The Data Warehouse Lifecycle Toolkit

Second Edition

Ralph kimbti
\hiri;\ U
Warren T homlhu.iili'
Im \IUIHI\

HHOCH.SCHULE
•" LIECHTENSTEIN
Bibliothek

1807•
: WILEY,
2007'

Wiley P

Contents

Acknowledgments ix

Introduction xxxi

Chapter 1 Introducing the Kimball Lifecycle I
Lifecycle History Lesson 1
Lifecycle Milestones 3
Program/Project Planning 4
Program/Project Management 4
Business Requirements Definition 5
Technology Track 5
Technical Architecture Design 5
Product Selection and Installation 6
Data Track 6
Dimensional Modeling 6
Physical Design 6
ETL Design and Development 7
Business Intelligence Application Track 7
BI Application Design 7
BI Application Development 7
Deployment 7
Maintenance 8
Growth 8
Using the Lifecycle Roadmap 8
1 Lifecycle Navigation Aids 9
1 Lifecycle Vocabulary Primer 9
Data Warehouse versus Business Intelligence 10
ETL System 11
Business Process Dimensional Model 12
Business Intelligence Applications 13
Conclusion 14

Chapter 2 Launching and Managing the Project/Program **15**

Define the Project 16
Assess Your Readiness for DW/BI 16
Strong Senior Business Management Sponsor(s) 16
Compelling Business Motivation 17
Feasibility 17
Factors Not Considered Readiness Deal Breakers 18
Address Shortfalls and Determine Next Steps 18
Strong Sponsor, Compelling Business Need, and Quality Data 19
Poor Quality Data 19
Weak Business Sponsor or IT-Only Sponsor 19
Too Much Demand from Multiple Business Sponsors 20
Well Meaning, But Overly Aggressive Business Sponsor 21
Legacy of Underperforming, Isolated Data Silos 21
Develop the Preliminary Scope and Charter 22
Focus on a Single Business Process 22
The Role of Rapid Application Development 24
Document the Scope/Charter 25
Build the Business Case and Justification 27
Determine the Financial Investments and Costs 27
Determine the Financial Returns and Benefits 28
Combine the Investments and Returns to Calculate ROI 30
Plan the Project 31
Establish the Project Identity 31
Staff the Project 32
Front Office: Sponsors and Drivers 33
Coaches: Project Managers and Leads 34
Regular Lineup: Core Project Team 35
Special Teams 38
Free Agents 39
Convert Individual Talent into a Team 40
Develop the Project Plan 40
Develop the Communication Plan 43
Project Team 44
Sponsor and Driver Briefings 45
Business User Community 45
Communication with Other Interested Parties 46
Manage the Project 46
Conduct the Project Team Kickoff Meeting 47
Monitor Project"Status 48
Project Status Meetings 48
Project Status Reports 49
Maintain the Project Plan 50
Consolidate the Project Documentation 50

Manage the Scope 50
Track Issues 51
Control Changes 52
Manage Expectations 53
Recognize Project Trouble Signs 53
Manage the Program 54
Establish Governance Responsibility and Processes 54
Elevate Data Stewardship to Enterprise Level 56
Leverage Methods and Architectural Best Practices 57
Conduct Periodic Assessments 57
Communicate, Communicate, Communicate 58
Conclusion 58
Managing the Effort and Reducing Risk 58
Assuring Quality 59
Key Roles 59
Key Deliverables 59
Estimating Considerations 60
Website Resources 60
Task List 61

Chapter 3 Collecting the Requirements 63
Overall Approach to Requirements Definition 64
Interviews versus Facilitated Sessions 66
Methods to Avoid for Collecting Requirements 67
Prepare for the Interview 68
Identify the Interview Team 68
Lead Interviewer 68
Scribe 68
Observers 70
Research the Organization 70
Select the Interviewees 71
Business Interviewees 71
IT and Compliance/Security Interviewees 72
Develop the Interview Questionnaires 73
Schedule the Interviews 73
Sequence the Interviews 73
Establish the Interview Time and Place 75
Prepare the Interviewees 76
Review Interviewing Ground Rules 77
Remember Your Interview Role 78
Assume You Will Learn 78
Verify Communications 78
Be Conversational 79
Maintain Interview Schedule Flexibility 79
Manage Expectations Continuously 80
Conduct the Interview 80
Program Business Interviews 82

Program IT Interviews 83
Program Compliance/Security Interviews 83
Wrap Up the Interview 84
Determine the Success Criteria 84
Say Thanks and See You Later 85
Review the Interview Results 85
Synthesize Around Business Processes 86
Prepare and Publish Requirements Deliverables 87
Interview Write^Ups •
Program Requirements Findings Document
Prioritize and Agree on Next Steps 91
Culminate with a Review and Prioritization Meeting 91
Close the Loop 93
Adjustments for Project Level Rgerjjirements 93
Project Level Approach 93
Prepare for the Project Requirements Interview 94
Select the Interviewees 95
Prepare the Interviewees 95
Conduct the Interviews 97
Review Existing Reports and Analyses 98
Wrap Up the Interview 99
Dig into the Data 99
Review the Interview Results 100
Prepare and Publish Project Deliverables 100
Agree on Next Steps and Close the Loop 101
Deal with Challenging Interviewees 101
• Abused User 101
Overbooked/Substitute User 102
Comatose User 102,
Overzealous User 102
Know-It-All User 103
Clueless User 103
Nonexistent User 103
Conclusion 104
Managing the Effort and Reducing Risk 104
Assuring Quality 105.
Key Roles 105
Key Deliverables 105
Estimating Considerations 106
Website Resources 106
Task List 107

Chapter 4 Introducing the Technical Architecture 109
The Value of Architecture 110
Technical Architecture Overview 112
Flow from Source System to User Screen 113
Common Architecture Features 115

Metadata Driven 115
Flexible Services Layers 117
Evolution of Your DW/BI Architecture 118
Back Room Architecture 119
General ETL Requirements 119
Build versus Buy 120
Back Room ETL Flow 121
Source Systems 121
Enterprise Resource Planning Systems 123
Operational Data Stores 124
Reporting Operational Data Stores 125
Master Data Management 125
XML Sources 126
Message Queues, Log Files, ar^d Redo Files 126
Proprietary Formats 126
Extract 127
Clean and Conform 127
Deliver 127
ETL Management Services 128
Additional Back Room Services and Trends 129
Data Service Providers 129
Functional Service Providers 129
Data Delivery Services 129
ETL Data Stores 130
ETL System Data Stores 130
Lookup and Decode Tables 130
Data Quality Data Stores 131
ETL Metadata 131
Back Room Summary 132
" Presentation Server Architecture 133
Business Requirements for Information "133
Detail Atomic Data 134
Aggregates 134
Aggregate Navigation 136
Design Disciplines within the Presentation Server 138
Adjusting the Presentation Server Architecture 138
Organizational Considerations 139
Presentation Server Metadata 140
Presentation Server Summary 141
Front Room Architecture 141
BI Application Types 141
BI Management Services 143
Shared Services 143
Vendor Specific Architectural Choices 150
BI Data Stores 151
Stored Reports 151

Application Server Caches 151
Local User Databases 151
Disposable Analytic Data Stores 152
Results from Analytic Applications 152
Downstream Systems 153
Data Store Security 153
Desktop Tool Architecture Approaches 154
BI Metadata 154
Front Room Summary 155
Infrastructure 156
Infrastructure Drivers 156
Back Room and Presentation Server Infrastructure Factors 157
Parallel Processing Hardware Architectures 159
Symmetric Multiprocessing*(5MP) 159
Massively Parallel Processing (MPP) 161
Non-Uniform Memory Architecture (NUMA)' 161
Clusters 161
Warehouse Appliances 162
Partitioning Hardware 163
Considerations Common to AH Parallel Architectures 163
Hardware Performance Boosters 163
Disk Issues 163
Memory 164
CPUs 165
Secondary Storage 165
Database Platform Factors 165
Characteristics of Relational Engines 165
Characteristics of OLAP Engines 166
Front Room Infrastructure Factors 167
Application Server Considerations 167
Desktop Considerations 168
Connectivity and Networking Factors 169
Infrastructure Summary" 170
Metadata 170
Value of Metadata Integration 171
Impact Analysis 171
Audit and Documentation 171
Metadata Quality and Management 171
Options for Metadata Integration 172
Single Source DW/BI System Vendors 172
Core Vendor Product 172
Do It Yourself 173
Metadata Summary 173
Security 173
Security Vulnerabilities 174
Threats to Physical Assets 174

Threats to Information and Software Assets 175
Threats to Business Continuance 176
Network Threats 176
Security Summary 177
Conclusion 178

Chapter 5 Creating the Architecture Plan and Selecting Products 179

Create the Architecture 180
Architecture Development Process 180
Develop the Application Architecture Plan 183
Step 1 — Form an Architecture Task Force 183
Step 2 — Gather Architecture-Related Requirements 184
Step 3 — Create a Draft Architectural Implications Document 184
Step 4 — Create the Architectase Model 185
Step 5 — Determine the Architecture Implementation Phases 186
Step 6 — Design and Specify the Subsystems 187
Step 7 — Create the Application Architecture Plan Document 187
Step 8 — Review the Draft 187
Example Application Architecture Plan Outline and Model 188
Select Products 191
Keep a Business Focus 191
Major DW / BI Evaluation Areas 192
Evaluate Options and Choose a Product 192
Step 1 — Understand the Purchasing Process 193
Step 2 — Develop the Product Evaluation Matrix 193
Step 3 — Conduct Market Research 194
Step 4 — Narrow Your Options to a Short List 196
Step 5 — Evaluate the Candidates 197
Step 6 — Recommend a Product 201
Step 7 —Trial 201
Step 8 — Contract Negotiations 201
Considerations for the Back Room and Presentation Server 202
Hardware Platform 202
DBMS Platform 203
ETL Tool 204
Considerations for the Front Room 205
Manage the Metadata 207
Appoint the Metadata Manager 207
Create the Metadata Strategy 208
Secure the System 210
Secure the Hardware and Operating System 211
Secure the Development Environment 211
Secure the Network 211
Network Components 212

Encryption 214
Authenticate the Users 215
Secure the Data 215
Provide Open Access for Internal Users 215
Itemize Sensitive Data 216
Minimize or Mask Sensitive Data 216
Secure the Data Access 217
Monitor Usage and Ensure Compliance 220
Plan for Backup and Recovery 220
Create the Infrastructure Map 221
Install the Hardware and Software 224
Conclusion 226
Managing the Effort and Reducing Risk 226
Assuring Quality 227
Key Roles 227
Key Deliverables 228
Estimating Considerations 228
Creating the Architecture Plan 228
Selecting Products 229
Metadata 229
Security 229
Website Resources 229
Task List 230

Chapter 6 Introducing Dimensional Modeling 233

Making the Case for Dimensional Modeling 234
What Is Dimensional Modeling? 234
What about Normalized Modeling? 235
Benefits of Dimensional Modeling 237
Dimensional Modeling Primer 238
Fact Tables 238
Fact Table Keys 240
Fact Table Granularity 240
Dimension Tables 241
Dimension Table Keys 243
Conformed Dimensions 244
Four-Step Dimensional Design Process 246
Step 1 — Choose the Business Process 246
Step 2 — Declare the Grain 246
Step 3 — Identify the Dimensions 247
Step 4 — Identify the Facts 247
Enterprise Data Warehouse Bus Architecture 248
Planning Crisis 248
Bus Architecture 249
Value Chain Implications 250
Common Matrix Mishaps 252
Taking the Pledge 253

More on Dimensions 253
Date and Time 253
Surrogate Date Keys 254
Time of Day 255
Date / Timestamps 255
Multiple Time Zones 256
Degenerate Dimensions 256
Slowly Changing Dimensions 257
Type 1: Overwrite the Dimension Attribute 257
Type 2: Add a New Dimension Row 258
Type 3: Add a New Dimension Attribute 258
Mini-Dimensions: Add a New Dimension 259
Hybrid Slowly Changing Dimension Techniques 261
Role-Playing Dimensions 262
Junk Dimensions 263
Snowflaking and Outriggers 265
Handling Hierarchies 268
Fixed Hierarchies 268
Variable Depth Hierarchies via Bridge Tables 268
Many-Valued Dimensions with Bridge Tables 270
More on Facts 273
Three Fundamental Grains 273
Transaction Fact Tables 273
Periodic Snapshot Fact Tables 274
Accumulating Snapshot Fact Tables 274
Facts of Differing Granularity and Allocation 276
Multiple Currencies and Units of Measure 278
Factless Fact Tables 280
Consolidated Fact Tables 281
Fables and Falsehoods About Dimensional Modeling 282
Fables Caused by Focusing on Departmental Reports 282
Fables Caused by Premature Summarization 284
Fables Caused by Overvaluing Normalization 285
Conclusion 286

Chapter 7 Designing the Dimensional Model 287
Modeling Process Overview 288
Get Organized 289
Identify Design Participants 289
Revisit the Requirements 292
Use Modeling Tools 293
Establish Naming Conventions 295
Provide for Source Data Research and Profiling 296
Obtain Facilities and Supplies 297
Recall the Four-Step Modeling Process 297
• Step 1 — Choose the Business Process 298
Step 2 — Declare the Grain 298

Step 3 — Identify the Dimensions 299
Step 4 — Identify the Facts 301
Design the Dimensional Model 301
Build the High Level Dimensional Model 302
Conduct the Initial Design Session 302
Document the High Level Model Diagram 303
Identify the Attributes and Metrics 304
Develop the Detailed Dimensional Model 305
Identify the Data Sources 305
Establish Conformed Dimensions 309
Identify Base Facts and Derived Facts 310
Document the Detailed Table Designs 311
Update the Bus Matrix 314
Identify and Resolve Modejjrjg Issues 314
Review and Validate the Model 316
Perform IT Data Model Review 318
Review with Core Users 319
Present to the Business Users 319
Finalize the Design Documentation 320
Embrace Data Stewardship 321
Conclusion 322
Managing the Effort and Reducing Risk 323
Assuring Quality 323
Key Roles 323
Key Deliverables 324
Estimating Considerations 324
Website Resources 324
Task List 325

Chapter 8 Designing the Physical Database and Planning for Performance 327
Develop Standards 328
Follow Naming Conventions 329
To Null or Not to Null? 330
Place Staging Tables 330
Develop File Location Standards 331
Use Synonyms or Views for User Accessible Tables 331
Primary Keys 332
Foreign Keys 334
Develop the Physical Data Model 335
Design the Physical Data Structure 335
Finalize the Source-to-Target Map 336
Star versus Snowflake 338
Use a Data Modeling Tool 340
Develop Initial Sizing Estimates 340
Build the Development Database 343
Design Processing Data Stores 343

Develop the Initial Index Plan 344
Indexing and Query Strategy Overview 345
B-Tree Index 345
Clustered Index 345
Bitmapped Index 346'
Other Index Types 346
Star Schema Optimization 347
Indexing Dimension Tables 347
Indexing Fact Tables 348
Indexing for Loads 349
Indexing for OLAP 349
Analyze Tables and Indexes after the Load 349
Design the OLAP Database 350
OLAP Data Granularity and Drillthrough 350
Perfecting the OLAP Dimensions "" 351
Defining OLAP Calculations 352
Build the Test Database 352
Design Aggregations • 353
Deciding; How to Aggregate 353
Deciding What to Aggregate 354
Maintaining Aggregations 355
Finalizing Indexes 357
Design and Build the Database Instance 357
Memory 358
Block Size 358
Save the Database Build Scripts and Parameter Files 358
Develop the Physical Storage Structure 359
Compute Table and Index Sizes 359
Develop the Partitioning Plan 360
Set up Storage 361
Fault Tolerance 362
Storage Area Networks 362
Configuration of Volumes and Drives 362
Conclusion 363
Managing the Effort and Reducing Risk 364
Assuring Quality 364
Key Roles 365
Key Deliverables 365
Estimating Considerations 365
Website Resources 366
Task List 367

Chapter 9 Introducing Extract, Transformation, and Load 369
Round Up the Requirements 370
Business Needs 370
Compliance 371
Data Quality 371

Security 372
Data Integration 372
Data Latency . 373
Archiving and Lineage 373
User Delivery Interfaces 373
Available Skills ' 374
Legacy Licenses 374
The 34 Subsystems of ETL 374
Extracting Data 375
Subsystem 1 — Data Profiling 375
Subsystem 2 — Change Data Capture System 376
Subsystem 3 — Extract System 378
Cleaning and Conforming Data 380
Improving Your Data Quality^Julture and Processes 380
Subsystem 4 — Data Cleansing System 381
Quality Screens 382
Responding to Quality Events 383
Subsystem 5 — Error Event Schema 383
Subsystem 6 — Audit Dimension Assembler 385
Subsystem 7 — Deduplication System 386
Subsystem 8 — Conforming System 386
Delivering Data for Presentation 387
Subsystem 9 — Slowly Changing Dimension Manager 387
Type 1: Overwrite 389
Type 2: Create a New Row 390
Type 3: Add a New Column 391
Hybrid: Combination of Types 391
Subsystem 10 — Surrogate Key Generator 392
Subsystem 11 — Hierarchy Manager 393
Subsystem 12 — Special Dimensions Manager 393
Subsystem 13 — Fact Table Builders ' 395
Transaction Grain Fact Table Loader 396
Periodic Snapshot Fact Table Loader 396
Accumulating Snapshot Fact Table Loader 397
Subsystem 14 — Surrogate Key Pipeline 398
Subsystem 15 — Multi-Valued Dimension Bridge Table Builder 400
Subsystem 16 — Late Arriving Data Handler 400
Subsystem 17 — Dimension Manager System 402
Subsystem 18 — Fact Provider System 402
Subsystem 19 — Aggregate Builder 403
Subsystem 20 — OLAP Cube Builder 404
Subsystem 21 — Data Propagation Manager 404
Managing the ETL Environment 405
Subsystem 22 — Job Scheduler 406
Subsystem 23 — Backup System 407

Backup 407
Archive and Retrieval 408
Subsystem 24 — Recovery and Restart System 409
Subsystem 25 — Version Control System 410
Subsystem 26 — Version Migration System 410
Subsystem 27 — Workflow Monitor 411
Subsystem 28 — Sorting System 412
Subsystem 29 — Lineage and Dependency Analyzer 412
Subsystem 30 — Problem Escalation System 413
Subsystem 31 — Parallelizing/Pipelining System 414
Subsystem 32 — Security System 415
Subsystem 33 — Compliance Manager 415
Subsystem 34 — Metadata Repository Manager 417
Real Time Implications 417
Real Time Triage 417
Real Time Tradeoffs 419
Real Time Partitions in the Presentation Server 421
Transaction Grain Real Time Partition 421
Periodic Snapshot Real Time Partition 422
Conclusion 423

Chapter 10 Designing and Developing the ETL System 425
ETL Process Overview 425
Getting Started 426
Develop the ETL Plan 428
Step 1 — Draw the High Level Plan 428
Step 2 — Choose an ETL Tool 429
Step 3 — Develop Default Strategies 430
Step 4 — Drill Down by Target Table 432
Ensure Clean Hierarchies 432
Develop Detailed Table Schematics 434
Develop the ETL Specification Document 435
Develop a Sandbox Source System 436
Develop One-Time Historic Load Processing 437
Step 5 — Populate Dimension Tables with Historic Data 438
Populate Type 1 Dimension Tables 438
Dimension Transformations 439
Dimension Table Loading 443
Load Type 2 Dimension Table History 445
Populate Date and Other Static Dimensions 446
Step 6. — Perform the Fact Table Historic Load 447
Historic Fact Table Extracts 447
Fact Table Transformations 448
Fact Table Loading 454
Test, Test, and Test Again 455
Develop Incremental ETL Processing 456
Step 7 —Dimension Table Incremental Processing 456

Dimension Table Extracts 456
Identify New and Changed Dimension Rows 457
Process Changes to Dimension Attributes 458
Step 8 — Fact Table Incremental Processing 459
Fact Table Extract and Data Quality Checkpoint 460
Fact Table Transformations and Surrogate Key Pipeline 461
Late Arriving Facts and the Surrogate Key Pipeline 462
Incremental Fact Table Load 463
Speed Up the Load Cycle 464
Step 9 — Aggregate Table and OLAP Loads 465
Step 10 — ETL System Operation and Automation 466
Schedule Jobs . 466
Handle Predictable Exceptions and Errors Automatically 467
Handle Unpredictable Errors Gracefully 467
Maintain Database Objects " 468
Develop and Test ETL Automation 468
Conclusion 469
Managing the Effort and Reducing Risk 469
Assuring Quality 470
Key Roles 470
Key Deliverables 471
Estimating Considerations 471
Website Resources 471
Task List • 472

Chapter 11 Introducing Business Intelligence Applications 473
Importance of Business Intelligence Applications . 474
Analytic Cycle for Business Intelligence 476
Stage 1: Monitor Activity 476
Stage 2: Identify Exceptions 477
Stage 3: Determine Causal Factors 477
Stage 4: Model Alternatives 478
Stage 5: Take Action and Track Results 478
More Implications of the Analytic Cycle • 479
Types of Business Intelligence Applications 479
Direct Access Query and Reporting Tools 480
Query Formulation 481
Analysis and Presentation Capabilities 483
User Experience 485
Technical Features 486
Standard Reports 487
Analytic- Applications 488
Pre-Built Analytic Applications 489
Read/Write Analytic Applications • 490
Dashboards and Scorecards 490-
Operational Business Intelligence 493
Data Mining 494

Data Mining Overview . 494
Data Mining in the Applications Architecture 498
Navigating Applications via the BI Portal 499
Density Considerations 501
Navigation Structure Based on Business Processes 502
Additional Portal Functions 502
Application Interface Alternatives 503
Conclusion 504

Chapter 12 Designing and Developing Business Intelligence Applications 505
Business Intelligence Application Resource Planning 506
Role of the BI Application Developer 506
Who Does the BI Applications Job? 506
Lifecycle Timing ^*,. . 507
Business Intelligence Application Specification 508
Create Application Standards and Templates 508
Determine Naming Standards 508
Create the Application Templates 509
Create Dashboard and Analytic Application Templates 512
Determine the Initial Application Set 512
Identify Report Candidates 512
Consolidate the Candidate List 514
Prioritize the Report List 514
Develop Detailed Application Specifications 515
Specify Application Content 517
Design the Navigation Framework and Portal 519
Review and Validate the Applications and Model 520
Review with the Business 521
Business Intelligence Application Development 522
Prepare for Application Development 522
Install and Test the BI Tools 522
Validate Your BI Application Interface Strategy 523
Set Up User Security 523
Set Up the Report Process Metadata System 524
Build the Applications 524
Follow the Core Process 525
Design and Develop Analytic Applications 527
Design and Develop Operational BI Applications 527
Include Data Mining Models 529
Validate the Data and Data Model 530
Create the Navigational BI Portal 530
Set Up Report Scheduling 532
Test and Verify the Applications and Data 532
Complete the Documentation 534
Plan for Deployment 534
Business Intelligence Application Maintenance 534

Conclusion 535
Managing the Effort and Reducing Risk 535
Assuring Quality 536
Key Roles 536
Key Deliverables 537
Estimating Considerations 537
BI Application Specification 537
• Development 538
Website Resources 538
Task List 539

Chapter 13 Deploying and Supporting the DW/BI System 541
System Deployment 542
Pre-Deployment Testing 543
System Testing Procedures*^'" 543
Data Quality Assurance Testing 546
Operations Process Testing 547
Live Testing 548
Performance Testing 549
Usability Testing 552
Desktop Readiness and Configuration 553
Deployment 554
Relational Database Deployment 554
ETL Deployment 556
OLAP Database Deployment 556
Report Deployment 557
Documentation and Training 558
Core Documentation 558
Business Process Dimensional Model Descriptions 558
Table and Column Descriptions 559
Report Descriptions 559
Additional Documentation 559
User Training 560
Design and Approach 560
Develop Training Materials 561
Create a Training Database 562
Plan for the Level of Effort 562
Maintenance and Support 563
Manage the Front Room 563
Provide User Support 563
Maintain the BI Portal 565
Manage Security 566
Monitor Usage 566
Report on Usage 567
Manage the Back Room 567
Support Data Reconciliation 568
Execute and Monitor the ETL System 568

Monitor Resources 569
Manage Disk Space 570
Tune for Performance 570
Backup and Recovery 571
Long Term Archiving 573
Conclusion 573
Managing the Effort and Reducing Risk 574
Assuring Quality 575
Key Roles 575
Key Deliverables 575
Estimating Considerations 576
Task List 577

Chapter 14 Expanding the DVU/BI System 579
Manage the Existing Environments- 579
Reach the Business Users 580
Manage Up 580
Measure and Market Your Success 581
Evaluate ROI 581
Monitor Success and Service, Metrics 583
Proactively Market the Data Warehouse 584
Communicate Constantly 584
Prepare for Growth and Evolution 585
Assess Your Current Environment 586
Prioritize Opportunities for Growth 587
Prioritize Minor Enhancements 587
Prioritize Major Initiatives 587
Manage Iterative Growth 588
Conclusion 590
Managing the Effort and Reducing Risk 590
Assuring Quality 590
Key Roles 591
Key Deliverables 591
Estimating Considerations 591

Glossary 593