# Contents

*Foreword* ..... *xv*

*About the Author* ..... *xvii*

*About the Technical Reviewer* ..... *xix*

*Acknowledgments* ..... *xxi*

*Introduction and AFAQ (Anticipated Frequently Asked Questions)* ..... *xxiii*

*Who Is This Book For?* ..... *xix*

*What Do I Need to Run the Examples?* ..... *xx*

*Why Isn't There Any Real-World Code?* ..... *xx*

*How Come You Don't Have Tables Listing All the Options/Methods/Parameters of Each Tool/Class/Method?* ..... *xx*

*Why Do I Keep Getting "File Not Found" Exceptions When I Run the Example Code?* ..... *xxi*

*What's Up with the Spinal Tap Quotes?* ..... *xxi*

*Chapter 1 The Evolution of Distributed Programming* ..... *1*

*Overview of Distributed Programming* ..... *1*

Layering an Application ..... *2*

The Five Principles of Distributed Design ..... *3*

Defining Scalability ..... *11*

*A Short History of Distributed Programming* ..... *13*

Centralized Computing ..... *13*

Two-tier Client/Server Architecture ..... *14*

Three-tier and N-tier Client/Server Architecture ..... *15*

The Web Architecture ..... *17*

*Microsoft and Distributed Computing* ..... 18
The Era of PC Dominance ..... 19
The Age of Enlightenment ..... 19
The Days of Disillusionment ..... 21
The Present: .NET ..... 23

*Summary* ..... 24

## *Chapter 2 This Is .NET* ..... 27

*Understanding the .NET Infrastructure* ..... 27
The Importance of Type ..... 28
The Three Cs of .NET: CTS, CLS, and CLR ..... 28
Using Namespaces ..... 30
Assemblies and Manifests ..... 32
Intermediate Language ..... 32

*Building and Configuring .NET Assemblies* ..... 33
Building a Private Assembly ..... 33
Building a Shared Assembly ..... 44

*Understanding .NET Versioning* ..... 54
Setting an Assembly's Version Information ..... 54
Revisiting the Application Configuration File ..... 57
Setting Machine-wide Version Policies ..... 58
Using the .NET Framework Configuration Tool ..... 58
Configuring Publisher Policy ..... 61
Policy Precedence ..... 64
Using the <codeBase> Element ..... 64
Viewing the Assembly Binding Log ..... 66
Summary of the Binding Process ..... 68

*Understanding Attributes and Reflection* ..... 68
Using CLR Attributes ..... 69
Implementing Custom Attributes ..... 71
Reflecting upon Reflection ..... 72
Attributes and Reflection in Perspective ..... 75

*Understanding Garbage Collection* ..... 75
Reference Counting vs. Garbage Collection ..... 76
Garbage Collection Internals ..... 78
Implementing the Finalize Method ..... 79
Implementing the IDisposable Interface ..... 81
Garbage Collection in Perspective ..... 84

*Serialization* ..... 84
Using the Serializable Attribute ..... 85
ISerializable and Formatters ..... 87

*Summary* ..... 89

## *Chapter 3 Introduction to .NET Remoting* ..... 91

*What Is Remoting?* ..... 91

*Understanding Application Domains* ..... 92
Programming with Application Domains ..... 93
Understanding Context ..... 95

*Marshaling Objects* ..... 105
Marshal By Value Objects ..... 105
Marshal By Reference Objects ..... 106
Static Methods and Other Remoting Details ..... 107
Summarizing Marshaling and Context Agility ..... 108

*Examining the .NET Remoting Framework* ..... 109
Looking at the Big Picture ..... 109
Well-Known vs. Client-Activated Objects ..... 110
Understanding Proxies ..... 111
Understanding Channels and Formatters ..... 114

*Summary* ..... 117

## *Chapter 4 Distributed Programming with .NET Remoting* ..... 119

*Implementing Well-Known Objects* ..... 119
Building the Server ..... 119
Building the Client ..... 123
Singleton Mode vs. SingleCall Mode ..... 127
Looking (Briefly) at Some Remoting Issues ..... 130
Remoting Configuration ..... 130

*Implementing Client-Activated Objects* ..... 138
Building the Server ..... 140
Building the Client ..... 142
Understanding Lease-based Lifetimes ..... 144

*Building Remoting Hosts* ..... 159
Hosting Remotable Objects in a Windows Service ..... 159
Hosting Remotable Objects in ASP.NET ..... 167

*Summary* ..... 172

## Chapter 5 Additional Remoting Techniques ..... 175

Solving the Metadata Deployment Issue ..... 175
- Deploying Metadata Assemblies ..... 176
- Deploying Interface Assemblies ..... 186
- Using the Soapsuds Utility ..... 193
- Summary of Deployment Issues ..... 200

Calling Remote Objects Asynchronously ..... 201
- Understanding Delegates ..... 201
- Using Delegates for Local Asynchronous Calls ..... 206
- Using Delegates for Remote Asynchronous Calls ..... 214
- Summarizing Asynchronous Remoting ..... 227

Understanding Call Context ..... 228
- Call Context vs. Thread Local Storage ..... 229
- Using Call Context with Remoting ..... 230
- Using Call Context with Asynchronous Calls ..... 233
- Using Call Context Headers ..... 235

Summary ..... 236

## Chapter 6 Understanding XML Web Services ..... 237

Web Services Overview ..... 237
- Why Web Services? ..... 238
- Web Service Composition ..... 239
- The World Wide Web Consortium ..... 247

Building and Consuming Web Services in .NET ..... 248
- The IIS to ASP.NET to Web Service Relationship ..... 248
- Using Code-Behind ..... 249
- Building Web Services with Visual Studio .NET ..... 251
- Consuming the Web Service ..... 255
- Calling Web Services Asynchronously ..... 258
- Returning Custom Types from the Web Service ..... 259
- Using the ASP.NET Session Object ..... 268

Remoting vs. Web Services ..... 270

Summary ..... 271

*Chapter 7 Understanding COM Interop* ..... 273

*The Need for COM Interop* ..... 273

*Managed to Unmanaged Interop* ..... 274
Understanding the Runtime Callable Wrapper ..... 274
Building an Interop Assembly ..... 275

*Unmanaged to Managed Interop* ..... 276
Understanding the COM Callable Wrapper ..... 277
Registering an Assembly for COM Interop ..... 278
Writing Managed Code for COM Interop ..... 279
Managed Code and COM Versioning ..... 285

*Summary* ..... 288

*Chapter 8 Leveraging Component Services* ..... 289

*Component Services Overview* ..... 289
Component Services Motivation ..... 290
Revisiting Context ..... 290
Survey of Component Services ..... 291
Survey of COM+ Configuration Settings ..... 292

*Building Serviced Components in Managed Code* ..... 295
Populating the COM+ Catalog ..... 296
Experimenting with a Simple Serviced Component ..... 299
Examining COM+ and .NET Interaction ..... 317
Just-In-Time Activation ..... 319
Understanding Object Pooling ..... 329
Using Object Construction ..... 334

*Automatic Transactions* ..... 335
The Distributed Transaction Coordinator ..... 336
Enabling Transactions ..... 338
Determining the Transaction's Outcome ..... 339

*Consuming Serviced Components* ..... 346
Exposing Objects with DCOM ..... 346
Exposing Objects with .NET Remoting ..... 348

*Investigating New Features in COM+ 1.5* ..... 351
Application Recycling and Pooling ..... 351
Configurable Transaction Isolation Levels ..... 353
SOAP Services ..... 354

*Summary* ..... 355

*Chapter 9 .NET Message Queuing* ..... 357

*Message Queuing Overview* ..... 357
Why Message Queuing? ..... 358
Message Queuing Architecture ..... 359
Message Queuing vs. Remoting vs. Web Services ..... 360

*Installing and Administering MSMQ* ..... 360
MSMQ Installation Options ..... 360
Creating and Managing Queues ..... 363

*Using .NET Message Queuing* ..... 365
Building the Sender ..... 365
Building the Receiver ..... 370
Sending Custom Types in Messages ..... 376

*Writing Queued Components in Managed Code* ..... 384
The Queued Component Architecture ..... 385
Implementing a Queued Component ..... 387
Handling Queued Component Exceptions ..... 388

*Summary* ..... 391

*Appendix Data Access with ADO.NET* ..... 395

*The Need for ADO.NET* ..... 395
ADO.NET: The Big Picture ..... 396

*Understanding ADO.NET Namespaces* ..... 397

*The Types of System.Data* ..... 398

*Examining the DataColumn Type* ..... 399
Building a DataColumn ..... 401
Adding a DataColumn to a DataTable ..... 403
Configuring a DataColumn to Function as a Primary Key ..... 403
Enabling Autoincrementing Fields ..... 404
Configuring a Column's XML Representation ..... 406

*Examining the DataRow Type* ..... 407
Understanding the DataRow.RowState Property ..... 407
The ItemArray Property ..... 410

*Details of the DataTable* ..... 411

*Building a Complete DataTable* ..... *413*
Manipulating a DataTable: Deleting Rows ..... *416*
Manipulating a DataTable: Applying Filters and Sort Orders ..... *417*
Manipulating a DataTable: Updating Rows ..... *420*
*Understanding the DataView Type* ..... *422*
*Understanding the Role of the DataSet* ..... *425*
Members of the DataSet ..... *427*
Building an In-Memory DataSet ..... *427*
*Expressing Relations Using the DataRelation Type* ..... *432*
Navigating Between Related Tables ..... *433*
*Reading and Writing XML-Based DataSets* ..... *437*
*Building a Simple Test Database* ..... *438*
*ADO.NET Managed Providers* ..... *440*
*Working with the OleDb Managed Provider* ..... *441*
Establishing a Connection Using the OleDbConnection Type ..... *442*
Building a SQL Command ..... *444*
Working with the OleDbDataReader ..... *445*
Connecting to an Access Database ..... *447*
Executing a Stored Procedure ..... *448*
*The Role of the OleDbDataAdapter Type* ..... *451*
Filling a DataSet Using the OleDbDataAdapter Type ..... *452*
*Working with the SQL Managed Provider* ..... *455*
The System.Data.SqlTypes Namespace ..... *456*
Inserting New Records Using the SqlDataAdapter ..... *456*
Updating Existing Records Using the SqlDataAdapter ..... *459*
*Autogenerated SQL Commands* ..... *461*
*Filling a Multitabled DataSet (and Adding DataRelations)* ..... *464*
*Summary* ..... *467*

***Index*** ..... *469*