# Analysis of Methods for Background Execution in Modern Web Applications

**Analyse von Verfahren für Hintergrundausführung in modernen Webanwendungen**
Bachelor-Thesis von Yannick Reifschneider
Tag der Einreichung:

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2. Gutachten: Prof. Dr. Stefan Katzenbeisser

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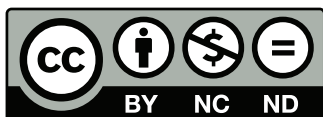
# Erklärung zur Bachelor-Thesis

Hiermit versichere ich, die vorliegende Bachelor-Thesis ohne Hilfe Dritter nur mit den angegebenen Quellen und Hilfsmitteln angefertigt zu haben. Alle Stellen, die aus Quellen entnommen wurden, sind als solche kenntlich gemacht. Diese Arbeit hat in gleicher oder ähnlicher Form noch keiner Prüfungsbehörde vorgelegen.

Darmstadt, den June 18, 2019

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(Yannick Reifschneider)

## Contents

## 1 Abstract

The application development industry shifts towards not developing native applications but instead use the browser as a universally available user interface platform. Web applications are indeed now capable of almost any task which would require a native application in the recent past. Popular word processing or spreadsheet applications for example are implemented with web technologies. A web site also has a completely different attack surface for a malicious actor then native applications. Browser engines do their best to protect their users of malicous web sites and also conserve energy.

In this paper we analyse major browsers regarding their behaviour of JavaScript code exection, when the execution page is in the background and not visible to the user. We show that the energy conserving methods of desktop browsers can easily be circumvented to do arbitrary calculations for unlimited time while the web site is not user visible. With these findings we trace popular websites to see if they use similar methods to execute code regulary in the background.

## 2 Introduction

### 2.1 Motivation

- Possible side channel attack (i.e. via sensor readings)

- A XSS vulnerability in a popular website could use the visitors as a botnet for a DDOS attack

### 2.2 Related works

## 3 Background information

### 3.1 The JavaScript execution model

Why a simple infinite loop is not feasable: Web page becomes unresponsive. If you don't yield back to the event loop, you can no longer react to changes in the environment, for example to detect, if the browser is now in the foreground again. This is at least true in the main loop, have to check for service worker or web worker context.

### 3.2 Web workers

## 4  Analysis of different background execution methods

### 4.1  Timers

Standard method for scheduling a recurring function in JavaScript. The setInterval function allows to specify a function and an interval in milliseconds after which a function is repeatedly called until the interval is cancelled.

### 4.2  Web workers

Using the worker-timers[1] library to run a scheduler on a web worker, which calls a callback on the main loop. This circumvents the setInterval throttling, when a browser tab is in the background.

### 4.3  Service workers

Service workers have advantages. They run independent of the browser tab. They stay can stay aliver after the browser tab, which installed the service worker is closed.

- Multiple methods for background execution:

- Simple set interval after activation

- In response to network request (corresponding website has to be open to trigger a network call)

- Website push notifications (has to be allowed by user)

- Web Background Synchronization API[2]

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[1]  `https://github.com/chrisguttandin/worker-timers`
[2]  `https://wicg.github.io/BackgroundSync/spec/`

## 4.4  Desktop web browsers

### 4.4.1  Google Chrome

Chrome on macOS does not allow sensor readings while in background.
AmbientLightSensor has to be enabled via flags.

### 4.4.2  Mozilla Firefox

Firefox does not support the Sensors API, but implements an older specification of the ambient light sensor API. This older API does not allow to specify a frequency in which the event handler is called. Also, this API is no longer enabled by default since Firefox 60 due to privacy concerns. Also Firefox does not call the event handlers, when the tab is in the background

### 4.4.3  Apple Safari

## 4.5  Mobile web browsers

On iOS we only analyse Mobile Safari, because Apple does not allow other browser engines in the Apple AppStore. Every other browser app has to use the system-provided webview to be in accordance with § 2.5.6 from Apple Review Guidelines[3].
On Android, we can differentiate between different browser engines.

### 4.5.1  iOS Mobile Safari

### 4.5.2  Chrome for Android

### 4.5.3  Firefox for Android

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[3]  `https://developer.apple.com/app-store/review/guidelines/#software-requirements`

## 5 Tracing of background execution on popular websites

Using the Alexa Top 100 Website list.

### 5.1 Method for measuring background execution

Maybe with puppeteer[4], web developer tools or with OpenWPM[5] or with simple hooking the JavaScript functions

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[4]  `https://pptr.dev/`
[5]  `https://github.com/mozilla/OpenWPM`

## 6  Evaluation of tracing results

## 7 Conclusion