PWAMP - Combine technology for faster loading and improved user experience.

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This diploma thesis is submitted to the Faculty of Computing at Blekinge Institute of Technology in partial fulfillment of the requirements for the diploma degree in Software Engineering. The thesis is equivalent to 10 weeks of full time studies.

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1 Introduction

As the standard for Internet speeds increases, we also expect the load times to follow the same track. Every second should be highly prioritized, even a 100-millisecond delay in website load time can hurt conversion rates by 7% [1], which in turn could mean a loss of millions of dollars in some cases. However, the requirements for what a website should do and how they should engage the user are greater than ever, making it more difficult for a web developer to maintain or improve the performance as a result from this, especially across a variety of network conditions and devices [2]. A constant search for balanced development takes place, where the goal is to show and engage its content in the most optimal way.

In this study, I will examine to what extent a PWAMP (Progressive Web App Mobile Pages) implementation could enhance performance on a website against a regular PWA (Progressive Web App). PWAMP is a combination of AMP (Accelerated Mobile Pages) and PWA. AMP is a relatively new HTML framework created by Google and built on open source [3].

AMP primarily works to reduce the load time for web pages. Mainly, AMP reduces the load time by excluding extensive use of Javascript and limits the user's amount of external Cascading Style-Sheet (CSS). However, the use of Google's proxy-based network (Google AMP Cache) should further improve this [3].

PWAs can offer engaging material to users and function more like a regular application, with dynamic content, push notifications, offline capability and a mobile-first principle that gives you the ability to use the mobile's functionalities and add the it to your homescreen [4].

There are currently three official approaches to combining these techniques [5].

- AMP as data source for your PWA.
- AMP as entry-point into your PWA.
- AMP pages with PWA features.

The last two approaches I have chosen to study further and to examine, with the aim to gain deeper understanding how such web pages can be created and how it could affect the end result for a user.

2 Focus

The focus of the study is how a Progressive Web App can be developed with various techniques and how this could affect the applications performance and the users experience as a result. Google AMP and Gatsby [6] are in focus as selected technologies.

The following implementations will be evaluated:

- Google Accelerated Mobile Pages to Progressive Web App with Gatsby.
- Google Accelerated Mobile Pages with Progressive Web App features.
- Progressive Web App with Gatsby.

2.1 Research Questions

RQ1: How does the choice of technique differ in relation to the development of the applications? These aspects will be covered and compared:

A. Implementation of content.

B. Implementation of PWA features.

To better understand the effects of these implementations, a comparison of developments can help to gain knowledge about developing with this strategy, and at the same time provide a clue as to why performance can be differentiated. It will also lay a foundation for later research questions.

RQ2: How does the choice of technique affect the performance of the applications? These scenarios will be represented and measured:

A. Users first visit.

B. Users first visit including second navigation.

AMP and PWAs are perceived as alternatives to a quick website, but often in different aspects of the website. First impression of a website visit is important, but does not represent all of the users' behaviour. Given that performance can be affected in different stages of the site, it is interesting to analyze both initial load and include site navigation as a parameter, because the results may vary. With answering this question, the reader should get a better understanding of the extent to which an implementation of this type can affect an application.

RQ3: To what extent is performance affected at different connection speeds on a mobile device?

As the growth of mobile usage is increasing to consume web content, it becomes relevant to measure the extent to which results are affected on such a device, in addition to the actual data that must be downloaded and paid for by the end user.

It is important to note that the study is not conducted to show exact implementations on how to reduce load times in the most optimal way, but rather showcase possible solutions and alternatives that might improve a website's performance under right circumstances. In a scenario where the highest possible

performance would be achieved, there are certainly individual optimizations and improvements that could be targeted and evaluated outside of this focus area.

3 Method

Two types of studies will be conducted to answer the research questions below. In order to understand the field, the techniques and the direct differences in development, a literature study is necessary. As performance is a major focus of the study and is represented from several different sets of techniques without previous known comparisons, an experiment will be done to clarify the effects and answer a set of the research questions.

3.1 Literature study

To answer **RQ1**, a literature study will be done to collect information and understanding about this area prior to answering the other questions.

To find the information needed for the study, the starting point should be to study Google AMP and Gatsby official documentation. This can create a basis and basic structure for how they themselves consider the respective techniques to handle this area. However, since there is no official variant combining these particular techniques, further information is needed to evaluate this. Since both techniques are relatively new, especially in combination, it can be difficult to find precise approaches documented. However, it will be important to try to find relevant sources that are based on the same principles and possibly border on this area.

The literature should be based on official documentation but also academic publications, through databases such as Diva, Google Scholar, IEEE, which allows for further snowball sampling. However, with the knowledge of the limited research in this area and the rapid development that is happening today, it may be necessary to open the restrictions further and compare material that can be found in books or web articles, which can be found through search engines like Google. Preliminary keywords that should be explored include *Google AMP, AMP as PWA, AMP to PWA, Progressive Web Accelerated Mobile Pages, Gatsby PWA* and may need to be combined to increase results. But with looser restrictions, the information should be evaluated more carefully and possibly backed up from several sources.

After the research, there should be enough information to make well-considered choices for what needs to be implemented in the application and report on how they could be done in the respective technology. It should be interesting to see how this can differentiate and in addition create an understanding of how this can affect development in the greater part.

3.2 Experiment

To answer **RQ2** and **RQ3**, three websites will be built and deployed. These should contain the same content and include a total of two pages to simulate real navigation done by a user. The difference within these sites should be the way the website is developed. The first web page will be entirely built with Gatsby, while the second website uses Google AMP as the first page and Gatsby for the remaining structure and the third site is completely built with Google AMP. Gatsby is chosen because it is a JavaScript framework with speed as high priority [6]. The author also got previous experience developing in this area and some similar implementations have been documented before. That will give more time for optimization of the development and accurate measurements.

WebPageTest in addition to Google Lighthouse will be used for measurements [7][12]. Metrics to measure are load time, first contentful pain, time to interactive, speed index, requests and application size, to get a complete overview of what is being loaded and how fast. In order to better understand the effect for a wider audience, different devices should be included in the testing with simulated connection speeds to represent differences that exist in reality.

It is important that a user's pattern can be imitated in the measuring, by going from one page to another and preserving the material already loaded and seeing results even after first loading. WebPageTest can measure values by direct link to the website, but also simulate that a user comes from eg. Google, where also Google AMP Cache will be used to deepen the study.

4 Motive and Value

A study done by Akamai in 2014 showed that 49% of e-commerce consumers expect a page to load in 2 seconds or less [8]. In comparison Backlinko analyzed 5.2 million websites and found out that the average page loading speed for a web page is 10.3 seconds on desktop and 27.3 seconds on mobile [9]. It is worth mentioning that the selection of web pages obviously affects the result. But it shows that improvement can be done and that this area is of high importance in this day and age.

The purpose of this study is to discover whether a combination of two relatively new web technologies that specialize in different areas can increase performance while potentially maintaining the user experience. A combination that holds the advantages of both techniques at best. With measured performance, the reader can visualize the direct effect and possibilities with an implementation like this. A challenge will be to show the results in a representative way where the potential and differences become essential. The data collected through such an experiment are necessary, but as the content on a commercially deployed website may vary, it could affect the outcome in a different scenario. It is also important to structure the websites in similar ways and try to exclude as many factors as possible created by the developers implementation.

The amount of web development techniques and tools is increasing just as the number of users using the web. A common way to develop is by choosing a technology stack where the front-end consists of a certain technology or framework. For developers, this research can be a good insight into a not-so-common and new method of development, by dividing your front-end into several parts for the

opportunity of increased benefits. it may help a developer gain more understanding of what is causing a slow website and broaden the view of how front-end development could be done.

Another challenge with a study of this type is the information that becomes essential to retrieve. As it is a topic within an area that is constantly growing and optimized, the sources need to be reviewed more carefully.

5 Literature Review

As stated in the book AMP: Building Accelerated Mobile Pages by Ruadhan O'Donoghue, "*Over half of your visitors won't get to see your message or what you have to offer if your web pages are slow. The Accelerated Mobile Pages (AMP) project exists because performance is so important. With AMP, you don't have to miss out on that 53 percent.*" [10] and refers to a statistical analysis done by google about mobile usage and performance [11].

One of few studies published in this area, *On the potential of Google AMP to promote local content in developing regions* [13]. A selection of news articles created with AMP was compared against their non-AMP version of the site. In the study, after measurements, they were able to find that the pages made with AMP had better performance.The benefits seen in fast load times were most affected in developing areas in the world but overall increased. However, the study is done on a larger scale and without any combined implementation in mind. It is also difficult to know how these no-AMP versions are implemented and how that could affect the outcome.

According to a Google AMP article about an integration with AMP to PWA, this could if done correctly make a link that leads to your PWA from one of the AMP feel almost instant. You should also see similar benefits but with some limitations with an AMP that has PWA features implemented [5]. These statements could strengthen this study's objectives and shows that opportunities for a combined strength exist. Nevertheless, no statistics are included to prove these claims and increase the importance of further valuable research to be done.

To gather references, BTH's library, Google Scholar and IEEE have been the main sources, where the resulting studies own references got explored and evaluated by importance.

6 Planning

A preliminary plan for conducting the entire study is given below. Depending on factors in the conduct of the study, it may mean that some parts may become more or less demanding, some may be moved and re-prioritized.

Week one and two (1 March - 14 March), planning:

- Planning of thesis structure, categorize sections to be included.
- Introduction, background, purpose and scope.

Week three, four and five (15 March - 4 April), literature research:

- Literature research for RQ1.
- Decide content and features to include.
- Find out how to implement content for each application type.
- Find out how to implement PWA features for each application.
- Evaluate the difference of implementations.

Week six and seven (5 April - 18 April), application:

- Building applications.
- Publish applications on webserver.

Week eight and nine (19 April - 2 May), experiment:

- Execution of RQ1 and RQ2.
- Measurement of applications.
- Evaluate results.

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