Build your first Analysis Services (Tabular Model) <not a Cube>!

(using the tutorials on docs.microsoft.com)

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Why Analysis Services?

Problem statements:

"We don't have per-user security on database x, y, or z"

"We want to secure our data"

"We want the business users to see THEIR data"

"ETL is hard/slow"

"We need real time and historical data"

Analysis Services Overview

Analysis Services (SSAS) is an online analytical data engine used in decision support and business analytics

It provides analytical data for business reports and client applications such as Reporting Services reports, Power BI, Excel, and other third-party data visualization tools

SSAS supports two modelling modes—multidimensional and tabular

Analysis Services Overview

One Semantic Model - Two Ways to Develop

Tabular models

Tables and relationships

Fast by design with in-memory

Easy to get started and simple

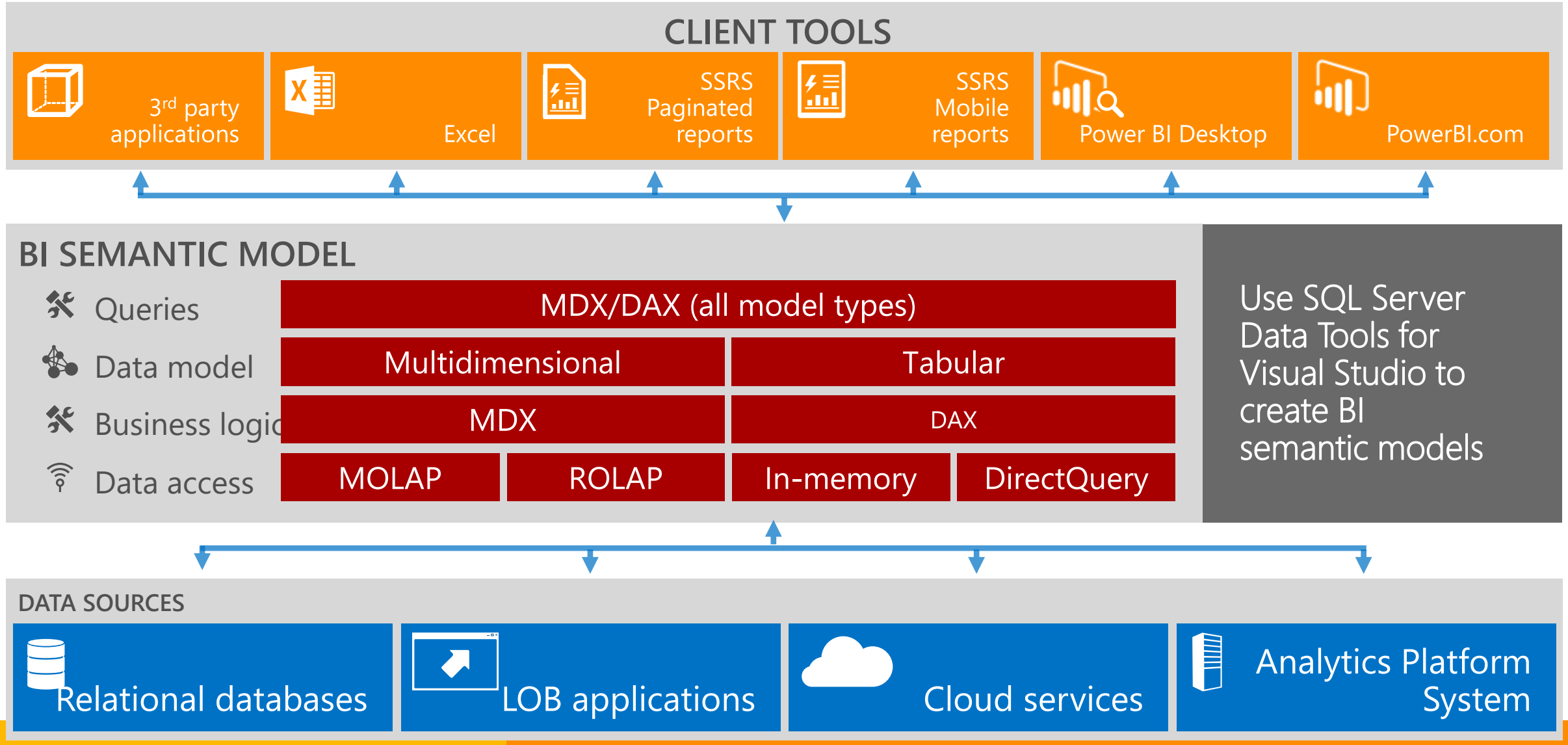
Multidimensional models

Dimensions and measure groups

Highly scalable and mature

Feature rich and complex

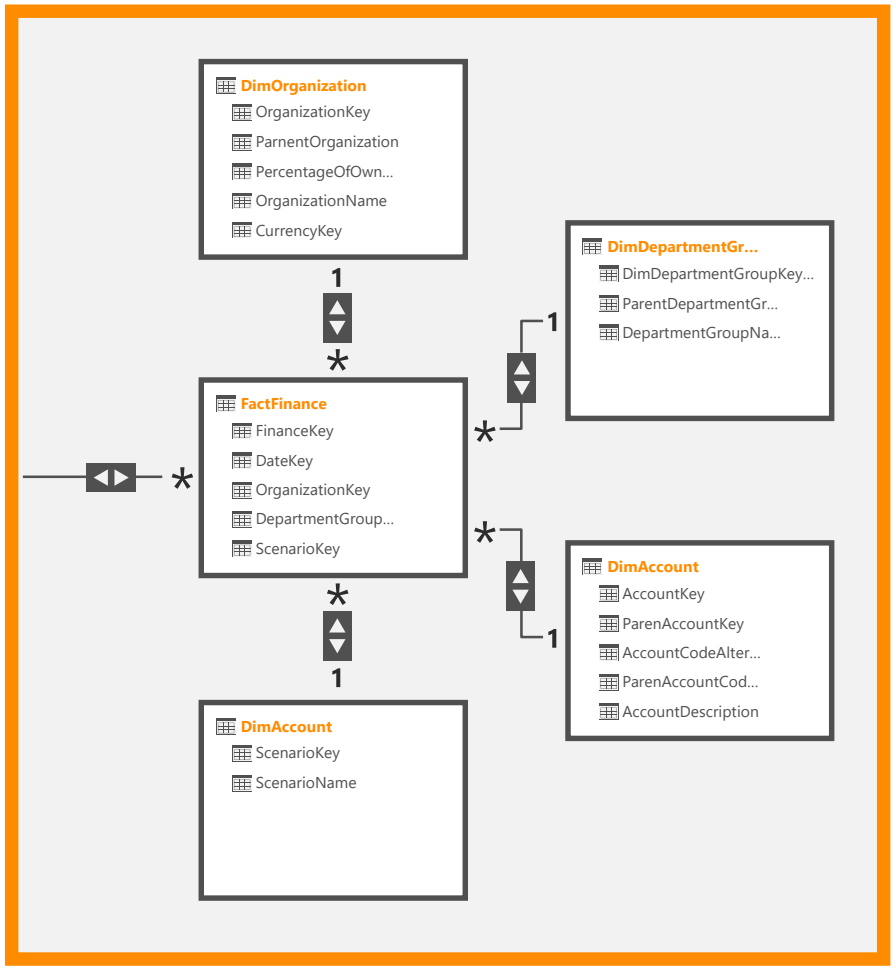
Analysis Services Architectural Overview



Modeling types

Type	Modeling description	Released
Tabular	Relational modeling constructs (model, tables, columns). Internally, metadata is inherited from OLAP modeling constructs (cubes, dimensions, measures). Code and script use OLAP metadata.	SQL Server 2012 and later (compatibility levels 1050 - 1103)[1]
Tabular in SQL Server 2016	Relational modeling constructs (model, tables, columns), articulated in tabular metadata object definitions in Tabular Model Scripting Language (TMSL) and Tabular Object Model (TOM) code.	SQL Server 2016 (compatibility level 1200)
Tabular in SQL Server 2017	Relational modeling constructs (model, tables, columns), articulated in tabular metadata object definitions in Tabular Model Scripting Language (TMSL) and Tabular Object Model (TOM) code.	SQL Server 2017 (compatibility level 1400)
Multidimensional	OLAP modeling constructs (cubes, dimensions, measures).	SQL Server 2000 and later
Power Pivot	Originally an add-in, but now fully integrated into Excel. Visual modeling only, over an internal Tabular infrastructure.	via Excel and Power Pivot or Power BI Desktop

Tabular models in SQL Server 2016 - Overview



New rich modeling capabilities

Bi-directional cross-filtering allows M:M and 1:1 relationships

50+ new DAX functions

Improved DirectQuery

New data sources: Oracle, Teradata, Analytics Platform System (APS)

Support for MDX queries in Excel and other client apps

Performance enhancements

Parallel partition processing

DAX query and measure enhancements (especially for Power BI)

Development

Tabular scripting language and object model

How do we get started with SSAS?

Take a look at the

Analysis Services Tabular adventure works tutorial:

http://tinyurl.com/SSASTAB
(https://docs.microsoft.com/en-us/sql/analysis-services/tabular-modeling-adventure-works-tutorial)

"This tutorial provides lessons on how to create an Analysis Services tabular model at the 1200 compatibility level by using SQL Server Data Tools (SSDT), and deploy your model to an Analysis Services server on-premises or in Azure."

Nomenclature in the Tabular Analysis Services world

Tables and Columns – Data imported or queried from data sources

Hierarchy - metadata that define relationships between two or more columns in a table.

Calculations – using DAX, aggregate, filter, extend, combine, and secure that data.

Measure - a calculation created using a DAX formula for use in a reporting client. Measures are evaluated based on fields, filters, and slicers users select in the reporting client application.

KPI - used to gauge performance of a value, defined by a Base measure, against a Target value, also defined by a measure or by an absolute value.

Perspective - Perspectives, in tabular models, define viewable subsets of a model that provide focused, business-specific, or application-specific viewpoints of the model.

Partition - Partitions divide a table into logical parts. Each partition can then be processed (Refreshed) independent of other partitions.

So, what are we learning?

a. How to create a new tabular model project in SSDT (SQL Server Developer Tools)
b. How to import data from a SQL Server relational database into an Analysis Services tabular model project.
c. How to create and manage relationships between tables in the model.
d. How to create and manage calculations, measures, and Key Performance Indicators that help users analyze model data.
e. *(Homework) Create and manage perspectives and hierarchies that help users more easily browse model data by providing business and application specific viewpoints.*
f. *(Homework) Create partitions that divide table data into smaller logical parts that can be processed independent from other partitions.*
g. *(Homework) How to secure model objects and data using roles with user members.*
h. How to deploy a tabular model to an Analysis Services server on-premises or in Azure.

You will need the following prerequisites:

The latest version of SQL Server Data Tools (SSDT). Get the latest version.

or… VS2017 with the Analysis Services add-in also works

The latest version of SQL Server Management Studio. Get the latest version.

A client application such as Power BI Desktop or Microsoft Excel.

A SQL Server instance with the Adventure Works DW 2014 sample database. This sample database includes the data necessary to complete this tutorial. Get the latest version.

An Azure Analysis Services or SQL Server 2016 or later Analysis Services instance to deploy your model to. Sign up for a free Azure Analysis Services trial.

DEMO

Demo of Analysis Services Tabular Model creation and deployment

- **Create**
- **Pull in data**
- **Report on data**

Resources

Tutorial on Analysis Services

http://tinyurl.com/SSASTAB

MSDN: SQL Server Analysis Services

https://msdn.microsoft.com/en-us/library/bb522607.aspx

Analysis Services and PowerPivot Team Blog

https://blogs.msdn.microsoft.com/analysisservices/

YouTube video of Azure Analysis Services

https://www.youtube.com/watch?v=44I48ufKhOs

EDx course on Analysis Services: 8 hours of content and hands-on labs

https://www.edx.org/course/sql-server-analysis-services-developing-microsoft-dat225x-0#!

Appendix A: Enterprise-grade Analysis Services

Analysis Services themes for SQL Server 2016

Improved productivity and performance

Easily create powerful models

Use SSAS as semantic model only

Improve manageability and security

Strengthen multidimensional support

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The multidimensional mode also includes a data mining engine

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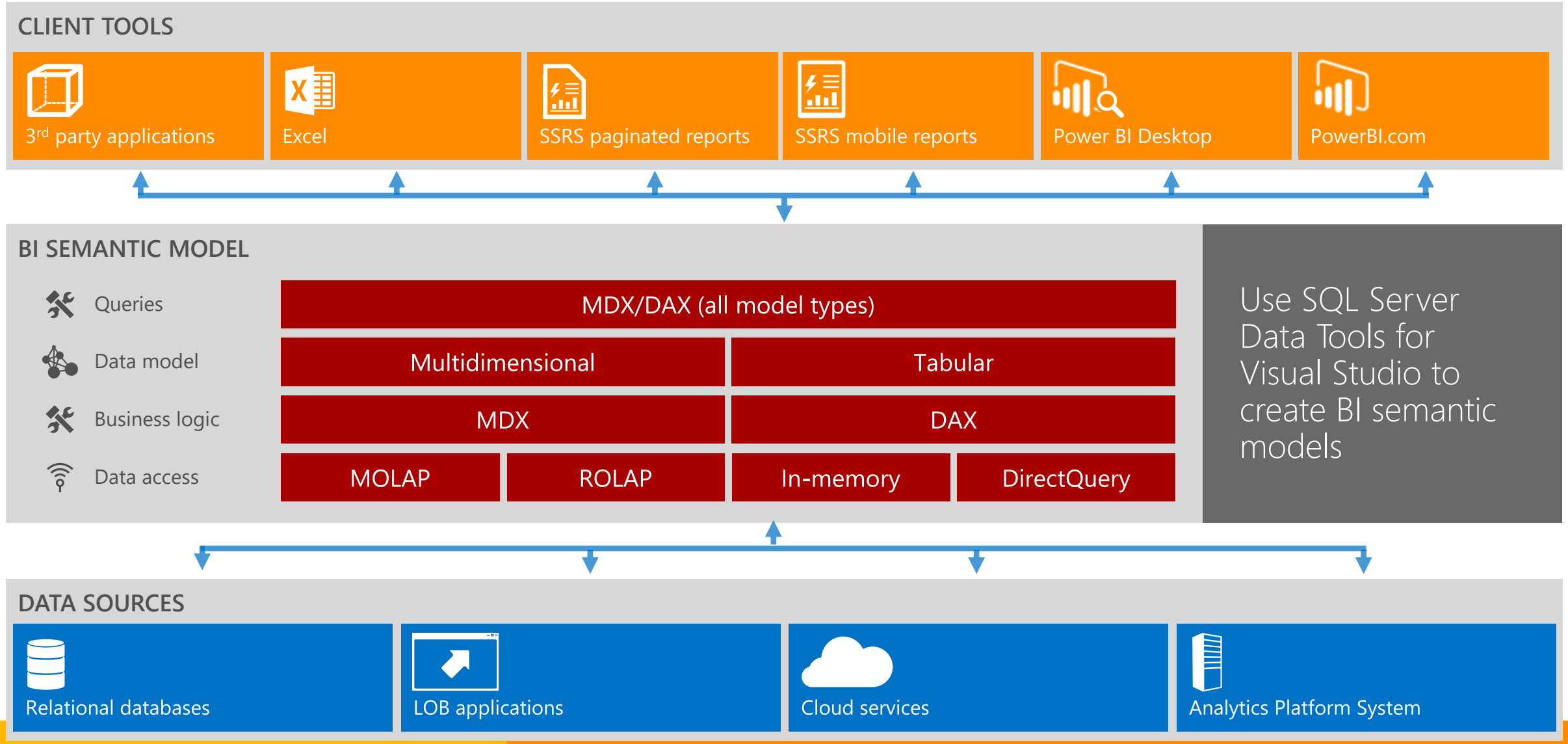


Multidimensional in SQL Server 2016 - Overview

Improvements in manageability, functionality, and performance

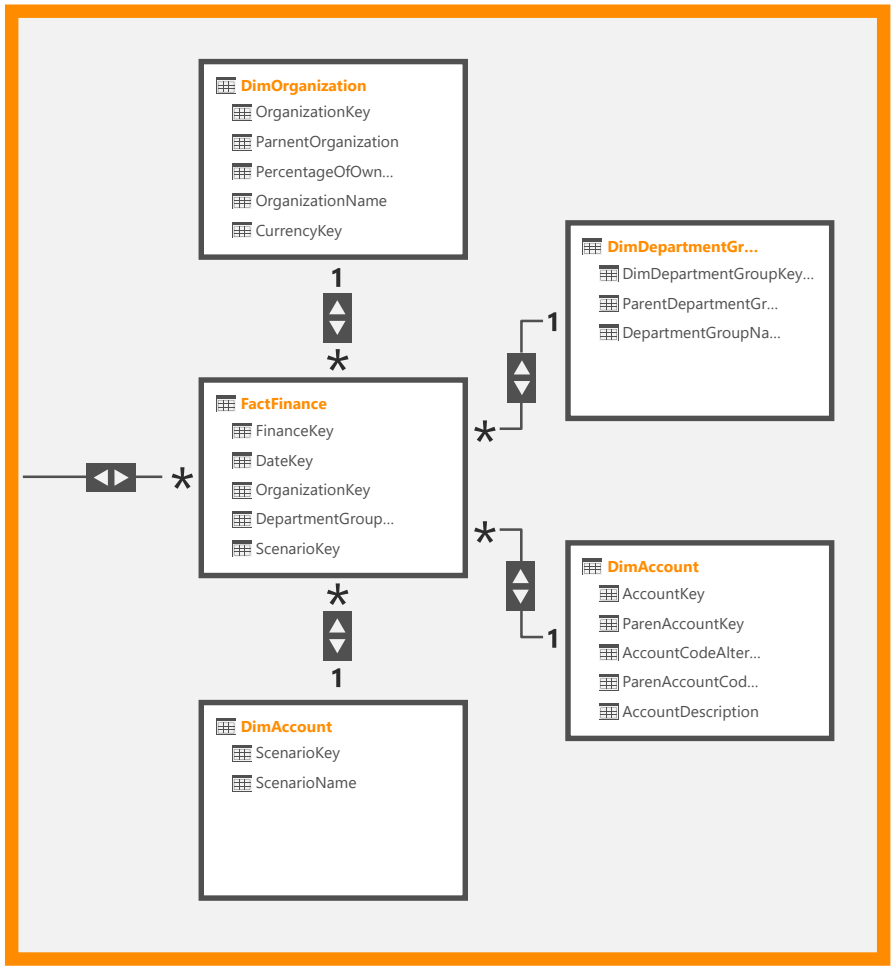
Use the latest data visualizations with existing multidimensional models in Power BI and Power BI Desktop

Distinct count ROLAP optimizations for data sources like DB2 and Oracle.

Customization options for drill-through behaviors for actions

Drill-through multi-selection support with Excel 2016

Tabular models in SQL Server 2016 - Overview



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New SSAS Features (Tabular and Multidimensional)

Analysis Services Management Objects (AMO) updates

AMO has been refactored to include a second assembly **Microsoft.AnalysisServices.Core**

This assembly includes common classes across SSAS modes: e.g. server, database, role

No breaking changes, but new application references should use **Microsoft.AnalysisServices.Core**

DBCC for Analysis Services runs internally to detect potential data corruption issues on database load

Can be run on demand if an administrator suspects problems with the data or model

DBCC runs different checks depending on whether the model is tabular or multidimensional

New SSAS Features (Tabular and Multidimensional)

Extended Events (xEvents) can now be managed and monitored within SSMS

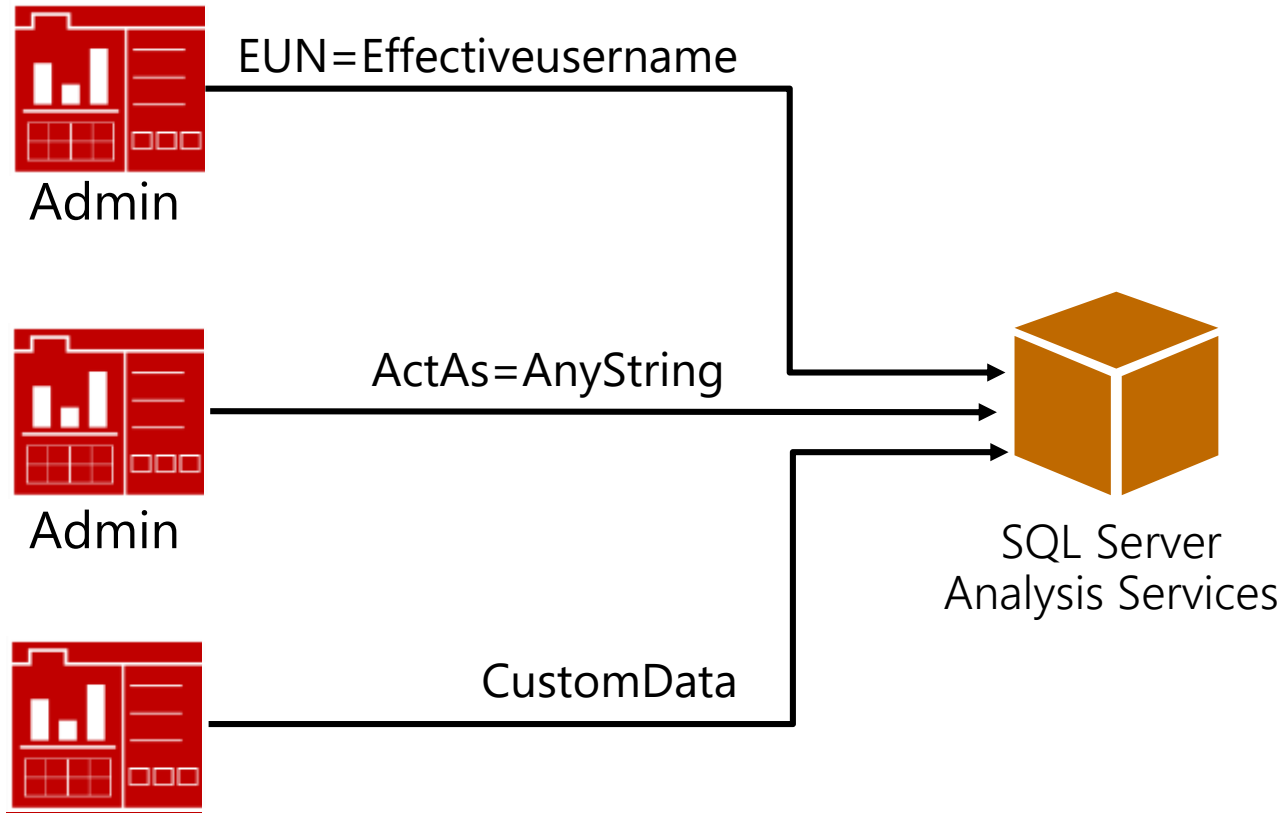
Live data streams can be monitored in real time, keeping session data loaded in memory for faster analysis

Data streams can also be saved to a file for offline analysis

In SSMS, it is now possible to add computer accounts as database Administrators

Custom authentication in SQL Server 2016

New security feature for tabular and MOLAP



With SQL 2016, you can connect users to SSAS when not part of a domain

- SSAS now supports non-AD users for role membership
- Connect to SSAS as Admin
- Pass any string with ActAs on connectionstring
- Authenticate in SSAS with DAX /MDX USERNAME function

New SSAS Features - Tabular

While most new tabular features are available only with SSAS 2016 models (compatibility level 1200), all tabular models can benefit from:

Parallel processing of multiple table partitions

Support for Visual Studio Configuration manager

Improved DAX formula editing (multi-line, tabs, comments)

Formula fixup (renaming objects will automatically update formula references)

Saving incomplete measures (all measures must be complete to deploy the project)

New behaviors with DAX variables

New DAX functions (~59)

New SSAS Features – More than 50 new DAX Functions

Examples:

Date and Time

CALENDAR

CALENDARAUTO

DATEDIFF

Math and Trig

SIN, COS, TAN, etc.

EVEN, ODD, EXP, ISO.CEILING, MROUND

Statistical

MEDIAN, MEDIANX, PERCENTILE.EXC, PERCENITLEX.EXC

New SSAS Features – Model Development

New 1200 model development features:

Calculated tables

Bi-directional cross filters

Display folders, to organize model elements into logical groups

Translations, to view models in a preferred language

DirectQuery enhancements

Improved SSDT modeling performance, thanks to TMSL (introduced later)

New SSAS Features – Calculated Tables

Define calculated tables to add new tables to the model, based on existing data from other tables

Defined by using DAX

Calculated tables are generally best for intermediate calculations of data stored in the model, rather than calculated on the fly

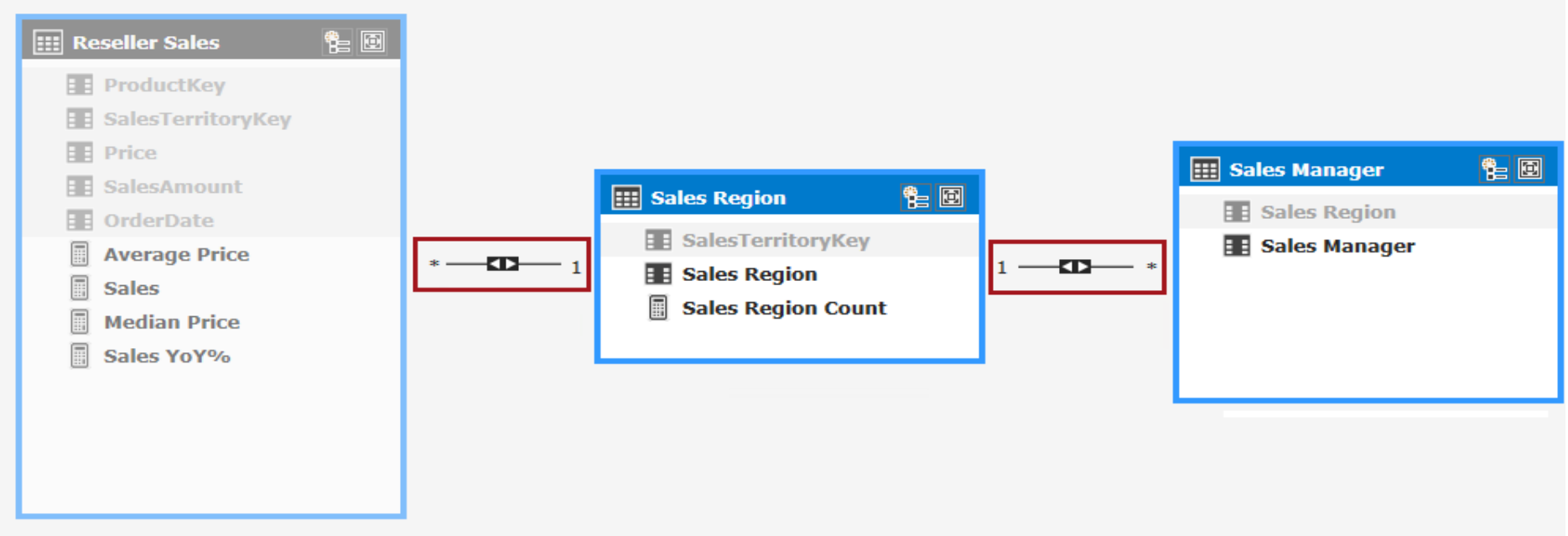
Calculated tables appear in Relationship view, and relationships can be defined with other tables

Calculated tables are recalculated in the same circumstances as calculated columns

New SSAS Features – Bi-Directional Cross Filters

Bi-directional cross filtering allows developers to define how filter context propagates between related tables

Bi-directional filters on both sides of a bridging table will solve the “many-to-many” problem—without the need to write DAX formulas



New SSAS Features – DirectQuery in Tabular

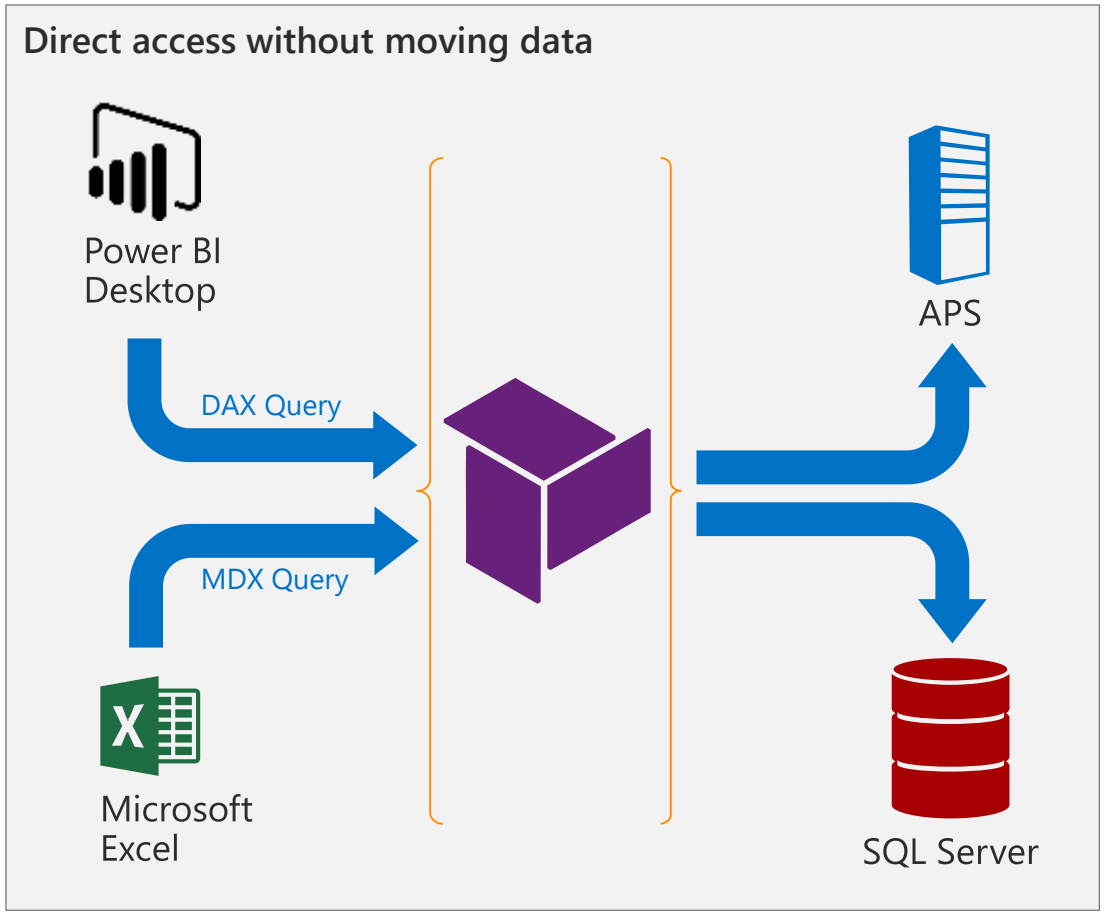
DirectQuery enhancements:

New data sources:

- Microsoft Analytics Platform System (APS)
- Oracle
- Teradata

Support for common analytical tools with MDX queries

Improved query generation, resulting in faster performance



New SSAS Features – DirectQuery in Tabular

DirectQuery enhancements [Continued]:

Row-level security, defined by model roles with DAX filters

Calculated columns (but not calculated tables), but note:

- In certain known cases, the same formula can return different results from a cached model compared to a DirectQuery model
- These differences are a consequence of the semantic differences between the in-memory analytics engine and the underlying data source, queried with SQL

Sample partitions, enabling in-memory data to be cached to facilitate model development

New SSAS Features – DirectQuery in Tabular

DirectQuery benefits:

Data is guaranteed to be up-to-date, with no extra management overhead of having to maintain a separate copy of the data

Data sets can be larger than the memory capacity of the SSAS server

DirectQuery can take advantage of provider-side query acceleration, such as that provided by xVelocity memory optimized column indexes

Security can be enforced by the back-end database, by using row-level security features from the back-end database—or alternatively, by using row-level security in the model

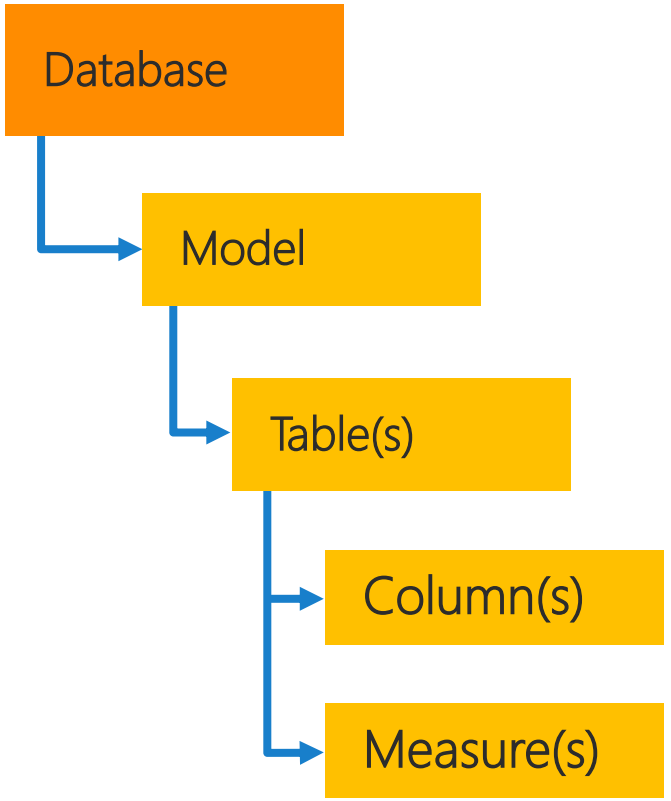
SSAS performs optimizations to ensure that the query plan for the query executed against the back-end database will be as efficient as possible

New SSAS Features – Tabular Object Model (TOM)

The Tabular Object Model (TOM) is part of AMO

With TOM, developers can now use familiar tabular concepts, rather than multidimensional concepts

This promotes simpler, and more readable, code when developing against tabular models



New SSAS Features – Tabular Object Model (TOM)

Tabular Object Model Example:

```
public void ReprocessTable(string cnnString, string dbName, string tableName)
{
    var server = new Server();
    server.Connect(cnnString);

    // Connect to the server
    Database db = server.Databases[dbName];

    // Connect to the database
    Model = db.Model;

    // Reprocess the table
    model.Tables[tableName].RequestRefresh(RefreshType.Full);
    model.SaveChanges(); // Commit the changes
}
```

New SSAS Features – Tabular Model Scripting Language (TMSL)

The Tabular Model Scripting Language (TMSL) allows for simplified scripting and development for tabular models

This new language describes and manages objects with JSON

SSMS database commands can produce TMSL scripts, including:

Create, Alter, Delete, Backup, Restore, Attach, and Detach

Changes to the model now only affect a single object instead of having to map everything to multidimensional objects—this makes metadata operations very fast

As metadata changes are now localized in the script, it allows for simple code merges

New SSAS Features – Tabular Model Scripting Language

The script to represent the schema of the model was developed together with the Power BI team, with the goal to have feature parity with the Power BI APIs to allow reusability between products

SSAS PowerShell cmdlet **Invoke-ASCmd** accepts tabular model scripting language commands

```
{
  "refresh": {
    "type": "full",
    "objects": [
      {
        "database": "Sales Analysis",
        "table": "Reseller Sales"
      }
    ]
  }
}
```

```
{
  "backup": {
    "database": "Sales Analysis",
    "file": "SalesAnalysis.abf",
    "password": "Pass@word1",
    "allowOverwrite": false,
    "applyCompression": true
  }
}
```

New SSAS Features – Multidimensional Improvements

Distinct count ROLAP optimizations for DB2 and Oracle data sources

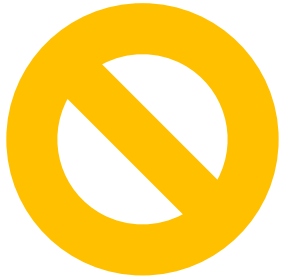
Drill-through multi-selection support with Excel 2016

Excel query optimizations

Excel PivotTables are now optimized when totals and subtotals are turned off

In this case, better optimized MDX queries are generating, delivering performance benefits for both MOLAP and tabular models

Deprecated SSAS Features



Not supported in the next major release of SQL Server:

Remote partitions

Remote linked measure groups

Dimensional writeback

Linked dimensions

Not supported in future releases of SQL Server:

SQL Server table notifications for proactive caching (use polling instead)

Session and local cubes (no replacement)

Tabular model 1100 and 1103 compatibility levels (use 1200)

SQL Server Profiler for trace capture (use xEvents) and replay (no replacement)

Discontinued SSAS Features

CalculationPassValue() MDX function (deprecated SSAS 2005)

CalculationCurrentPass() MDX function (deprecated SSAS 2005)

NON_EMPTY_BEHAVIOR query optimizer hint (deprecated SSAS 2008)

COM assemblies (deprecated SSAS 2008)

CELL_EVALUATION_LIST intrinsic cell property (deprecated SSAS 2005)

Upgrading to SSAS 2016

Upgrading to SSAS 2016 can be achieved by:

Server instance upgrade

Database upgrade

After upgrading, it is recommended to run the new DBCC for Analysis Services

Upgrading to SSAS 2016 – Server Instance Upgrade

A SSAS instance upgrade can achieved by:

- In-place upgrade
- Side-by-side upgrade

Supported for SQL Server 2008, or later

An instance upgrade cannot change the server mode

The compatibility levels of databases that are attached to a given instance remain the same, unless manually changed

Metadata and binary data is compatible between the two versions, and so there is no need to re-process databases

Upgrading to SSAS 2016 – Database Upgrade

Prior SSAS database versions can be hosted on SSAS 2016

The following compatibility levels can been deployed to SSAS 2016:

Mode	Level	Version
Multidimensional	1050	SQL Server 2005, 2008, 2008 R2
Multidimensional	1100	SQL Server 2012, or later
Tabular	1100	SQL Server 2012
Tabular	1103	SQL Server 2014
Tabular	1200	SQL Server 2016

Upgrading to SSAS 2016 – Database Upgrade

To upgrade a non-DirectQuery database, upgrade the SSDT project, and then deploy to the upgraded server

DirectQuery databases cannot be upgraded in-place

To upgrade DirectQuery databases:

In SSDT, turn off DirectQuery mode

Set the compatibility level to 1200

Turn DirectQuery mode back on

Deploy to the upgraded server

Upgrading to SSAS 2016 – Database Upgrade

Tabular databases benefit the most from an upgrade to SSAS 2016:

Take advantage of new developer features

The revised DirectQuery mode at compatibility 1200 delivers better performance, calculated columns, and row-level security enforced by SSAS roles

Tabular model metadata uses native terminology for object definitions, and TMSL is used to script database operations

Supported SSAS Features by Edition

SSAS 2016 is supported by **Enterprise**, **Standard** and **Developer** editions

Maximum compute capacity per instance:

Enterprise and Developer: Operating system maximum

Standard: Limited to lesser of 4 sockets or 24 cores

Maximum memory per instance:

Enterprise and Developer: Operating system maximum

Standard: Tabular: 16GB, and Multidimensional: 64GB

Standard edition limits AlwaysOn failover clusters to two nodes

Supported SSAS Features by Edition

Features supported only by **Enterprise** edition:

Scalable shared databases

Synchronize databases

Power Pivot for SharePoint

Only standard data mining algorithms and tools are supported in **Standard** edition

BI Semantic Model features are limited by edition

Supported SSAS Features by Edition

Standard edition does not support:

Perspectives

Multiple partitions

DirectQuery storage modes

Supported SSAS Features by Edition

Standard edition does not support:

Semi-additive measures (except LastChild)

Perspectives

Writeback dimensions *

Linked measures and dimensions *

Unlimited partitions (supports up to three)

Proactive caching

Push-mode processing

Direct writeback

Measure expressions

* Deprecated features

Summary

Seventh release of Analysis Services

Numerous new features and enhancements deliver improved development and management capabilities

Upgrade to SSAS 2016 is easily accomplished

Upgrading databases to SSAS 2016 is also easily accomplished by setting project compatibility levels, and redeploying

DirectQuery enhancements deliver many benefits for real time access to SQL Server, APS, Oracle and Teradata data sources

Resources

MSDN: SQL Server Analysis Services

https://msdn.microsoft.com/en-us/library/bb522607.aspx

MSDN: What's New in Analysis Services

Describes a complete list of new DAX functions

https://msdn.microsoft.com/en-us/library/bb522628.aspx

MSDN: Features Supported by the Editions of SQL Server 2016

https://msdn.microsoft.com/en-us/library/cc645993.aspx?#SSAS

Analysis Services and PowerPivot Team Blog

https://blogs.msdn.microsoft.com/analysisservices/

Youtube video of Azure Analysis Services

https://www.youtube.com/watch?v=44I48ufKhOs

EDx course on Analysis Services: 8 hours of content and hands-on labs

https://www.edx.org/course/sql-server-analysis-services-developing-microsoft-dat225x-0#!