#### **BUSINESS INTELLIGENCE**

#### SSAS - SQL Server Analysis Services

**Business Informatics Degree** 

#### **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
    - <u>http://msdn.microsoft.com/en-us/library/bb522607.aspx</u>
  - Tutorial from Books on Line
    - <u>http://msdn.microsoft.com/en-us/library/ms170208.aspx</u>

#### SSAS architetture

Third-party SharePoint Reporting Applications Services Excel **PowerPivot** Insights Project 'Crescent X THE. XMLA – XML for Analysis ÷ **BI Semantic Model** Multi-Data model Tabular dimensional Business logic MDX DAX and queries Direct ROLAP MOLAP VertiPag Data access Query LOB Applications Files **OData Feeds Cloud Services** Databases

**Business Intelligence Lab** 

### 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
  - $\square Properties \rightarrow Deployment$

ruggieri_FoodMart Property Pages		? ×
Configuration: Active(Development)	Platform: N/A	Configuration Manager
Configuration Properties Build Debugging Deployment	Options     Deployment Mode     Processing Option     Transactional Deployment     Target     Server     Database  Server  Analysis Services server to deploy 0p	Deploy Changes Only Default False )http:// <server_url> ruggieri_FoodMart</server_url>
		or front land
		OK Cancel Apply

#### **Business Intelligence Lab**

# 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)</li>
- 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
- 🗆 Туре
  - 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 environment
- 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

- 11
- 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!



**Business Intelligence** 

#### 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



MultiDimensional eXpressions

Language for querying OLAP cubes and for defining calculated members

Standard de-facto

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

ruggieri_FoodMart - Microsoft Visual Studio           File         Edit         View         Preject         Ruid         Debug         Debug         Debug	Giba Task Window Computing Hole	_ B	X					
	elonment - 🔊 🖓 🖏 🖬 🖓 -							
Sales cube [Design] Product dm [Design]	Customer, dim [Design] 🖌 Eood Mart, dsv. [Design] 🖌 Time By Day, dim [Design] 📝 Start Pag	1e - X	<b>*</b>					
Image: Substrate to congregation of the structure o	culations   🥃 KPIs 🥂 Actions 🛞 Partitions   🍘 Perspectives   🖓 Translations   😭	Browser						_
		- Wruggieri_FoodMart - Microsoft Visual Sto	udio	a iku turla			_ 8	×
			Development - 🔊 🖓 🎌 🏹 🕅	nurkà Teih				
Action Organizer	Name:	Sales.cube [Design] Product.dim [De	esign] Customer.dim [Design] Eood Mar	dsv [Design] / Time B	v Day.dim [Design]	Start Page	• X	( <b>†</b> )
Drillthrough Action		g Q Cube Structure	e 😭 Calculations 💓 KPIs 🔣 Actions 🕯	A Partitions 🙀 Perspe	ectives 💊 Translation	ns 🙀 Browser		Dep
	Action Target		Perspective: Sales	Language: D	efault 🔻			oloym
	Measure group members:	Sales	Dimension	()pe	erator Eilte	er Expression		ent P
	Sales Fact 1997 1998	B III Measures	<select dimension=""></select>		1100	a Expression		rogre
	☆ Condition (Optional)	Sales Count						s
		Store Cost	1					J <sup>P</sup> Proj
		Unit Sales	Classificazione 🔻					pertie
		SalesOverLastMonth	Beer Drop C	olumn Fields Here				<u>(</u> 3
	☆ Drillthrough Columns	too Product	The Year  Very Quarter The Month Store 9	ales				2
	Dimensions Return Columns	- {} Top_10_By_Profit	□ Q2 □ April \$230.8	4				Soluti
Calculation Tools	MEASURES Store Sales, Store Cost, Unit Sales, S.	ale Brand Name	Image: May \$288.0 Image: Image: May \$288.0 Image: Image: Image: Image: May \$291.4	0				9
Metadata 🧚 Functions 🛄 Templates	to Customer Customer, Country, State Province, C	The Broduct Catagony	Total \$810.2	5				분
		alt. 🔲 🗄 Froduct Category	FI 03 \$859.5	5				Te
E 🔁 (All)	<pre><select dimension=""></select></pre>	Product Category     Product Family     Product Name		5 🔯 Data Sample	e Viewer (first 1	1000 records)		
Image: The second s	<pre></pre>	Product Family     Product Family     Product Subcategory     Product Subcategory	H Q3 \$859.5     H Q4 \$1,007     Total \$3,400     H 1998 \$6,756     Grand Tabal	5 🙀 Data Sample	e Viewer (first 1	1000 records)		
⊕ (All)     ⊕ Reporting     ⊕ Standard	<pre></pre>	Product Category     Product Pamily     Product Name     Product Nubcategory     Units Per Case     Data Silicatione	⊞ Q3         \$\$59.5           ⊡ Q4         \$1,007           Total         \$3,400           ⊞ 1998         \$6,756           Grand Total         \$10,15	5 Data Sample [Sales Fact 19	e Viewer (first 1	1 <b>000 records)</b> Sales Fact 19 [Sa	iles Fact 19 [\$Customer].	_ □
	<pre><select dimension=""></select></pre>	III → Product Setup()     Product Setup()     Product Name     Product Name     Product Name     Product Subcategory     III → Product Subcategory     III → Case     IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	☐ Q3 \$859.5 ☐ Q4 \$1,000 Total \$3,400 ☐ 1998 \$4,756 Grand Total \$10,15	5 Data Sample [Sales Fact 19 15.16	e Viewer (first 1 [Sales Fact 19 [ 5.6092 4	Sales Fact 19 [Sa	iles Fact 19 [\$Customer]. Trujillo Ira	
<ul> <li></li></ul>	<pre></pre>	Product Calculation y     Product Name     Product Name     Product Name     Product Name     Units Per Case     Lassificatione     Day of Week     B     Month of Year	田 Q3         \$3659.5           田 Q4         \$1,007           Total         \$3,400           田 1998         \$67,55           Grand Total         \$10,15	5 7 7 7 7 7 7 7 7 7 7 7 7 7	e Viewer (first 1 [Sales Fact 19] 5.6092 4 2.5272 3	Sales Fact 19 [Sales Fact 19 ]	iles Fact 19 [\$Customer]. Trujillo Ira Whitten Fred	[ [\$Cus ▲ USA USA
E _ (All) B _ Reporting D _ Standard	<pre></pre>	Here Service Ser	田 Q3         \$365,5           田 Q4         \$1,007           Total         \$3,400           田 1998         \$67,55           Grand Total         \$10,15	5 <b>Data Sample</b> [Sales Fact 19 15.16 6.48 2.28	e Viewer (first 1 [Sales Fact 19 [ 5.6092 4 2.5272 3 1.026 2	Sales Fact 19 [Sales Fact 19 ]	ales Fact 19 [\$Customer]. Trujillo Ira Whitten Fred Norris Timoth	
E _ (All) B _ Reporting E _ Standard	<pre></pre>	the second	田 Q3         \$365,5           田 Q4         \$1,007           Total         \$3,400           田 1996         \$5,756           Grand Total         \$10,15	5 <b>Data Sample</b> <b>Sales Fact 19</b> 15.16 6.48 2.28 10.36	e Viewer (first 1 [Sales Fact 19 [ 5.6092 4 2.5272 3 1.026 2 4.144 4	Sales Fact 19 5 1 1 1 1 1 1 1 1 1	iles Fact 19 [\$Customer]. Trujilo Ira Whitten Fred Norris Timoth Cummings Ri	Iš USA USA USA USA USA
E _ (All) B _ Reporting E _ Standard	Additional Properties	the second	Im Q3         \$3659.5           Im Q4         \$1,000           Total         \$3,400           Im 1998         \$57,55           Grand Total         \$10,15	5 7 7 7 7 7 7 7 7 7 7 7 7 7	e Viewer (first 1 [Sales Fact 19 [ 5.6092 4 2.5272 3 1.026 2 4.144 4 0.814 2	Sales Fact 19         [Sales Fact 19]           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1	iles Fact 19 [\$Customer], Trujilo Ira Whitten Fred Norris Timoth Cummings Ri Hahn Glenn	USA USA USA USA USA USA
<ul> <li>All)</li> <li>⇒ Geporting</li> <li>⇒ Standard</li> </ul>	Additional Properties     Default:     True	the second	El Q3 \$365,5 El Q4 \$1,007 Total \$3,400 Grand Total \$10,15	5 <b>Data Sample</b> 7 <b>Sales Fact 19</b> 15.16 6.48 2.28 10.36 2.2 2.73	e Viewer (first 1 [Sales Fact 19] 5.6092 4 2.5272 3 1.026 2 4.144 4 0.814 2 1.3104 3	1000 records)	iles Fact 19 [\$Customer], Trujilo Ira Whitten Fred Norris Timoth Cumnings Ri Hahn Glenn Koman Denis	[ [\$Cus USA USA USA USA USA USA USA
Error List Output	Additional Properties     Default:     True	the second	El Q3 \$359.5 El Q4 \$1,007 Total \$3,400 Grand Total \$7,75 Grand Total \$10,15	Solution	e Viewer (first J [Sales Fact 19] [5.6092 4 2.5272 3 1.026 2 4.144 4 0.814 2 1.3104 3 1.6416 4	1000 records           Sales Fact 19         [Sales 19]           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1	les Fact 19 [\$Customer], Trujilo Ira Whitten Fred Norris Timoth Cummings Ri Hahn Glenn Koman Denis Pacheco Kare	USA USA USA USA USA USA USA
(Al) P (Al) P Standard P Standard P Standard P Standard Ready	Additional Properties     Default:     True     In 1	the second	☐ Q3 \$359.5 ☐ Q4 \$1,007 Total \$3,400 Grand Total \$10,15	Solution         Solution           7         [Sales Fact 19           15.16         6.48           2.28         10.36           2.2         2.73           4.56         2.73	E Viewer (first 1         [Sales Fact 19]         [S.6092         4           2.5272         3         1.026         2           4.144         4         0.814         2           1.3104         4         0.814         2           0.814         2         0.816         3           0.816         3         0.816         4	Sales Fact 19         [Sales Fact 19]           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1	Iles Fact 19 [\$Customer]. Trujilo Ira Whitten Fred Norris Timoth Cummings Ri Hahn Glenn Koman Denis Pacheco Kare Bunczewski R	[ [\$Cus • USA USA USA USA USA USA USA USA USA USA
Ready	Additional Properties     Default:     True     In 1	B Product Samply     Product Name     Product Name     Product Name     Product Name     Product Subcategory     Units Per Case     Accassificatione     Day Of Week     Month Of Year     Day Of Week     The Day     The Day     The Vear	☐ Q3 \$359.5 ☐ Q4 \$1,007 Total \$3,400 Grand Total \$10,15	Solution         Solution           Image: Solution of the second seco	E Viewer (first 1         I           [Sales Fact 19]         [           5.6092         4           2.5272         3           1.026         2           4.144         4           0.814         2           1.3104         3           0.8736         3           0.912         2	Sales Fact 19         [Sales Fact 19]           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1	ales Fact 19 [\$Customer], Trujillo Ira Whitten Fred Norris Timoth Cummings Ri Hahn Glenn Koman Denis Pacheco Kare Bunczewski R Harrison Jose	Image: Constraint of the second se
Error List Output	Additional Properties     Default:     True     In 1	trong to the second of the second second of the second second of the second seco	☐ Q3 \$359.5 ☐ Q4 \$1,007 Total \$3,400 Grand Total \$10,15	Sales         Sales         Sales         Sample           7         [Sales Fact 19         15.16         6.48           2.28         10.36         2.2         2.73           4.56         2.73         2.28         6.48	E Viewer (first 1         [5]           [5]         5.6092         4           2.5272         3           1.026         2           4.144         4           0.814         2           1.6416         4           0.8736         3           0.912         2           2.6568         3	Sales Fact 19         [5a           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1	ales Fact 19 [\$Customer], Trujillo Ira Whitten Fred Norris Timoth Cummings Ri Hahn Glenn Koman Denis Pacheco Kare Bunczewski R Harrison Jose Beninati Barry	Image: Constraint of the second se
(Al)     (Al)     Standard     Standard	Additional Properties     Default:     True     In 1	trop Last Casedory         Troduct Casedory         Troduct Casedory         Troduct Name         Product Name         Product Name         Product Name         Product Name         Droduct Name         Day Of Week         The bate         The bate         The bay         The bay         The bay         The Year	☐ Q3 \$359.5 ☐ Q4 \$1,007 Total \$3,400 Grand Total \$10,15	Sales         Sales <th< td=""><td>E Viewer (first 1 5-6092 4 2.5272 3 1.026 2 4.144 4 0.814 2 1.3104 3 1.6416 4 0.8736 3 0.912 2 2.6568 3 1.728 2</td><td>Sales Fact 19         [5a           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1</td><td>ales Fact 19 [\$Customer]. Trujilo Ira Whitten Fred Norris Timoth Cummings Ri Hahn Glenn Koman Denis Pacheco Kare Bunczewski R Harrison Jose Beninati Barry Martucci Mar</td><td>Image: Constant of the second secon</td></th<>	E Viewer (first 1 5-6092 4 2.5272 3 1.026 2 4.144 4 0.814 2 1.3104 3 1.6416 4 0.8736 3 0.912 2 2.6568 3 1.728 2	Sales Fact 19         [5a           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1	ales Fact 19 [\$Customer]. Trujilo Ira Whitten Fred Norris Timoth Cummings Ri Hahn Glenn Koman Denis Pacheco Kare Bunczewski R Harrison Jose Beninati Barry Martucci Mar	Image: Constant of the second secon
(All)     (All)     Standard     Standard	Additional Properties     Default:     True     In 1	trop Last Casedory         Troduct Casedory         Product Name         Product Name         Product Name         Product Name         Product Name         Product Name         Units Per Case         Classificatione         Units Per Case         Quarter         The Day         Quarter         The Day         The Day         The Name         The Nam         The Name         The Name	☐ Q3 \$359.5 ☐ Q4 \$1,007 Total \$3,400 Grand Total \$10,15	Sales         Sales <th< td=""><td>Sales Fact 19         [           5.6092         4           2.5272         3           1.026         2           4.144         4           0.814         2           1.6416         4           0.8736         3           1.6426         2           2.6568         3           1.728         2</td><td>Sales Fact 19         [5a           5ales Fact 19         [5a           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1</td><td>iles Fact 19 [\$Customer]. Trujilo Ira Whitten Fred Norris Timoth Cummings Ri Hahn Glenn Koman Denis Pacheco Kare Bunczewski R Harrison Jose Beninati Barry Martucci Mar Kartz Kay</td><td>Image: Constant of the second secon</td></th<>	Sales Fact 19         [           5.6092         4           2.5272         3           1.026         2           4.144         4           0.814         2           1.6416         4           0.8736         3           1.6426         2           2.6568         3           1.728         2	Sales Fact 19         [5a           5ales Fact 19         [5a           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1	iles Fact 19 [\$Customer]. Trujilo Ira Whitten Fred Norris Timoth Cummings Ri Hahn Glenn Koman Denis Pacheco Kare Bunczewski R Harrison Jose Beninati Barry Martucci Mar Kartz Kay	Image: Constant of the second secon
Call     Call	Additional Properties     Default:     True     In 1	Product Samply     Product Name     Product Name	☐ Q3 \$359.5 ☐ Q4 \$1,007 Total \$3,400 Grand Total \$10,15	Sales         Sales         Sales         Sample           [Sales Fact 19         15.16         6.48         2.28         10.36         2.2         2.73         4.56         2.73         4.56         2.73         4.56         2.73         4.56         3.3         2.73         3.3         2.73	Viewer (first 1           [Sales Fact 19]         [           5.6092         4           2.5272         3           1.026         2           4.144         4           0.814         2           1.3104         3           1.6416         4           0.8736         3           0.912         2           2.6568         3           1.728         2           1.353         3           0.9555         3	Sales Fact 19         [5a           Sales Fact 19         [5a           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1	iles Fact 19 [\$Customer]. Trujilo Ira Whitten Fred Norris Timoth Cummings Ri Hahn Glenn Koman Denis Pacheco Kare Bunczewski R Harrison Jose Beninati Barry Martucci Mar Kartz Kay Biss Roseann	Image: Constraint of the second sec
Ready	Additional Properties     Default:     True     In 1	Product Rampy     Product Name     Product Subcategory     Units Per Case     Quarter     Day Of Week     Month Of Year     Quarter     The Day     The Day     The Poay     Day of Units     The Vear     The Vear     The Vear     The Vear     Day     Output	☐ Q3 \$359.5 ☐ Q4 \$1,007 Total \$3,400 Grand Total \$10,15	Sales         Sales         Sample           [Sales Fact 19]         15.16         6.48         2.28           10.36         2.2         2.73         4.56         2.73         4.56         2.28         6.48         4.32         3.3         2.73         7.77	e Viewer (first 1 5.6092 4 5.6092 3 1.026 2 4.144 4 0.814 2 1.3104 3 1.6416 4 0.8736 3 0.912 2 2.6568 3 1.728 2 1.728 2 1.353 3 3.4488 3	Sales Fact 19         [Sales Fact 19]           Sales Fact 19         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1	iles Fact 19 [\$Customer]. Trujilo Ira Whitten Fred Norris Timoth Cummings Ri Hahn Glenn Koman Denis Pacheco Kare Bunczewski R Harrison Jose Beninati Barry Martucci Mar Kartz Kay Bliss Roseann Haynes Phil	[ [\$Cus ▲ USA USA USA USA USA USA USA USA USA USA
Ready	Additional Properties     Default:     True     In 1	K     K    K	Im Q3         \$359.5           Im Q4         \$1,000           Total         \$3,400           Grand Total         \$10,15	Sales         Sales         Sample           [Sales Fact 19]         15.16         6.48           2.28         10.36         2.2           2.73         4.56         2.73           2.28         6.48         4.32           3.3         2.73         7.77           7.44         5.5         5.5	e Viewer (first 1 5.6092 4 5.6092 3 1.026 2 4.144 4 0.814 2 1.3104 3 1.6416 4 0.8736 3 0.912 2 2.6568 3 1.728 2 1.728 2 1.728 3 3.4188 3 3.2736 4	Sales Fact 19         [Sales Fact 19]           Sales Fact 19         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1	ales Fact 19 [\$Customer]. Trujilo Ira Whiten Fred Norris Timoth Cummings Ri Hahn Glenn Koman Denis Pacheco Kare Bunczewski R Harrison Jose Beninati Barry Martucci Mar Kartz Kay Bliss Roseann Haynes Phil Trujilo Ruth	[ [\$Cus ▲ USA USA USA USA USA USA USA USA USA USA
Ready	Additional Properties     Default:     True     In 1	K     K    K	☐ Q3 \$359.5 ☐ Q4 \$1,007 Total \$3,400 Grand Total \$10,15 Grand Total \$10,15 (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	Solution         Solution           Image: Solution of the second seco	E Viewer (first 1         [           5.6092         4           2.5272         3           1.026         2           4.144         4           0.814         2           1.3104         4           0.8736         3           0.912         2           2.6568         3           1.728         2           3.34188         3           3.2736         4	Sales Fact 19         [Sales Fact 19]           Sales Fact 19         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1           1         1	Ales Fact 19 [\$Customer]. Trujilo Ira Whitten Fred Norris Timoth Cummings Ri Hahn Glenn Koman Denis Pacheco Kare Bunczewski R Harrison Jose Beninati Barry Martucci Mar Kartz Kay Bliss Roseann Haynes Phil Trujilo Ruth	[ \$\\$Cus \leq USA

⊆lose

#### 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

#### Data storage modes

				OLAP Server 🗢	MOLAP 🗢	ROLAP 🗢	HOLAP 🗢	Offline 💠
lhe K	?()  /	AP co	ASC	Essbase	Yes	Yes	Yes	
				icCube	Yes	No	No	Offline Cubes 🗗
16				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	
	Figure 20: ROL	AP Meets Applicat	ion Requirements	SAP NetWeaver BW	Yes	Yes	No	
Retail Merchant DSS 100 × Banking Profit DSS 100 × Financials EIS		× × <b>ROLAP</b> × × × × × ×	$\times$	Promotion Analysis DSS Insurance Policy DSS Bank Credit Scoring DSS Utility Task DSS				

Dimensionality (Orthogonal Dimensions)

1000

100

10

×

#### Storage model

17

#### Can be set for whole cube or for single dimensions

🏠 Di	mension Stor	age Settings	- Customer				_ 🗆 ×
۲	<u>S</u> tandard settin	Ig					
		Real-time HOLAP '	Me	dium-latency MOLAP	ı	Scheduled MOLAP	ń
	ī		i.	i.	I.		Ļ
	Real-time ROLAP	I	.ow-latency MOLAP		Automatic MOLAP		MOLAP
	- Measu - Notific - Proces	ire group data ations are not ssing must be e	and aggregatic received when ither scheduled	ons are stored data change d or performe	d in a multidim s. d manually.	ensional forr	nat.
0	C <u>u</u> stom setting						
	To view or n	nodify settings	, click Options.			[	Options
				0	<	Cancel	Help

5torage mode:	MOLAP			ľ			
	🔽 Enable proa	Enable proactive caching					
General Notifications	;]						
Cache Settings -							
🔽 Update th	e cache when data chan	ges					
Sįlence in	terval:	10	Seconds 💌				
Silence <u>o</u>	verride interval:	10	Minutes				
Drop outd	ated cache						
Latency:			(Not enabled)				
🔽 Update th	e <u>c</u> ache periodically						
Rebuild in	nterval:		(Not enabled)				
Options							
Bring online	e immediately	E Apply :	ettings to dimensions				
Enable <u>R</u> OI	.AP aggregations						
The current notific source or the Ana Administrator priv	cation method is set to S lysis Services service acc ileges on the SQL Server	QL Server. This opti count be configured . Click Options to m	on requires that either the dat to use an account with Systen odify this setting,	a 1			
			<u> </u>				

//

#### **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

**Business Informatics Degree** 

## 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)

**Business Informatics Degree** 

#### **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>]

35

#### 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

#### 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
  - Qlextra: 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