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MyWebGuard: Toward a User-Oriented Tool for Security and Privacy Protection on the Web

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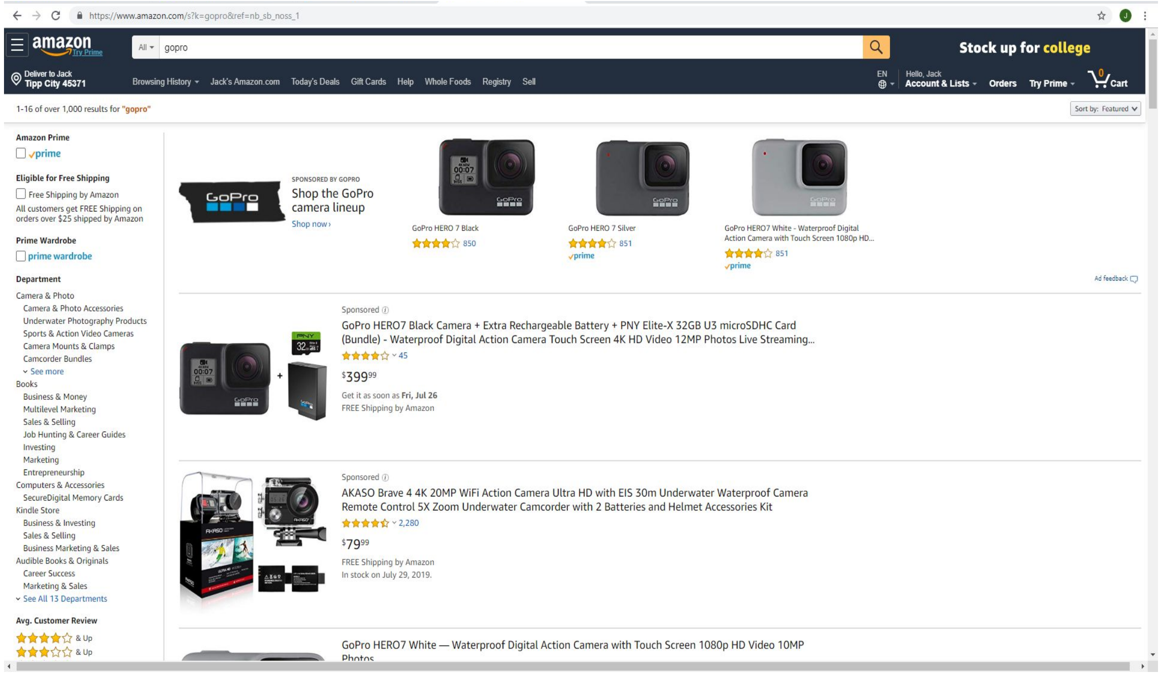
Link: https://bit.ly/2VsEAhM

Privacy on the web- Tracker Example



https://www.amazon.com/s?k=gopro&ref=nb_sb_noss_1

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1-16 of over 1,000 results for "gopro"

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Amazon Prime

□ prime

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Prime Wardrobe

□ prime wardrobe

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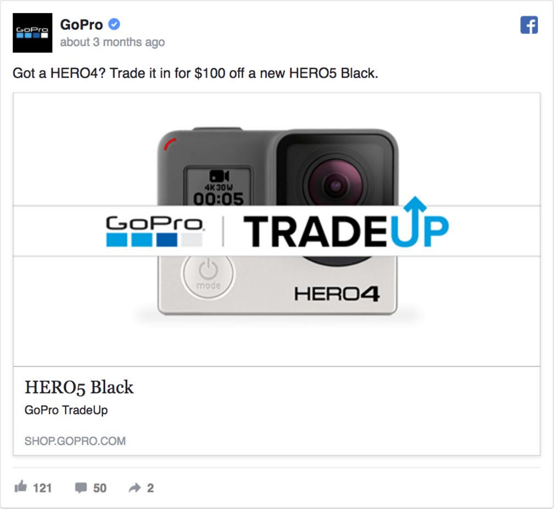

GoPro
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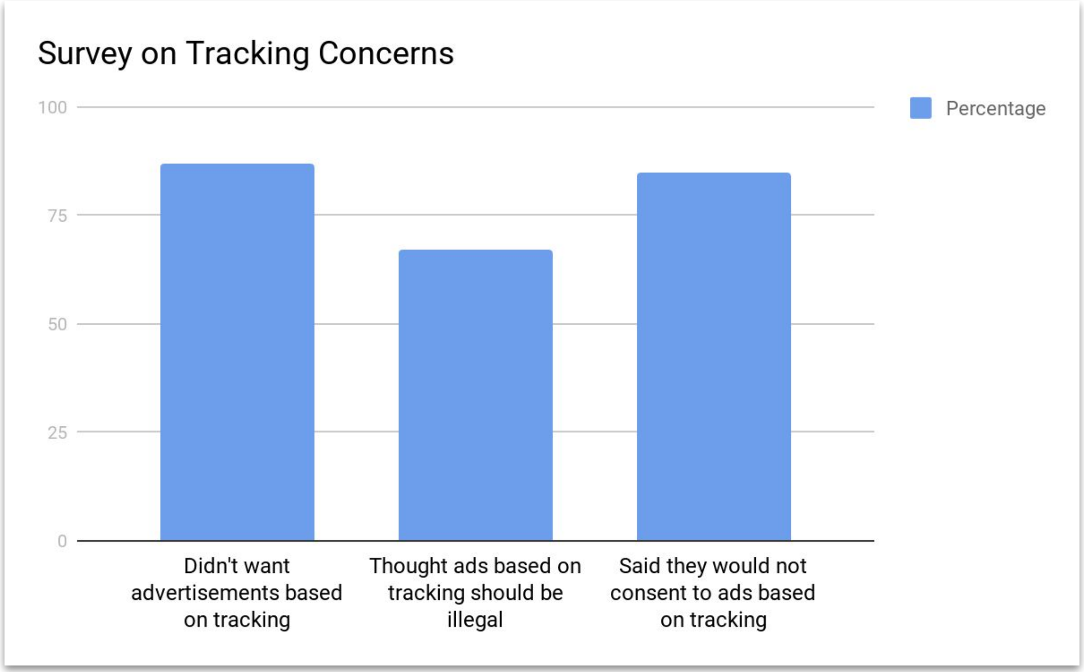
121 50 2

User Concerns

- Amount of malicious content on web?
  - Around 18.5 million websites are compromised at a given time each week
  - Average website attacked 44 times a day
- What are the options for a user?
  - Do Not Track- Websites do not have to honour
  - Blocker Extensions
  - Brave Browser

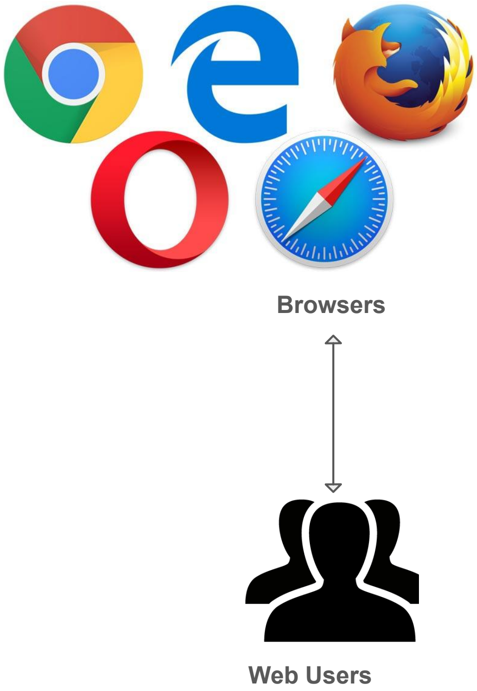
https://www.securityweek.com/185-million-websites-infected-malware-any-time

User Tracking Concerns



Mayer, J.R., Mitchell, J.C.: Third-party web tracking: Policy and technology. In: 2012 IEEE Symposium on Security and Privacy. pp. 413–427. IEEE (2012)

Existing solutions

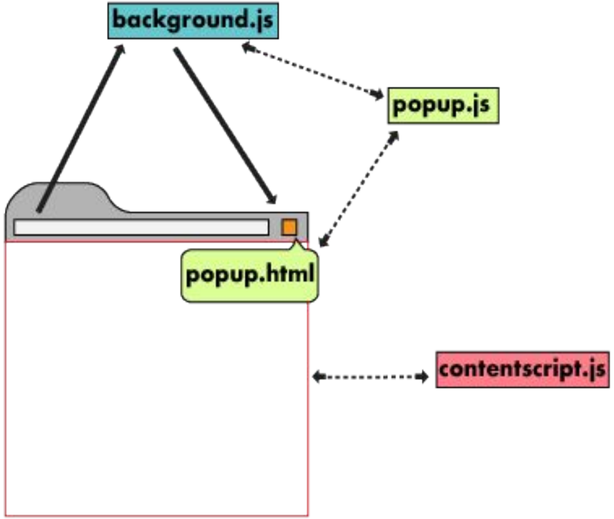


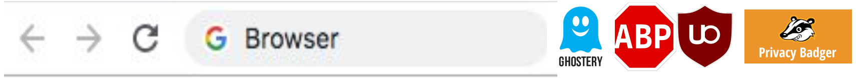
- There are more than 80 browsers in the industry, including popular ones such as Google Chrome, Apple Safari, Mozilla Firefox.
- Some of these are more committed to privacy than others such as Brave who disable third-party cookies to ensure user privacy, which in turn can limit usability.

Is user safe from only browser?

Browser Extensions

- A browser extension is a small software module for customizing a web browser.
- Extensions are small software programs that customize the browsing experience. They enable users to tailor Chrome functionality and behavior to individual needs or preferences.
- They are built on web technologies such as HTML, JavaScript, and CSS.



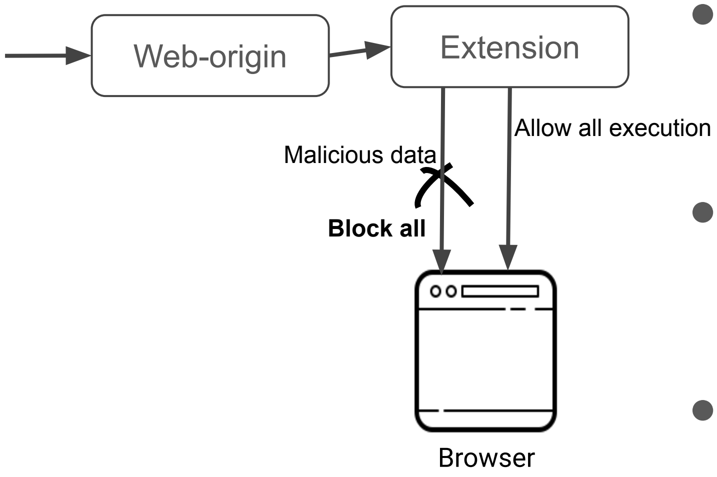


Is user safe from browser and extensions?

Web Users

- There are many browser extensions for privacy and top extensions are, Ghostery, Ublock, Simple Blocker, and AdBlock.
- Still, can attackers gain access to user data?

Limitations of existing solutions



Block all or do nothing.

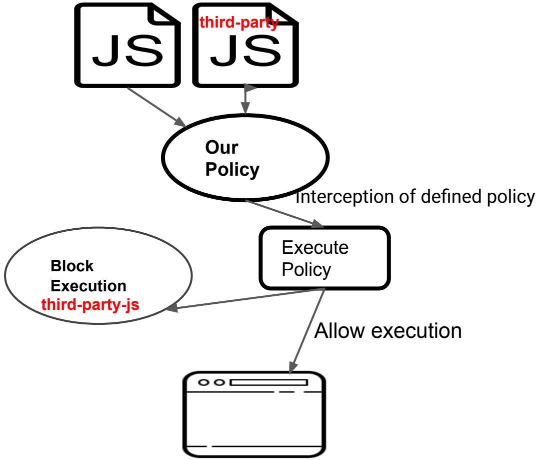
- Existing browser extensions only enforce block on all the attacks or allow there is no categorization.
- Extensions are predefined, so there are new trackers or other third-party content they are not blocked by these extensions.
- Popular security extensions like Ghostery and uBlock do not detect data leakage from sources and sinks.

Motivation

- Preserve user privacy on the web
  - Third-party trackers
  - Malicious injected webpage content
- Allow for an ethical middle ground for the collection of user data with the consent of the user
- User-centric
  - User defined control for third-party privacy accessibility
  - Allow user in real time to make privacy relevant decisions

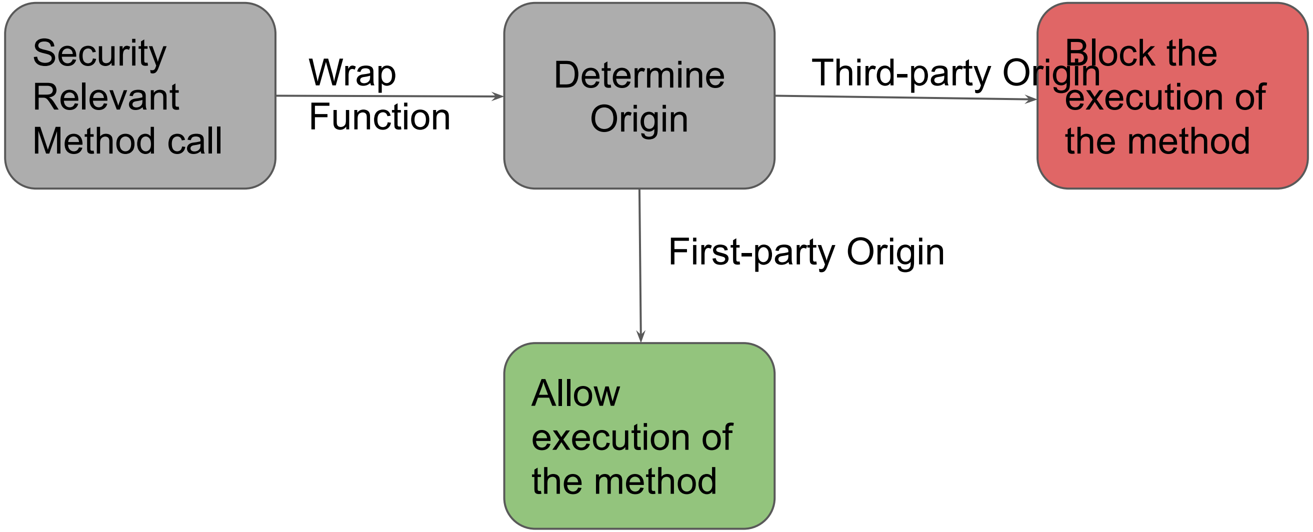
Our Approach

- Monitor JavaScript sources and sinks, distinguishing origin of code
  - Sources and Sinks: Where any JS API can execute
  - Utilize runtime stack to distinguish between first/third-party code
- Enforce policies on these channels to protect against privacy violations, based on code origin



How do we enforce a policy?

- When a monitored JavaScript API is called
  - Determine origin of code using runtime stack
  - Screen through relevant policy
  - Allow API to proceed or block the call in the case of a violation
    - Consult the user in the case of a privacy violation to allow for an override if requested


Security Relevant Method call
Wrap Function
Determine Origin
Third-party Origin
Block the execution of the method
First-party Origin
Allow execution of the method

Policy Example: Read Cookie

If the determined origin is not allowed to read the cookie, then we block the request

```
Object.defineProperty(document, "cookie",
{get: function(){ //JavaScript attempts to read the cookie
 //Determine the origin of the code
      //if origin is allowed
           //return the original value
     //else
           //block the request

  },
  //...
});
```

Policy Example: Image Policies

Img sources are wrapped and passed through policies to protect against malicious content in img sources

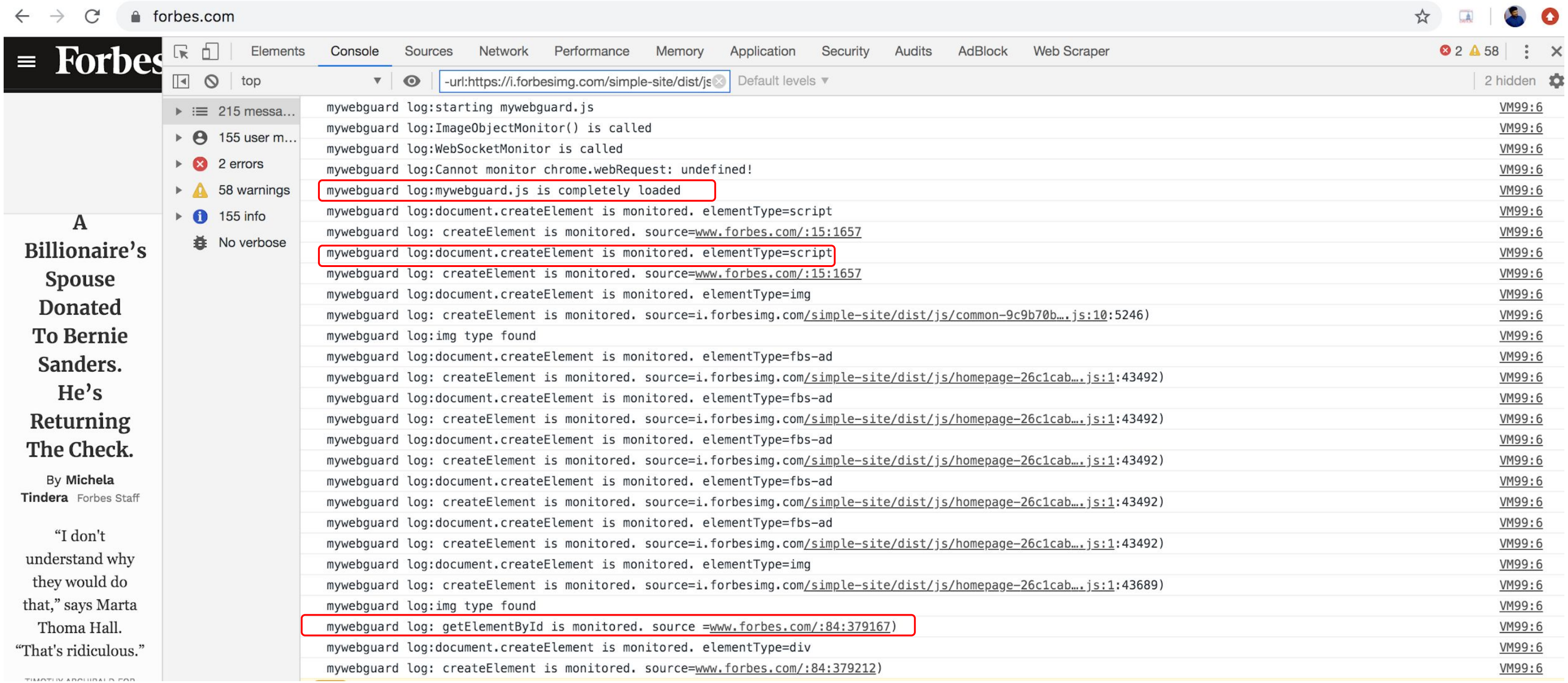
```
var imgPolicy = {
    get: function(obj, prop) {/* policies for get */},
    set: function(obj, prop, value) {/* policies for set */}
};

//save the original image

class ImageWrapper {
    constructor(height, width) {
        //create image object from original image
        //pass image object through relevant policy
        //return sanitized image
    }
}

//replace the requested image with sanitized image
```

Interception of operation



A Billionaire's Spouse Donated To Bernie Sanders. He's Returning The Check.

By Michela Tindera Forbes Staff

"I don't understand why they would do that," says Marta Thoma Hall. "That's ridiculous."

```
mywebguard log:starting mywebguard.js                                                          VM99:6
mywebguard log:ImageObjectMonitor() is called                                                  VM99:6
mywebguard log:WebSocketMonitor is called                                                      VM99:6
mywebguard log:Cannot monitor chrome.webRequest: undefined!                                    VM99:6
mywebguard log:mywebguard.js is completely loaded                                              VM99:6
mywebguard log:document.createElement is monitored. elementType=script                         VM99:6
mywebguard log: createElement is monitored. source=www.forbes.com/:15:1657                     VM99:6
mywebguard log:document.createElement is monitored. elementType=script                         VM99:6
mywebguard log: createElement is monitored. source=www.forbes.com/:15:1657                     VM99:6
mywebguard log:document.createElement is monitored. elementType=img                            VM99:6
mywebguard log: createElement is monitored. source=i.forbesimg.com/simple-site/dist/js/common-9c9b70b….js:10:5246)   VM99:6
mywebguard log:img type found                                                                  VM99:6
mywebguard log:document.createElement is monitored. elementType=fbs-ad                         VM99:6
mywebguard log: createElement is monitored. source=i.forbesimg.com/simple-site/dist/js/homepage-26c1cab….js:1:43492) VM99:6
mywebguard log:document.createElement is monitored. elementType=fbs-ad                         VM99:6
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mywebguard log: createElement is monitored. source=i.forbesimg.com/simple-site/dist/js/homepage-26c1cab….js:1:43689) VM99:6
mywebguard log:img type found                                                                  VM99:6
mywebguard log: getElementById is monitored. source =www.forbes.com/:84:379167)                VM99:6
mywebguard log:document.createElement is monitored. elementType=div                            VM99:6
mywebguard log: createElement is monitored. source=www.forbes.com/:84:379212)                  VM99:6
```
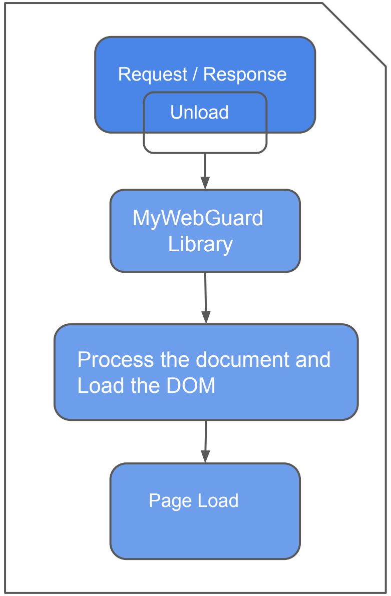
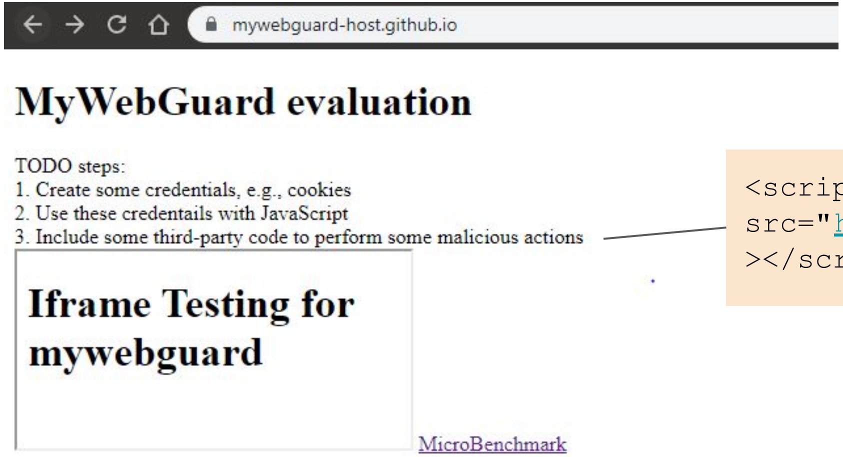

MyWebGuard Browser Extension Implementation



- We have developed a JavaScript library and deployed in the browser extension to self-protect the web users.
- Our interception library(CoreFlashJax) run first before a web page is loaded, we have implemented our JavaScript library code in innerHTML property so that when page loads it will be set as a first current page.
- We have implemented interception for data source access and data sink channels.

Evaluation Setup

- We set up on our host websites (first-party) with third-party JavaScript code implemented
  - We test our extension on the host website with simulated attacks from third party code



MyWebGuard evaluation

TODO steps:
1. Create some credentials, e.g., cookies
2. Use these credentails with JavaScript
3. Include some third-party code to perform some malicious actions

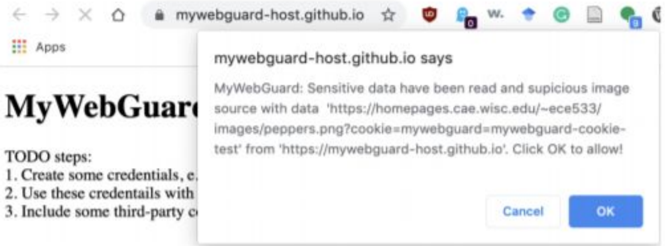
Iframe Testing for mywebguard

MicroBenchmark

```
<script
src="https://mywebguard-thirdparty.github.io/script.js "
></script>
```

Demonstration

We notice that data leakage and tracking requests are caught by MyWebGuard and users would be notified



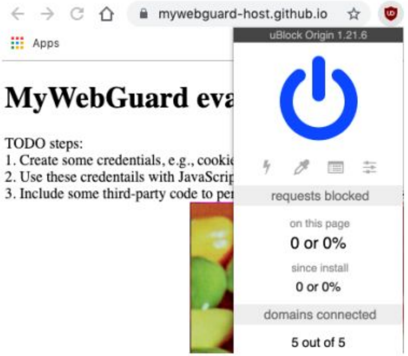
MyWebGuar

TODO steps:
1. Create some credentials, e.
2. Use these credentails with
3. Include some third-party c

mywebguard-host.github.io says

MyWebGuard: Sensitive data have been read and supicious image source with data 'https://homepages.cae.wisc.edu/~ece533/images/peppers.png?cookie=mywebguard=mywebguard-cookie-test' from 'https://mywebguard-host.github.io'. Click OK to allow!

However, the simulated data leakage and tracking requests were ignored by uBlock, one of the popular browser privacy extensions



MyWebGuard eva

TODO steps:
1. Create some credentials, e.g., cooki
2. Use these credentails with JavaScrip
3. Include some third-party code to pe

requests blocked

on this page

0 or 0%

since install

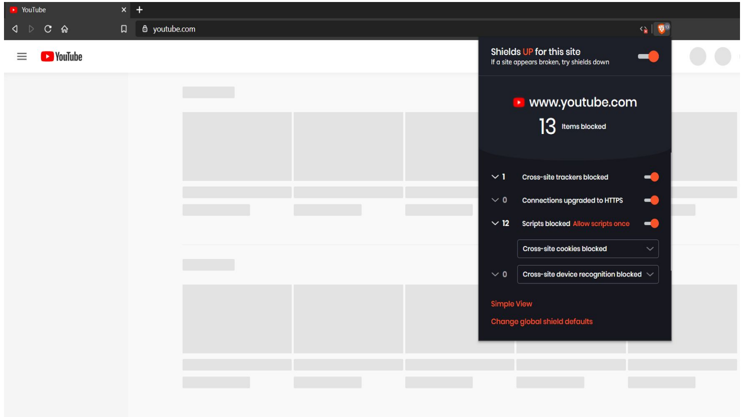
0 or 0%

domains connected

5 out of 5

Functionality

- When examining Brave browser, which has a JavaScript-blocking mechanism, we test some websites
- We notice several <u>breakages</u> and <u>loading issues</u> (such as YouTube)

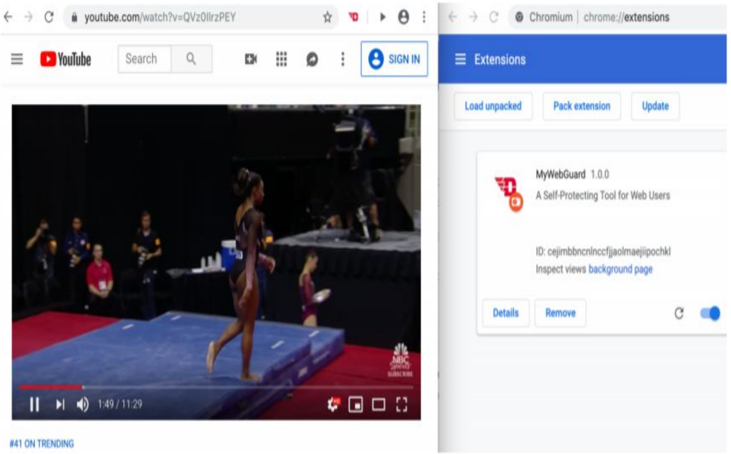


Shields UP for this site
If a site appears broken, try shields down

www.youtube.com
13 Items blocked

1 Cross-site trackers blocked
0 Connections upgraded to HTTPS
12 Scripts blocked Allow scripts once
Cross-site cookies blocked
0 Cross-site device recognition blocked

Simple View
Change global shield defaults



youtube.com/watch?v=QVz0llrzPEY

Chromium | chrome://extensions

Extensions

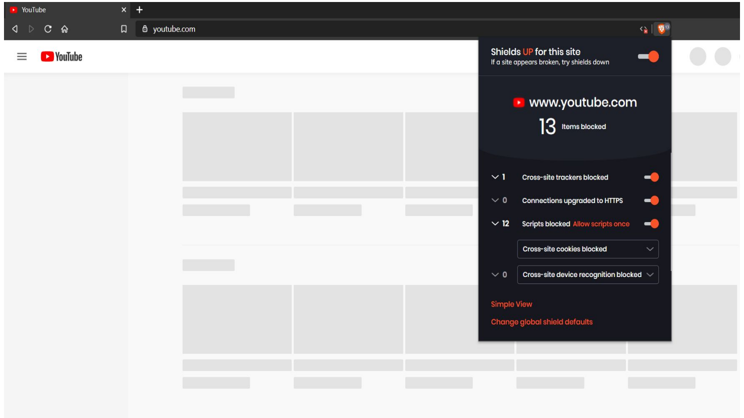
Load unpacked
Pack extension
Update

MyWebGuard 1.0.0
A Self-Protecting Tool for Web Users
ID: cejimbbncnlnccfjjaolmaejiipochkl
Inspect views background page

Details
Remove

Functionality

- We do not notice any issues when loading those websites (like YouTube) with MyWebGuard



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If a site appears broken, try shields down

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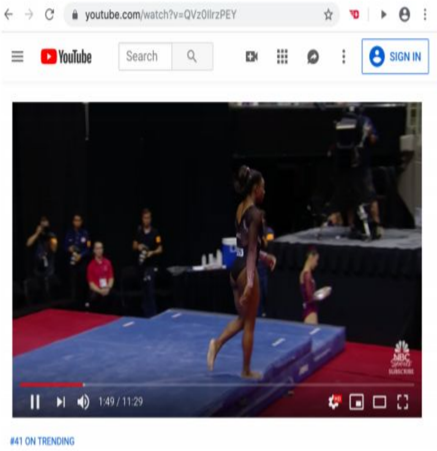
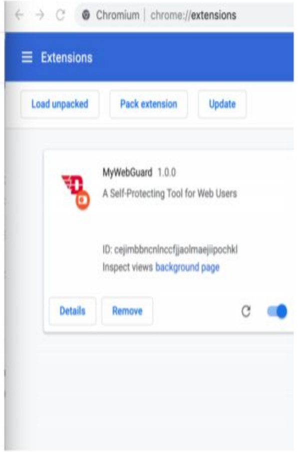
Simple View
Change global shield defaults





Chromium | chrome://extensions

Extensions

Load unpacked | Pack extension | Update

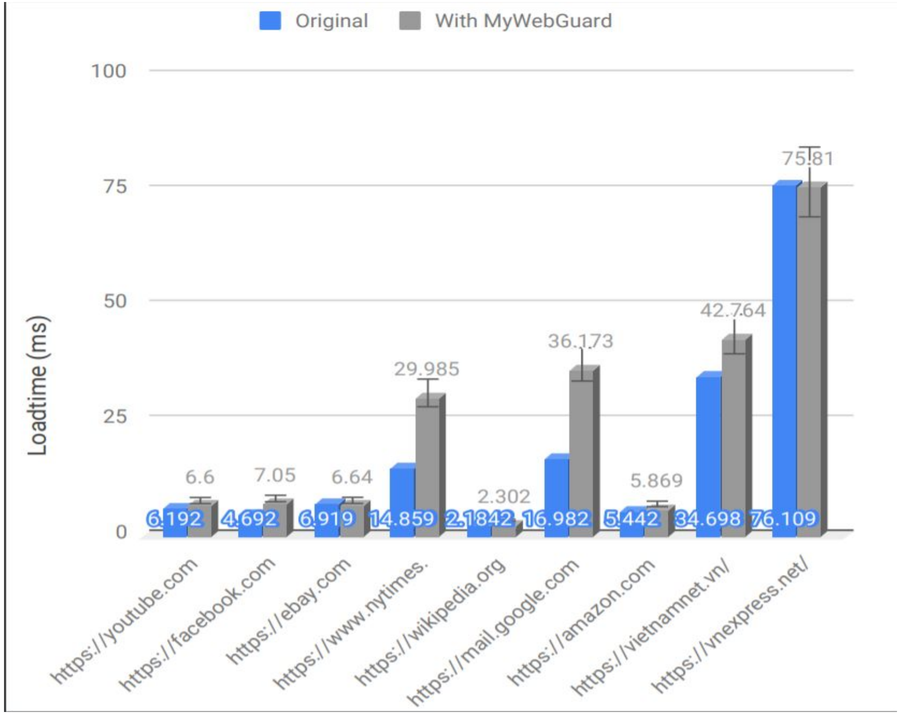
MyWebGuard 1.0.0
A Self-Protecting Tool for Web Users

ID: cejimbbncnlncfjjaolmaejiipochkl
Inspect views background page

Details | Remove

Runtime Evaluation

- We tested MyWebGuard with both Chromium and Brave browsers (on Ubuntu 18.04.2 LTS) on real websites
    - The overheads are not noticeable as shown in the graph



Contribution

- Browser-agnostic approach to preventing privacy leakage not monitored by contemporary solutions
- Present a compromise to “all-or-nothing” filter lists
- Advances conventional same-origin policy standard by enforcing different policies for each source of code
- Evaluation of approach overhead shows a lightweight yet effective implementation

Future Work

- Extend and refine policies and enforcement mechanism
  - Machine learning to produce practical policies
  - Effectiveness when built into a browser
- Allow for end-users to customize privacy preferences
- Perform large-scale evaluations of MyWebGuard
  - On top websites
  - Interference with co-existing browser extensions

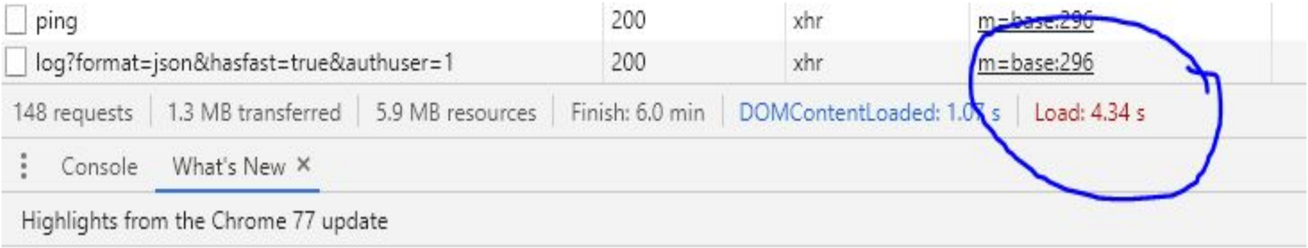
Thank You

Intelligent System Security Lab
Department of Computer Science, University of Dayton
https://isseclab-udayton.github.io/

Runtime Evaluation

We now test our extension on different sites (such as EBay, Amazon, FaceBook…)

To avoid anomalies, we test each site 10 times, recording the loading times (time for a site to finish loading its required contents



□ ping	200	xhr	m=base:296
□ log?format=json&hasfast=true&authuser=1	200	xhr	m=base:296

148 requests | 1.3 MB transferred | 5.9 MB resources | Finish: 6.0 min | DOMContentLoaded: 1.07 s | Load: 4.34 s

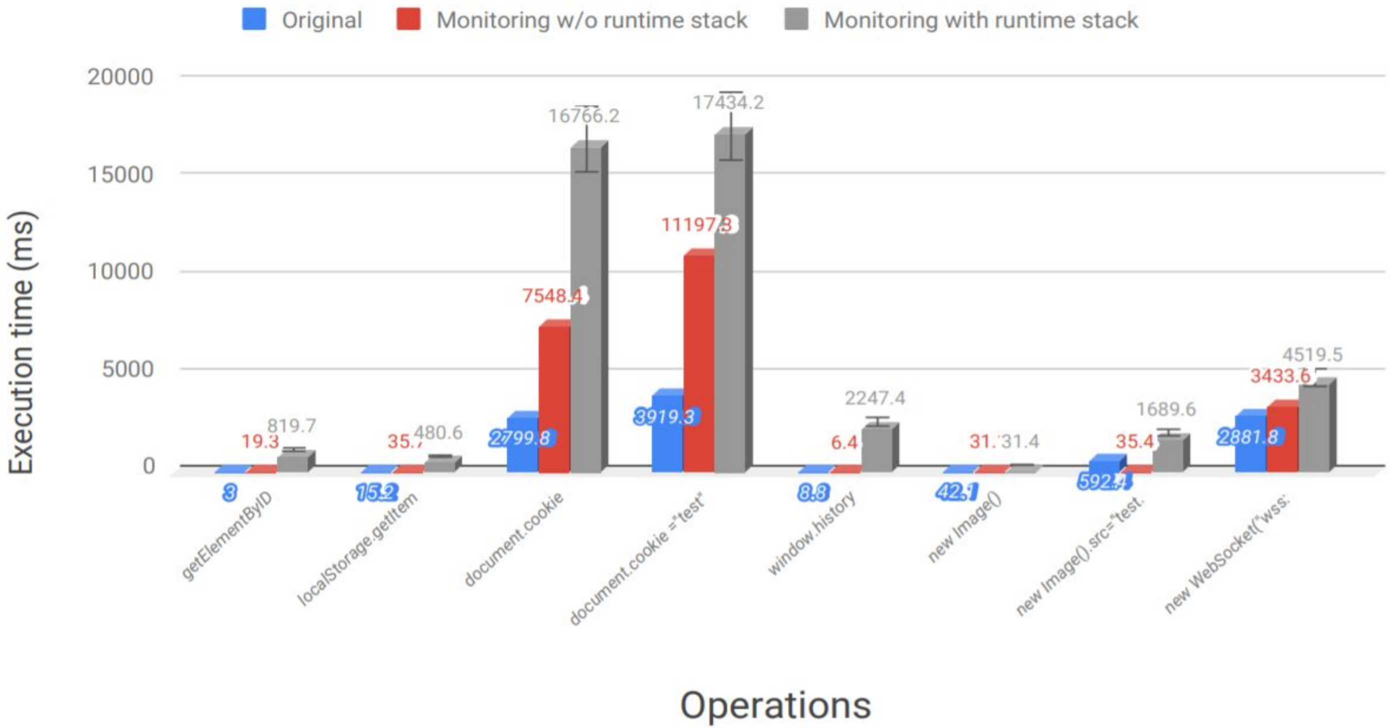
Highlights from the Chrome 77 update

Runtime Evaluation

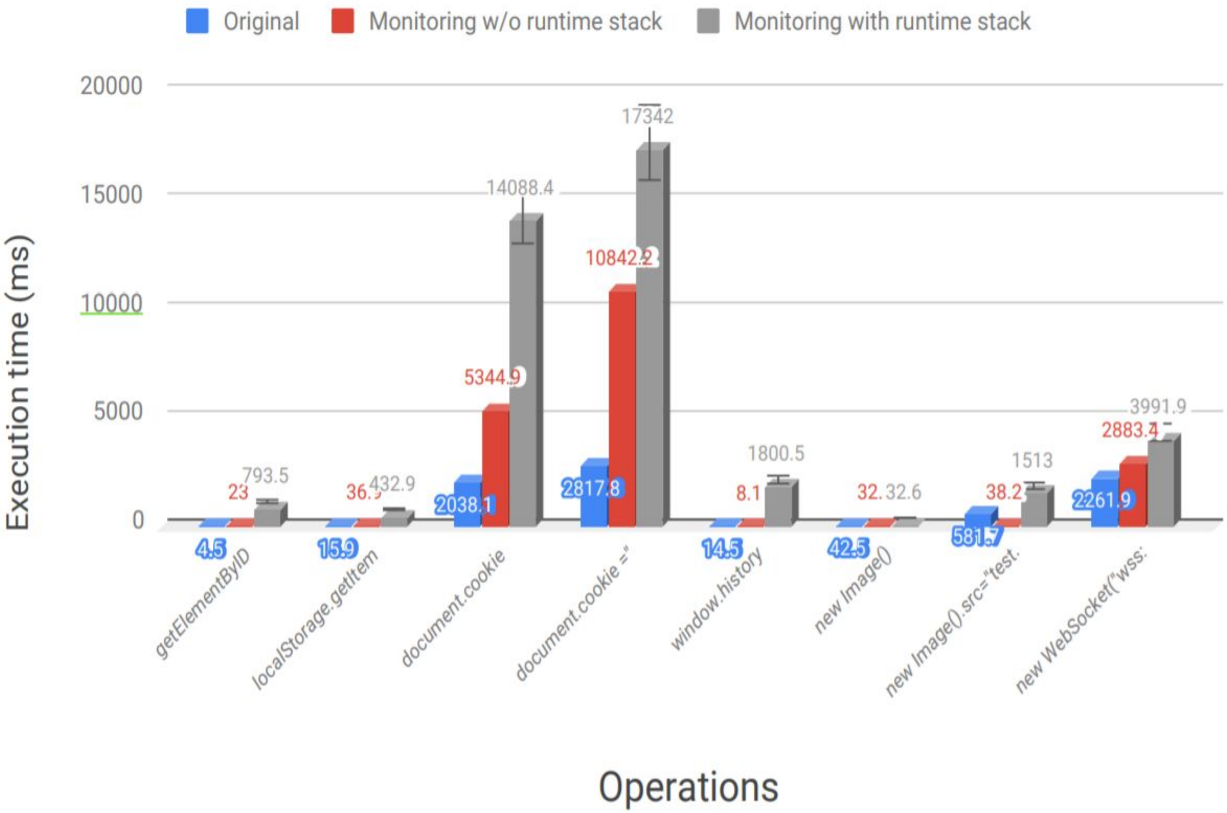
We tested MyWebGuard with both Chromium and Brave browsers (on Ubuntu 18.04.2 LTS) using our testing simulation

There exists a slowdown time on both browsers, which is due to the runtime stack that helps track the code origin

Performance overhead in Chromium



Performance overhead in Brave


🟦 Original
🟥 Monitoring w/o runtime stack
⬜ Monitoring with runtime stack
Execution time (ms)
getElementByID
localStorage.getItem
document.cookie
document.cookie ="
window.history
new Image()
new Image().src="test.
new WebSocket("wss:
Operations