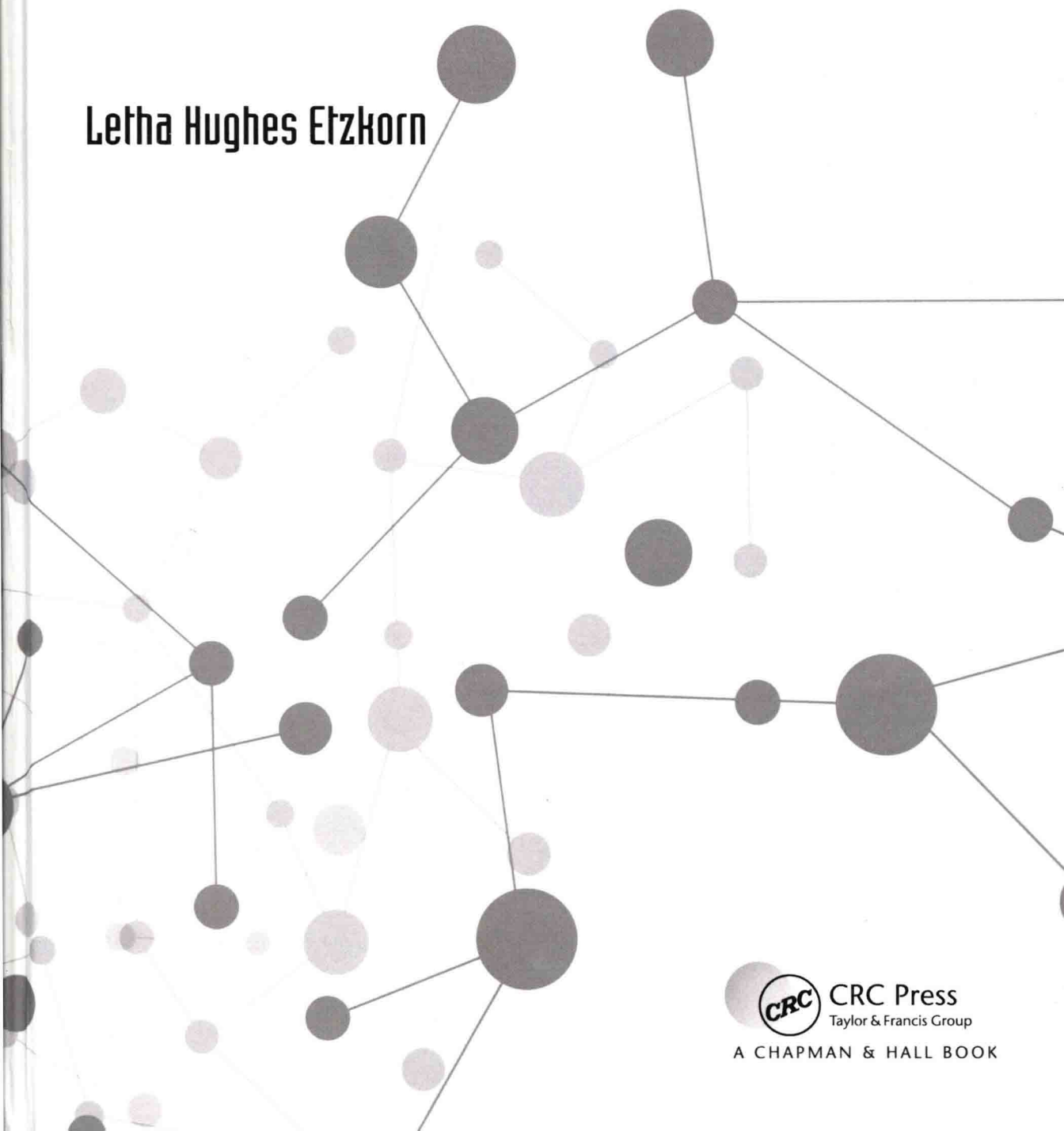


INTRODUCTION TO **MIDDLEWARE**

Web Services, Object Components,
and Cloud Computing

Letha Hughes Etzkorn



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Web Services, Object Components,
and Cloud Computing

Dedication

To my husband and sweetheart, Dave, who always does so much for me (he did most of the review of the proofs for this textbook), to the other centers of my heart: Tricia and Chris, and to the memory of Daddy and Mama. Mama always wanted one of her kids to write a book, although I don't think a textbook was what she had in mind.

Online Resources

The following Online Resources can be found at <https://www.crcpress.com/Introduction-to-Middleware-Web-Services-Object-Components-and-Cloud-Computing/Etz Korn/p/book/9781498754071>

| | |
|------------|-------------------------------------|
| Chapter 17 | Environmental Monitoring Project |
| Chapter 18 | Sailboat Marina Project |
| Appendix A | Architectural Styles for Comparison |
| Appendix B | Helpful Tricks |

Preface

What I am primarily interested in presenting in this textbook is a comparison of different middleware technologies and the overarching middleware concepts they are based on. My expectation is that students can come out of a course that uses (the major portions of) this textbook and be able to select an appropriate middleware technology to use for any given task, and also to be able to learn new middleware technologies as they appear over time without being greatly overwhelmed by any particular new concept. Middleware technologies come and go and have different advantages and disadvantages but many of the concepts overlap. They should also have sufficient background in the area to enable them to be critical thinkers when the next new middleware fads appear.

Also, students will become well-functional in a given middleware technology after they study the sections dealing with that technology in this textbook. One of my goals is that students will acquire some practical skills that can be used to acquire good jobs after graduation, that is, buzzwords on the resume that they actually deserve, based on real projects that they have actually done. These middleware technology sections can also be useful for practitioners in industry who are working to expand their skills.

I have taught the technologies in small enough chunks that I hope not to lose anyone along the way. I have also tried not to make too many assumptions about how much the student already knows. I have a substantial quantity of background material, but I put most of it in separate chapters or sidebars, so it can be skipped by better prepared students. I have provided sufficient portions of code that the students can run the examples without having to do such mundane tasks as, for example, web searches to figure out what library functions must be included to make the code run, as I have found that kind of grunt work greatly discourages students. I have also provided larger, more practical examples for when the students have become familiar with the technology (these are in separate chapters, Chapter 17 and 18, which are available with this textbook as online resources).

Also, to encourage students to actually read the textbook, I have adopted a somewhat informal and breezy tone throughout the book, used real examples from my past experience in industry, added a little extra (sometimes extraneous) detail at times to make projects feel a little more real to the students, and even tried to be mildly humorous on occasion. I tried to capture in this book the way I teach my own courses on a sleepy day right after lunch when students are having trouble keeping their eyes open. So many students nowadays google for the answer to questions rather than reading the class notes or the class textbook, and often the answers out there in the wild aren't very good answers. The easier and more fun it is to read the textbook, and the more they get out of it per unit time spent reading it, the more likely they will be to persevere.

There are several different courses that could be taught using this textbook. Suggested courses and how to use this textbook for these courses follow. (I teach Course A and Course B myself.)

Depending on how in depth you cover the material, and what kind of prerequisites you expect, most of these courses could be taught anywhere from sophomore level to graduate level.

Normally for Course A and Course B, I don't require a prior network course. An operating systems course is a suggested co-requisite. However, if you require a prior networking course and a prior operating systems course, you should be able to cover the material in more depth—possibly covering more sections of more chapters—and the course in that case would be more appropriate at the graduate level (or advanced senior level).

Course A: (senior level/graduate level—could be taught at junior level depending on prerequisites and chapters covered.)

Course Name: Client/Server Architectures or An Introduction to Middleware

This course examines different client/server architectures and introduces modern middleware technologies that can be used for each of the different paradigms. The different paradigms are compared.

Suggested Textbook use:

Chapter 1

Chapter 2

Chapter 3 (depending on course prerequisites)

Chapter 4 (depending on course prerequisites)

Cover portions of Chapter 5 if you want to examine security aspects of middleware

Cover Chapter 6 if you select one or more of the .Net technologies

Select ONE distributed object component technology from Chapter 8, this would be:

- CORBA, *or*
- .NET Remoting, *or*
- Enterprise Java Beans

Chapter 9

Select ONE non-RESTful technology from Chapter 10 (you must cover SOAP and WSDL), this would be:

- JAX-WS, *or*
- WCF

Select ONE RESTful technology from Chapter 11 or Chapter 12, this would be:

- AJAX, *or*
- Java Servlets and JAX-RS, *or*
- WCF-RESTful, *or*
- ASP.NET MVC and/or ASP.NET CORE 1.0

(NOTE: it's difficult to examine JAX-RS without a prior knowledge of servlets. You could cover servlets alone without JAX-RS, but if so you should thoroughly examine how they can be made RESTful along with ways in which they can be created in a less RESTful manner.)

Chapters 17 and 18 (available as online resources) provide larger, practical examples for each of the technologies in Chapters 8, 10, 11, and 12.

(NOTE: depending on how you set up the course, you can give an overview of cloud computing interfaces as examples of RESTful technology. If so, you would make use of either Chapter 13 or Chapter 14.)

Chapter 15

Chapter 16

Course B: (senior level/graduate level—could be taught at junior level depending on prerequisites and chapters covered.)

Course Name: Introduction to Cloud Computing

This course examines modern cloud computing, with an emphasis on open source cloud software.

Suggested Textbook use:

Chapter 1, Section 1.3.6

Chapter 2, Sections 2.4, 2.5, and 2.6

Chapter 3 (depending on course prerequisites)

Chapter 4 (depending on course prerequisites)

Chapter 5 (depending on course prerequisites)

Chapter 7

Chapter 9

Chapter 11, Section 11.1 (just so they see a practical RESTful web service)

Chapter 13

Chapter 14

Chapter 15 (because clouds make heavy use of MOM)

Chapter 16, Section 16.3.2

Course C: (senior level/graduate level—could be taught at junior level depending on prerequisites and chapters covered.)

Course Name: Introduction to Web Services

This course examines modern web service architectures.

You may choose to use only RESTful architectures or a mixture of non-RESTful and RESTful architectures (nowadays it would be unusual to use non-RESTful only).

Suggested Textbook use:

Chapter 1

Chapter 2

Chapter 3 (depending on course prerequisites)

Chapter 4 (depending on course prerequisites)

Chapter 5 (depending on course prerequisites)

Cover Chapter 6 if you select one or more of the .Net technologies

Chapter 9

Chapter 10 (select one or more web services technologies as desired)

Chapter 11 (select one or more web services technologies as desired)

Chapter 12 (select one or more web services technologies as desired)

For technologies chosen from Chapter 10, Chapter 11, and Chapter 12, you may use the associated larger practical examples from Chapter 17 and Chapter 18, as desired. Chapters 17 and 18 are online resources.

Chapter 16 (Here focus only on web service architectures and architectural styles)

Course D: (This course is probably junior level or sophomore level depending on choices.)

Course Name: Introduction to Web Programming

This course examines how to program on the World Wide Web.

Requires supplementary material from w3schools on HTML, CSS, JavaScript, PHP.

Suggested Textbook use:

Chapter 1, Sections 1.3.4, 1.3.5

Chapter 2, Sections 2.4, 2.5

Chapter 3

Chapter 4

Chapter 9

Either Chapter 10 or Chapter 11 or Chapter 12 or selected portions.

- Choose Chapter 11, Sections 11.1 and 11.2 if this is a sophomore course.
- You may have to teach Java if this is a sophomore course.
- You may use larger practical examples associated with the chosen technology from Chapter 17 or Chapter 18, as desired. Chapters 17 and 18 are online resources.

Course E: (This course is probably junior level or sophomore level depending on choices.)

Course Name: Advanced Object-Oriented Software Development in Java

This course examines advanced object-oriented programming including advanced use of Java libraries. Includes Java Graphics APIs such as AWT or Swing, and Java Middleware including Enterprise Java Beans and Java Servlets.

Suggested Textbook use:

Should be supplemented with web pages, etc., dealing in more depth with Java Graphics APIs.

Note that the selected sections in Chapter 18 include a basic introduction to Java Swing libraries. Chapter 18 is available in online resources.

Chapter 1, Section 1.3.2

Chapter 2, Section 2.3

Chapter 3

Chapter 4

Chapter 8, Section 8.3

Chapter 11, Section 11.2 (can possibly also use Section 11.3)

Chapter 18, Sections 18.1 and 18.4 (possibly also Section 18.5)—this contains the Java Swing GUI examples as part of the middleware code (note that additional java swing material is included in Section 17.1.4, if you cover that section, stick just to the java swing material)
 Chapters 17 and 18 are available in online resources.

Course F: (This course is probably junior level or even sophomore level depending on choices.)

Course Name: Advanced Object-Oriented Software Development in C# with .NET

Suggested Textbook use:

Should be supplemented with web pages (or a textbook) dealing in basics related to the C# language. Note that the selected sections include a basic introduction to Windows Presentation Foundation. Could be supplemented with web pages and materials with more extensive WPF or possibly additional aspects of .NET.

Chapter 1, Section 1.3.2, 1.3.4, 1.3.5

Chapter 2, Section 2.3, 2.4, 2.5

Chapter 3

Chapter 4

Chapter 6

Chapter 8, Section 8.2

Chapter 10, Sections 10.1, 10.2, 10.4

Chapter 12

Chapter 17, Sections 17.2, 17.3, and 17.4—this contains an introduction to Windows Presentation Foundation as part of the larger practical middleware examples. Chapter 17 is available in online resources.

Other possible courses where this textbook might be useful:

- Course on advanced cloud computing
 - This course would focus on the internals of an open source cloud and how the open source clouds are actually implemented.
 - Would have to be supplemented by looking at the actual code from a particular open source cloud (OpenStack, CloudStack).
- Course on system administration in the cloud:
 - This course would focus on how to set up a cloud, and on standard system administration issues that would arise in a cloud, with a particular look at security issues.
 - Would have to be supplemented by web pages associated with specific open source clouds such as OpenStack or CloudStack.
- Course on virtualization:
 - This course would focus on various kinds of virtualization techniques, including hypervisors and containers, and how those can be used in practice.
 - Would have to be supplemented by web pages associated with specific open source hypervisors such as KVM or Xen or on containers such as LXC or Docker.
- Course on analysis and design patterns
 - The idea is that this course would first teach general design patterns and analysis patterns and then focus on networking/middleware/cloud patterns as examples.
 - Supplemented by web pages such as www.vincehuston.org/dp
 - Supplemented by textbooks such as the Gang of Four design patterns book (Gamma, Helm, Johnson, and Vlissides) (possibly the Analysis Patterns book by Fowler).

Letha Hughes Etzkorn
The University of Alabama in Huntsville

Author

Dr. Letha Hughes Etzkorn is a professor in the Computer Science Department at The University of Alabama in Huntsville with more than 30 years of experience. She earned her master's degree and PhD in computer science from The University of Alabama in Huntsville, and bachelor's and master's degrees in electrical engineering from the Georgia Institute of Technology, Atlanta, Georgia. She is a registered professional engineer (Electrical Engineering, State of Georgia) and is a senior member of the Institute of Electrical and Electronics Engineers. She has graduated 16 PhD students so far. She has served as an associate editor/member of editorial board for several journals. Prior to her career in academia, Dr. Etzkorn worked in industry for several years, primarily in networking, modems, and embedded systems, for companies including Motorola, Hayes Microcomputer Products, and Lockheed-Georgia.

Dr. Etzkorn has published more than 100 peer-reviewed research papers. Also, she has received more than \$3.9 million in grants and contracts as Principal Investigator or Co-Principal Investigator from federal agencies including the National Security Agency (NSA), the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and the U.S. Army. Some of her major research areas are in software engineering (software metrics, program comprehension), middleware, and cybersecurity within the Internet of Things. She has taught more than 28 different courses, including courses at both undergraduate and graduate levels. These include (among others) courses in software engineering, computer architecture, computer networks, computer security, and, of course, middleware and cloud computing.

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