setting up the option in: **Join Properties > Pass Through > Yes** (Figure 9). As the generated SQL code will be directly send to the third-party database, pay attention not to use any SAS® specific functions in the expression builder.

![Figure 9 In-database processing of SQL join](image)
LIBNAME OPTIONS

The libname options explained at previous sections can be setup under libname properties: Options > Advanced Options > Other Options > Option(s) to appended (Figure 10). Resulting libname statement can be seen with a right click on the libname > Display LIBNAME (Figure 11).

Figure 10 Setting up the libname options

Figure 11 generated libname statement

DATA STEP AND PROC SQL OPTIONS

The SQL transformation named “Create Table” can be used to create a third-party database table. No database specific options will be send to the database. Therefore, the following option has to be set to “No”: Options > Database pass-through > SQL pass-through.

Figure 12 shows an example of how the proc sql options can be used to create and load data in a table. These options are located on Table Options > Select the output table > General. Figure 13 shows the code automatically generated by SAS® and the translated code sent for execution to the third-party database.

Note that, alternatively, the bulkload option can be set to “Yes” in: Options > General > Bulkload.

Figure 12 Create table options
Similarly, the “Table Loader” transformation can be parametrized with loading options in: Options > Loader > Additional data table options. As seen previously, no database specific options will be sent, so Options > Additional Options > Use the optimized pass-through facility for SQL statements has to be set to “No”.

**SYSTEM OPTIONS**

System options can be specified on global scope for a job in job Properties > Options > General (Figure 14).
It can also be specified for a transformation in transformation Properties > Options > Additional Options > System options (Figure 15).

Figure 15 System options applicable to a transformation

CONCLUSION

SAS/ACCESS® is providing an automatic translation of the SAS® code. Therefore, SAS® users can rely on their knowledge and SAS® developments are back-end independent. Indeed, the only extra knowledge needed is a set option and how to combine them to fine-tune the in-database processing. Nevertheless, explicit pass-through SQL code can be sent to the third-party database.

REFERENCES


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