

# Modern Web Performance Optimization

Methods, Tools, and Patterns to Speed Up  
Digital Platforms

—  
Shailesh Kumar Shivakumar

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# ***Modern Web Performance Optimization: Methods, Tools, and Patterns to Speed Up Digital Platforms***

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Bengaluru, India

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*I would like to dedicate this book to whom I owe more than I can ever repay and those who have immensely blessed me.*

*My parents, Shivakumara Setty V and Anasuya T M,  
for their unending love and strength*

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# About the Author



**Dr. Shailesh Kumar Shivakumar** is an inventor, author, researcher, and enterprise architect. He is an award-winning, digital technology practitioner with skills in technology, practice management, and a wide spectrum of digital technologies, including enterprise portals, content systems, enterprise search, and performance engineering. Dr. Shailesh has a distinctive record for the “maximum [number of] books on digital technologies published internationally by a single author,” awarded by the India Book of Records. He was featured in national daily

newspapers for this achievement. He has received a Grandmaster honor from the Asia Book of Records. He is a Guinness World Records holder for successfully developing a mobile application in a coding marathon. Google’s knowledge graph on Dr. Shailesh can be accessed at <https://g.co/kgs/8hz565>.

Dr. Shailesh has a PhD in computer science and completed an executive program in business management. He is the author of seven technical books published by the world’s top academic publishers. He has published a dozen technical white papers, blogs, and technical magazine articles and has authored eight textbook chapters for undergraduate programs. He has published more than twenty research papers in reputed international journals and is a member of the editorial boards for three leading international journals. Dr. Shailesh has presented multiple papers at IEEE conferences and a JavaOne conference. Dr. Shailesh’s work is quoted and mentioned in world’s reputed knowledge sources such as Wikipedia and Quora.

Dr. Shailesh has inventions related to web security and personalization and holds two US patents. He also has ten patent applications. He has given talks and participated in panel discussions at international conferences. He has been twice interviewed by *InfoQ* magazine, an international magazine on software topics. He was on the Conference Advisory Committee of the International Conference on Computational Intelligence and Communication (ICCIC-19).

## ABOUT THE AUTHOR

Dr. Shailesh has more than 19 years of industry experience and was the chief architect in building a digital platform, which won a Best Web Support Site 2013 global award. He is a seasoned architect who is deeply focused on enterprise architecture, building alliance partnerships with product vendors. He has a proven track record of executing complex, large-scale programs. He has successfully architected and led many engagements for Fortune 500 clients. He has built globally deployed enterprise applications. He also has headed up a center of excellence for digital practices and developed several digital solutions as well as intellectual property to accelerate digital solution development. He has led multiple thought leadership and productivity improvement initiatives and has been part of special interest groups related to emerging web technologies at his organization.

Dr. Shailesh was awarded the prestigious Albert Nelson Marquis Lifetime Achievement Award 2018 for technology leadership and has won multiple other awards, including a listing in *Marquis Who's Who 2018* and the prestigious Infosys Award for Excellence 2013-14 for multitalented thought leader. He has been awarded multiple awards at his organization for his exemplary performance and contributions, including the Pinnacle Award, Brand Ambassador Award 2013, Unit Champion Award, Best Project Team Award, and Best Employee Award 2015. He is featured as an “Infy star” in the Infosys Hall of Fame. He was honored as the chief guest of honor at Presidency College’s IT Fest COMPUTANTRA-2018 and was a guest of honor at ISTE student chapters at BNMIT, Bangalore.

Dr. Shailesh holds numerous professional certifications, including TOGAF 9, Deep Learning Nanodegree certification from Udacity, AWS Certified Solutions Architect, Oracle Certified Master (OCM) in Java EE5 Enterprise Architect, IBM Certified SOA Solution Designer, and IBM Certified Solution Architect Cloud Computing Infrastructure. He can be reached at <https://drshailesh.in/>.

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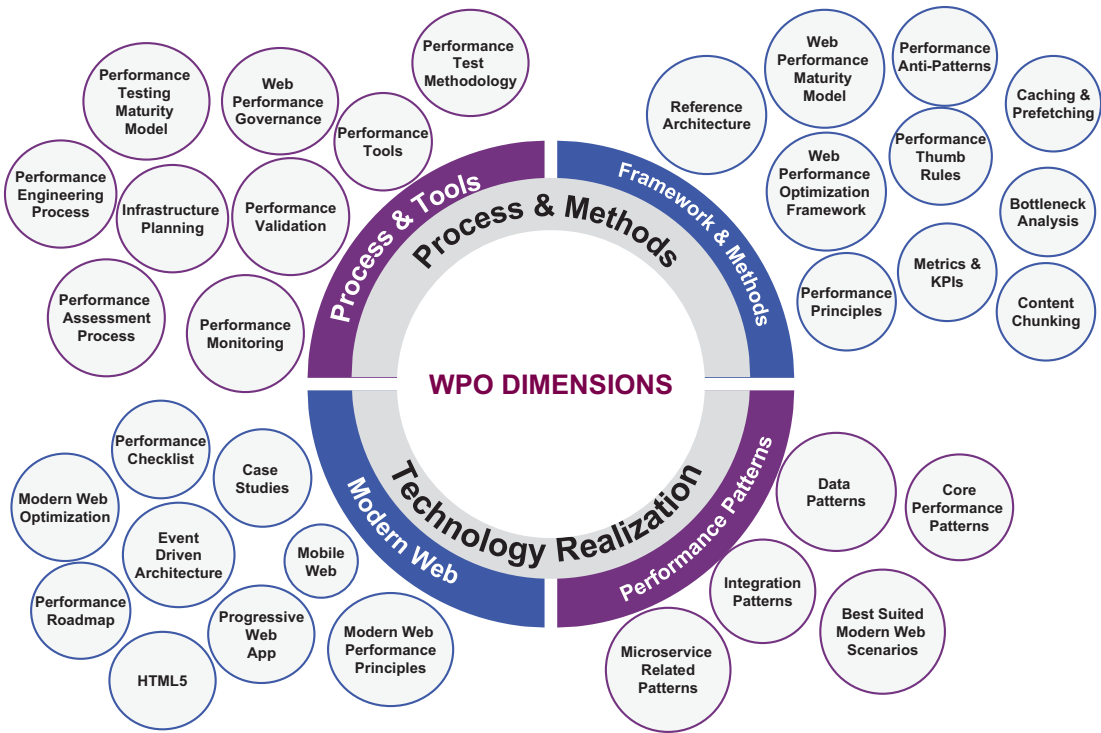
# Introduction

Modern web platforms are popular user-engagement tools. They are important vehicles for enterprises to realize their digital strategies. The optimal performance of the modern web is a key success factor to drive user traffic and keep web users engaged by providing useful information. Web architects and performance engineers need to design for optimal performance in the modern web for the long-term success of web systems. Performance is a critical success factor for modern web platforms. It leads to high user satisfaction, increased user engagement, increased user traffic, and more. Web performance optimization (WPO) deals with various aspects of modern web performance.

## WPO Dimensions Explored in This Book

Performance optimization is a journey spanning various life cycle stages of a project. To achieve optimal performance, you should look at end-to-end layers, solution components, performance testing, monitoring, and infrastructure.

This book adopts a multifaceted approach to WPO. The core WPO dimensions discussed in the book are depicted in [Figure I-1](#).



**Figure I-1.** WPO dimensions

Broadly we can categorize the WPO dimensions into “Process and Methods” and “Technology Realization” categories. The “Process and Methods” category covers the process and tools and framework and methods dimensions; The “Technology Realization” category covers modern web and performance patterns dimensions. The **Process and Tools** dimension discusses performance optimization processes, tools, and governance. Various performance testing tools, the web performance test methodology, performance governance, and the performance testing maturity model are in this dimension. Performance monitoring methods, tools, and best practices are examined. Infrastructure-related optimizations are also a part of this dimension. I cover this dimension in Chapter 2, Chapter 3 and Chapter 6.

The **Framework and Methods** dimension explains methods and best practices in performance optimization. In this context, proven performance best practices, methods, tools, KPIs (key performance indicators), and metrics and principles for modern web platforms are covered. Performance optimizations across various layers, reference architecture, performance metrics, and KPIs, network-related performance optimizations, and caching methods and are covered. The web performance

optimization framework provides comprehensive coverage of performance optimizations at various SDLC phases and various application layers. Performance antipatterns, the web performance maturity model, and bottleneck analyses are also in this dimension. I cover various topics of this dimension in Chapter 3, Chapter 4 and Chapter 5.

The **Performance Patterns** dimension covers patterns related to performance, data, and integration used in various modern web platforms. You learn various details about each of the patterns, including solution, drivers, flow, advantages and disadvantages, and applicable scenarios. I describe applicable real-world scenarios for core performance-related patterns (such as progressive web architecture patterns, Cache aside pattern, the PRPL pattern, and the isomorphic pattern), data-related patterns (such as SAGA, CQRS, data lakes, and NoSQL), and integration-related patterns (such as microservices, event-driven architecture, and GraphQL). For each of the patterns I cover the applicable modern web scenarios. I also discuss common best practices and variants in each of the patterns. I cover various topics of this dimension in Chapter 10, Chapter 11 and Chapter 12.

The **Modern Web** dimension explains the tenets of modern web technologies, such as PWA, HTML5, and event-driven architecture. I describe core performance optimizations principles for modern web platforms, and you look at real-world case studies on performance engineering and legacy modernization and modern web development. The case studies cover layer-wise performance assessments, web performance assessment approach, web performance assessment exercise, web performance optimization recommendations, and performance-related design recommendations. I cover this dimension in Chapter 4, Chapter 8 and Chapter 9.

## How This Book Is Organized

The book is organized into five parts based on logically related performance topics.

- **Part 1** focuses on performance challenges, scenarios, and commonly adopted performance best practices. This part mainly covers the performance optimization of traditional web applications. It surveys existing performance optimization methods and lists the most common performance optimization methods.

- **Part 2** dives into modern web platforms and describes design guidelines, performance principles, performance optimization methods, tools, and principles. There is a discussion on mobile web applications and progressive web applications. This part also elaborates on the “web performance optimization framework,” which covers performance optimization dimensions.
- **Part 3** covers various aspects of performance testing, including key performance testing metrics, workload modeling, web performance test methodology, and performance testing maturity model. This part also discusses performance monitoring to maintain optimal performance. A discussion on performance monitoring includes monitoring metrics, application performance monitoring (APM), building performance monitoring ecosystem, and infrastructure planning for performance.
- **Part 4** looks closely at two real-world performance optimization case studies. A performance engineering case study covers layer-wise challenges, solution components, performance optimization, infrastructure analysis, recommendations, and performance roadmaps. A legacy web optimization case study covers the web performance assessment approach, a web performance assessment exercise, web performance optimization recommendations, and performance-related design recommendations.
- **Part 5** covers the main patterns that impact the performance of modern web platforms. It discusses the context, drivers, solution, advantages, and applicable modern web scenarios for core performance patterns, data-related patterns, and integration-related pattern. For each of the patterns, there are applicable real-world scenarios.
- The Appendix four include checklists and templates. The checklists and templates compliment the methods and frameworks discussed in the chapters. This includes a web performance checklist, database performance checklist, performance test report template, performance test strategy template, and security assessment checklist. You can use the templates and checklists as reference for code reviews and performance testing.

# Key Takeaways of This Book

After reading this book, you should understand the following performance optimization methods and frameworks.

- The comprehensive web performance optimization framework covering performance optimization methods for all SDLC phases and the performance maturity model
- Web performance taxonomy at various layers of the modern web application
- Performance optimizations methods, design principles, tools, and frameworks for modern web platforms
- Performance optimization processes, such as bottleneck analysis, performance assessment, performance testing, performance monitoring, workload modeling, and infrastructure planning
- Various performance metrics and KPIs for performance monitoring and testing
- Real-world performance engineering case studies for end-to-end performance optimization across all layers
- Modern web optimization principles, methods, and tools
- Performance patterns to optimize the performance, data, and integration of the modern web
- Usable templates, checklists such as web performance checklist, database performance checklist, performance test report template, performance test strategy template, modern web application security assessment checklist from the appendix sections

## Intended Audience

The book is intended for digital enthusiasts, performance engineers, web developers, front-end engineers, integration architects, data architects, full stack developers, enterprise architects, project managers, program managers, and CIOs.

---

**Note** Examples of various tools, technologies, and frameworks are provided in discussing WPO concepts. All the examples are for pedagogical purposes, and as such, the book does not recommend any particular tool or technology.

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# **PART I**

# **Introduction to Web Performance Optimization**

## CHAPTER 1

# Getting Started with Web Performance Optimization

A faster web page positively impacts the user experience and ultimately leads to increased user satisfaction. It influences online revenue and search engine rankings. User traffic and repeat visits are also dependent on web page performance. Web performance optimization (WPO) plays a crucial role in optimizing the performance of public web pages.

This chapter looks at the key impact factors of WPO. It describes WPO dimensions, WPO lifecycle stages, WPO governance concepts, and layer-wise WPO optimization methods.

## Web Performance Optimization (WPO)

Web performance optimization covers methods, tools, and best practices to improve the end-to-end performance of a web page. The main WPO topics—such as impact, dimensions, and gaps, are covered in this section.

Web performance optimization (WPO) involves all methods to improve the performance of a web page. WPO includes optimizing the performance of page components, such as HTML content, web components, page elements, and page assets. End-to-end WPO provides techniques, best practices, rules of thumb, and methodologies. The key components used in WPO are web content, images, videos, CSS/JS files, XML/JSON files, and other presentation components.

WPO has an impact on the following aspects.

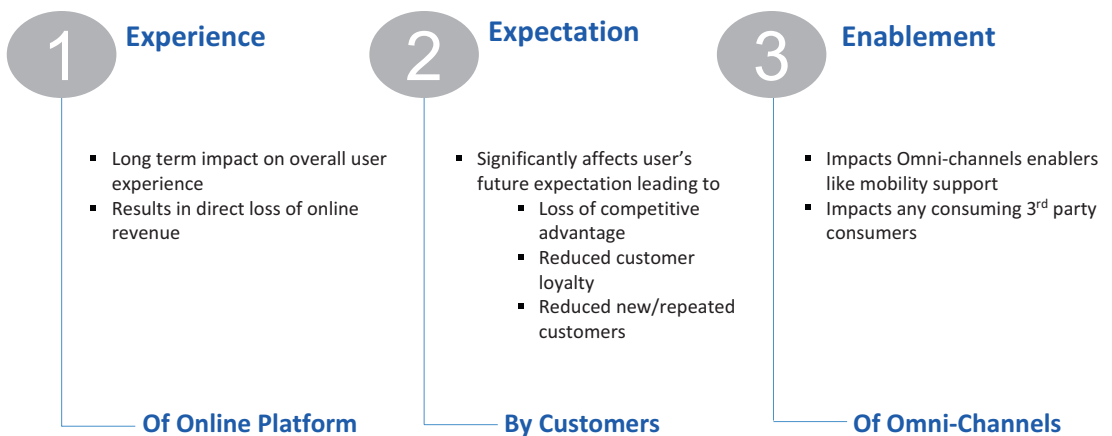
- **Customer churn:** Research indicates that customers tend to abandon slower web pages.
- **User impact:** The page performance impacts usability. The performance of landing/gateway pages and key processes is directly co-related to the overall user experience.
- **Site traffic:** User engagement and user traffic increases for fast loading pages. The high performance pages also increase the conversion rate and reduces the abandonment rate.
- **Revenue:** Online revenue is directly correlated to the performance of key pages and transactions for e-commerce sites.
- **Multi-device optimization:** The web page performance plays a crucial role in usability on mobile devices
- **Search engine ranking:** Search engines use page performance as one of the ranking criteria.
- **Omnichannel advantage:** Mobile devices can easily access a page that performs well.

The impact of WPO on page performance is depicted in Figure 1-1.



**Figure 1-1.** *Impact of WPO*

The high-level impact WPO categories are depicted in Figure 1-2.



**Figure 1-2.** *WPO impact categories*