

Streamlining Cvent's Data Fetching Process

(Technical Paper)

Importance of Website Optimization in Full Stack Development

(STS Paper)


A Thesis Prospectus Submitted to the
Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia


In Partial Fulfillment of the Requirements of the Degree
Bachelor of Science, School of Engineering

Moez Sohail

Fall, 2022

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Signature  Date 11/19/2022
Moez Sohail

Approved  Date 11/19/2022

STS Advisor: Richard D. Jacques, Ph.D., Department of Engineering & Society

Introduction

In the past few decades, web development has evolved rapidly. More software engineers are becoming full stack developers as companies transition to the digital world. Full stack development refers to the entire development process of an application, including front-end and back-end development. Front-end development refers to the parts of a web application that users can see and interact with which is also known as client-side. Back-end development refers to the parts of a web application that users cannot see which is known as server-side. Full stack developers can use many front-end and back-end languages and frameworks to create web applications. Front-end and back-end development are interdependent and together they provide the foundation of functional web applications (Chauhan, 2022). However, as web applications become more complex, it is important to optimize front-end and back-end performances to improve user experience.

This past summer, I had the opportunity to work at Cvent as a Software Engineer Intern. The main problem Cvent faced during my time at the company was that its Instant Book platform inefficiently obtained data from external sources. As a result, I replaced existing data access modules with Apollo data sources, modern classes that increase efficiency when obtaining information from a specific source. Through this experience, I learned more about full stack development and different front-end and back-end optimization techniques. For my technical topic, I will explore the Instant Book inefficiency problem in depth. For my STS research, I will explore the importance of website optimization in full stack development and how it affects user retention and conversion rates.

Technical Topic

Cvent is a Virginia-based software-as-a-service company that provides software solutions to event planners for virtual, hybrid, and onsite events. One platform they provide is Instant Book, which allows small businesses to find and book venues. This summer, I joined one of the many teams that support this platform, specifically focusing on optimizing and modernizing the software with industry best practices. However, after users reported delays when searching for venues or trying to book them, it was evident that Cvent was facing a decrease in the performance of the Instant Book platform. This is a significant issue in that the company must improve performance and increase user experience, otherwise the company would lose customers. When searching, Instant Book fetches data from various data providers to increase the number of potential venues. It was determined that the platform's lack of performance was due to back-end issues where GraphQL queries to REST APIs were not optimized. As a full stack application, the performance of Instant Book relies heavily on the back-end performance. The front-end user interface that allows users to search for and book venues cannot perform quickly if the back-end is not optimized. As a solution, I replaced the inefficient data accessors with Apollo data sources, which are modern classes that increase efficiency when obtaining information from REST APIs via GraphQL. The project was split into four phases: design, implementation, testing, and deployment taking ten weeks during the summer of 2022.

Regarding GraphQL optimization, there are many methods that can be used to optimize queries. Some of these methods include deduplication and caching. Deduplication is a technique that prevents duplicate GraphQL queries from running on the server. Caching is a technique that keeps local copies of frequently accessed data so that it can be obtained faster instead of having to go through databases (Cochrane et al., 2022). The Apollo data source solution I implemented

uses deduplication and caching to improve the performance of GraphQL queries to external REST APIs. By default, Apollo data sources use an in-memory cache to store the results of previous operations. For REST data sources specifically, caching is based on the HTTP response's Cache-Control header and lifecycle methods (Sands-Ramshaw, 2020). I used the parent class of this REST data source to solve the Instant Book platform's inefficiency issues.

For the design of my technical project, there is a back-end service called `csn-venue-core` inside the Instant Book platform that contains seven different data accessors. In each of these data accessors, there are various fields that can be accessed via IDs. Resolvers, which are functions or methods that resolve a value for a type or field in a schema, access these fields in `csn-venue-core` (Stuart, 2018). To increase the overall performance of the Instant Book platform, each of these data accessors needs to be replaced with Apollo data source classes that contain optimized methods corresponding to each field. After refactoring a data accessor, each corresponding resolver needs to be updated to use the new data source and the data source needs to be added to the Apollo server. Once all seven data accessors are refactored, the Instant Book platform will experience faster load times, increasing user retention.

STS Topic

As the complexity of web applications increases over time, website performance becomes even more important. Website performance refers to the speed and availability of a website. Speed involves how fast the website can be loaded after making a request in a web browser, whereas availability involves the percentage of time the website can be accessed (Low, 2022). Many factors can hinder website performance, such as heavy CSS and JavaScript use, bad

server/hosting, poor coding standards, too many widgets and plugins, and hotlinking, which involves showing images that are hosted on another server (Chorny, 2022).

Bad performing websites are slow in loading and rendering content that causes users to abandon the site. According to statistics, users are more likely to abandon a website the longer it takes to complete tasks. For example, a one second delay results in 7% of users abandoning a site. That number increases to 25% if there is a four second delay. The percentage is worse on mobile devices, where 53% of users will abandon the page if it takes longer than three seconds to load. (Oldfield, 2020). Not only does website performance affect user retention, but it also affects conversion rates, which is defined as the rate at which users perform a desired action. Some examples include signing up for an account, making a purchase, or subscribing to a newsletter. When comparing site speed to conversion rates, a site that loads in one second has a conversion rate that is three times larger than a site that loads in five seconds. Additionally, a site that loads in one second has a conversion rate that is five times larger than a site that loads in ten seconds (Wiegand, 2022). Hence, faster loading sites have substantially higher retention and conversion rates.

The best way to improve conversion rates and user retention is to optimize the performance of websites. For example, a group of Pinterest developers optimized the front-end, network, and back-end of the application and as a result, wait time was decreased by 40% and the signup conversion rate increased by 15%. Furthermore, the team now focuses on website performance to increase user growth (Meder et al., 2017). Another example can be seen through Walmart.com who experienced a sharp decline in the conversion rate after load times increased from one second to four seconds. However, after optimizing the website, Walmart experienced a 2% increase in the conversion rate for every one second of improvement in load time (Everts,

2014). Hence, optimization of website performance has a direct influence on user retention and conversion rates.

It is evident that researching website performance and how to improve front-end and back-end performance is important in that it will allow companies to understand how to obtain new users and how to retain previous users. Website speed has a direct effect on user retention and conversion rates for desired actions. Websites with fast loading times retain and attract more customers than websites with slow loading times. Also, quick websites improve user experience, making it more likely for users to make a purchase or sign up for an account. By understanding different front-end and back-end optimization techniques, companies will be able to prioritize different areas of development depending on their needs, ensuring that resources are not wasted. Furthermore, website performance also influences conversion rates, revenue, user satisfaction, and search engine ranking, which all play a role in the overall success of a company.

Research Question and Methods

In my STS research, the question I seek to answer is the importance of website optimization in full stack development and how it affects user retention and conversion rates. In my research, I will analyze different front-end and back-end optimization techniques through different articles and case studies to determine which techniques are the most effective. Many techniques can be used to enhance front-end and back-end performance. Some front-end optimization techniques include but are not limited to removing unnecessary data, reducing the number of server calls, compressing files, and optimizing images. Some back-end optimization techniques include but are not limited to optimizing databases via indexes and normalization,

using a cache to avoid duplicate queries, and making fewer database calls using joins when applicable. By understanding which techniques are most effective in reducing website speed, companies will be able to prioritize development accordingly. Furthermore, companies will be able to increase user retention and conversion rates that will help maximize the overall success of the application. However, since front-end and back-end development are interdependent, companies will have to optimize both front-end and back-end performance to drastically reduce website speed to affect user retention and conversion rates.

Conclusion

For my technical deliverable, I designed and implemented a data source refactor for the inefficient data accessors in the Instant Book platform during my time at Cvent this past summer. After deploying the optimized Apollo data source classes, users now experience faster load times when searching for venues and trying to book them. Furthermore, Cvent has experienced higher rates of user retention. These changes will also help Cvent secure new customers who are looking for software to instantly find/book venues. For my STS deliverable, I will research the importance of website optimization in full stack applications and analyze different front-end and back-end optimization techniques. Once my research is complete, companies will understand the importance of website optimization and will be able to optimize their front-end or back-end development accordingly using the best techniques. By optimizing their applications, companies will be able to maximize user retention, conversion rates, revenue, user satisfaction, and search engine ranking.

References

- Chauhan, V. (2022, May 9). Frontend Versus Backend Web Development. Retrieved October 30, 2022, from UXmatters website:
<https://www.uxmatters.com/mt/archives/2022/05/frontend-versus-backend-web-development.php>
- Chornyy, A. (2022, May 23). The 5 Factors That Affect Website Speed and Tools to Check. Retrieved October 30, 2022, from Plerdy website: <https://www.plerdy.com/blog/website-speed-factors-and-tools/>
- Cochrane, B., & Debrunner, D. (2022, June 27). GraphQL Optimization: It's More than N+1. Retrieved October 30, 2022, from The New Stack website:
<https://thenewstack.io/graphql-optimization-its-more-than-n1/>
- Everts, T. (2014, April 9). How Does Web Page Speed Affect Conversions? Retrieved October 30, 2022, from Radware Blog website:
<https://blog.radware.com/applicationdelivery/wpo/2014/04/web-page-speed-affect-conversions-infographic/>
- Low, J. (2022, October 10). Website Performance Explained. Retrieved October 30, 2022, from WebHostingSecretRevealed website:
<https://www.webhostingsecretrevealed.net/blog/web-hosting-guides/website-performance-explained/>
- Meder, S., Antonov, V., & Chang, J. (2017, March 3). Driving user growth with performance improvements. Retrieved October 30, 2022, from Pinterest Engineering Blog website:
<https://medium.com/pinterest-engineering/driving-user-growth-with-performance-improvements-cfc50dafadd7#.wwimdmkpp>

Oldfield, T. (2020, November 12). Site performance and its impact on user experience. Retrieved October 30, 2022, from Digital Communications team blog website:
<https://digitalcommunications.wp.st-andrews.ac.uk/2020/11/12/site-performance-and-its-impact-on-user-experience/#:~:text=A%20site%20with%20poor%20performance>

Sands-Ramshaw, L. (2020, April 13). A Deep Dive on Apollo Data Sources. Retrieved October 30, 2022, from Medium website: <https://blog.graphql.guide/a-deep-dive-on-apollo-data-sources-778618ce06d2>

Stuart, M. (2018, December 11). GraphQL Resolvers: Best Practices. Retrieved October 30, 2022, from The PayPal Technology Blog website: <https://medium.com/paypal-tech/graphql-resolvers-best-practices-cd36fdbcef55>

Wiegand, M. (2022, April 20). Portent. Retrieved October 30, 2022, from Portent website: <https://www.portent.com/blog/analytics/research-site-speed-hurting-everyones-revenue.htm#:~:text=The%20first%205%20seconds%20of>