Event-Based Programming

Taking Events to the Limit

Ted Faison

Apress®

Event-Based Programming: Taking Events to the Limit

Copyright © 2006 by Ted Faison

All rights reserved. No part of this work may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or by any information storage or retrieval system, without the prior written permission of the copyright owner and the publisher.

ISBN-13: 978-1-59059-643-2

ISBN-10: 1-59059-643-9

Printed and bound in the United States of America 9 8 7 6 5 4 3 2 1

Trademarked names may appear in this book. Rather than use a trademark symbol with every occurrence of a trademarked name, we use the names only in an editorial fashion and to the benefit of the trademark owner, with no intention of infringement of the trademark.

Lead Editor: Jonathan Hassell
Technical Reviewer: Fernando De Gasperis
Editorial Board: Steve Anglin, Ewan Buckingham, Gary Cornell, Jason Gilmore, Jonathan Gennick, Jonathan Hassell, James Huddleston, Chris Mills, Matthew Moodie, Dominic Shakeshaft, Jim Sumser, Keir Thomas, Matt Wade
Project Manager: Beth Christmas
Copy Edit Manager: Nicole LeClerc
Copy Editor: Nicole Abramowitz
Assistant Production Director: Kari Brooks-Copony
Production Editor: Kelly Winquist
Compositor: Susan Glinert
Proofreader: Liz Welch
Indexer: Ted Faison
Artist: Kinetic Publishing Services, LLC
Cover Designer: Kurt Krames
Manufacturing Director: Tom Debolski

Distributed to the book trade worldwide by Springer-Verlag New York, Inc., 233 Spring Street, 6th Floor, New York, NY 10013. Phone 1-800-SPRINGER, fax 201-348-4505, e-mail `orders-ny@springer-sbm.com`, or visit `www.springeronline.com`.

For information on translations, please contact Apress directly at 2560 Ninth Street, Suite 219, Berkeley, CA 94710. Phone 510-549-5930, fax 510-549-5939, e-mail `info@apress.com`, or visit `www.apress.com`.

The information in this book is distributed on an "as is" basis, without warranty. Although every precaution has been taken in the preparation of this work, neither the author(s) nor Apress shall have any liability to any person or entity with respect to any loss or damage caused or alleged to be caused directly or indirectly by the information contained in this work.

The source code for this book is available to readers at `www.apress.com` in the Source Code section.

Contents

About the Author xv
About the Technical Reviewer xvii
Acknowledgments xix
Introduction xxi

CHAPTER 1 Coupling 1

Coupling Is Inevitable 2
The Coupling Symbol 4
Is Coupling Bad? 5
The Nature of Coupling 5
Static Coupling 6
Dynamic Coupling 7
Static vs. Dynamic Coupling 9
Coupling Flavors 9
Logic Coupling 10
Type Coupling 18
Signature Coupling 25
Coupling Space 31
Coupling Charts 33
Coupling Diagrams 35
Coupling Diagrams As Guides for System Changes 36
Coupling Transforms 38
Logic-Coupling Transforms 38
Type-Coupling Transforms 46
Common Coupling Scenarios 52
Coupling with User-Defined Types 64
Coupling Due to Interfaces 65
Coupling Due to Method Parameters 67
Summary 69

CHAPTER 2 Events and Notifications 71

Defining Events and Notifications 71
A Brief History of Events 74
Nomenclature and Semantics 77
Event Subscription 78
The Subscription Process 79

Subscription Models 80
Channels 81
Types 83
Filters 83
Groups 87
Subscription Policies 89
Summary 89

CHAPTER 3 Notification Delivery 91

Delivery Protocols 91
Delivery Using Shared Resources 93
Shared Files 94
Shared Memory 95
Semaphores 99
Serialized Connections 102
Delivery Using Procedure Calls 103
Local Procedure Calls 105
Remote Procedure Calls 105
Notification Architectures 106
Direct Delivery 106
Indirect Delivery 108
Delivery Synchrony 113
Synchronous Delivery 114
Asynchronous Delivery 114
Delivery Fanout 115
Quality of Service 117
Reliability 117
Priority 118
Timing 118
Throughput 118
Order 119
Transactions 119
Delivery Order 121
Causal Order 121
Partial Order 123
Total Order 128
Summary 129

CHAPTER 4 Notification Payloads 131

The Delivery Mechanism As a Constraint 131
Payload Size vs. Notification Frequency 132
Notifications Sent Using Shared Resources 132

Notifications Sent Using Procedure Calls 134
Should the Payload Be Immutable? 134
String-Based Payloads 135
Record-Based Payloads 136
Object-Based Payloads 137
Payload Marshaling 140
Payloads for Fetching Data: Envelopes 143
Composite Payloads 146
Summary 147

CHAPTER 5 A Survey of Commercial Systems 149

Direct-Delivery Systems 149
.NET 150
JavaBeans 157
Delphi 164
COM 167
Indirect-Delivery Systems 168
CORBA 169
COM+ 175
Microsoft MSMQ 178
JMS 185
SmartSockets 191
Rendezvous 193
Summary 197

CHAPTER 6 Diagrams for Event-Based Systems 199

UML Diagrams 199
State Machine Diagrams 199
Activity Diagrams 201
Sequence Diagrams 204
Communication Diagrams 206
Interaction Overview Diagrams 207
Component Wiring Diagrams 208
Other Diagrams 209
Lollipop Diagrams 210
SDL Diagrams 210
Espresso Diagrams 212
Catalysis Diagrams 214
Summary 216

CHAPTER 7 Signal Wiring Diagrams 217

Software ICs 217
Objects 218
Signals 220
PC Signals 220
SR Signals 221
Pins 223
Naming Pins 223
Input Pins 224
Output Pins 226
Wiring Pins Together 228
Numbering Pins 228
Pin-Legend Tables 229
One-to-Many Connections 230
Many-to-One Connections 230
Statically Bound Signals 231
Components 234
Buses 235
Showing One-to-Many Connections 237
Showing Many-to-One Connections 238
Depicting Distributed Systems 239
Switches 240
Switch Controllers 241
Showing Switching Information 244
Switching at the Interface Level 245
Pages 246
Labeling Pages 246
Multipage Signals 247
Levels of Detail 249
Labeling Items in Multipage Diagrams 251
Signal Timing 251
Considerations on Wiring Diagrams 251
Summary 252

CHAPTER 8 The Mechanics of Event Firing 253

Checking to See if Subscribers Exist 254
What to Do When No Subscribers Are Available 254
Packaging the Notification Payload 255
Protecting the Subscriber List 255
Sending the Event Notification 256
Using Messages 256
Using Procedure Calls 264
Using a Shared Resource 276

Reaching All Subscribers 295
Unicast Notifications 296
Multicast Notifications 296
The Fire Method 299
Naming Conventions 299
Using Procedure Calls 301
Using Messages 306
Asynchronous Firing 306
Optimization 307
Summary 309

CHAPTER 9 Event-Based Interaction Patterns 311

A Natural Language Perspective 312
The Push-Pull Model 313
Push Interactions 313
Pull Interactions 315
Blind Interactions 317
Synchronous Blind Interactions 318
Asynchronous Blind Interactions 319
Transparent Interactions 323
Pushed Feedback 324
Polled Feedback 325
Interruptible Interactions 327
Interruptible Blind Interactions 328
Interruptible Transparent Interactions 329
Handshaking 331
Summary 332

CHAPTER 10 Functional Roles 333

Workers 334
What Workers Should Do 334
Composite Workers 335
What Workers Shouldn't Do 336
How Complex Should a Worker Be? 337
Worker Examples 338
Coordinators 359
What Is a Coordinator? 359
Coordinator Teams 360
Key Coordination Tasks 361
Builders 386
Smart Builders 388
Background Builders 389
JIT Builders 394

Binders 398
Late Binding 401
Smart Binders 416
JIT Binders 417
Dynamic Binding 428
Routers 433
Routers in Layered Architectures 433
Routers As Notification Forwarders 434
Routers As Bridges 435
An Example: Interconnecting Coordinators 435
Summary 442

CHAPTER 11 Case Study 1: A System Browser 443

System Requirements 443
System Design 446
Life-Cycle Management 450
Builder 460
Binder 463
The Menu and Toolbar 466
Persistent User Settings 472
The Folders Navigator 475
The Search Navigator 483
Use Cases 493
Testing the System 495
The NavigatorFolders Test Fixture 495
The ContentFileList Test Fixture 499
The NavigatorSearch Test Fixture 502
Summary 506

CHAPTER 12 Case Study 2: A Pipelined HTTP Service 507

System Requirements 508
System Design 510
Managing the Connection Pool 514
The Connection Team 518
Testing the System 543
Summary 566

CHAPTER 13 Case Study 3: A Distributed Workflow System 567

Functional Requirements 567
Project Configuration 569
The Client Component 570
C# Code 575
VB .NET Code 586
The Server Components 596
The Order Processor Component 597
C# Code 599
VB .NET Code 605
The Parts Scheduling Component 611
The Vehicle Assembly Component 625
The Invoicing Component 629
Common Types Used in the System 634
C# Code 636
VB .NET Code 637
Testing the Complete System 640
Summary 641

APPENDIX A Glossary 643

APPENDIX B References 647

INDEX 655