

Battery Status Not Included: Assessing Privacy in Web Standards



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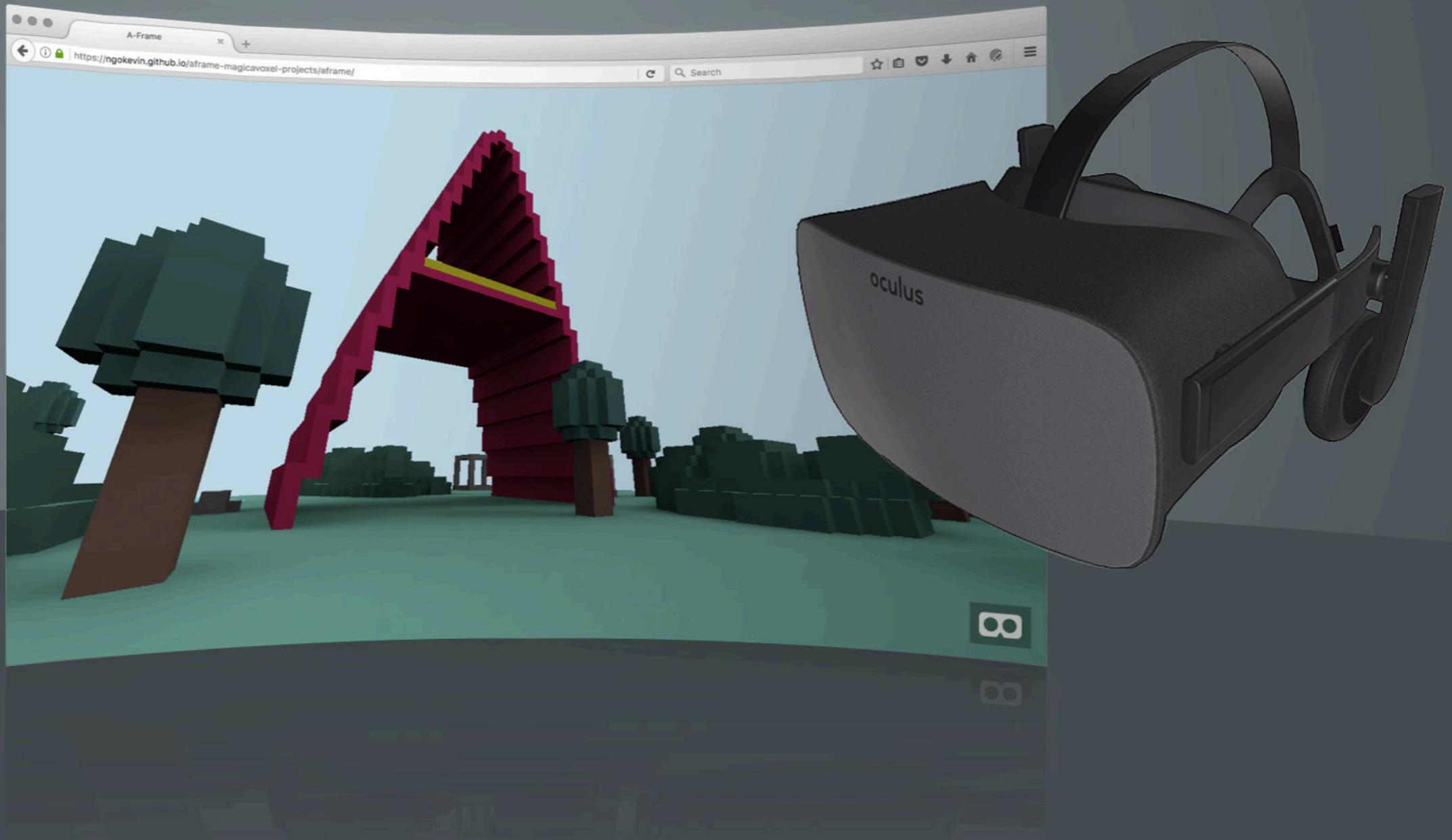
Arvind Narayanan
Princeton University
randomwalker.info

New Web features lead to privacy concerns

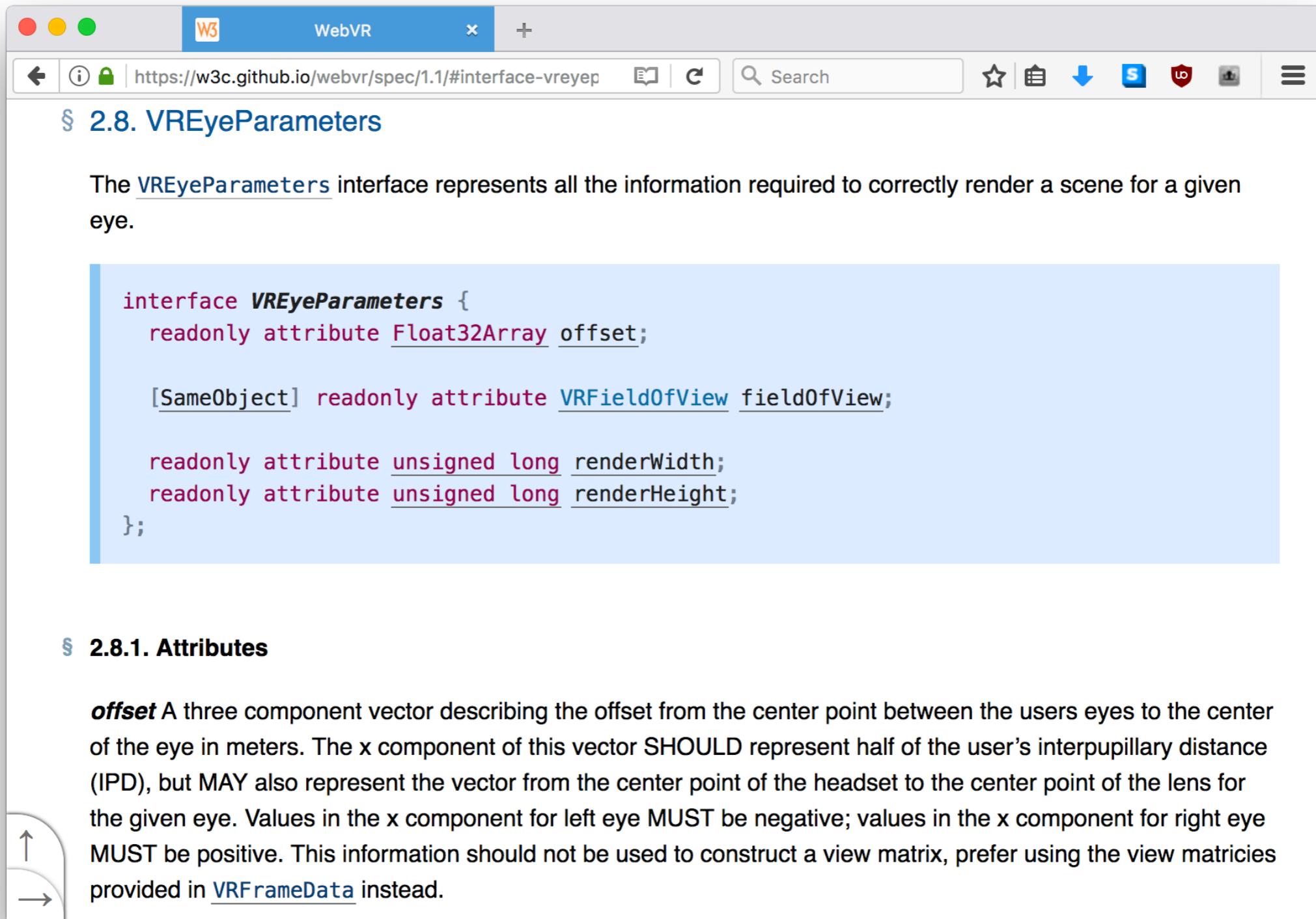
New Web features lead to privacy concerns



New Web features lead to privacy concerns



New Web features lead to privacy concerns



The screenshot shows a web browser window titled "WebVR" with the URL <https://w3c.github.io/webvr/spec/1.1/#interface-vreyep>. The page content is about the `VREyeParameters` interface.

§ 2.8. VREyeParameters

The `VREyeParameters` interface represents all the information required to correctly render a scene for a given eye.

```
interface VREyeParameters {
  readonly attribute Float32Array offset;

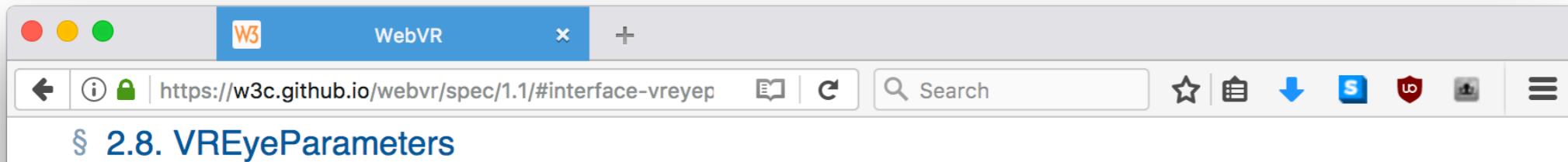
  [SameObject] readonly attribute VRFieldOfView fieldOfView;

  readonly attribute unsigned long renderWidth;
  readonly attribute unsigned long renderHeight;
};
```

§ 2.8.1. Attributes

offset A three component vector describing the offset from the center point between the users eyes to the center of the eye in meters. The x component of this vector SHOULD represent half of the user's interpupillary distance (IPD), but MAY also represent the vector from the center point of the headset to the center point of the lens for the given eye. Values in the x component for left eye MUST be negative; values in the x component for right eye MUST be positive. This information should not be used to construct a view matrix, prefer using the view matrices provided in `VRFrameData` instead.

New Web features lead to privacy concerns

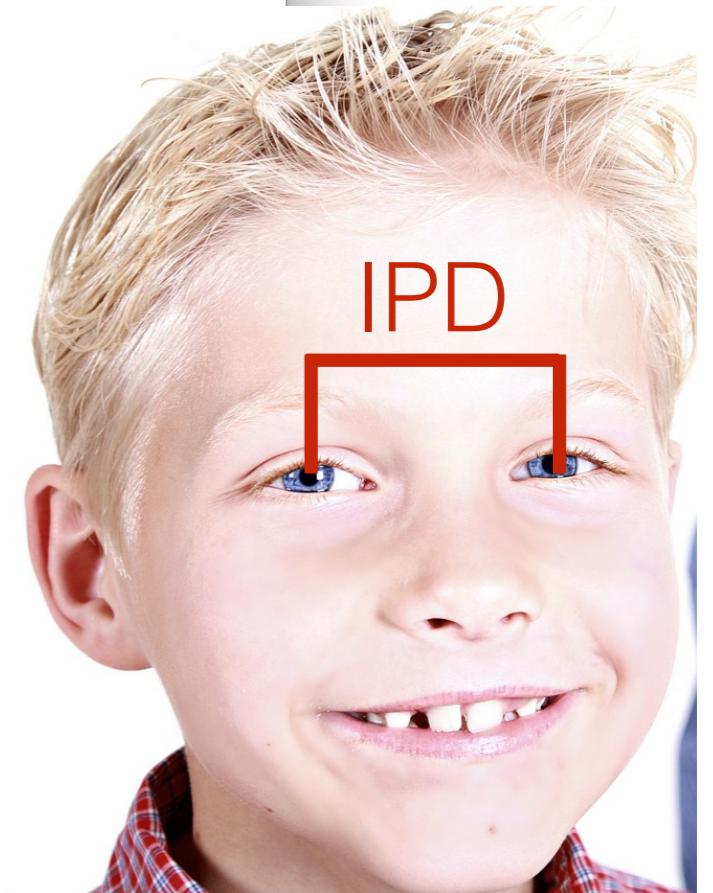


The screenshot shows a web browser window with the title bar "WebVR". The address bar displays the URL <https://w3c.github.io/webvr/spec/1.1/#interface-vreyep>. The main content area is titled "§ 2.8. VREyeParameters". It contains a code snippet for the `VREyeParameters` interface:

```
interface VREyeParameters {
  readonly attribute Float32Array offset;
  [SameObject] readonly attribute VRFieldOfView fieldOfView;
  readonly attribute unsigned long renderWidth;
  readonly attribute unsigned long renderHeight;
};
```

The `VREyeParameters` interface represents all the information required to correctly render a scene for each eye.

```
interface VREyeParameters {
  readonly attribute Float32Array offset;
  [SameObject] readonly attribute VRFieldOfView fieldOfView;
  readonly attribute unsigned long renderWidth;
  readonly attribute unsigned long renderHeight;
};
```



§ 2.8.1. Attributes

offset A three component vector describing the offset from the center point between the user's eyes of the eye in meters. The x component of this vector SHOULD represent half of the user's interpupillary distance (IPD), but MAY also represent the vector from the center point of the headset to the center point of the lens for the given eye. Values in the x component for left eye MUST be negative; values in the x component for right eye MUST be positive. This information should not be used to construct a view matrix, prefer using the view matrices provided in `VRFrameData` instead.



The W3C has a self-review questionnaire

A screenshot of a web browser window displaying the "Self-Review Questionnaire: Security and Privacy" document. The browser interface includes a blue header bar with the W3C logo and the title, a navigation bar with back, forward, and search buttons, and a toolbar with various icons. The main content area features the W3C logo at the top, followed by the title "Self-Review Questionnaire: Security and Privacy" in large blue text, and the subtitle "W3C Working Group Note 10 December 2015". Below this, there are sections for "This version:", "Latest published version:", "Editor's Draft:", and "Editor:", each with a corresponding URL link. At the bottom, there is a "PUBLIC DOMAIN" logo and a copyright notice. The left side of the browser window has a vertical blue bar labeled "W3C Working Group Note".

This version:
<http://www.w3.org/TR/2015/NOTE-security-privacy-questionnaire-20151210/>

Latest published version:
<http://www.w3.org/TR/security-privacy-questionnaire/>

Editor's Draft:
<https://w3ctag.github.io/security-questionnaire/>

Editor:
Mike West, Google Inc., mkwst@google.com

To the extent possible under law, the editors have waived all copyright and related or neighboring rights to this work. This document is also made available under the [W3C Software and Document License](#).

Abstract

This document lists a set of questions one could ask about the security and privacy impact of a new feature or specification. It is meant as a tool that groups or individuals can use as a guide during a self-review, pointing towards important questions in areas where expertise might be lacking.

The W3C has a self-review questionnaire

W3C Working Group Note

W3 Self-Review Questionnaire: S x +

https://www.w3.org/TR/security-privacy-questionnaire/#drop-fe

Search

1 Introduction

2 Threat Models

- 2.1 Passive Network Attackers
- 2.2 Active Network Attackers
- 2.3 Same-Origin Policy Violations
- 2.4 Third-Party Tracking

3 Questions to Consider

- 3.1 Does this specification deal with personally-identifiable information?
- 3.2 Does this specification deal with high-value data?
- 3.3 Does this specification introduce new state for an origin that persists across browsing sessions?
- 3.4 Does this specification expose persistent, cross-origin state to the web?
- 3.5 Does this specification expose any other data to an origin that it doesn't currently have access to?
- 3.6 Does this specification enable new script execution/loading mechanisms?
- 3.7 Does this specification allow an origin access to a user's location?
- 3.8 Does this specification allow an origin access to sensors on a user's device?
- 3.9 Does this specification allow an origin access to aspects of a user's local computing environment?
- 3.10 Does this specification allow an origin access to other devices?
- 3.11 Does this specification allow an origin some measure of control over a user agent's native UI?
- 3.12 Does this specification expose temporary identifiers to the web?
- 3.13 Does this specification distinguish between behavior in first-party and third-party contexts?
- 3.14 How should this specification work in the context of a user agent's "incognito" mode?
- 3.15 Does this specification persist data to a user's local device?
- 3.16 Does this specification have a "Security Considerations" and "Privacy Considerations" section?
- 3.17 Does this specification allow downgrading default security characteristics?

4 Mitigation Strategies

- 4.1 Secure Contexts
- 4.2 Explicit user mediation
- 4.3 Drop the feature

Conformance Index

Terms defined by this specification

Terms defined by reference

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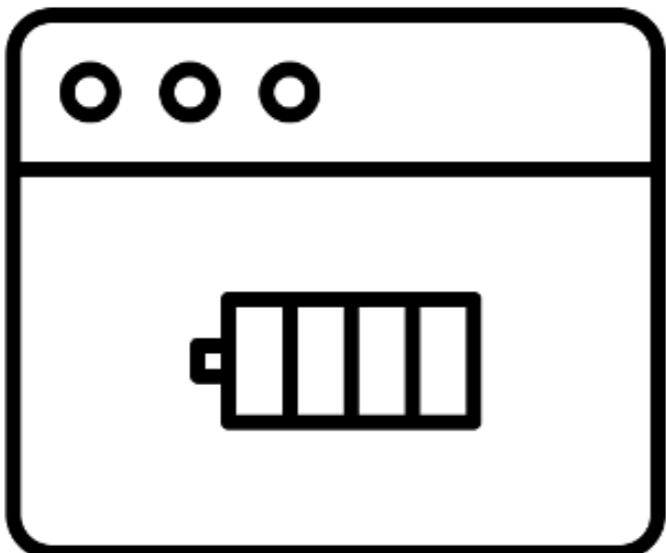
W3C Privacy Interest Group (PING) offers guidance and reviews

The mission...is to improve the support of privacy in Web standards by:

1. Monitoring ongoing privacy issues that affect the Web
2. Investigating potential areas for new privacy work
3. Providing guidelines and advice for addressing privacy in standards development.

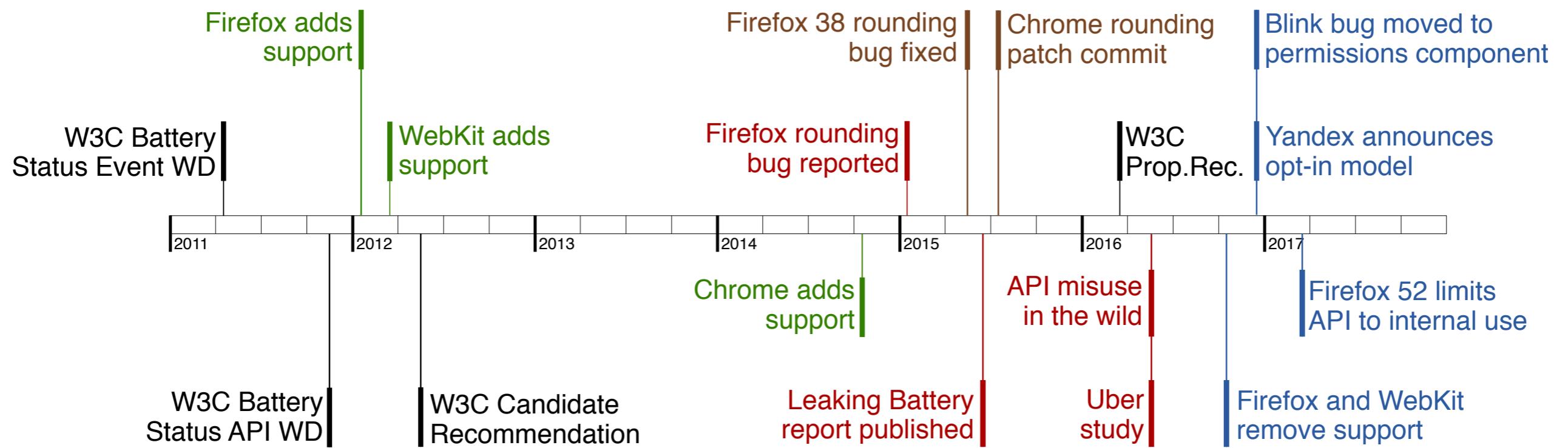
<https://www.w3.org/2011/07/privacy-ig-charter>

The Battery Status API



- charge **level**
 - value between 0 and 1
 - e.g 0.43 if the battery at 43%
- **charging** status
 - boolean indicator
- time to charge or discharge
 - **dischargingTime**
 - **chargingTime**
 - time in seconds

The development and adoption of the API



Mid 2012: Candidate Recommendation adds security and privacy considerations

The screenshot shows a web browser window displaying the W3C Candidate Recommendation page for the Battery Status API. The page content includes sections on Terminology, Security and privacy considerations, and the NavigatorBattery interface, along with a WebIDL snippet.

W3C Candidate Recommendation

Battery Status API

<https://www.w3.org/TR/2012/CR-I>

3. Terminology

The [Function](#) interface represents a function in the scripting language being used as defined in [HTML5].

The concepts [queue a task](#) and [fires a simple event](#) are defined in [HTML5].

The terms [event handlers](#) and [event handler event types](#) are defined in [HTML5].

4. Security and privacy considerations

The API defined in this specification is used to determine the battery status of the hosting device. The information disclosed has minimal impact on privacy or fingerprinting, and therefore is exposed without permission grants. For example, authors cannot directly know if there is a battery or not in the hosting device.

5. **NavigatorBattery** Interface

The [NavigatorBattery](#) interface is exposed on the [Navigator](#) object.

WebIDL

```
Navigator implements NavigatorBattery;
```

<https://www.w3.org/TR/2012/CR-battery-status-20120508/>

Mid 2012: Candidate Recommendation adds security and privacy considerations

The screenshot shows a web browser window displaying the W3C Candidate Recommendation for the Battery Status API. The URL in the address bar is <https://www.w3.org/TR/2012/CR-I-battery-status-20120508/>. The page content includes sections on Terminology, Security and privacy considerations, and the NavigatorBattery Interface. A red arrow points from the text "the information disclosed has a minimal impact on privacy or fingerprinting" in the Security section to the corresponding text in the Terminology section.

W3C Candidate Recommendation

Battery Status API

https://www.w3.org/TR/2012/CR-I-battery-status-20120508/

3. Terminology

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WebIDL

```
Navigator implements NavigatorBattery;
```

“the information disclosed has a **minimal impact** on privacy or fingerprinting”

New research exposes multiple privacy vulnerabilities

The screenshot shows a web browser window with a PDF viewer extension. The title bar says '616.pdf'. The address bar shows the URL <https://eprint.iacr.org/2015/616.pdf>. The page content is a PDF document with the following text:

The leaking battery
A privacy analysis of the HTML5 Battery Status API

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² KU Leuven, ESAT/COSIC and iMinds, Leuven, Belgium
{gunes.acar,claudia.diaz}@esat.kuleuven.be

Abstract. We highlight privacy risks associated with the HTML5 Battery Status API. We put special focus on its implementation in the Firefox browser. Our study shows that websites can discover the capacity of users' batteries by exploiting the high precision readouts provided by Firefox on Linux. The capacity of the battery, as well as its level, expose a fingerprintable surface that can be used to track web users in short time intervals. Our analysis shows that the risk is much higher for old or used batteries with reduced capacities, as the battery capacity may potentially serve as a tracking identifier. The fingerprintable surface of the API could be drastically reduced without any loss in the API's functionality by reducing the precision of the readings. We propose minor modifications to Battery Status API and its implementation in the Firefox browser to address the privacy issues presented in the study. Our bug report for Firefox was accepted and a fix is deployed.

New research exposes multiple privacy vulnerabilities

The screenshot shows a PDF document titled "ccs16_online_tracking.pdf" from the URL https://senglehardt.com/papers/ccs16_online_tracking.pdf. The document is a measurement study on online tracking. It features two authors: Steven Englehardt (Princeton University, ste@cs.princeton.edu) and Arvind Narayanan (Princeton University, arvindn@cs.princeton.edu). The title is "Online Tracking: A 1-million-site Measurement and Analysis". Below the title, a blue link states "This is an extended version of our paper that appeared at ACM CCS 2016." The abstract discusses the largest measurement of online tracking, involving 1 million websites and 15 types of measurements, including stateful and stateless tracking, browser privacy tools, and cookie syncing. The paper uses an open-source tool, OpenWPM, which is described as an automated consumer browser supporting parallelism and comprehensive instrumentation. The browser itself is noted for being difficult to automate, so the researchers used a stripped-down browser (31) and expanded on FourthParty (33) for instrumentation. The paper also addresses memory leaks in browsers and the challenges of instrumenting them for analysis.

ccs16_online_tracking.pdf

https://senglehardt.com/papers/ccs16_online_tracking.pdf

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Automatic Zoom

Search

Online Tracking:
A 1-million-site Measurement and Analysis

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This is an extended version of our paper that appeared at ACM CCS 2016.

ABSTRACT

We present the largest and most detailed measurement of online tracking conducted to date, based on a crawl of the top 1 million websites. We make 15 types of measurements on each site, including stateful (cookie-based) and stateless (fingerprinting-based) tracking, the effect of browser privacy tools, and the exchange of tracking data between different sites (“cookie syncing”). Our findings include multiple sophisticated fingerprinting techniques never before measured in the wild.

This measurement is made possible by our open-source web privacy measurement tool, OpenWPM¹, which uses an automated version of a full-fledged consumer browser. It supports parallelism for speed and scale, automatic recovery from failures of the underlying browser, and comprehensive browser instrumentation. We demonstrate our platform’s strength in enabling researchers to rapidly detect, quantify, and characterize emerging online tracking behaviors.

to resort to a stripped-down browser [31] (a limitation we explore in detail in Section 3.3). (2) We provide comprehensive instrumentation by expanding on the rich browser extension instrumentation of FourthParty [33], without requiring the researcher to write their own automation code. (3) We reduce duplication of work by providing a modular architecture to enable code re-use between studies.

Solving these problems is hard because the web is not designed for automation or instrumentation. Selenium,² the main tool for automated browsing through a full-fledged browser, is intended for developers to test their *own* websites. As a result it performs poorly on websites not controlled by the user and breaks frequently if used for large-scale measurements. Browsers themselves tend to suffer memory leaks over long sessions. In addition, *instrumenting* the browser to collect a variety of data for later analysis presents formidable challenges. For full coverage, we’ve found it necessary to have three separate measurement points:

New research exposes multiple privacy vulnerabilities

1. The Battery API could be used as a short-term identifier
2. Firefox was exposing high-precision values for charge level, which allowed battery capacity to be recovered
3. Scripts were abusing the API to track users in the wild

The specification was updated
to address privacy vulnerabilities

1. Should avoid high precision readouts
2. Should inform the user when and who is using the API
3. May ask the user for permission
4. May obfuscate or expose fake values

Early 2017: Several vendors remove or restrict support, citing privacy and lack of use



Restricted to non-web content



Removed from source code



Open bug (filed under permissions?)



Yandex.Browser

Opt-in, otherwise dummy values

Our data supports Mozilla's decision

We measured usage on the top 50,000 sites

33 third-parties on 815 sites use the API

- 16 used it for tracking
 - Mostly fingerprinting
- 8 used it for benign purposes
 - Mostly performance measurement
- 9 unclassified

How can we improve the
privacy review process?

The specification process should include
a privacy review of implementations

Specification requires two implementations to progress

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a privacy review of implementations

Specification requires two implementations to progress



Why not require a privacy review of these specifications?

The specification process should include
a privacy review of implementations

Specification requires two implementations to progress



Why not require a privacy review of these specifications?

—> Similar precision issues found during privacy review of
Ambient Light Sensors API, which included implementation
auditing.

API use in the wild should be audited after implementation

Trackers are the early adopters of any new API!

API use in the wild should be audited after implementation

Trackers are the early adopters of any new API!

- Niche adopters will use the API as intended
 - e.g. an online game using WebRTC for multiplayer
- One or two somewhat popular tracking scripts can push the malicious use to thousands of sites.
 - e.g. Canvas being used to fingerprint

API use in the wild should be audited after implementation

It's not clear that the measurement community will continue to support fingerprinting measurement

API use in the wild should be audited after implementation

It's not clear that the measurement community will continue to support fingerprinting measurement

Concerns:

1. Lack of novelty in measurement techniques
2. Measurement of each new API is a small contribution
3. Specifications can't wait for the publication cycle

API use in the wild should be audited after implementation

It's not clear that the measurement community will continue to support fingerprinting measurement

Concerns:

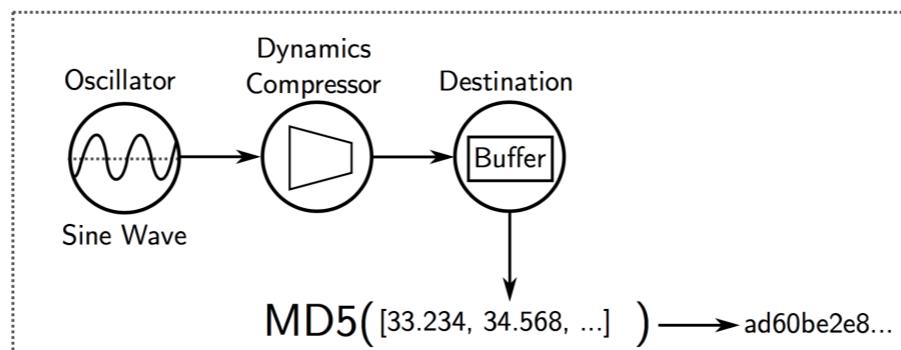
1. Lack of novelty in measurement techniques
2. Measurement of each new API is a small contribution
3. Specifications can't wait for the publication cycle

Suggestions:

1. Measurement through browser telemetry probes?
2. Regular measurement by browser vendors?
3. Public measurements by an NGO — something like archive.org

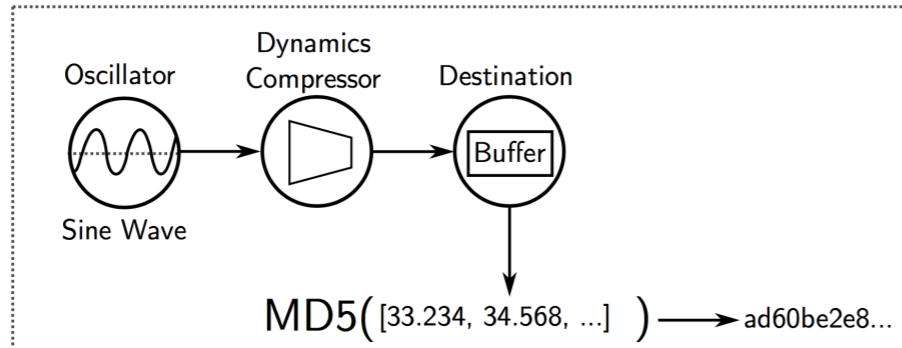
Specification authors should carry out privacy assessments with multiple threat models

An example: fingerprinting with the Audio API



Specification authors should carry out privacy assessments with multiple threat models

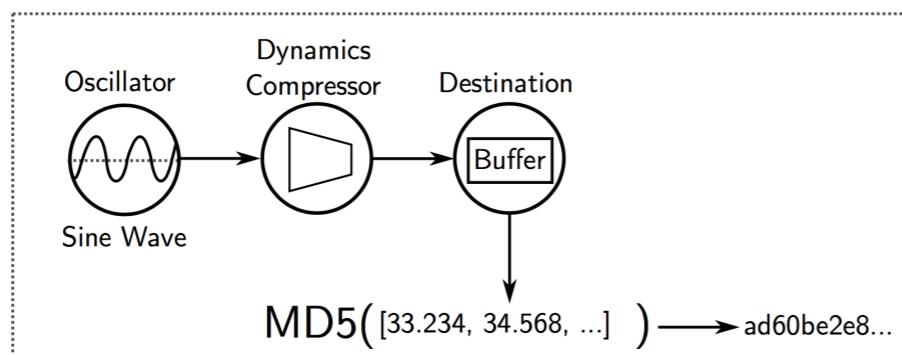
An example: fingerprinting with the Audio API



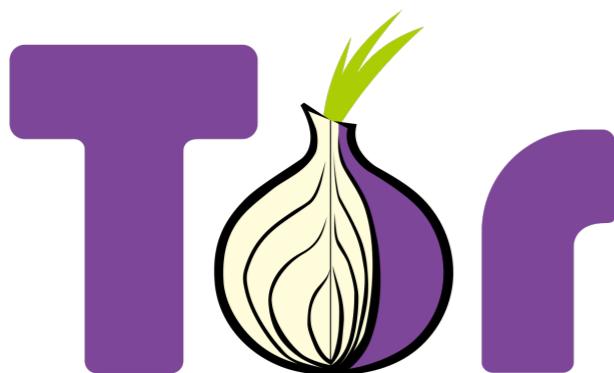
User's OS and
browser

Specification authors should carry out privacy assessments with multiple threat models

An example: fingerprinting with the Audio API



\approx User's OS and browser



This is a concern for the Tor Browser!

Thank you!

In summary:

1. Improve incentives for academics to contribute research
2. **Include audits of implementations in reviews**
3. **Audit API use after deployment**
4. **Carry out analysis in multiple threat models**
5. Avoiding over-specification supports innovative solutions
6. Provide guidance for web developers in addition to vendors

Full paper:

https://senglehardt.com/papers/iwpe17_battery_status_case_study.pdf