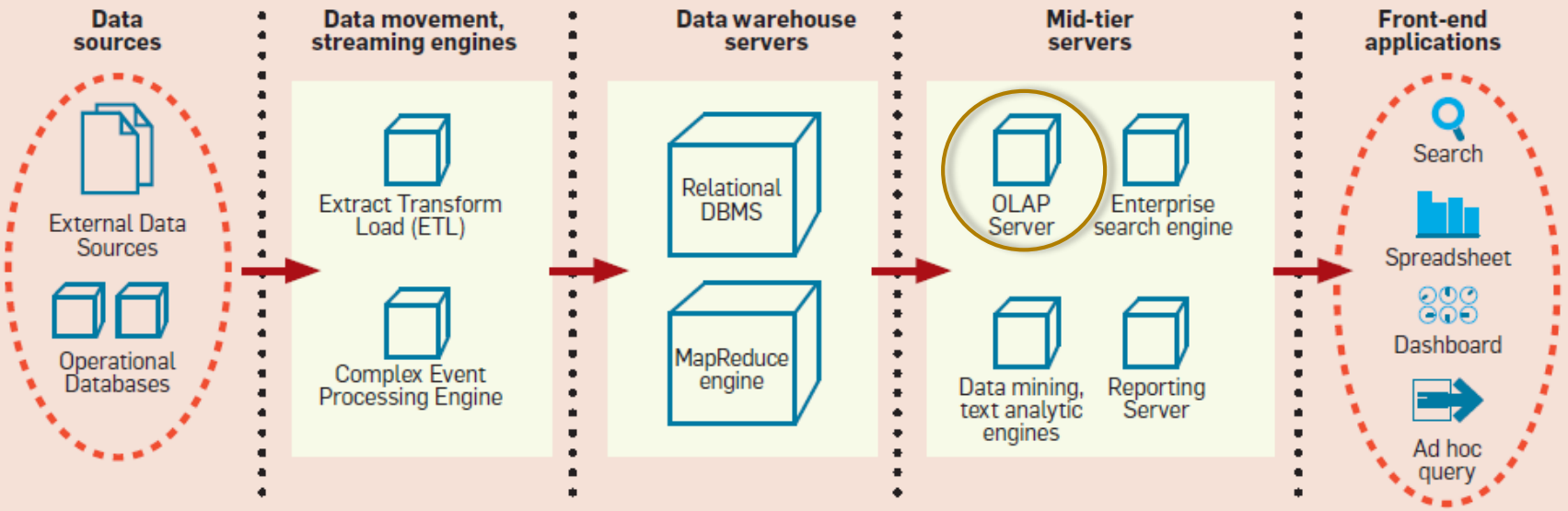
BUSINESS INTELLIGENCE

SSAS - SQL Server Analysis Services

BI Architecture

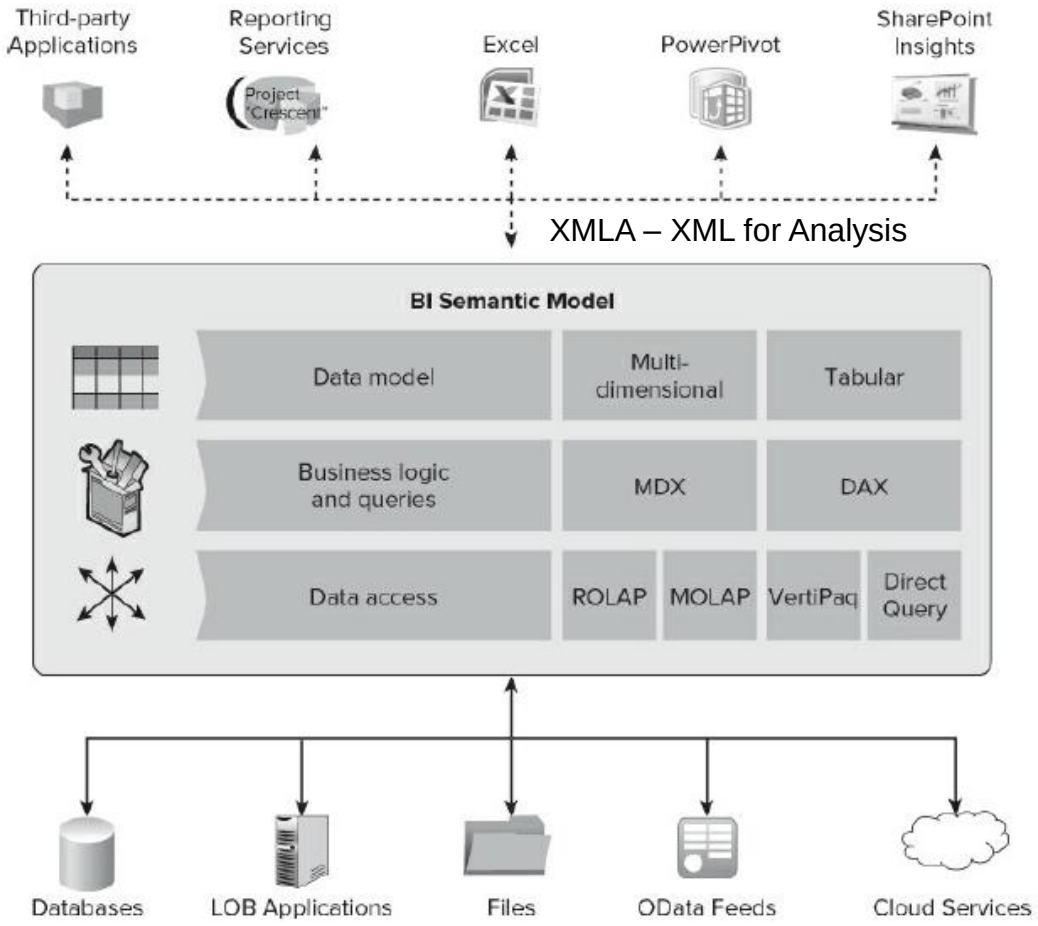
Figure 1. Typical business intelligence architecture.



SSAS: SQL Server Analysis Services

- It is both an OLAP Server and a Data Mining Server
  - Distinct from the RDBMS engine
  - Can access ODBC, OLE DB, CSV, XML data sources
- Most OLAP concepts are covered
  - Dimensions, hierarchies, measures, attributes, calculated metrics, key performance indexes, actions (URL links, drill-through, report launch), …
  - Query language (MDX) for querying data cubes
- Docs and samples
  - Documentation
    - http://msdn.microsoft.com/en-us/library/bb522607.aspx
  - Tutorial from Books on Line
    - http://msdn.microsoft.com/en-us/library/ms170208.aspx

SSAS architetture



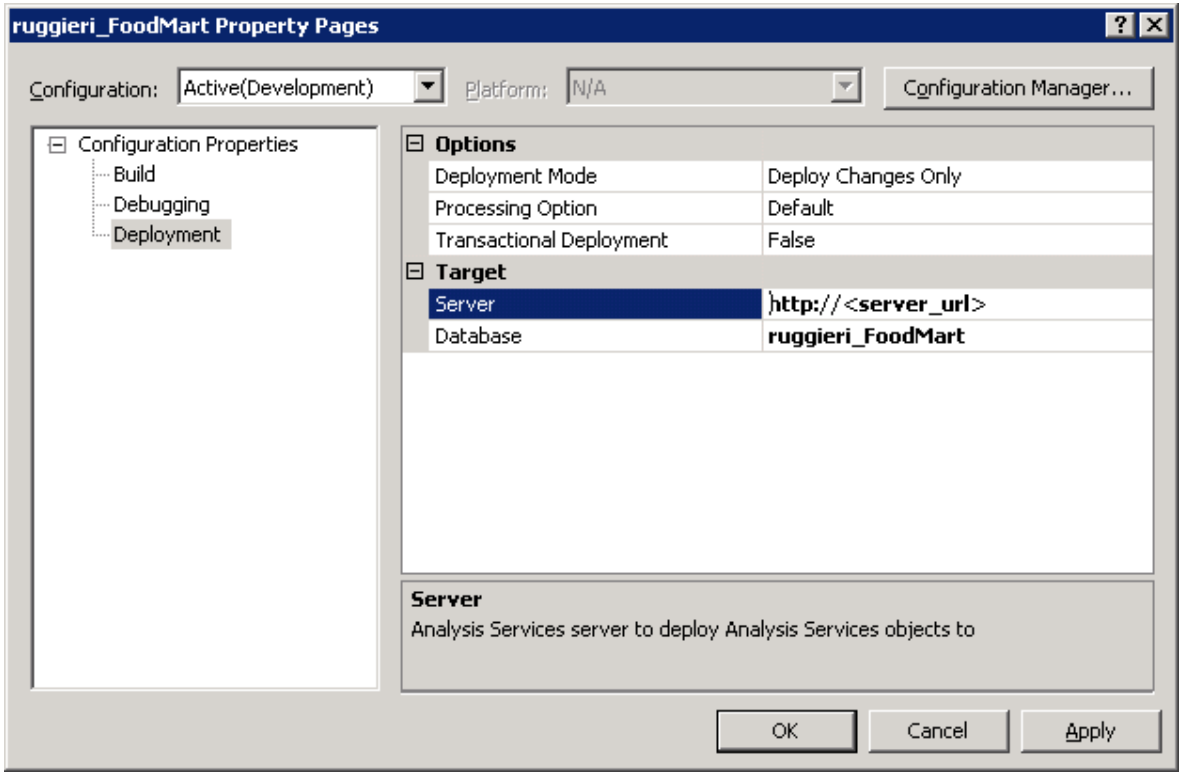
SSAS projects

- Developing environment is SSDT
  - Project type: Analysis services multidimensional and data mining
- IMPORTANT!
  - Name of SSAS projects must be prefixed by your account

<account>_<name>

SSAS Server for deployment

- Right click on project name
  - Properties → Deployment



SSAS project folders

- Data source
  - Sets the data sources
    - Use your login and password to SQL Server
    - Use OLE DB for SQL Server if client/server are different versions (eg., you are using a version < SQL 2016)
  - Impersonification credentials
    - Specify 'Use the service account'
- Data source view (DSV)
  - A view of data sources
    - Disconnected access to data sources
    - Names of attributes/tables can be changed *(without affecting the source!)*
    - Calculated attributes and tables *(without affecting the source!)*
    - External keys *(without affecting the source!)*

SSAS project folders

- Dimensions
  - Type: standard / time
    - Time is useful to derive hierarchies directly from a 'datetime' attribute
  - Create new wizard
    - Select existing table
    - Key column: primary key (surrogate key)
      - Name column: descriptive key
    - Attributes
      - Select none at the wizard stage
  - Organize attributes into hierarchies
    - in the dimension structure pane

Useful attribute properties

- AttributeHierarchyVisible
  - Flat hiearchies with only the attribute is visibile
    - This is by default
- OrderBy
  - Default ordering method in visualization
- DiscretizationMethod
  - Discretization of continuous attributes into bins
- Type
  - Leave ‘regular’
- Usage
  - Modes: key, regular and parent

Build-deploy-processing

- Build
  - Syntactic check of correctness of the SSAS project
  - Run by the SSDT client enviroment
- Deploy
  - The project is copied on the deployment SSAS server
  - Data cubes are not re-processed
    - Nevertheless, features that do not depend on data re-processing are updated, eg., formatting of numbers, calculated metrics
- Processing
  - The deployment server re-computes the data cubes by accessing the data sources

Build-deploy-processing

- Issue with current SQL server installation:
  - A delay of about 30 seconds is experienced at each deploy and at each process operations
  - Hope it will be solved with a future service pack.
    - Be patient!

Data exploration

- Panel: browsing
  - Pivot table + filters
- Since SQL Server 2012
  - Data exploration in Excel

Calculated members

- Calculated metrics:
  - Net sales
  - Margin
  - Sum year to date
  - Average sale amount per customer
  - Average sale amount per sale
  - Rank of products wrt sales
  - …
- Calculated members:
  - Top 5 selling products
  - …
- They do not exist on the data cube
  - They are calculated at run-time

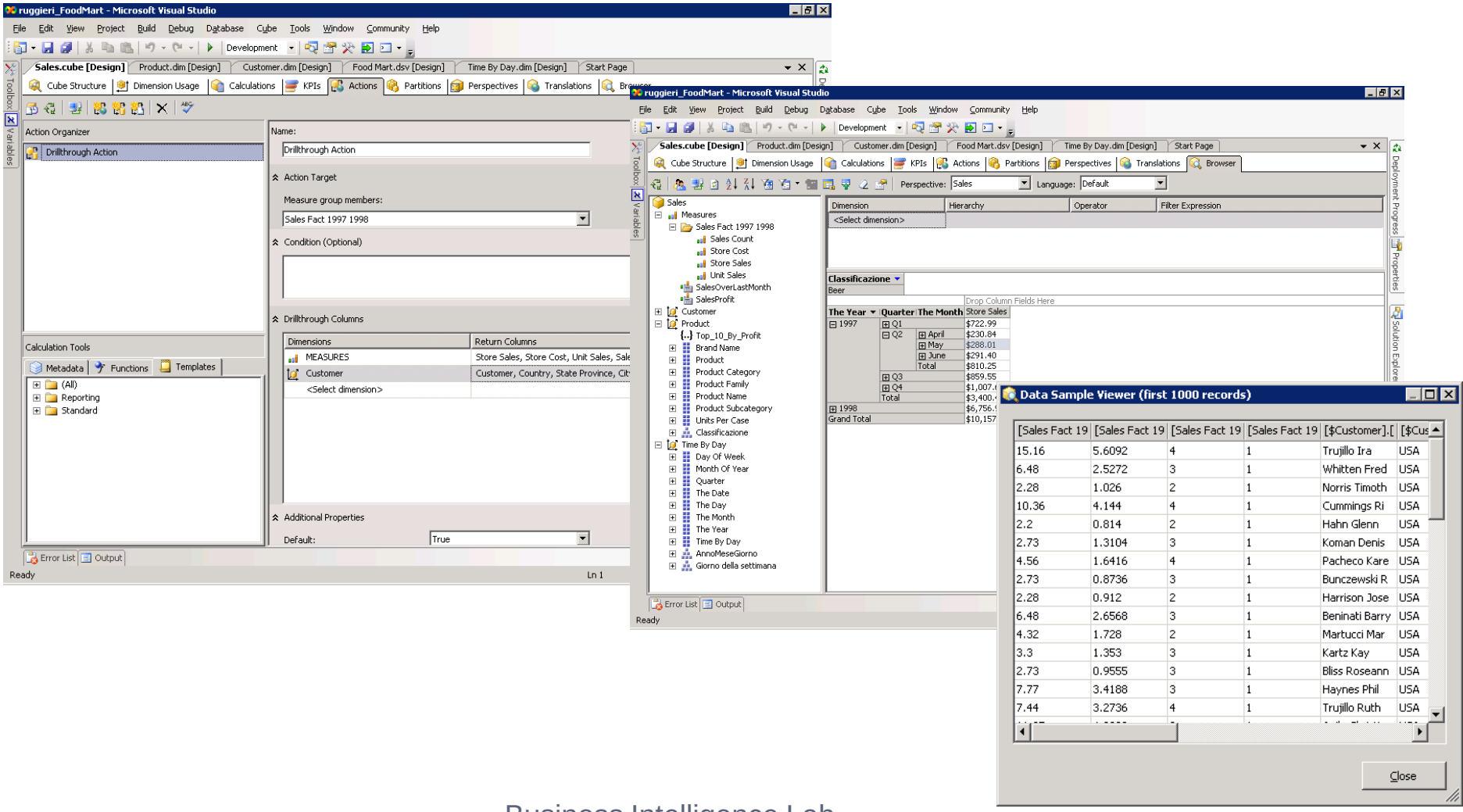
MDX

MultiDimensional eXpressions

Language for querying OLAP cubes and for defining calculated members

Standard de-facto

Drill-through actions (rightclick -> 'show details' in Excel)



Data cube storage model

ROLAP (Relational OLAP)

- relational engine enhanced with CUBE BY and analytic SQL
  - materialized views + bitmap/columnstore indexes + star-join optimization
  - performance
  - scalability

MOLAP (Multidimensional OLAP)

- multidimensional array store on disk/memory in binary format
  - very efficient for a small number of hierarchies
  - do not scale well on space data

HOLAP (Hybrid OLAP)

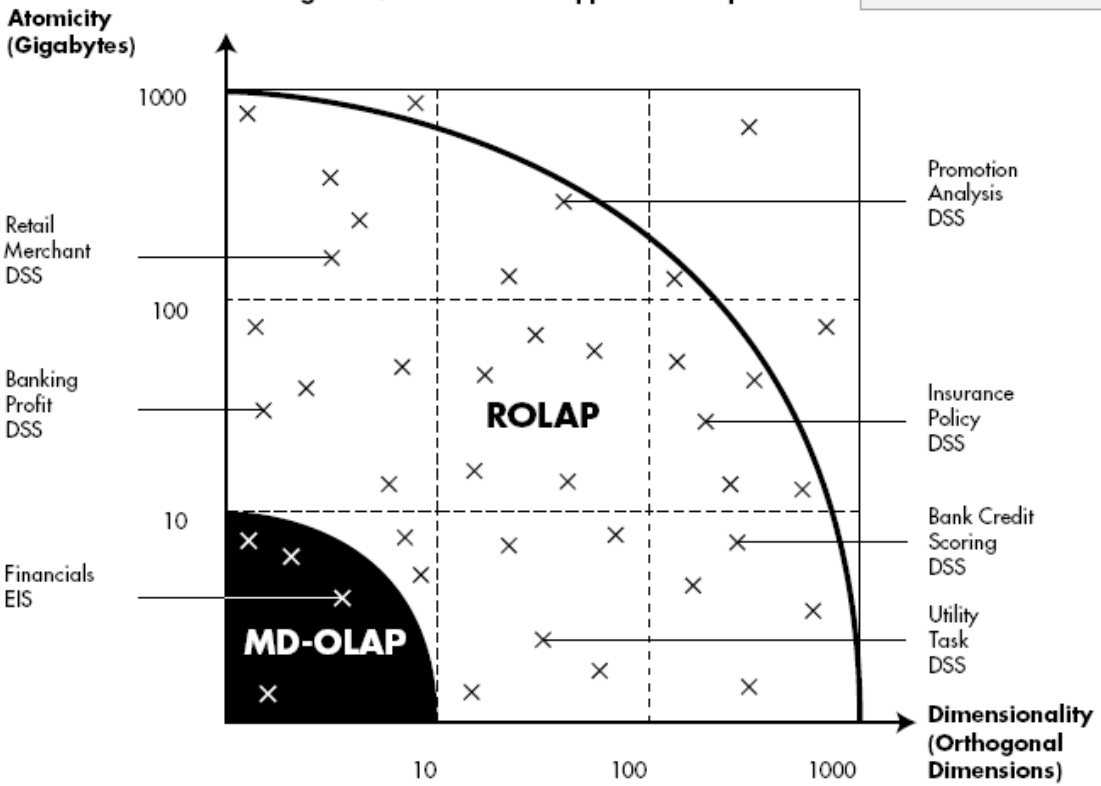
- trade-off between the previous two solutions
  - most accessed cuboids on MOLAP, others on ROLAP

The ROLAP case

Data storage modes

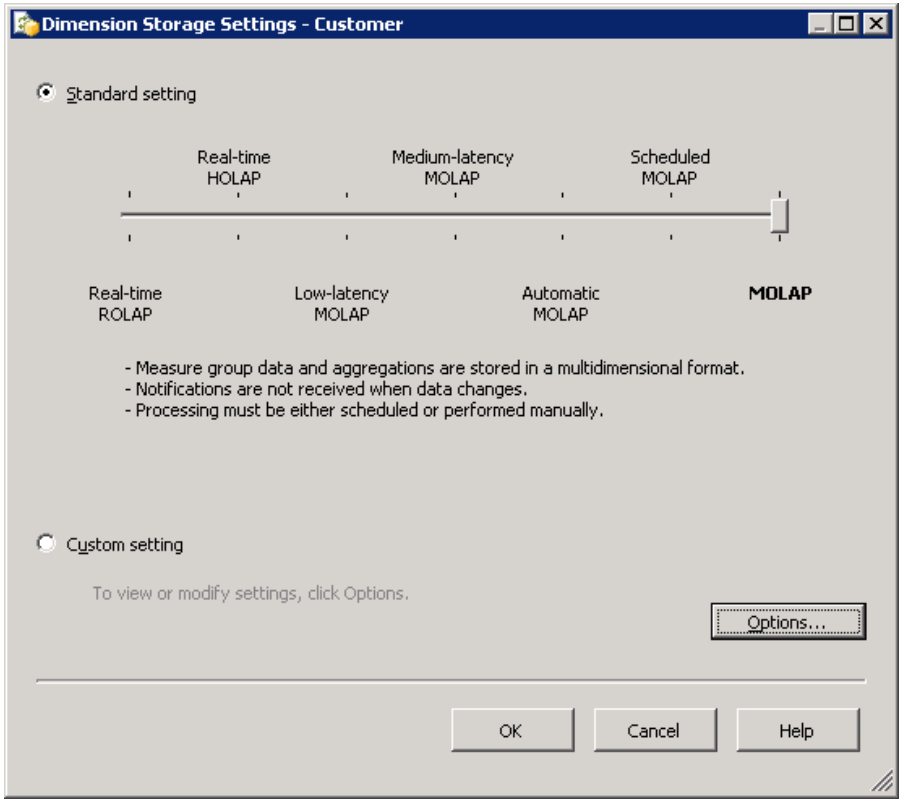
OLAP Server	MOLAP	ROLAP	HOLAP	Offline
Essbase	Yes	Yes	Yes	
icCube	Yes	No	No	Offline Cubes
Microsoft Analysis Services	Yes	Yes	Yes	Local cubes, PowerPivot for Excel
MicroStrategy Intelligence Server	Yes	Yes	Yes	MicroStrategy Office, Dynamic Dashboards
Mondrian OLAP server	No	Yes	No	
Oracle Database OLAP Option	Yes	Yes	Yes	
Palo	Yes	No	No	
SAS OLAP Server	Yes	Yes	Yes	
TM1	Yes	No	No	
SAP NetWeaver BW	Yes	Yes	No	

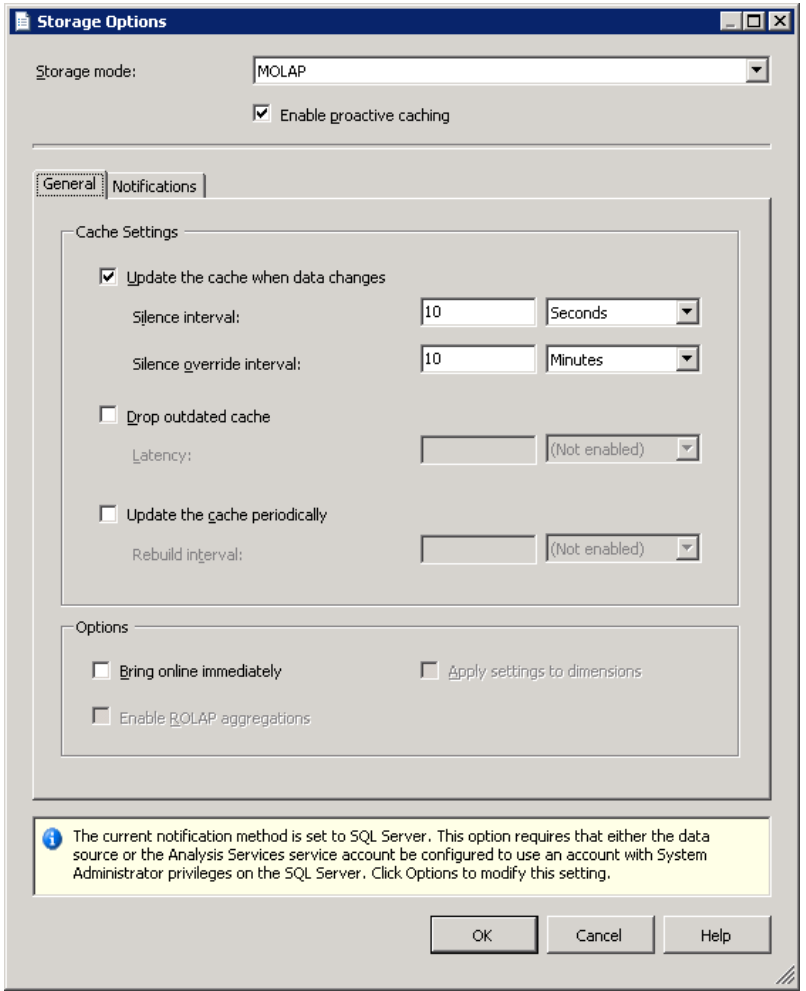
Figure 20: ROLAP Meets Application Requirements



Storage model

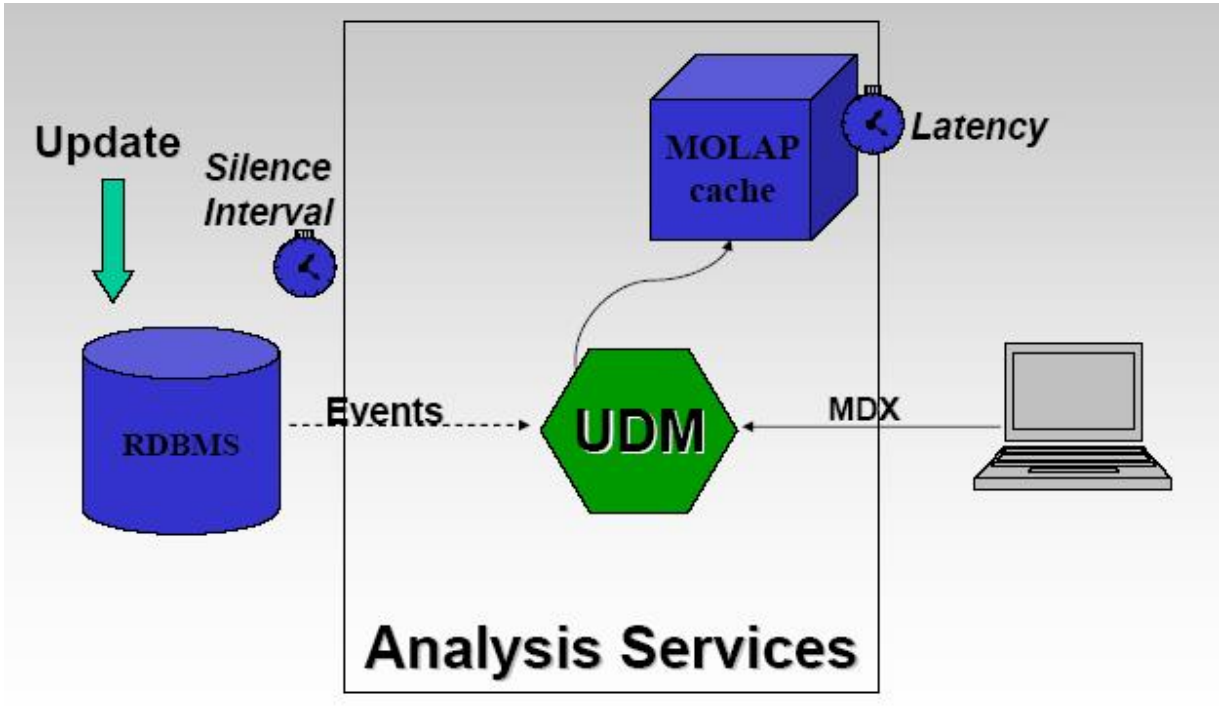
- Can be set for whole cube or for single dimensions





Proactive caching

- Proactive caching
  - Latence time for refresh
  - Silence time (after refresh)



Other features of SSAS

- KPI – Key performance index
  - Metrics with target values shown
- Perspectives
  - Subsets of objects, e.g., sub-cubes for product manager, store manager ..
- Roles
  - Access rights management
- …
- Self-service Business Intelligence
  - PowerPivot for Excel/SharePoint
  - Tabular data model (evolution of PowerPivot)
    - Different instance of SSAS, different SSDT project type, different query language (DAX – Data Analysis eXpressions)

BUSINESS INTELLIGENCE LABORATORY

SSAS Practice

Data analysts: final user

- Explore a report produced from a multidimensional view, using:
  - a reporting tool
    - Browser, Excel, Microstrategy, …
  - only data exploration primitives:
    - Drill down and roll-up over pre-defined hierarchies
    - Existing calculated measures
    - Slide and dice
    - Filter and sort

Q0 on foodmart

- What is the distribution of sales
  - by quarter?
  - and by customer city?
  - in absolute value
  - in percentage wrt the total
  - in percentage wrt the country of residence of customers

Q1 on foodmart

- What are the 5 best product categories
  - as per total sales?
  - as per number of items sold?
  - as per number of distinct customers?
  - in each quarter of 1998 and gender?
  - in the CA state?

Q1 on foodmart

- What are the 5 best product categories
  - as per total sales?
  - as per number of items sold?
  - as per number of distinct customers?
  - in each quarter of 1998 and gender?
  - in the CA state?

Data analysts: OLAP designer

- Design data cubes and reports
  - by defining
    - existing hierarchies from the DW
    - existing metrics from the DW
    - calculated members
    - and reprocessing data cubes
  - using a tool for OLAP design
    - with read-only rights on the DW

Q2 on foodmart

- Which stores are the most profitable
  - mean profit wrt customers
    - = (total sales – total cost) / number of customers
  - mean profit wrt baskets
    - = (total sales – total cost) / number of baskets
- evaluated
  - in each quarter of 1998 and gender?
  - in the CA state?
  - *in each month wrt previous month?* MDX

Q2 on foodmart

- Which stores are the most profitable
  - mean profit wrt customers
    - = (total sales – total cost) / number of customers
  - mean profit wrt baskets
    - = (total sales – total cost) / number of baskets
- evaluated
  - in each quarter of 1998 and gender?
  - in the CA state?
  - *in each month wrt previous month?* MDX

Q3 on foodmart

- Which are the 5 product categories with the best margin
  - for each age-range of customers?
- evaluated
  - in each quarter of 1998 and gender?
  - in the CA state?
  - *in each month wrt previous month?* MDX

Data analysts: DW designer

- Design and maintain the DW to satisfy new requirements
  - by re-designing conceptual and logical shemata
  - adding new dimensions and attributes
  - adding new data marts
- and managing the population of data
  - using ETL tools

Q4 on foodmart

- What quantity (in Kg) has been sold
  - in each quarter of 1998 and gender?
  - in the CA state?
  - *in each month wrt previous month?* MDX

Q5 on foodmart

In September 1998, store 7 changed its type

- from ‘Supermarket’ to ‘Deluxe Supermarket’
- with new store_id = 25, but it is the same store!

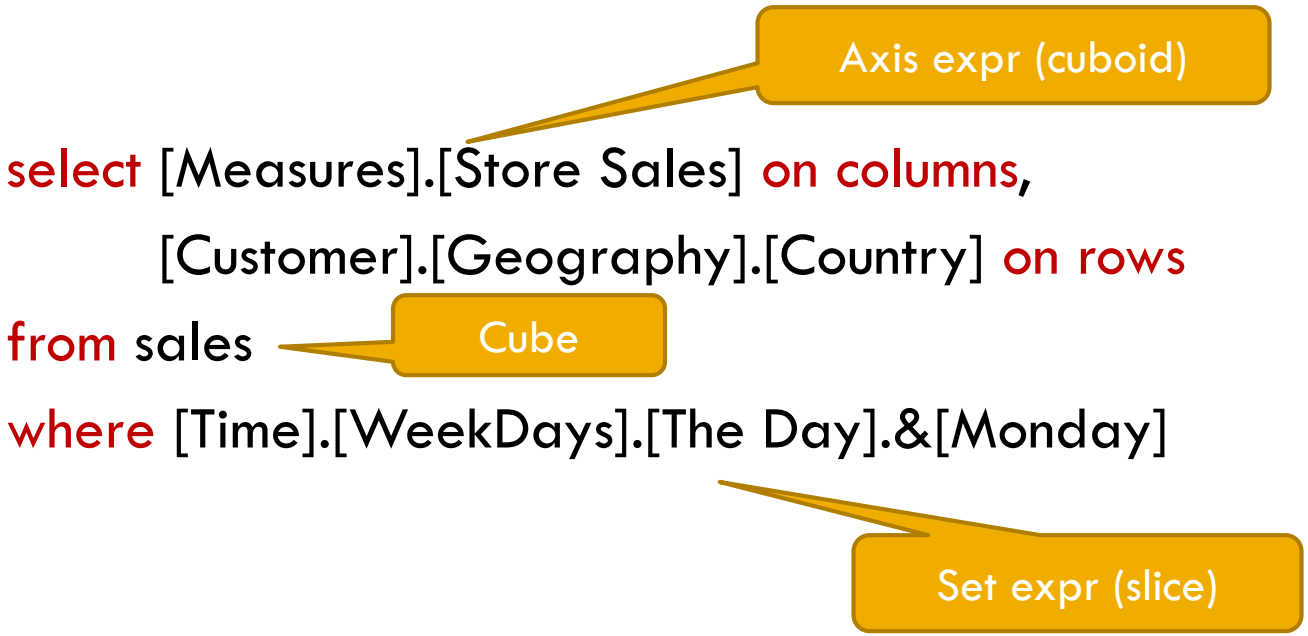
- Which stores are the most profitable
  - in each quarter of 1998?

BUSINESS INTELLIGENCE LABORATORY

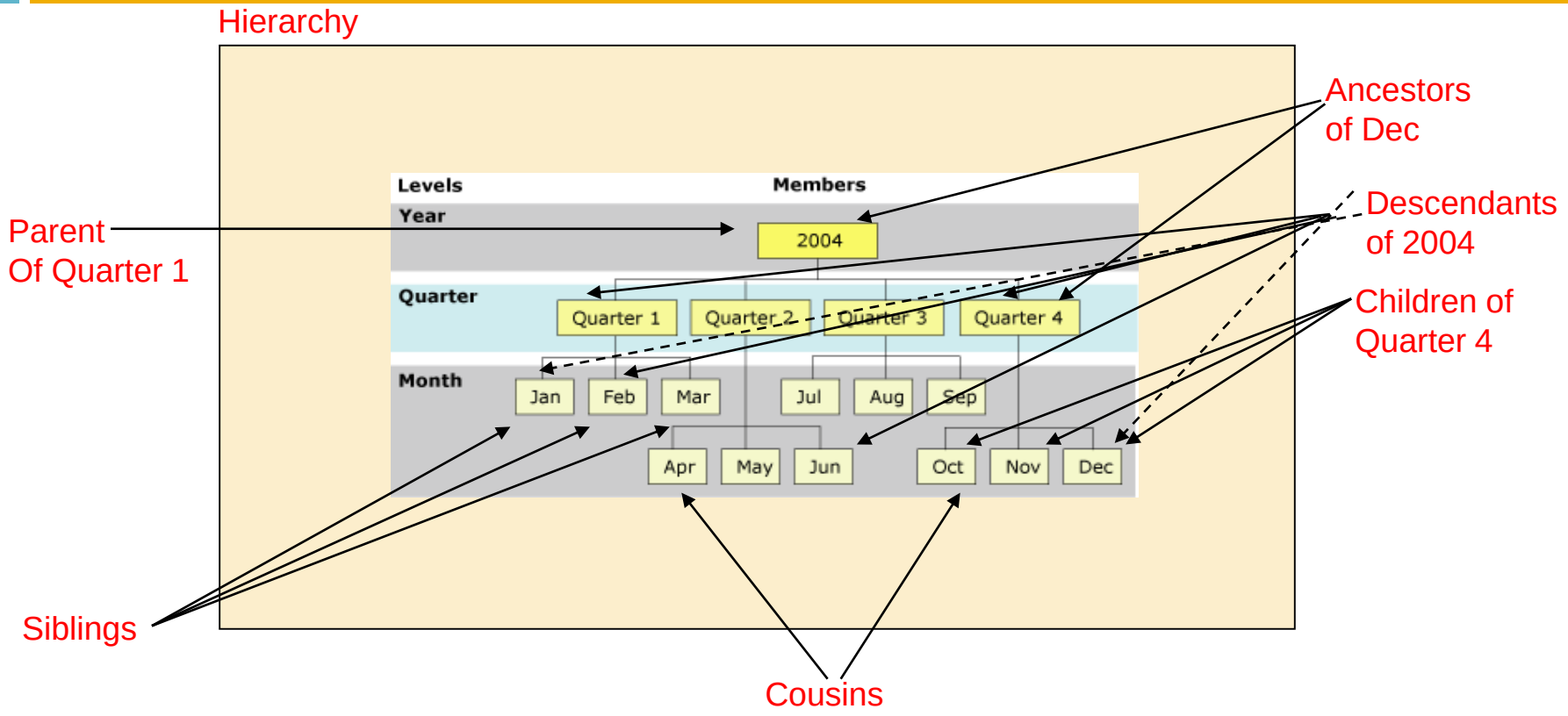
MultiDimensional eXpressions (MDX)

MDX Queries

[WITH < formula > [, < formula > ...]]
SELECT [< axis > , [< axis > ...]]
FROM [< cube >]
[WHERE <set>]



Members of hierarchies & nav. functions



Syntax: [DimensionName].[HierarchyName].[LevelName].[MemberName]
Example: [Store].[Time].[Quarter].&[Quarter 1]

Syntax: [DimensionName].[HierarchyName].[Path from root]
Example: [Store].[Time]. [All].[2004].[Quarter 1]

Tuples, Sets, Axis

[WITH < formula > [, < formula > ...]]
SELECT [< axis > , [< axis > ...]]
FROM [< cube >]
[WHERE <set>]

- Axis
  - axis ::= [NONEMPTY] Set ON (alias| AXIS(number) | number)
    - aliases COLUMNS, ROWS, PAGES, SECTIONS, and CHAPTERS
- Sets
  - Set ::= tuple | {tuple, …, tuple} | set + set | set – set | set_function(parameters)
  - Denotes a set of members/tuples
- Tuples
  - Tuple ::= Member | (Member, …, Member)
  - Denotes a data cube cell by its coordinates
  - No two members over the same hierarchy
    - Two member over the same dimension is OK
- Cube
  - subselects are admitted

Calculations

[WITH < formula > [, < formula > ...]]
SELECT [< axis > , [< axis > ...]]
FROM [< cube >]
[WHERE <set>]

- Calculated member
  - Formula ::= MEMBER alias_name AS mdx_expr
- Named set formula
  - Formula ::= SET alias_name AS set

- Syntax of MDX expressions

  mdx_expr ::= *Numeric* | (*Tuple*, *Numeric*)

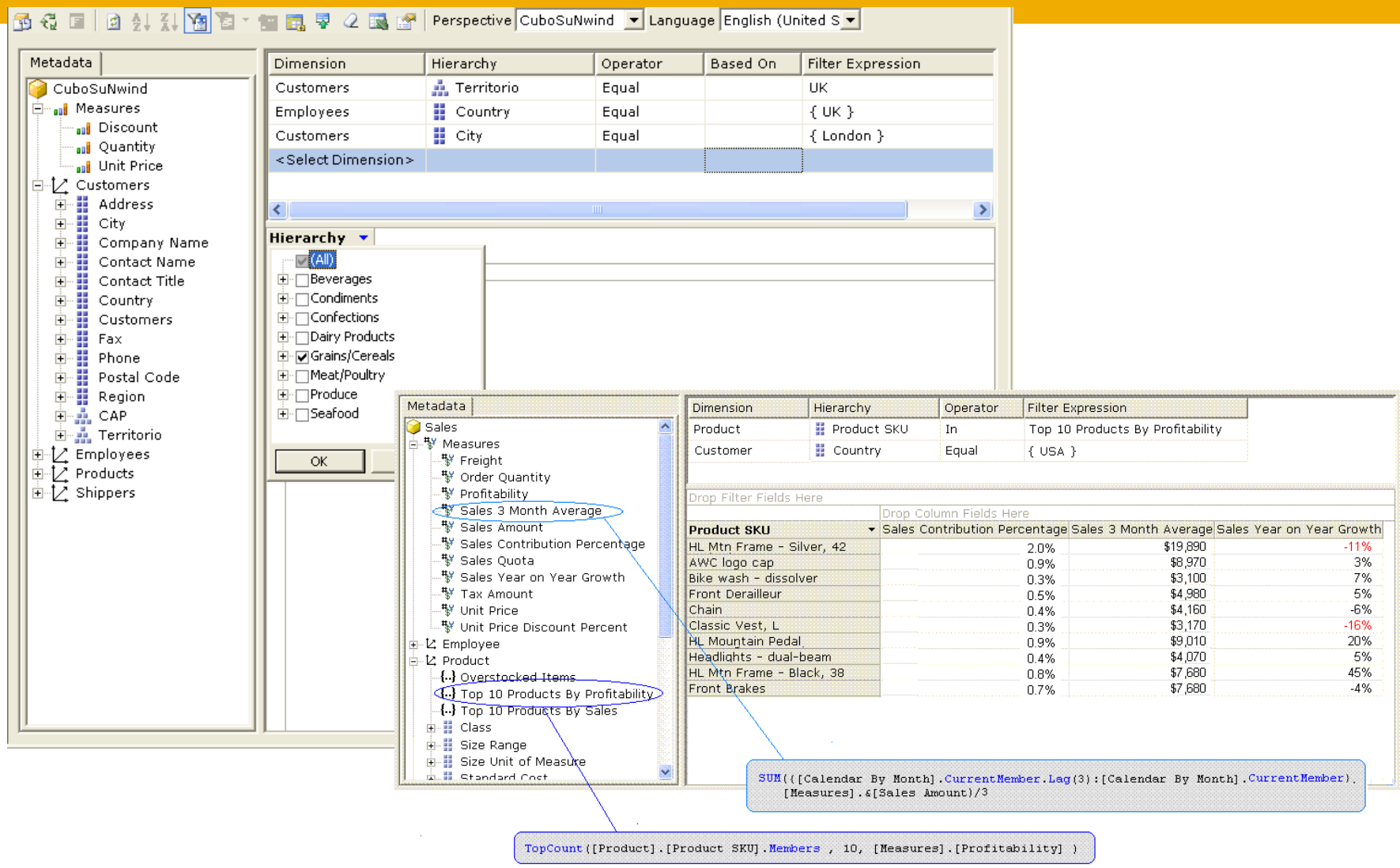
  Numeric ::= [Measures].[measure name]
  | numeric_function(*Parameters*)
  | *Numeric* + *Numeric* | *Numeric* - *Numeric*
  | *Numeric* / *Numeric* | *Numeric* * *Numeric*

  - Meaning:

    Numeric: the expression Numeric is evaluated on the current cell

    (Tuple, Numeric): the expression Numeric is evaluated on the cell Tuple

Calculations in SSDT + Excel



Exercise on the FoodMart cube

- Re-do the explorative data analysis exercise (queries Q0-Q3) using MDX instead of Excel/BIDS
- Extra queries
  - Q1extra: top 5 categories wrt sales since 1 Jan 1998 in CA in March 1998
  - extra: how many cities per sales region had more than 4.000 dollars of total sales in March 1998