Speed Metrics Guide

Choosing the Right Metrics to Use When Evaluating Websites

Matthew Edgar

Apress®

Speed Metrics Guide

Choosing the Right Metrics to Use When Evaluating Websites

Matthew Edgar

Apress®

Speed Metrics Guide: Choosing the Right Metrics to Use When Evaluating Websites

Matthew Edgar
Centennial, CO, USA

ISBN-13 (pbk): 979-8-8688-0154-9 ISBN-13 (electronic): 979-8-8688-0155-6
https://doi.org/10.1007/979-8-8688-0155-6

Managing Director, Apress Media LLC: Welmoed Spahr
Acquisitions Editor: Shivangi Ramachandran
Development Editor: James Markham
Editorial Assistant: Jessica Vakili

Cover designed by eStudioCalamar

Distributed to the book trade worldwide by Springer Science+Business Media New York, 1 New York Plaza, Suite 4600, New York, NY 10004-1562, USA. Phone 1-800-SPRINGER, fax (201) 348-4505, e-mail orders-ny@springer-sbm.com, or visit www.springeronline.com. Apress Media, LLC is a California LLC and the sole member (owner) is Springer Science + Business Media Finance Inc (SSBM Finance Inc). SSBM Finance Inc is a **Delaware** corporation.

For information on translations, please e-mail booktranslations@springernature.com; for reprint, paperback, or audio rights, please e-mail bookpermissions@springernature.com.

Apress titles may be purchased in bulk for academic, corporate, or promotional use. eBook versions and licenses are also available for most titles. For more information, reference our Print and eBook Bulk Sales web page at http://www.apress.com/bulk-sales.

Any source code or other supplementary material referenced by the author in this book is available to readers on GitHub. For more detailed information, please visit https://www.apress.com/gp/services/source-code.

Paper in this product is recyclable

Table of Contents

About the Author

Matthew Edgar is a partner at Elementive (www.elementive.com), a Colorado-based consulting firm specializing in technical SEO. Over the last 20 years, Matthew has helped hundreds of clients optimize their websites, improving organic traffic and conversions. His clients include startups, small businesses, and Fortune 500 companies. Matthew is the author of *Tech SEO Guide* (Apress, 2023) and has spoken at leading SEO conferences, including SMX, MozCon, and MarTech. Matthew holds a Master's in Information and Communications Technology from the University of Denver. Learn more and connect at MatthewEdgar.net.

Introduction

The Challenge of Measuring Website Speed

The benefits of faster websites are well known. Faster websites offer a better user experience and typically have higher conversion rates. Faster websites may rank better in organic search results and are easier for robots to crawl. Because of these benefits, many companies invest heavily to improve their website's speed.

Unfortunately, companies often invest in the wrong areas and do not meaningfully improve the website's speed. Investing in the right areas and making a meaningful difference starts by understanding how to correctly measure a website's speed and knowing how to use those measurements to identify the biggest opportunities.

Speed reports can be difficult to understand with so many metrics available. TTFB, FCP, LCP, TBT, or TTI might be slow, but what do these acronyms represent about website speed? The harder question to answer is what actions should be taken if a metric is slower than it ought to be? If multiple metrics are slower than they ought to be, which metric should be improved first to have the greatest impact? Answering these questions requires not only understanding what the metric represents but also understanding how each metric relates to the bigger picture of website loading.

Understanding Speed Metrics

This book explores the different speed metrics and explains how to use each metric to evaluate the different factors contributing to slower website speeds.

There is a metric to describe each stage of a website's loading process. By using a combination of these metrics, it becomes clear which stage is slower and where investments ought to be made. This book starts at the beginning of the loading process, with metrics describing the initial connection to the website, and continues through to the end of the loading process, with metrics describing how quickly visitors can interact with the webpage.

Every chapter reviews a different metric, discussing what it measures and what it means if that metric is slow. Each chapter will also discuss ways to improve that metric. However, this is not a detailed technical discussion of how to rework the website's code or server configuration. Instead, each chapter provides an overview of related optimization tactics and summarizes the key points to consider that are most relevant to a specific metric.

Help Everyone Involved Measure Website Speed

Improving a website's speed is the responsibility of everyone working on a website. That includes the developers and engineers building the website, but also includes designers and the UX team, copywriters and content producers, marketers and SEOs, along with the company's executives. This book is written for this broader audience with the goal of helping everyone involved with the website know how to measure and evaluate a website's speed. While this book assumes readers have some general knowledge about websites, it does not assume everybody reading has a deeply technical background.

Each chapter will discuss the different tools that can be used to measure that metric and identify related opportunities for improvement. The tools discussed in this book are all available for free and can be used by everyone, including developers and non-developers. There are paid versions of these tools available that offer deeper insight, especially at scale for larger websites. While the paid versions are helpful, paying for a tool should not be a requirement. The free versions of tools offer plenty of information to begin measuring website speed and identifying opportunities.

When to Use Each Metric

Each chapter also discusses when each metric is most useful. Some metrics should be regularly monitored. Evaluating those metrics weekly, monthly, quarterly, or after major site changes can help identify opportunities and problems. Other metrics should be used during a deeper diagnostic project to investigate those opportunities and problems further. Some metrics are better to use as KPIs and include in reports for stakeholders.

Using the metrics where they are the most useful will make it easier for everyone working on the website to understand the website's speed. More importantly, with each metric used in the appropriate ways, it will be easier to determine how to make the website load faster.

PART I

Initial Connection

CHAPTER 1

DNS Lookup Time

When a visitor requests a webpage, the first step the browser takes is translating the website's domain name into an IP address. A browser needs an IP address to establish a connection with a website. For example, the domain name matthewedgar.com would be translated into the IP address 15.197.142.173. The browser retrieves the IP address from the DNS (Domain Name System) records. Because this is the first step, more time spent translating the domain into an IP address can slow subsequent steps, making the visitor wait longer to see the webpage.

What DNS Lookup Time Measures

DNS Lookup Time measures how long it takes the browser to retrieve the requested domain's IP address.

DNS Resolution Steps

The process of translating a domain name into an IP address is known as DNS resolution. The common analogy is to compare DNS resolution to looking up a person's name in a phone book to find their phone number. That analogy is helpful but oversimplifies the process of DNS resolution and leaves it unclear why DNS lookup times contribute to slower speeds. To understand the speed implications of DNS resolution, it is important to understand more details about the steps involved when a browser requests

M. Edgar, *Speed Metrics Guide*, https://doi.org/10.1007/979-8-8688-0155-6_1

the domain's IP address. These steps are shown in Figure 1-1 and include the following:

1. **Check local cache on the visitor's device:** The browser first checks if the IP address for the requested domain is cached (or saved) locally on the visitor's device. The IP address will be cached if this visitor previously visited the domain. If the IP address is found in the local cache, the browser uses that IP address to access the website and no further steps are required.

2. **DNS resolver:** If the IP address is not cached on the visitor's device, the browser sends a query to the DNS resolver to find the IP address. DNS resolvers are typically kept with the visitor's Internet Service Provider (ISP). If the IP address for a domain is already cached by the DNS resolver, the IP address is returned directly to the visitor's device. The IP address may be cached because other visitors using the same ISP have previously requested the IP address for this domain. If the IP address is not in the cache, the resolver will process the subsequent queries for the IP address. Once the IP address is returned from a query, the resolver then sends the IP address back to the visitor's device.

3. **Root server:** If the IP address was not cached by the resolver, the query is next sent to the Root DNS server. Root DNS servers store information about top-level domains (TLDs). In the URL matthewedgar.com, the TLD is .com. The Root DNS server does not contain information about

each domain's IP address. Instead, when queried, the root DNS server returns information about the location of the server that manages that TLD.

4. **TLD server:** The query for the IP address is then sent to the TLD server. This is the server responsible for managing a specific TLD, like .com. The TLD server responds with the location of the authoritative DNS server.

5. **Authoritative DNS server:** The query is next sent to the authoritative DNS server. This is the server that hosts the website or the server that manages the DNS for the domain. The authoritative DNS server looks up the IP address in its database and sends that IP address back to the browser.

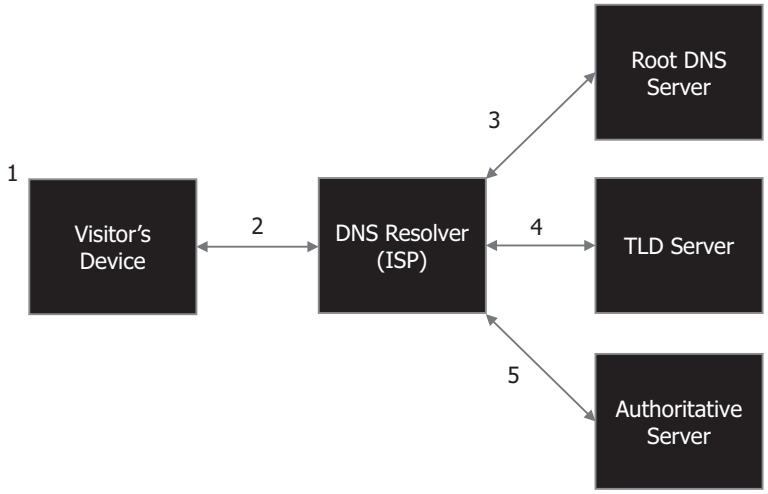

Figure 1-1. *DNS lookup process, numbers reference steps discussed in the text*

How a Visitor's Geographic Location Affects DNS Lookup Time

The servers involved in DNS resolution have a specific geographic location. The farther away the visitor's computer is physically from those servers, the longer it will take for the browser's request for the IP address to travel from the visitor's computer to the authoritative DNS server and the longer it will take for the IP address to be sent back from the authoritative DNS server to the browser. The greater the physical distance, the greater the delay, or latency, will be. Steps can be taken to minimize latency and will be discussed later in the chapter. It is important to measure DNS lookup times from anywhere in the world visitors are physically located. If most visitors are physically close to the authoritative server, then DNS lookup times will generally be faster.

DNS TTL: IP Address Cache Duration

Caching speeds up the DNS resolution process by eliminating the need to always route the query to the authoritative DNS server. However, the IP address for a domain may eventually change so it can only be saved for so long. How long the IP address can be saved in cache is specified in a DNS record's Time to Live (TTL) value. The TTL value is specified in seconds and can range from 1 second to 604,800 seconds (7 days). More typically, TTL values will be set between 30 seconds and 86,400 seconds (1 day).

Optimal DNS TTL Value

A larger TTL value will result in longer caching times. Because longer caching times reduce the steps required to retrieve an IP address, longer caching times can improve the website's speed. For example, if a visitor returns to a website within the cache time, the DNS information would

not be retrieved again because that information would already be saved in the browser. Even if a particular visitor does not have the IP address information stored in the local cache, the IP address information may be cached by the visitor's ISP, eliminating the need to connect to the Root, TLD, and authoritative DNS servers.

While longer caching times may improve speed, larger TTL values also mean it takes longer to send updates to the DNS information back to a visitor. There may be an emergency, such as a server failure, that requires changing the server's IP address more quickly. If a website's TTL value is 86,400 seconds (1 day), then it would take one full day for the cache to clear and the new IP address information to be requested. Having visitors wait one full day before seeing the new IP address would not be acceptable, especially if the IP address is changed in response to an emergency.

There is not a correct TTL value. Recommendations range widely with some recommendations to set TTL values to an hour (3600 seconds) and other recommendations to set TTL values to five minutes (600 seconds) or less. Instead, the goal is to strike a balance between faster speeds and the need to respond to emergencies. If DNS lookup time is excessively long, then adjusting TTL values to increase caching times may help improve website speed.

Implications of Third-party Resources

When a website is loading, files can be requested from multiple domains. Other resources – like fonts, videos, or images – might be hosted on other domains. For example, myexamplewebsite.com might use fonts from Google's font library. If so, a DNS lookup would need to be made of fonts.gstatic.com, where the fonts are hosted along with the DNS lookup for the primary domain of myexamplewebsite.com. Each additional domain requested adds to the total DNS lookup time.

Measuring DNS Lookup Time

DNS Lookup Time should be measured at the domain level for the primary domain and all third-party domains used by the website. Testing a single page from the domain is sufficient because this metric will not change for individual pages on the same domain. Subdomains should be tested separately if they use a separate hosting environment. For example, mysite.com may be hosted separately from images.mysite.com, each with a distinct authoritative DNS server. The DNS Lookup Time for each domain should be measured across different the different geographic locations to evaluate latency. When DNS Lookup Time is slower for a specific domain, more details about the DNS lookup process can be evaluated to determine where in the process problems might exist.

DNS Lookup Time Benchmarks

The most common recommendation comes from Sematext, which recommends DNS lookup times be between 20 and 120 milliseconds.[1] DNSPerf's benchmark test (discussed later in this section) considers DNS lookup times greater than 40 milliseconds to be slower.

Global DNS Lookup Time: DNS Speed Benchmark

DNSPerf's DNS Speed Benchmark (www.dnsperf.com/dns-speed-benchmark) provides a straightforward visual report that measures DNS lookup times across the world. This provides a helpful, initial review to identify what issues may exist with latency resulting from the visitor's physical location. If issues are found, then a deeper analysis can be conducted with other tools.

[1] "What Is DNS Lookup Time & How to Reduce It?" 2023. Sematext. September 10, 2023. https://sematext.com/glossary/dns-lookup-time

In DNSPerf, begin by entering the domain name to test and select the test location. By default, this tool will test DNS lookup time across the world. This could be narrowed to a continent or a country close to where visitors to this website are located. If most visitors are from the United Kingdom, latency from the United States is irrelevant.

An example result from this test is shown in Figure 1-2. Below the map, a table shows the detailed latency for specific cities, shown in Figure 1-3. In this example, the latency times are within acceptable ranges in the eastern part of the United States, with latency times well under 50 milliseconds. However, latency times worsen toward the western United States, reaching up to 84 milliseconds in Seattle. Times grow even slower outside the United States, with locations in Europe exceeding 100 milliseconds and approaching 200 milliseconds. If this website only targets visitors in the eastern United States, the DNS lookup times are acceptable. However, if this website targets visitors located elsewhere, then longer DNS lookup times would cause slower speeds.

Figure 1-2. *DNSPerf.com – DNS Speed Benchmark – map view*

LATENCY TIME	LOCATION	LATENCY TIME	LOCATION
224 ms	Australia, Melbourne (DC236)	211 ms	New Zealand, Auckland (DC294)
243 ms	Australia, Sydney (DC157)	140 ms	Romania, Bucharest (DC23)
280 ms	Australia, Sydney (DC264)	151 ms	Russia, Moscow (DC271)
196 ms	Australia, Sydney (DC371)	152 ms	Russia, Saint Petersburg (DC38)
136 ms	Austria, Vienna (DC154)	123 ms	Slovakia, Bratislava (DC104)
96 ms	Brazil, Salvador (DC470)	248 ms	South Africa, Cape Town (DC526)
111 ms	Brazil, Sao Paulo (DC436)	271 ms	South Africa, Johannesburg (DC317)
116 ms	Brazil, Sao Paulo (DC269)	164 ms	Turkey, Bursa (DC161)
116 ms	Brazil, Sao Paulo (DC393)	156 ms	Turkey, Istanbul (DC513)
Record Not Found	China, Beijing (DC207)	99 ms	United Kingdom, London (DC346)
147 ms	Egypt, Cairo (DC464)	100 ms	United Kingdom, London (DC61)
143 ms	Finland, Helsinki (DC228)	28 ms	United States, Ashburn (DC378)
112 ms	France, Marseille (DC525)	31 ms	United States, Chicago (DC339)
111 ms	Germany, Frankfurt am Main (DC426)	56 ms	United States, Denver (DC428)

Figure 1-3. *DNSPerf.com DNS Speed Benchmark test – detailed table of latency by location*

Domain Connections: WebPageTest

Third-party resources hosted on other domains require separate DNS connections, adding to the overall load time for the website. To determine if third-party resources are contributing to slower speeds, DNS lookup times should be measured for all third-party domains used on the website. If DNS lookup times are slower for certain domains, using *prefetch* (discussed later in this chapter) may help.

WebPageTest (`www.webpagetest.org/`) measures the DNS lookup times for the website's primary domain and any third-party domains used by the website. WebPageTest tests can be run from different locations, helping to show variance due to geographic latency. WebPageTest

provides a few locations on the "Simple Configuration" settings, while the "Advanced Configuration" settings provide a wider list of test locations. These tests should be run on different pages of the website as each page may use different third-party resources.

Information about third-party resources is provided in the "Connection View" report. After running a test on WebPageTest, access this report by selecting "Details" in the "View" menu and then scroll to "Connection View." As seen in the example "Connection View" report, shown in Figure 1-4, each domain requested when loading this page on the website is listed. Looking horizontally across the chart, a bar is provided for each domain showing different aspects of that domain's loading process. DNS lookup times are in the first part of that bar, indicated by the arrow providing a visual of how much time DNS resolution consumes for the primary domain and every third-party domain used on the tested page.

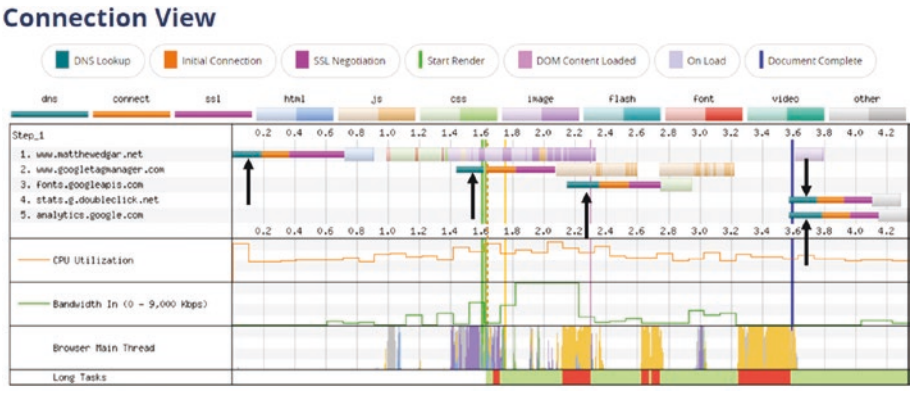

Figure 1-4. *WebPageTest – Connection View report showing the load times for each domain*

Specific DNS lookup times, shown in milliseconds, can be measured using the "Request Details" table below the "Connection View" report, shown in Figure 1-5. Sort the table by the "DNS Lookup" column to see the milliseconds required to connect to that domain.