
Enterprise Integration Patterns

*Designing, Building,
and Deploying Messaging Solutions*

Gregor Hohpe
Bobby Woolf

With Contributions by
Kyle Brown
Conrad F. D’Cruz
Martin Fowler
Sean Neville
Michael J. Rettig
Jonathan Simon

◆ Addison-Wesley

Boston • San Francisco • New York • Toronto • Montreal
London • Munich • Paris • Madrid
Capetown • Sydney • Tokyo • Singapore • Mexico City

Contents

Foreword by John Crupi	xv
Foreword by Martin Fowler	xvii
Preface	xix
Acknowledgments	xxv
Introduction	xxix
Chapter 1: Solving Integration Problems Using Patterns	1
The Need for Integration	1
Integration Challenges	2
How Integration Patterns Can Help	4
The Wide World of Integration	5
Loose Coupling	9
One-Minute EAI	11
A Loosely Coupled Integration Solution	15
Widgets & Gadgets 'R Us: An Example	17
Internal Systems	18
Taking Orders	18
Processing Orders	20
Checking Status	26
Change Address	30
New Catalog	32
Announcements	33
Testing and Monitoring	34
Summary	37
Chapter 2: Integration Styles	39
Introduction	39
File Transfer (<i>by Martin Fowler</i>)	43

Shared Database (<i>by Martin Fowler</i>)	47
Remote Procedure Invocation (<i>by Martin Fowler</i>)	50
Messaging	53
Chapter 3: Messaging Systems	57
Introduction	57
Message Channel	60
Message	66
Pipes and Filters	70
Message Router	78
Message Translator	85
Message Endpoint	95
Chapter 4: Messaging Channels	99
Introduction	99
Point-to-Point Channel	103
Publish-Subscribe Channel	106
Datatype Channel	111
Invalid Message Channel	115
Dead Letter Channel	119
Guaranteed Delivery	122
Channel Adapter	127
Messaging Bridge	133
Message Bus	137
Chapter 5: Message Construction	143
Introduction	143
Command Message	145
Document Message	147
Event Message	151
Request-Reply	154
Return Address	159
Correlation Identifier	163
Message Sequence	170
Message Expiration	176
Format Indicator	180

Chapter 6: Interlude: Simple Messaging	183
Introduction	183
Request-Reply Example	183
Publish-Subscribe Example	185
JMS Request-Reply Example	187
Request-Reply Example	187
Request-Reply Code	189
Invalid Message Example	196
Conclusions	197
.NET Request-Reply Example	198
Request-Reply Example	198
Request-Reply Code	200
Invalid Message Example	205
Conclusions	206
JMS Publish-Subscribe Example	207
The Observer Pattern	207
Distributed Observer	208
Publish-Subscribe	209
Comparisons	212
Push and Pull Models	213
Channel Design	219
Conclusions	222
Chapter 7: Message Routing	225
Introduction	225
Content-Based Router	230
Message Filter	237
Dynamic Router	243
Recipient List	249
Splitter	259
Aggregator	268
Resequencer	283
Composed Message Processor	294
Scatter-Gather	297
Routing Slip	301



Process Manager	312
Message Broker	322
Chapter 8: Message Transformation	327
Introduction	327
Envelope Wrapper	330
Content Enricher	336
Content Filter	342
Claim Check	346
Normalizer	352
Canonical Data Model	355
Chapter 9: Interlude: Composed Messaging	361
Loan Broker Example	361
Obtaining a Loan Quote	361
Designing the Message Flow	362
Sequencing: Synchronous versus Asynchronous	364
Addressing: Distribution versus Auction	366
Aggregating Strategies: Multiple Channels versus Single Channel	368
Managing Concurrency	368
Three Implementations	369
Synchronous Implementation Using Web Services <i>(by Conrad F. D’Cruz)</i>	371
Solution Architecture	371
Web Services Design Considerations	372
Apache Axis	376
Service Discovery	379
The Loan Broker Application	379
Components of the Loan Broker Application	381
Client Application	396
Running the Solution	397
Performance Limitations	399
Limitations of This Example	400
Summary	400
Asynchronous Implementation with MSMQ	401
Loan Broker Ecosystem	401
Laying the Groundwork: A Messaging Gateway	402



Base Classes for Common Functionality	405
Designing the Bank	410
Designing the Credit Bureau	412
Designing the Loan Broker	413
Refactoring the Loan Broker	431
Putting it All Together	435
Improving Performance	435
A Few Words on Testing	440
Limitations of This Example	443
Summary	444
Asynchronous Implementation with TIBCO ActiveEnterprise	
<i>(by Michael J. Rettig)</i>	445
Solution Architecture	445
The Implementation Toolset	448
The Interfaces	451
Implementing the Synchronous Services	452
The Loan Broker Process	455
Managing Concurrent Auctions	459
Execution	460
Conclusions	462
Chapter 10: Messaging Endpoints	463
Introduction	463
Messaging Gateway	468
Messaging Mapper	477
Transactional Client	484
Polling Consumer	494
Event-Driven Consumer	498
Competing Consumers	502
Message Dispatcher	508
Selective Consumer	515
Durable Subscriber	522
Idempotent Receiver	528
Service Activator	532
Chapter 11: System Management	537
Introduction	537
Control Bus	540



Detour .....	.545
Wire Tap .....	.547
Message History .....	.551
Message Store .....	.555
Smart Proxy .....	.558
Test Message .....	.569
Channel Purger .....	.572
Chapter 12: Interlude: System Management Example	577
Loan Broker System Management .....	.577
Instrumenting the Loan Broker .....	.578
Management Console .....	.579
Loan Broker Quality of Service .....	.579
Verify the Credit Bureau Operation .....	.587
Credit Bureau Failover .....	.592
Enhancing the Management Console .....	.595
Limitations of This Example .....	.602
Chapter 13: Integration Patterns in Practice	603
Case Study: Bond Pricing System (<i>by Jonathan Simon</i>) .....	.603
Building a System .....	.603
Architecture with Patterns .....	.604
Structuring Channels .....	.610
Selecting a Message Channel .....	.614
Problem Solving with Patterns .....	.618
Flashing Market Data Updates .....	.618
Major Production Crash .....	.620
Summary .....	.623
Chapter 14: Concluding Remarks	625
Emerging Standards and Futures	
in Enterprise Integration (<i>by Sean Neville</i>) .....	.625
The Relationship between Standards and Design Patterns .....	.626
Survey of Standards Processes and Organizations .....	.627
Business Process Components and Intra-Web	
Service Messaging .....	.629
ebXML and the Electronic Business Messaging	
Service (ebMS) .....	.631

Business Process Execution Language for Web Services (BEPL4WS)	634
Web Service Choreography Interface (WSCI)	636
Java Business Process Component Standards	637
WS-*	639
Conclusions	647
Bibliography	649
Index	659