

# **Architecting High Performing, Scalable and Available Enterprise Web Applications**

**hailesh Kumar Shivakumar**

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# Architecting High Performing, Scalable and Available Enterprise Web Applications

*Shailesh Kumar Shivakumar*



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# Dedication

I would like to dedicate this book to:

*My parents, Shivakumara Setty V and Anasuya T M,  
from whom I was bestowed upon their relentless strength and love,*

*My wife, Chaitra Prabhudeva, and my son, Shishir,  
from whom I was loaned their enduring support and time,*

*My in-laws, Prabhudeva T M and Krishnaveni B,  
from whom I am indebted to for their perpetual help and courage.*

# Preface

This book is about architecting enterprise web applications that are easily scalable with high availability and high performance. We will look at other important topics in enterprise architecture, such as security and caching. Any successful and robust enterprise architecture must address these concerns in sufficient detail for the architecture to be successful in the long run.

Scalability, availability, and performance are the top three concerns for an enterprise architect. These nonfunctional requirements play a pivotal role in shaping the user experience in short-term transactions and in long-term relationships. For business, these parameters directly impact the online revenue, business growth, competitiveness and are, therefore, of high business interest.

Unlike functional requirements, where the requirements, business rules, and verification criteria are well defined and documented, these nonfunctional requirements are often ambiguously specified and poses challenges in fool-proof verification.

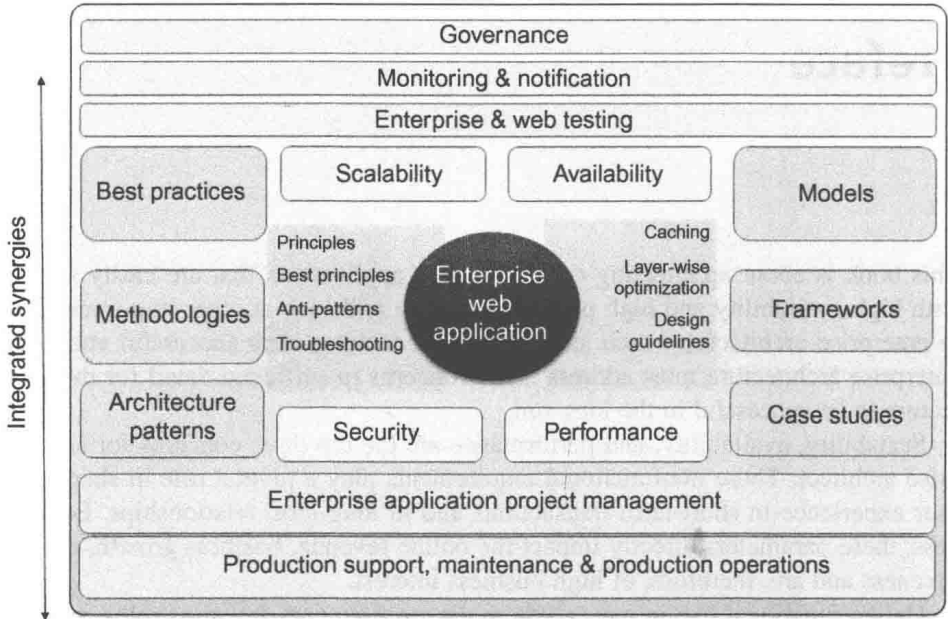
## All-around quality

Software quality is an integral part of a software project. Various quality metrics are featured on project dashboards and in project status reports, and they form an important factor in the acceptance criteria for a project's delivery sign-off. Quality has wide-range and long-term implications such as maintainability, interoperability, portability, and end-user satisfaction.

Quality is a multidimensional and multiphased attribute that needs to be achieved throughout the project lifecycle and beyond project delivery. Achieving all-around high quality in software projects therefore remains a challenging task, because it requires various gating criteria of different dimensions at different stages, and an in-depth understanding of the system and the problem domains. Achieving this quality requires 360° thinking from all perspectives.

## 360° view: key highlights and differentiators of the book

The book takes a holistic view of three quality attributes—scalability, availability, and performance—and aims to provide a 360° viewpoint on achieving these attributes. The 360° viewpoint can be defined in two dimensions: The first one is the



Synergized view of enterprise web application quality.

holistic approach to exploring quality criteria. In this approach, we look at each of these quality criteria from an enterprise web application standpoint, and we also explore synergies between techniques and the methodologies that can be applied in order to achieve these quality attributes. To quote an example, caching is a highly efficient technique, which is normally used for achieving high performance; however, the same technique, if designed elegantly, can also help us achieve high availability and it also makes the system scalable. Therefore, many techniques have a multidimensional impact (and side impact) on quality attributes. The examples, methodologies, models, and case studies highlighted in this book all aim to touch base on exploring this concept. The second dimension of the 360° viewpoint is about the end-to-end lifecycle of the enterprise application. While exploring each of the quality criteria in various chapters, we will see the techniques, best practices, and methodologies that are applicable in all lifecycle stages from project inception till production support of the enterprise application. We have a chapter called “Operations and Maintenance” dedicated specifically to looking at sustained quality maintenance aspects.

Another novel aspect of this book is that it covers two crucial elements in the overall scheme of things: enterprise web testing and project management. While testing and project management are not strictly related to the architecture exercise *per se*, they are essential for the success of the end product. However, strong the architecture principles are, the enterprise application would not achieve its intended purpose if it is not thoroughly verified and project-managed. While enterprise testing acts as a quality gating criteria, project management defines the execution strategy. Ultimately, both of them have impact on the end deliverable.

Throughout the book, we will look at some techniques that get mentioned in more than one of the chapters. Techniques such as virtualization, asynchronous invocation, distributed computing, and redundancy get repeated while discussing each of the quality attributes. This is the natural effect of a multifaceted exploration approach wherein we look at different dimensions of the same technique relevant to the context of the chapter. After all, these techniques are not mutually exclusive; they complement each other to achieve high quality.

Another aspect I have tried in the book is to introduce and explain some of the practically proven and adopted best practices in real-world engagements. Whether quality models, frameworks, examples, troubleshooting tips, analysis process, or special-case scenarios, they all are derived from my practical experience of several engagements. I have also tried to quantify some of the concepts and insights through simple graphs, to provide the broad idea.

To summarize, the key differentiators of this book are:

- Exploration of synergies between techniques and methodologies to achieve quality attributes
- 360° viewpoint approach for achieving overall quality
- Holistic view of quality in the context of ecosystem components such as testing and project management
- Detailed case study of the application of concepts discussed
- Practitioner viewpoint on techniques, methodologies, models, and best practices
- Bulleted summary and tabular representation of concepts for effective understanding
- Production operations and troubleshooting tips.

## Motivation for the book

I have had the opportunity to architect some very large-scale and complex enterprise applications in my decade-long career. In the process, I got exposed to various technologies, development cultures, patterns, problems, and implementation approaches. The beauty of an architecture assignment is that no two scenarios will remain the same; the technology stack, the integrating systems, long-term goals, and the technology roadmap are among a good number of factors that make each architecture scenario unique. This gave me the opportunity to experiment in enterprise architecture and to witness the result of those experiments.

In addition to the architect role, I also consider myself lucky to have played various kinds of roles in the industry. One of the roles was that of performance engineering consultant wherein I had the opportunity to look into performance issues of varying complexities.

When I look back at those experiences and analyze my experiments, I have the following observations, among others:

- **Range of software quality:** Software quality is an umbrella term with a broad range of meanings (and perceptions). It could range anywhere from an end-user experience faced by a customer to code quality encountered by a developer. Due to a broad range of views,



it is worth exploring software quality from various angles. In this book, I have tried to explore the main quality attributes—scalability, performance, and availability—from various perspectives.

- **Impact of horizontal elements on software quality:** Horizontal elements such as caching and security influence the key quality attributes to a great extent. Hence, an efficient design for these horizontal elements is warranted. I have also explored the impact of caching and scalability on three quality attributes.
- **Integrated view of software quality:** Quality attributes cannot be achieved in isolation. An integrated and synergized set of strategies needs to be followed to achieve and sustain the quality Service Level Agreement (SLA) for an extended duration. Enterprise testing and project management also play vital roles in achieving the overall quality of the enterprise application. These two are aspects of an enterprise ecosystem that can impact the overall effectiveness of the architecture.
- **Achieving and maintaining end-to-end quality:** This concept needs different treatment, apart from trying to achieve each of goal in isolation during a particular phase of the project. I have tried to touch base on all of the main aspects of end-to-end program engagement. While I have discussed some of these concepts in the “Project Management” chapter, another chapter on “Operations and Maintenance” explores these concepts further.
- **Practically proven patterns, techniques, and methodologies:** During my consulting exercises, I discovered that some problem scenarios had the same theme, a recurring problem pattern caused by the known root cause. This recurring problem pattern can be easily avoided through proper planning and adopting best practices and methodologies. I have discussed a range of patterns, models, techniques, and practically implemented frameworks throughout this book. In some places, I have also documented my findings through graphs to explain the idea visually.
- **Technology updates:** Change is the only constant in the technology area. I have tried to discuss some of the recent technological trends and developments, such as services scalability, web analytics-based monitoring, and enterprise web testing, within the applicable context.

Overall, this book is an honest attempt to share with the technical community my findings, insights, and practically proven methodologies.

## Main themes and focus areas

The main themes and focus areas of this book are:

- **Technology-agnostic view:** I have tried to take a technology-agnostic view while elaborating concepts, explaining models, patterns, and best practices. In some instances, for making concrete explanations, I have taken concrete examples from enterprise Java and open-source frameworks. However, the techniques and methodologies can be applied to any technology.
- **Enterprise web:** This is the main focal point. All quality attributes, methodologies, patterns, case studies, and examples revolve around this theme. Hence, the scope of items is mainly enterprise web-related. However, project management and operations chapters are generic enough that they are applicable to any type of enterprise project.



- **Case study:** Each of the quality-related chapters has a case study at the end of the chapter, which further reinforces the concepts discussed. There is also a detailed case study in Chapter 9 that exclusively elaborates an end-to-end architecture case study. This chapter discusses an end-to-end architecture of an online e-commerce web application.
- **In-house deployment:** Some of the techniques and calculations related to sizing and capacity planning assume an in-house deployment model. However, there are brief discussions about cloud as an alternative option, wherever necessary.
- **Recent trends in web technology:** I have tried to cover some of the recent developments in enterprise web technology such as HTML 5, responsive web design, and others, wherever applicable.
- **Practical experiences:** Though we discuss many theoretical concepts, we put greater emphasis on aspects that have been put in practice and are thus already proved in enterprise application scenarios. This applies to the models, frameworks, examples, case studies, patterns, and best practices discussed throughout this book.
- **Coherence means of achieving quality:** Various models, techniques, and best practices act in coherence to achieve the quality attributes in the context of the chapter as well as in the context of overall quality.

## Organization of chapters

The chapters of this book are organized as follows:

- **Chapter 1: Architecting Scalable Enterprise Web Applications:** This chapter mainly discusses the challenges, best practices, techniques, patterns, examples, and process for achieving scalability in enterprise applications. It provides details about sizing and capacity planning, scalability testing, and achieving layer-wise scalability.
- **Chapter 2: Ensuring High Availability for Your Enterprise Applications:** We will see the key tenets of high availability, motivations for availability, the availability analysis process, challenges at various layers, availability patterns, the 5R model for availability, anti-patterns, and availability testing.
- **Chapter 3: Optimizing Performance of Enterprise Web Application:** This chapter mainly discusses web performance optimization techniques and provides analysis of various factors influencing the end web page performance. It also discusses various performance design guidelines, principles, and best practices at various lifecycle phases of the project. The chapter also introduces smart asset proxy, progressive semantic loading, and the performance optimization framework for optimizing delivery of static assets.
- **Chapter 4: Caching for Enterprise Application:** Various impacts of caching on quality attributes are discussed, along with cache concepts, caching patterns, cache metrics, and comprehensive caching strategy.
- **Chapter 5: Securing Enterprise Application:** We will see security strategies along with vulnerability, threat, and risk assessments. The chapter also discusses various security principles, policies, and testing.
- **Chapter 6: Enterprise Web Application Testing:** In this chapter, we see various challenges related to web testing and best practices, analysis of testing methodologies, the UCAPP testing model, security testing, services testing, and key testing metrics.
- **Chapter 7: Project Management for Enterprise Applications:** Various aspects related to enterprise project management are discussed in this chapter. These include leading

quality indicators, automated quality control, productivity improvement measures, continuous quality improvement framework, and the governance approach.

- **Chapter 8: Operations and Maintenance:** This chapter discusses the main development operations methods, namely, continuous build and deployment. It also talks about monitoring and notification, production troubleshooting scenarios, and production operations.
- **Chapter 9: Enterprise Architecture Case Study: ElectronicsDeals Online:** This is a comprehensive case study that closely mimics real-world scenarios. We will start with the basic architecture and add scalability, availability, and performance optimization features for the application.

## Target audience

This book caters to various roles within the technology community. Here is a brief summary of people who will find this book useful:

### Target audience of the book

Role	Benefits of this book
Enterprise architects	<ul style="list-style-type: none"> <li>• Get to know about new models, techniques, and practically proven frameworks for achieving all-around quality in enterprise projects</li> <li>• Learn common pitfalls and anti-patterns to be avoided</li> <li>• Appreciate concepts in case studies; use it as reference</li> </ul>
Infrastructure architects	<ul style="list-style-type: none"> <li>• Get to know about best practices for sizing and capacity planning</li> <li>• Get to know about techniques related to bottleneck analysis, the quality establishment process, and all infrastructure-related concepts related to scalability, availability, and performance</li> </ul>
Performance engineers	<ul style="list-style-type: none"> <li>• Learn various techniques, best practices, and patterns used in web performance optimization</li> <li>• Learn about three novel models and frameworks related to smart asset proxy, progressive semantic loading, and performance optimization frameworks</li> </ul>
Software developers	<ul style="list-style-type: none"> <li>• Learn best practices and architecture patterns that can be adopted in early stages of software development</li> <li>• Learn about tools, coding checklists, best practices, techniques, and processes that can be used in their day-to-day development activities</li> <li>• Leverage techniques and models using in-reference case studies</li> </ul>

(Continued)

**(Continued)**

<b>Role</b>	<b>Benefits of this book</b>
Software testers	<ul style="list-style-type: none"> <li>• Get to know about various enterprise web testing techniques and open source testing tools</li> <li>• Understand the bigger picture and impact of testing on quality attributes</li> </ul>
Project managers	<ul style="list-style-type: none"> <li>• Learn about lead indicators of issues, proactive quality process, automated quality control strategy, governance models, and other aspects of effective program management</li> </ul>
Production support, maintenance personnel; and system administrators	<ul style="list-style-type: none"> <li>• Learn effective practices related to monitoring, maintenance, production operations, and troubleshooting</li> <li>• Use the book as a reference guide for adopting best practices in maintenance and operations</li> </ul>
Students	<ul style="list-style-type: none"> <li>• Learn various concepts related to scalability, availability, security, caching, performance</li> <li>• Understand various best practices, principles, patterns, and design guidelines used for architecting an enterprise application</li> </ul>
Audience interested in enterprise architecture	<ul style="list-style-type: none"> <li>• Get a holistic view of quality attributes and key concepts, design principles, and patterns related to enterprise architecture</li> </ul>

Based on the benefits for a given role, the book can act as a reference guide or technology handbook.

**Declaration**

- Utmost care is taken to ensure the accuracy and novelty of this book's content. In case there are any inaccuracies, which I sincerely regret, they are entirely my own. In the case that the reader thinks of any corrections or feedback, please do write me at Shailesh.shivakumar@gmail.com.
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## About the Author

**Shailesh Kumar Shivakumar** is a senior technology architect at Infosys Technologies Limited with over 13 years of industry experience. His areas of expertise include Java enterprise technologies, performance engineering, enterprise portal technologies, user interface components, and performance optimization. He is a Guinness world-record holder of participation, for successfully developing a mobile application in coding marathon. He has four patent applications, including two US patent applications in the area of web and social technologies.



He was involved in multiple large-scale and complex online transformation projects for the Fortune 500 clients of his organization. He also provided on-demand consultancy in performance engineering for critical projects across various units in the organization. He has hands-on experience of the breadth of technologies—web technologies, portal technologies, and database technologies—and has worked on multiple domain areas such as retail, manufacturing, finance, e-commerce, avionics, and more. He was the chief architect of an online platform that won a “best web support site” award among global competitors. He also led numerous large-scale pre-sales pursuits and initiatives.

He is a regular blogger at Infosys Thought Floor, and many of his technical white papers are published on the Infosys external site. He delivered two talks at the Oracle JavaOne 2013 conference on performance optimization and project management and has presented a paper at the IEEE conference on knowledge management systems. He also headed a center of excellence for portals and is currently the practice lead for enterprise portal practice at his organization and leads a group of architects. He led multiple thought leadership and productivity improvement initiatives and was part of special interest groups (SIGs) related to emerging web technologies at his organization.

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He has won numerous awards including the prestigious Infosys Awards for Excellence 2013–14 “Multitalented thought leader” under “Innovation—Thought Leadership” category, “Brand ambassador award” for MFG unit, delivery

excellency award, and multiple spot awards, and he has received honors from the executive vice chairman of his organization. He is featured as an “Infy star” in the Infosys Hall of Fame and recently led a delivery team that won the “best project team” award at his organization.

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# Contents

<b>Preface</b>	<b>xi</b>
<b>About the Author</b>	<b>xix</b>
<b>Acknowledgments</b>	<b>xxi</b>
<b>1 Architecting Scalable Enterprise Web Applications</b>	<b>1</b>
1.1 Introduction	1
1.2 Scalability layers	3
1.3 Key tenets of enterprise scalability	4
1.4 Challenges for scalability	7
1.5 Scalability patterns and best practices	11
1.6 Architecting scalable systems	41
1.7 Scalability testing	50
1.8 Scalability anti-patterns	51
1.9 Case study	52
1.10 Chapter summary	56
<b>2 Ensuring High Availability for Your Enterprise Web Applications</b>	<b>59</b>
2.1 Introduction	59
2.2 High availability planning	60
2.3 Challenges to high availability	68
2.4 High availability architecture patterns and best practices	70
2.5 High availability for storage, network, and database components	75
2.6 High availability database	77
2.7 Network availability	78
2.8 5R model for high availability	79
2.9 Other aspects of high availability	86
2.10 Availability anti-patterns	91
2.11 High availability governance	92
2.12 Uninterrupted system and application maintenance	92
2.13 High availability testing	94
2.14 Case study	94
2.15 Chapter summary	98
<b>3 Optimizing Performance of Enterprise Web Application</b>	<b>101</b>
3.1 Introduction	101
3.2 WPO concepts and analysis	101
3.3 WPO strategy	104
3.4 Optimizing performance for supporting ecosystem components	119

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3.5	Asset optimization strategy	122
3.6	Other dimensions of performance optimization	133
3.7	Performance anti-patterns	135
3.8	Web analytics-based performance improvement	136
3.9	Performance governance framework	137
3.10	Case study for top-down performance optimization	137
3.11	Chapter summary	140
<b>4</b>	<b>Caching for Enterprise Web Application</b>	<b>143</b>
4.1	Introduction	143
4.2	Impact on scalability, availability, and performance	145
4.3	Cache concepts	146
4.4	Cache design	148
4.5	Caching patterns	151
4.6	Caching antipatterns	151
4.7	Caching strategy	154
4.8	Cache metrics and administration	156
4.9	Chapter summary	158
<b>5</b>	<b>Securing Enterprise Web Application</b>	<b>159</b>
5.1	Introduction	159
5.2	Security strategy	159
5.3	Vulnerability, threat, and risk assessment	161
5.4	Designing security principles and policies	163
5.5	Implementing security policy at all levels	166
5.6	Security testing and monitoring	166
5.7	Chapter summary	178
<b>6</b>	<b>Enterprise Web Application Testing</b>	<b>179</b>
6.1	Introduction	179
6.2	Web testing challenges	179
6.3	Testing best practices	182
6.4	Testing estimation at each project phase	183
6.5	UCAPP testing model for enterprise applications	183
6.6	Other aspects of testing	193
6.7	Chapter summary	198
<b>7</b>	<b>Project Management for Enterprise Applications</b>	<b>199</b>
7.1	Introduction	199
7.2	Survey and analysis of enterprise software projects	199
7.3	Project management best practices during various phases of the software project	199
7.4	Lead indicators of quality issues	200
7.5	Proactive quality approach techniques	201
7.6	Project quality tools and metrics	214
7.7	Governance	216
7.8	Chapter summary	219