SQL SERVER 2016

SSAS Monitoring and Performance Tuning with Extended Events

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Microsoft Certified
- MCSE Business Intelligence
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Microsoft SQL Server

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1. SSAS Performance Optimization 10K Foot View

2. Profiler vs Extended Events

3. SQL Server Instance QueryLog Properties

4. SQL Server 2016 Profiler & Extended Events Demos

5. Interpreting Extended Events Data

6. Extended Events Integration with SSIS Demo

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Out of Scope

Everything not SSAS Query Logging

- — Page Splits
- — Uncommitted Transactions
- — Wait Statistics
- — Latches
- — Error Sessions

http://www.jasonstrate.com/extended-event-resources/

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http://www.jasonstrate.com/extended-event-resources/

Recommended Reading: Expert Cube Development … by Chris Webb, Alberto Ferrari and Marco Russo (hyperlink in photo)

Partitions: Why do we care?

1.   Impacts cube processing speed

2.   Impacts end-user query response times

3.   Allows you to archive old data

Aggregations: Why do we care?
1.   Aggregations are a shortcut to acquiring a SUM() or a COUNT(). Think of aggregations as pre-calculated totals.

2.	Correctly designed aggregations = better query performance

Notes:

1.	**Hierarchies**

2.	**Partitions**

   a.	Create at least 4GB equal-size partitions

   b.	Align partitions with source system partitions

   c.	Match the partitions slice property with the WHERE clause

   d.	Sort data for best compression

   e.	Only reprocess the current partition

3.	**Aggregations**

   a.	Create usage-based aggregation designs

   b.	Do not exceed 1/3 the size of the partition

   c.	Place aggregations on attributes used in hierarchies

4.	**MDX**

   1.	Exhaust all other options for business logic

   2.	Test and Optimize!
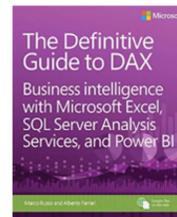
Recommended Reading: (hyperlinks in photos)

1. Definitive Guide to DAX by Alberto Ferrari and Marco Russo

2. DAX Patterns by Marco Russo, Alberto Ferrari and Daniele Perilli

3. www.daxpatterns.com

4. Performance Tuning of Tabular Models → https://msdn.microsoft.com/en-us/library/dn393915.aspx

Performance Tuning Tabular 2012 Models → https://msdn.microsoft.com/en-us/library/dn393915.aspx

Please review Rachel Martin's PPTX on optimizing PowerPivot / tabular models. Her slide deck is not copied here.

Original Kasper de Jonge's Server Memory Report for Excel 2013 → http://www.kasperonbi.com/what-is-using-all-that-memory-on-my-analysis-server-instance/

See **Extended Events** slide for troubleshooting long running queries.

Please read **chapters 13, 14, 15 & 16** of Alberto Ferrari and Marco Russo's book, The Definitive Guide to DAX: Business Intelligence with Microsoft Excel, SQL Server Analysis Services, and Power BI →
https://books.google.com/books/about/The_Definitive_Guide_to_DAX.html?id=sJm9CgAAQ BAJ&source=kp_cover&hl=en

Note: It is useless to have two or more sockets on the same server as SSAS Tabular does not recognize the NUMA architecture which splits memory between different sockets.

From https://msdn.microsoft.com/en-us/library/ms174514.aspx

HardMemoryLimit → threshold at which Analysis Services begins rejecting requests outright due to memory pressure.

LowMemoryLImit → IS APPLICABLE TO TABULAR. The MSDN write up is misleading. You have to read the entire article. Set LowMemoryLimit to about 80% OR LESS of the TotalMemoryLimit.

TotalMemoryLImit → An upper threshold at which Analysis Services begins releasing memory more aggressively to make room for requests that are in execution as well as new high priority requests.

VertiPaqMemoryLimit → For tabular instances, a lower threshold at which the server first begins releasing memory allocated to infrequently used objects.

Delora's notes on tabular memory settings

VertiPaqMemoryLimit

> Controls maximum amount of memory that can be used by VertiPaq objects (dictionaries and segments)

> If we turn VertiPaq paging on, the VertiPaq memory limit defaults to about 60%

If the VertiPaqMemoryLimit passes above the LowMemoryLimit, SSAS will start cleaning out the cache

> If memory usage climbs, cache cleaning will become more aggressive.

If memory passes above TotalMemoryLimit (default 80%), all caches not in use are cleaned out

Set LowMemoryLimit to about 80% OR LESS of the TotalMemoryLimit

HardMemoryLimit -- if memory exceeds this limit, active sessions will be cancelled in an attempt to get below the HardMemoryLimit;

> defaults to 0 (is 1/2 way between the TotalMemoryLImit and server memory limit)

> If there are 10GB on the server, and TotalMemoryLimit is set to 8GB, the HardMemoryLimit will set to 9GB

Do not set TotalMemoryLimit close to the physical memory on the machine b/c by the time you trigger the HardMemoryLimit, the gab is too narrow

Slide notes:

1. In tabular models, **cardinality** reigns supreme. Denormalization and parsing columns into multiple columns are two possible solutions to columns with high cardinality (columns containing multiple unique values, like string comments).

2. Set your LowMemoryLimit to 80% OR LESS of the TotalMemoryLimit (which defaults to 80% of total server memory)

3. Hardware priorities

   1. CPU clock speed of 3 GHz or more
   2. Memory speed of 1833, 2133 or 2400 MHz
   3. Number of cores
   4. Memory size used to store the entire DB, execute process operations, and execute queries.

Effects of clearing the cache for tabular models and MultiD cubes →
https://msdn.microsoft.com/en-us/library/hh230974.aspx

Performance Tuning Tabular 2012 Models → https://msdn.microsoft.com/en-us/library/dn393915.aspx

Please review Rachel Martin's PPTX on optimizing PowerPivot / tabular models. Her slide deck is not copied here.

Original Kasper de Jonge's Server Memory Report for Excel 2013 →
http://www.kasperonbi.com/what-is-using-all-that-memory-on-my-analysis-server-instance/

Notes:

1.   Push as much **business logic** as possible to the data model. Just because you can calculate it in DAX does not mean you should. Both DAX and MDX should be considered a solution of last resort.

2.   End user **query performance** trumps all. You often will incur additional ETL work and longer model processing times to speed query times.

3. Both DAX and MDX can often be written in more than one way and yet achieve the same output. Look at query durations via **Extended Events** and focus on optimizing the long-running queries.

4. Align database **partitions** with model partitions for faster processing.

5. Consider accumulating and periodic **snapshot fact tables** to speed up in-memory report writers

6. Warm the cache after cube processing so the first user of the day does not have to wait for their personal query to warm the cache for everyone.

Performance Tuning 10K Foot View

MultiD Cache
- Built in the formula engine when evaluating calculations
- Built in the storage engine for results of queries

Tabular Cache
- Models are stored in memory (or direct query)
- Aggregations and calculations are performed at query time
- Exists as a result of MDX queries

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https://msdn.microsoft.com/en-us/library/hh230974.aspx

Features Not Supported in the Next Version of SQL Server →

https://msdn.microsoft.com/en-us/library/ms143729.aspx

Notes:

1. Monitor user logins, durations and execution count

2. Understand and correct Slow Running Queries

   1. Storage Engine

   2. Query Engine

3. Warm the Cache: this applies to MultiD. (You can clear the cache of a tabular model, but there is little point to warm the cache.)

SQL Server 2016 Profiler

1. Being deprecated by Microsoft

2. The fastest way to log SSAS query activity for immediate analysis

3. Footprint is "heavier" than Extended Events, so not the best solution for scheduled logging

4. In **Event Selection** window, be sure to **Show All Properties** and select the events used by SSAS

Features Not Supported in the Next Version of SQL Server →

https://msdn.microsoft.com/en-us/library/ms143729.aspx

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SQL Server 2016 Extended Events

1. Not a new SQL 2016 feature. You could use XMLA in earlier SQL versions.

   https://blog.crossjoin.co.uk/2012/05/05/using-xevents-in-ssas-2012/

2. Graphical user interface in SSMS is a new 2016 feature.

3. Currently you can only add, not edit EE via SSMS

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Chris Webb's BI Blog, **Using Xevents in SSAS 2012** →
https://blog.crossjoin.co.uk/2012/05/05/using-xevents-in-ssas-2012/

Query Logging

1. Designed for use by SSAS multidimensional cube usage based aggregations

2. SSAS tabular model activity is not logged here

3. Does not contain an actual SELECT statement

Log \ QueryLog \ CreateQueryLogTable
Log \ QueryLog \ QueryLogConnectionString
Log \ QueryLog \ QueryLogSampling
Log \ QueryLog \ QueryLogTableName

TABULAR
Query Logging

1. As of SQL Server 2016 CU1, it is possible to configure query logging in Properties of the tabular 2016 instance, but tabular query metadata is never written to the specified log table.

Log \ FlightRecorder \ Enabled	true	
Log \ QueryLog \ CreateQueryLogTable	true	
Log \ QueryLog \ QueryLogConnectionString	Provider=SQLNCLI11.1;...	
Log \ QueryLog \ QueryLogSampling	1	
Log \ QueryLog \ QueryLogTableName	SSASQueryLog	

2. To capture tabular query detail there are at least five options:
    a. **Capture via Extended Events (preferred), Import to SQL Server via SSIS and report via SSRS**
    b. DMVs and SSIS
    c. Activity Viewer from CodePlex
    d. SQL Profile Trace (not a long-term solution) and SSIS
    e. ASTrace2012 from CodePlex, but not written for SQL 2016 yet

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Please see DTSX file named **Warm the SSAS Cube Cache.dtsx**. This is a SSIS package from another PW client, but it contains tasks for stopping, importing data, and restarting extended events.

Using DMVs to Monitor SSAS → https://msdn.microsoft.com/en-us/library/hh230820.aspx

Activity Viewer and ASTrace2012 via CodePlex → http://sqlsrvanalysissrvcs.codeplex.com/

Note: The SSAS logging properties were originally intended for multidimensional cubes with the intent of creating usage-based aggregations from the log. Tabular models do not have pre-processed totals / aggregations, so the use of the query log would only be to see User Ids and query durations.

MULTIDIMENSIONAL: ANALYZING MDX QUERY PLANS
Extended Events

1. Key Multidimensional Extended Events
   - Progress Reports \ Progress Report Begin
   - Progress Reports \ Progress Report End
   - Queries Events \ Query Begin
   - **Queries Events \ Query End**
   - Query Processing \ Execute MDX Script Begin
   - Query Processing \ Execute MDX Script End
   - Query Processing \ Get Data From Aggregation
   - Query Processing \ Query Cube Begin
   - Query Processing \ Query Cube End
   - Query Processing \ **Query Subcube**
   - **Query Processing \ Query Subcube Verbose**
   - Query Processing \ Resource Usage

2. Use to trouble-shoot and retest long-running queries

3. Be sure to clear your cache!

Query Duration = SUM([duration] of Query End event)

Storage Engine Duration = SUM([duration] of Query Subcube event)

Formula Engine Duration = (Query Duration) − (Storage Engine Duration)

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RMC = Right Mouse Click

```
<ClearCache xmlns="http://schemas.microsoft.com/analysisservices/2003/engine">
     <Object>
          <DatabaseID>MySSASdatabaseName</DatabaseID>
     </Object>
</ClearCache>
```

Query Subcube Verbose

[Dimension Name] (0,0,0) = there are 3 attributes in the [Dimension Name]

0 = default member was returned

* (star) = all members were returned for the attribute. Scroll right and the * (star) should appear by a particular attribute

A specific number = a specific member is being returned (the data ID, not the key value)

+ (plus) = greater than one member was returned

http://blogs.msdn.com/b/sqlcat/archive/2007/03/05/ssas-partition-slicing.aspx

https://thomasivarssonmalmo.wordpress.com/2012/01/28/my-quick-guide-to-ssas-query-tuning-part-one/

TABULAR: ANALYZING DAX QUERY PLANS
Extended Events

1. Use to monitor tabular models
    1. Query duration via **Query End** event
    2. DAX query plans via **Dax Query Plan** event
    3. VertiPaq cache information via **VertiPaq SE Query Cache Match** event
    4. VertiPaq storage engine information via **VertiPaq SE Query End** event
    5. End-user activity, number of requests etc.

2. Use to understand and retest long-running queries

Query Duration = SUM([duration] of Query End event)

Storage Engine Duration = SUM([duration] of **VertiPaq Scan** event subclass)

Formula Engine Duration = ([duration] of **Query End** event) less (Storage Engine Duration)

$$\text{Cores used in VertiPaq Operation} = \frac{([CPU\ Time]\ of\ \textbf{VertiPaq Scan}\ event\ subclass)}{([Duration]\ of\ \textbf{VertiPaq Scan}\ event\ subclass)}$$

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RMC = Right Mouse Click

Steps to Create Extended Event Session

In SSMS, connect to tabular instance

Expand Management

Right mouse click on Sessions --> New Session

On Events page, select events

    Category "profiler" are those events that match up to SQL Server Profiler

    Category "pureExevent" are those events that are new to Extended Events

Click the <Configure> button and *for each event*, see the Event fields tab showing the data being returned

Click the back button in the <Select> button

Go to the Data Storage page -- you can have multiple targets

    Event File -- XEL file that will be placed on hard disc at a default location of your SSAS log directory

    Event string -- live stream of the data

    Ring buffer

        Retained in memory

        Does not go to a file

Only available when the service is up and running. Data goes away when the SSAS service is restarted

Go to Advanced page

Retention mode - how do you want to handle events?

Capture all events?

Loose some events in favor of performance?

Xevents is pretty lightweight vs Profiler Trace

Dispatch latency -- how long do you want to wait until you serve the events from the buffer to the target for processing

Memory size -- the larger the buffer, the longer before we dispatch the data to the target

Partition mode

Memory per CPU

Memory per node

Script to new query editor window

Open XEL file in SSMS

File --> Open --> Merge Extended Events

From the XE Viewer, right mouse click to add columns to the event display window

Warming the Cache with SSIS Demo

SSIS Control Flow

1. Stop Xevent Session
2. Import xEvent File
3. Delete xEvent file
4. Get MDX queries meeting criteria
5. Execute each MDX query
6. Delete old SQL DB xEvent data
7. Start xEvent Session

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Monitoring SSAS 2016 Activity with Extended Events
http://www.delorabradish.com/ssas/monitoring-performance-tuning-troubleshooting-sql-server-analysis-services-ssas-2016-activity-with-extended-events

Profiler vs Extended Events for SSAS 2016 Database Administration
http://www.delorabradish.com/dba/sql-server-profiler-2016-vs-extended-events-for-analysis-services-ssas-database-administration

Performance Tuning of Tabular Models
https://msdn.microsoft.com/en-us/library/dn393915.aspx

Reference of Profiler event numbers and names
https://blogs.msdn.microsoft.com/danhardan/2008/09/09/sql-profiler-eventclass-eventsubclass-column-descriptions/

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Questions?
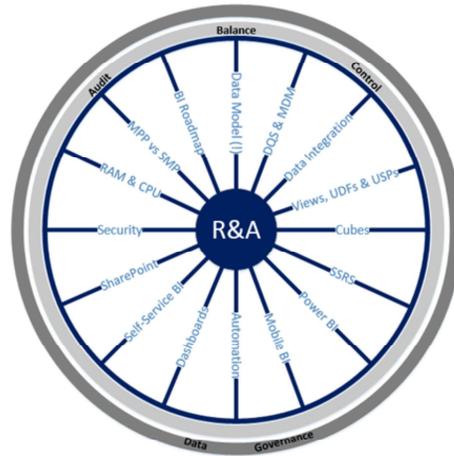
Talking Points:

1. If you have not defined a single report, how will your end result be optimized for reporting?

2. How do we frequently sacrifice the permanent, R&A, on the alter of the immediate, a faster ETL?
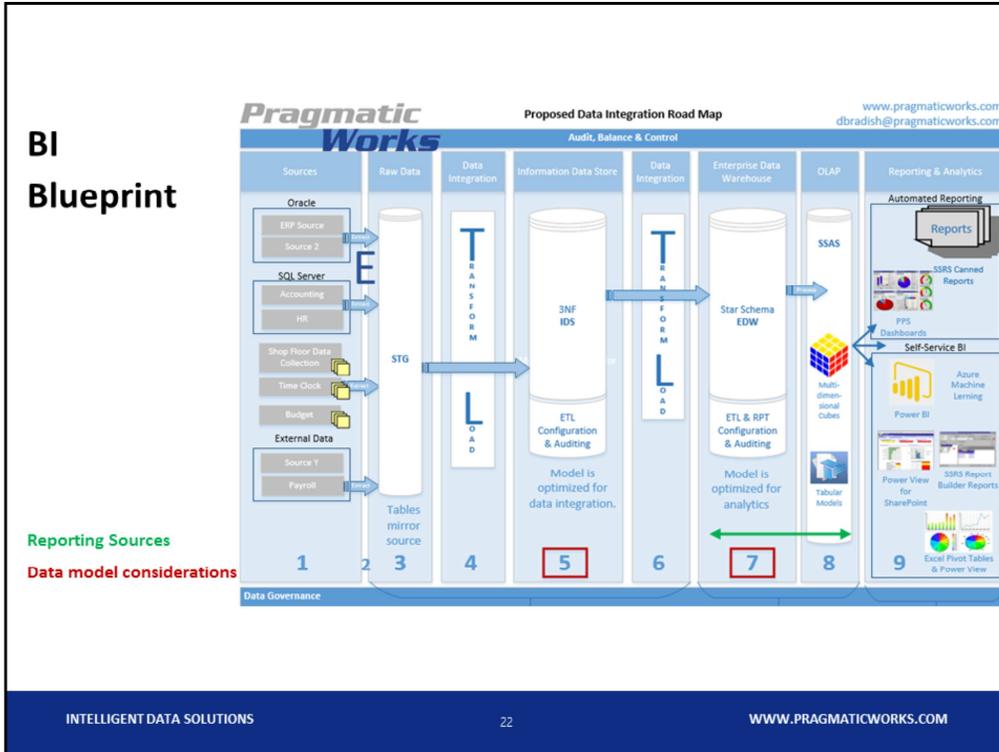
Today's focus will be on modeling for pipes #5 and #7 (the red boxes) understanding that the plan is for all analytics to source from pipes #7 and #8 (the green arrow)
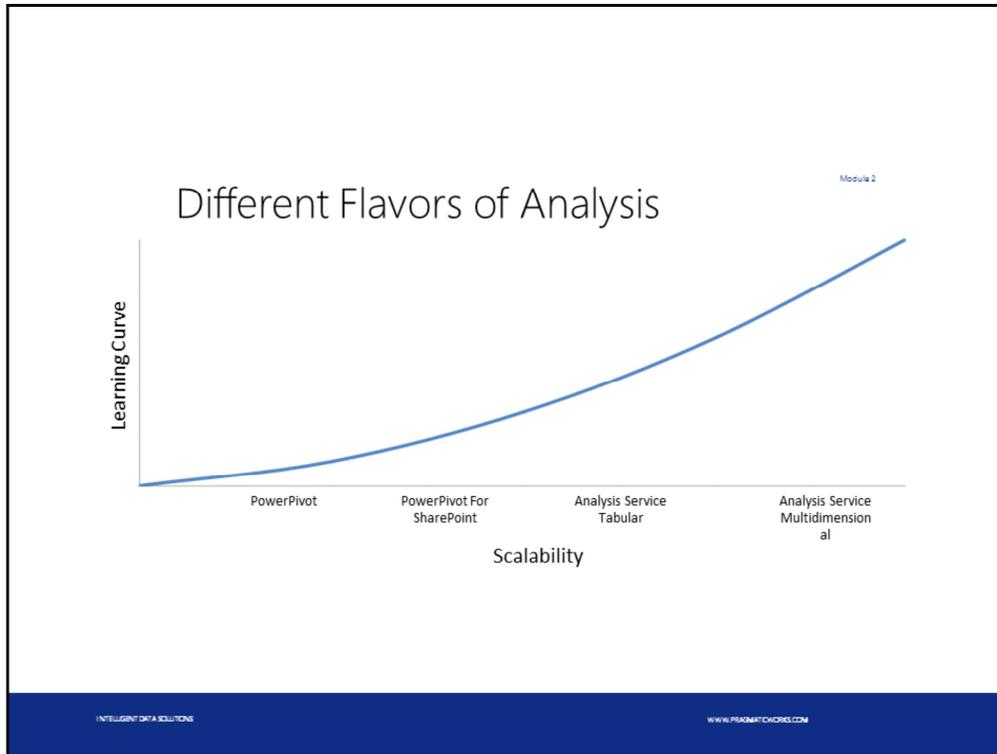
Notes from online course:

Different flavors of SSAS have different best use cases

Y axis = difficulty to learn, time to develop

X axis = scalability

Different flavors of SSA include

1. Powerpivot on your personal machine
2. Powerpivot for SharePoint which is a PP model deployed out to SharePoint environment that uses server resources for queries
3. SSAS tabular
4. SSAS multidimensional

PP for personal BI

- Least scalable
- Data size restrictions
- Limited to personal laptop
- Little learning curve, little complexity

PP for SharePoint

- Same as PP on your personal machine, but is now PP deployed out to your SP environment
- Database is stored in Analysis Services running behind the scenes
- Using server resources
- More people can see it and use it
- A team BI solution

SSAS tabular

- Available in SQL Server 2012
- Column compression
- Has features not in PP, role based security, partitioning
- Used in place of PP for SharePoint, but does not need SP
- Allows you to take your PP model right into SSAS via wizard

SSAS Multi

- Most scalable, but also the most complex
- Take the most time to develop
- Requires a lot more expertise
- Requires knowledge of the DW, partitioning strategies, aggregations
- Steepest learning curve but the most scalable (TB data sources with 50 + GB cube sizes)