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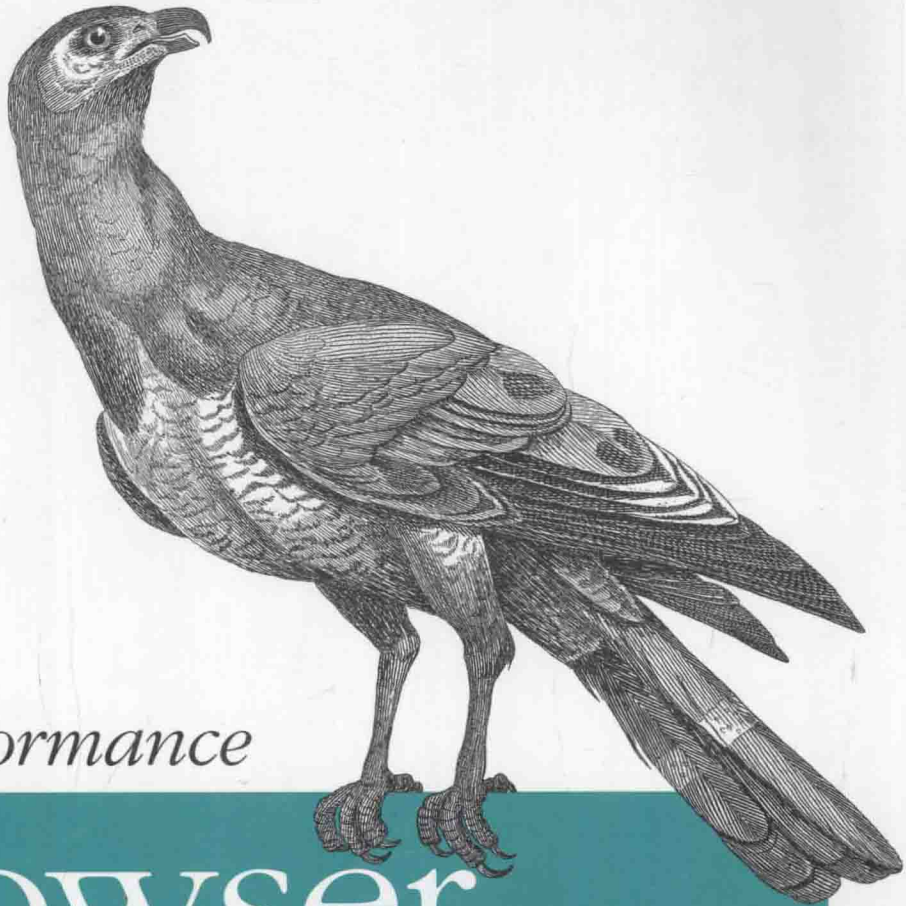

*High Performance*

# Browser Networking

O'REILLY®

東南大學出版社

*Ilya Grigorik* 著

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# High Performance Browser Networking

*Ilya Grigorik* 著

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南京 东南大学出版社

**图书在版编目（CIP）数据**

高性能浏览器网络:英文/(美)格里戈利克(Grigorik, I.)著.—影印本.—南京：东南大学出版社，2014.9

书名原文：High Performance Browser Networking

ISBN 978-7-5641-4961-1

I. ① 高… II. ①格… III. ①浏览器－英文 IV. ① TP393.092

中国版本图书馆 CIP 数据核字（2014）第 102959 号

江苏省版权局著作权合同登记

图字：10-2014-146 号

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英文原版由 O'Reilly Media, Inc. 出版 2013。

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高性能浏览器网络（影印版）

出版发行：东南大学出版社

地　　址：南京四牌楼 2 号　　邮编：210096

出 版 人：江建中

网　　址：http://www.seupress.com

电子邮件：press@seupress.com

印　　刷：常州市武进第三印刷有限公司

开　　本：787 毫米 × 980 毫米　16 开本

印　　张：25.25

字　　数：494 千字

版　　次：2014 年 9 月第 1 版

印　　次：2014 年 9 月第 1 次印刷

书　　号：ISBN 978-7-5641-4961-1

定　　价：74.00 元

本社图书若有印装质量问题，请直接与营销部联系。电话（传真）：025-83791830

# Foreword

"Good developers know how things work. Great developers know why things work."

We all resonate with this adage. We want to be that person who understands and can explain the underpinning of the systems we depend on. And yet, if you're a web developer, you might be moving in the opposite direction.

Web development is becoming more and more specialized. What kind of web developer are you? Frontend? Backend? Ops? Big data analytics? UI/UX? Storage? Video? Messaging? I would add "Performance Engineer" making that list of possible specializations even longer.

It's hard to balance studying the foundations of the technology stack with the need to keep up with the latest innovations. And yet, if we don't understand the foundation our knowledge is hollow, shallow. Knowing how to use the topmost layers of the technology stack isn't enough. When the complex problems need to be solved, when the inexplicable happens, the person who understands the foundation leads the way.

That's why *High Performance Browser Networking* is an important book. If you're a web developer, the foundation of your technology stack is the Web and the myriad of networking protocols it rides on: TCP, TLS, UDP, HTTP, and many others. Each of these protocols has its own performance characteristics and optimizations, and to build high performance applications you need to understand why the network behaves the way it does.

Thank goodness you've found your way to this book. I wish I had this book when I started web programming. I was able to move forward by listening to people who understood the why of networking and read specifications to fill in the gaps. High Performance Browser Networking combines the expertise of a networking guru, Ilya Grigorik, with the necessary information from the many relevant specifications, all woven together in one place.

In *High Performance Browser Networking*, Ilya explains many whys of networking: Why latency is the performance bottleneck. Why TCP isn't always the best transport mechanism and UDP might be your better choice. Why reusing connections is a critical optimization. He then goes even further by providing specific actions for improving networking performance. Want to reduce latency? Terminate sessions at a server closer to the client. Want to increase connection reuse? Enable connection keep-alive. The combination of understanding what to do and why it matters turns this knowledge into action.

Ilya explains the foundation of networking and builds on that to introduce the latest advances in protocols and browsers. The benefits of HTTP 2.0 are explained. XHR is reviewed and its limitations motivate the introduction of Cross-Origin Resource Sharing. Server-Sent Events, WebSockets, and WebRTC are also covered, bringing us up to date on the latest in browser networking.

Viewing the foundation and latest advances in networking from the perspective of performance is what ties the book together. Performance is the context that helps us see the why of networking and translate that into how it affects our website and our users. It transforms abstract specifications into tools that we can wield to optimize our websites and create the best user experience possible. That's important. That's why you should read this book.

—Steve Souders, Head Performance Engineer, Google, 2013



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# Preface

The web browser is the most widespread deployment platform available to developers today: it is installed on every smartphone, tablet, laptop, desktop, and every other form factor in between. In fact, current cumulative industry growth projections put us on track for 20 billion connected devices by 2020—each with a browser, and at the very least, WiFi or a cellular connection. The type of platform, manufacturer of the device, or the version of the operating system do not matter—each and every device will have a web browser, which by itself is getting more feature rich each day.

The browser of yesterday looks nothing like what we now have access to, thanks to all the recent innovations: HTML and CSS form the presentation layer, JavaScript is the new assembly language of the Web, and new HTML5 APIs are continuing to improve and expose new platform capabilities for delivering engaging, high-performance applications. There is simply no other technology, or platform, that has ever had the reach or the distribution that is made available to us today when we develop for the browser. And where there is big opportunity, innovation always follows.

In fact, there is no better example of the rapid progress and innovation than the networking infrastructure within the browser. Historically, we have been restricted to simple HTTP request-response interactions, and today we have mechanisms for efficient streaming, bidirectional and real-time communication, ability to deliver custom application protocols, and even peer-to-peer videoconferencing and data delivery directly between the peers—all with a few dozen lines of JavaScript.

The net result? Billions of connected devices, a swelling userbase for existing and new online services, and high demand for high-performance web applications. Speed is a feature, and in fact, for some applications it is *the feature*, and delivering a high-performance web application requires a solid foundation in how the browser and the network interact. That is the subject of this book.

## About This Book

Our goal is to cover what every developer should know about the network: what protocols are being used and their inherent limitations, how to best optimize your applications for the underlying network, and what networking capabilities the browser offers and when to use them.

In the process, we will look at the internals of TCP, UDP, and TLS protocols, and how to optimize our applications and infrastructure for each one. Then we'll take a deep dive into how the wireless and mobile networks work under the hood—this radio thing, it's very different—and discuss its implications for how we design and architect our applications. Finally, we will dissect how the HTTP protocol works under the hood and investigate the many new and exciting networking capabilities in the browser:

- Upcoming HTTP 2.0 improvements
- New XHR features and capabilities
- Data streaming with Server-Sent Events
- Bidirectional communication with WebSocket
- Peer-to-peer video and audio communication with WebRTC
- Peer-to-peer data exchange with DataChannel

Understanding how the individual bits are delivered, and the properties of each transport and protocol in use are essential knowledge for delivering high-performance applications. After all, if our applications are blocked waiting on the network, then no amount of rendering, JavaScript, or any other form of optimization will help! Our goal is to eliminate this wait time by getting the best possible performance from the network.

*High-Performance Browser Networking* will be of interest to anyone interested in optimizing the delivery and performance of her applications, and more generally, curious minds that are not satisfied with a simple checklist but want to know how the browser and the underlying protocols actually work under the hood. The "how" and the "why" go hand in hand: we'll cover practical advice about configuration and architecture, and we'll also explore the trade-offs and the underlying reasons for each optimization.

Our primary focus is on the protocols and their properties with respect to applications running in the browser. However, all the discussions on TCP, UDP, TLS, HTTP, and just about every other protocol we will cover are also directly applicable to native applications, regardless of the platform.

## Conventions Used in This Book

The following typographical conventions are used in this book:

*Italic*
: Indicates new terms, URLs, email addresses, filenames, and file extensions.

`Constant width`
: Used for program listings, as well as within paragraphs to refer to program elements such as variable or function names, databases, data types, environment variables, statements, and keywords.

**`Constant width bold`**
: Shows commands or other text that should be typed literally by the user.

*`Constant width italic`*
: Shows text that should be replaced with user-supplied values or by values determined by context.

This icon signifies a tip, suggestion, or general note.

This icon indicates a warning or caution.

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# PART I
# Networking 101

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