

Contents

Foreword	xiii
Preface.....	xv
About the Author.....	xix
CHAPTER 1 Introduction to Data Virtualization	1
1.1 Introduction.....	1
1.2 The World of Business Intelligence Is Changing	1
1.3 Introduction to Virtualization.....	3
1.4 What Is Data Virtualization?.....	4
1.5 Data Virtualization and Related Concepts	5
1.5.1 Data Virtualization versus Encapsulation and Information Hiding	5
1.5.2 Data Virtualization versus Abstraction	6
1.5.3 Data Virtualization versus Data Federation	7
1.5.4 Data Virtualization versus Data Integration.....	8
1.5.5 Data Virtualization versus Enterprise Information Integration.....	9
1.6 Definition of Data Virtualization	9
1.7 Technical Advantages of Data Virtualization.....	10
1.8 Different Implementations of Data Virtualization	14
1.9 Overview of Data Virtualization Servers	14
1.10 Open versus Closed Data Virtualization Servers	15
1.11 Other Forms of Data Integration.....	16
1.12 The Modules of a Data Virtualization Server	18
1.13 The History of Data Virtualization	19
1.14 The Sample Database: World Class Movies	22
1.15 Structure of This Book.....	25
CHAPTER 2 Business Intelligence and Data Warehousing	27
2.1 Introduction.....	27
2.2 What Is Business Intelligence?.....	27
2.3 Management Levels and Decision Making.....	28
2.4 Business Intelligence Systems	29
2.5 The Data Stores of a Business Intelligence System.....	30
2.5.1 The Data Warehouse	30
2.5.2 The Data Marts	34
2.5.3 The Data Staging Area.....	35
2.5.4 The Operational Data Store	37
2.5.5 The Personal Data Stores	38
2.5.6 A Comparison of the Different Types of Data Stores	38

2.6	Normalized Schemas, Star Schemas, and Snowflake Schemas	39
2.6.1	Normalized Schemas	40
2.6.2	Denormalized Schemas	40
2.6.3	Star Schemas.....	41
2.6.4	Snowflake Schemas	43
2.7	Data Transformation with Extract Transform Load, Extract Load Transform, and Replication	44
2.7.1	Extract Transform Load.....	44
2.7.2	Extract Load Transform.....	45
2.7.3	Replication.....	46
2.8	Overview of Business Intelligence Architectures	47
2.9	New Forms of Reporting and Analytics	48
2.9.1	Operational Reporting and Analytics.....	48
2.9.2	Deep and Big Data Analytics.....	49
2.9.3	Self-Service Reporting and Analytics.....	49
2.9.4	Unrestricted Ad-Hoc Analysis	50
2.9.5	360-Degree Reporting.....	51
2.9.6	Exploratory Analysis	51
2.9.7	Text-Based Analysis.....	52
2.10	Disadvantages of Classic Business Intelligence Systems	53
2.11	Summary	56
CHAPTER 3	Data Virtualization Server: The Building Blocks	59
3.1	Introduction	59
3.2	The High-Level Architecture of a Data Virtualization Server	59
3.3	Importing Source Tables and Defining Wrappers	60
3.4	Defining Virtual Tables and Mappings	62
3.5	Examples of Virtual Tables and Mappings	66
3.6	Virtual Tables and Data Modeling	76
3.7	Nesting Virtual Tables and Shared Specifications	77
3.8	Importing Nonrelational Data	79
3.8.1	XML and JSON Documents.....	79
3.8.2	Web Services.....	84
3.8.3	Spreadsheets	86
3.8.4	NoSQL Databases.....	86
3.8.5	Multidimensional Cubes and MDX.....	89
3.8.6	Semistructured Data.....	92
3.8.7	Unstructured Data.....	95
3.9	Publishing Virtual Tables	96
3.10	The Internal Data Model	101
3.11	Updatable Virtual Tables and Transaction Management	106

CHAPTER 4	Data Virtualization Server: Management and Security	109
4.1	Introduction.....	109
4.2	Impact and Lineage Analysis.....	109
4.3	Synchronization of Source Tables, Wrapper Tables, and Virtual Tables	110
4.4	Security of Data: Authentication and Authorization.....	112
4.5	Monitoring, Management, and Administration	114
CHAPTER 5	Data Virtualization Server: Caching of Virtual Tables.....	119
5.1	Introduction.....	119
5.2	The Cache of a Virtual Table	119
5.3	When to Use Caching	120
5.4	Caches versus Data Marts.....	122
5.5	Where Is the Cache Kept?	122
5.6	Refreshing Caches	123
5.7	Full Refreshing, Incremental Refreshing, and Live Refreshing	124
5.8	Online Refreshing and Offline Refreshing	125
5.9	Cache Replication.....	126
CHAPTER 6	Data Virtualization Server: Query Optimization Techniques	127
6.1	Introduction.....	127
6.2	A Refresher Course on Query Optimization	128
6.3	The Ten Stages of Query Processing by a Data Virtualization Server.....	132
6.4	The Intelligence Level of the Data Stores.....	134
6.5	Optimization through Query Substitution	134
6.6	Optimization through Pushdown	137
6.7	Optimization through Query Expansion (Query Injection).....	139
6.8	Optimization through Ship Joins	140
6.9	Optimization through Sort-Merge Joins	141
6.10	Optimization by Caching.....	142
6.11	Optimization and Statistical Data	142
6.12	Optimization through Hints	143
6.13	Optimization through SQL Override.....	143
6.14	Explaining the Processing Strategy	145
CHAPTER 7	Deploying Data Virtualization in Business Intelligence Systems.....	147
7.1	Introduction.....	147
7.2	A Business Intelligence System Based on Data Virtualization	147
7.3	Advantages of Deploying Data Virtualization	148
7.4	Disadvantages of Deploying Data Virtualization.....	151
7.5	Strategies for Adopting Data Virtualization.....	151
	7.5.1 Strategy 1: Introducing Data Virtualization in an Existing Business Intelligence System.....	152

7.5.2	Strategy 2: Developing a New Business Intelligence System with Data Virtualization.....	157
7.5.3	Strategy 3: Developing a New Business Intelligence System Combining Source and Transformed Data	161
7.6	Application Areas of Data Virtualization.....	163
7.6.1	Unified Data Access.....	163
7.6.2	Virtual Data Mart	163
7.6.3	Virtual Data Warehouse—Based on Data Marts.....	165
7.6.4	Virtual Data Warehouse—Based on Production Databases.....	165
7.6.5	Extended Data Warehouse	167
7.6.6	Operational Reporting and Analytics.....	167
7.6.7	Operational Data Warehouse	168
7.6.8	Virtual Corporate Data Warehouse	169
7.6.9	Self-Service Reporting and Analytics.....	170
7.6.10	Virtual Sandbox	171
7.6.11	Prototyping	171
7.6.12	Analyzing Semistructured and Unstructured Data	172
7.6.13	Disposable Reports	173
7.6.14	Extending Business Intelligence Systems with External Users.....	173
7.7	Myths on Data Virtualization.....	174

CHAPTER 8 Design Guidelines for Data Virtualization177

8.1	Introduction.....	177
8.2	Incorrect Data and Data Quality	177
8.2.1	Different Forms of Incorrect Data	178
8.2.2	Integrity Rules and Incorrect Data.....	179
8.2.3	Filtering, Flagging, and Restoring Incorrect Data.....	179
8.2.4	Examples of Filtering Incorrect Data	180
8.2.5	Examples of Flagging Incorrect Data.....	184
8.2.6	Examples of Restoring Misspelled Data.....	186
8.3	Complex and Irregular Data Structures	188
8.3.1	Codes without Names	188
8.3.2	Inconsistent Key Values	190
8.3.3	Repeating Groups	192
8.3.4	Recursive Data Structures.....	192
8.4	Implementing Transformations in Wrappers or Mappings.....	197
8.5	Analyzing Incorrect Data.....	197
8.6	Different Users and Different Definitions.....	198
8.7	Time Inconsistency of Data	199
8.8	Data Stores and Data Transmission	200
8.9	Retrieving Data from Production Systems	202

8.10	Joining Historical and Operational Data	203
8.11	Dealing with Organizational Changes.....	204
8.12	Archiving Data	205
CHAPTER 9	Data Virtualization and Service-Oriented Architecture	207
9.1	Introduction	207
9.2	Service-Oriented Architectures in a Nutshell.....	207
9.3	Basic Services, Composite Services, Business Process Services, and Data Services	209
9.4	Developing Data Services with a Data Virtualization Server.....	211
9.5	Developing Composite Services with a Data Virtualization Server	213
9.6	Services and the Internal Data Model	215
CHAPTER 10	Data Virtualization and Master Data Management.....	217
10.1	Introduction	217
10.2	Data Is a Critical Asset for Every Organization	217
10.3	The Need for a 360-Degree View of Business Objects	219
10.4	What Is Master Data?.....	219
10.5	What Is Master Data Management?.....	221
10.6	A Master Data Management System.....	222
10.7	Master Data Management for Integrating Data.....	224
10.8	Integrating Master Data Management and Data Virtualization.....	224
CHAPTER 11	Data Virtualization, Information Management, and Data Governance.....	231
11.1	Introduction	231
11.2	Impact of Data Virtualization on Information Modeling and Database Design	231
11.3	Impact of Data Virtualization on Data Profiling.....	234
11.4	Impact of Data Virtualization on Data Cleansing.....	239
11.5	Impact of Data Virtualization on Data Governance	239
CHAPTER 12	The Data Delivery Platform—A New Architecture for Business Intelligence Systems	243
12.1	Introduction	243
12.2	The Data Delivery Platform in a Nutshell.....	243
12.3	The Definition of the Data Delivery Platform	244
12.4	The Data Delivery Platform and Other Business Intelligence Architectures	245
12.5	The Requirements of the Data Delivery Platform.....	247
12.6	The Data Delivery Platform versus Data Virtualization.....	249
12.7	Explanation of the Name	250
12.8	A Personal Note.....	251

CHAPTER 13 The Future of Data Virtualization	253
13.1 Introduction	253
13.2 The Future of Data Virtualization According to Rick F. van der Lans	254
13.2.1 New and Enhanced Query Optimization Techniques.....	254
13.2.2 Exploiting New Hardware Technology	255
13.2.3 Extending the Design Module.....	256
13.2.4 Data Quality Features.....	258
13.2.5 Support for the Push-Model for Data Access.....	258
13.2.6 Blending of Data Virtualization, Extract Transform Load, Extract Load Transform, and Replication	259
13.3 The Future of Data Virtualization According to David Besemer, CTO of Composite Software	260
13.3.1 The Empowered Consumer Gains Ubiquitous Data Access	261
13.3.2 IT's Back Office Becomes the Cloud	261
13.3.3 Data Virtualization of the Future Is a Global Data Fabric.....	261
13.3.4 Conclusion.....	262
13.4 The Future of Data Virtualization According to Alberto Pan, CTO of Denodo Technologies	262
13.5 The Future of Data Virtualization According to James Markarian, CTO of Informatica Corporation.....	264
13.5.1 How to Maximize Return on Data with Data Virtualization	265
13.5.2 Beyond Looking Under the Hood	266
Bibliography	267
Index	269