Software Pipelines and SOA
Releasing the Power of Multi-Core Processing

Cory Isaacson

Addison-Wesley
Upper Saddle River, NJ • Boston • Indianapolis • San Francisco
New York • Toronto • Montreal • London • Munich • Paris • Madrid
Capetown • Sydney • Tokyo • Singapore • Mexico City
Contents

Foreword xv
Preface xvii
Acknowledgments xxi
About the Author xxiii
Introduction xxv

Section I: Pipelines Theory 1

CHAPTER 1 Parallel Computing and Business Applications 3

Mechanical Solutions: Parallel Computing at the Operating System Level 5
    Symmetric Multiprocessing 5
    Clustering 5
Automated Network Routing: Parallel Computing by Predetermined Logic 6
Grid Computing: Parallel Computing by Distribution 6
Parallel Computing for Business Applications 7
The Solution: Software Pipelines 8
Fluid Dynamics 10
Software Pipelines Example 11
Summary 16

CHAPTER 2 Pipelines Law 17

The Problem of Wasted CPU Power 17
Fluid Dynamics 18
Pipelines Law: The Basic Rule 19
Corollary 1: Limitations on the Flow 20
Corollary 2: Restrictions on the Output Flow 21
Software Pipelines Rules 22
Rule 1 22
Rule 2 23
Rule 3 26
Summary 30
CHAPTER 3  Pipelines Examples  31

Bank ATM System (Single-Tier Distribution)  31
   Pipelines  32
   Pipeline Distributor  33
Bank ATM System (Multi-Tier Distribution)  35
   Secondary Pipeline Tier  36
   Primary Pipeline Tier  41
Summary  43

CHAPTER 4  Pipelines Patterns  45

Service Invocation Patterns  47
   Push Pattern  47
   Pull Pattern  47
Message Exchange Patterns  49
   One-Way Pattern  49
   Request-Response Pattern  49
Pipeline Routing Patterns  51
   Round-Robin Routing Pattern  52
   Content-Based Routing Pattern  53
   Custom Routing Pattern  54
   Join Pattern  55
Distributor Patterns  55
   Single Distributor Pattern  56
   Multi-Tier Distributor Pattern  56
   Client Distributor Pattern  58
   Database Sharding Distributor Pattern  58
Distributor Connector Patterns  60
   Local Method Invocation Pattern  61
   Socket Invocation Pattern  62
   Web Service Invocation Pattern  62
   Other Patterns  62
Summary  62

CHAPTER 5  Pipelines: The Organizational Impact  65

Strategic Evaluation  66
Budget Impact  68
Section II: Pipelines Methodology 79

Chapter 6  Software Pipelines Optimization Cycle: Overview 81

Yet Another Software Methodology? 81
SPOC Overview 82

Chapter 7  The Five Steps of SPOC 85

Summary 88

Chapter 8  Pipelines by Example: Introducing the Pipelines Bank Corporation 89

SPOC Report Template 93
Summary 94

Chapter 9  SPOC Step 1: Pipelines Objectives 95

Step 1.1: Identify Business Objectives/Requirements 96
Step 1.2: Determine Input Processing Rate 102
Step 1.3: Determine Future Potential Input Processing Rate 104
Step 1.4: Measure Current Capacity 107
Step 1.5: Calculate Performance Gap 109
Step 1.6: Define Pipelines Targets 111
Summary 113
CHAPTER 10  SPOC Step 2: Pipelines Analysis  115

Step 2.1: Map Current Process Flow  116
Step 2.2: Identify Existing Components  119
Step 2.3: Measure Processing Rate of Existing Components  121
Step 2.4: Calculate Processing Rate of Entire Flow  124
Step 2.5: Identify Restriction Points  127
Summary  129

CHAPTER 11  SPOC Step 3: Pipelines Design  131

Step 3.1: Define Service Flow Design  133
Step 3.2: Identify New Components  138
Step 3.3: Identify Pipeline Opportunities  141
Step 3.4: Define Pipelines Scheme  145
Step 3.5: Determine Distributor Rate  151
Step 3.6: Design Physical Deployment Environment  154
Step 3.7: Define/Optimize Pipelines Design  155
  Pipeline the Downstream Service  156
  Pipeline Services Independently  159
  Pipeline the Entire Service  161
Summary  168

CHAPTER 12  SPOC Step 4: Pipelines Implementation  169

Step 4.1: Establish Software Pipelines Framework  171
Step 4.2: Modify Existing Components  173
  Map Components to Service Flow  174
  Evaluate Components  174
  Determine How to Incorporate Components  174
  Prepare Component Table  175
  Develop Components  175
Step 4.3: Develop New Components  178
Step 4.4: Orchestrate Service Flows  179
Step 4.5: Instrument Service Flow  181
Step 4.6: Develop/Modify Pipeline Sets  182
Step 4.7: Test and Optimize Pipelines Implementation  190
Summary  193
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Additional Distributor Connector Patterns</td>
<td>275</td>
</tr>
<tr>
<td></td>
<td>Define and Configure a Connector</td>
<td>275</td>
</tr>
<tr>
<td></td>
<td>Socket Connector</td>
<td>278</td>
</tr>
<tr>
<td></td>
<td>Web Service Connector</td>
<td>280</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>282</td>
</tr>
<tr>
<td>19</td>
<td>Using a Multi-Tier Distributor</td>
<td>283</td>
</tr>
<tr>
<td></td>
<td>Configure the Multi-Tier Distributors</td>
<td>284</td>
</tr>
<tr>
<td></td>
<td>Create the Client</td>
<td>289</td>
</tr>
<tr>
<td></td>
<td>Run the Service</td>
<td>292</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>293</td>
</tr>
<tr>
<td>20</td>
<td>Database Sharding Distributor</td>
<td>295</td>
</tr>
<tr>
<td></td>
<td>Database Shards Example</td>
<td>297</td>
</tr>
<tr>
<td></td>
<td>Create the Database Shards</td>
<td>299</td>
</tr>
<tr>
<td></td>
<td>Build the Service</td>
<td>299</td>
</tr>
<tr>
<td></td>
<td>Configure the Distributor</td>
<td>303</td>
</tr>
<tr>
<td></td>
<td>Configure the Sharding Driver</td>
<td>304</td>
</tr>
<tr>
<td></td>
<td>Create the Client</td>
<td>305</td>
</tr>
<tr>
<td></td>
<td>Run the Service</td>
<td>307</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>309</td>
</tr>
<tr>
<td>21</td>
<td>Pipelines Framework Overview</td>
<td>311</td>
</tr>
<tr>
<td></td>
<td>Interface Overview</td>
<td>311</td>
</tr>
<tr>
<td></td>
<td>AbstractMessage</td>
<td>312</td>
</tr>
<tr>
<td></td>
<td>PipelinesDistributor</td>
<td>313</td>
</tr>
<tr>
<td></td>
<td>PipelinesConnector</td>
<td>313</td>
</tr>
<tr>
<td></td>
<td>PipelinesRouter</td>
<td>313</td>
</tr>
<tr>
<td></td>
<td>Pipeline</td>
<td>314</td>
</tr>
<tr>
<td></td>
<td>PipelineService</td>
<td>314</td>
</tr>
<tr>
<td></td>
<td>Pipelines Instrumentor</td>
<td>314</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>322</td>
</tr>
</tbody>
</table>
Chapter 22: Pipelines Bank Corporation (PBCOR) Example 323

- Account Transaction 323
- Pipelines Configuration 328
- Spring Framework 332
- Database Access 333
  - AuthorizeTransactionService 339
- Connect Services 342
  - ValidateService 345
  - DebitTransactionService 345
- Run the Test 348
- Summary 349

Section IV: The Future of Software Pipelines 351

Chapter 23: The Future of Software Pipelines 353

- Final Words of Advice 353
- Ideas for the Future 354

Appendix: Pipelines Reference Framework

- Javadoc 357

Index 375