You Can't Touch This

WG2.8 meeting 2012

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07 November 2012

Motivation

92%

of all websites use

JavaScript

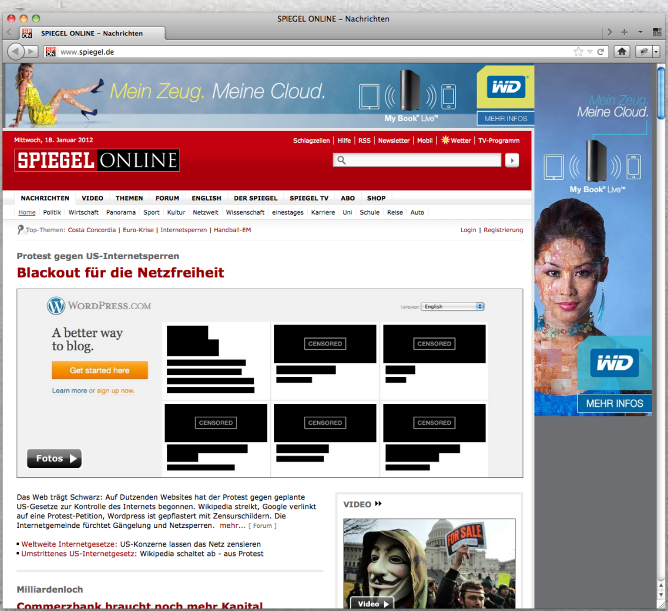
according to: `http://w3techs.com/`, 30/09/12

Thesis

The Full Employment Theorem for Research on JavaScript

- There will always be another JavaScript feature

Situation of a Web Programmer



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- Weltweite Internetgesetze: US-Konzerne lassen das Netz zensieren
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VIDEO

Video

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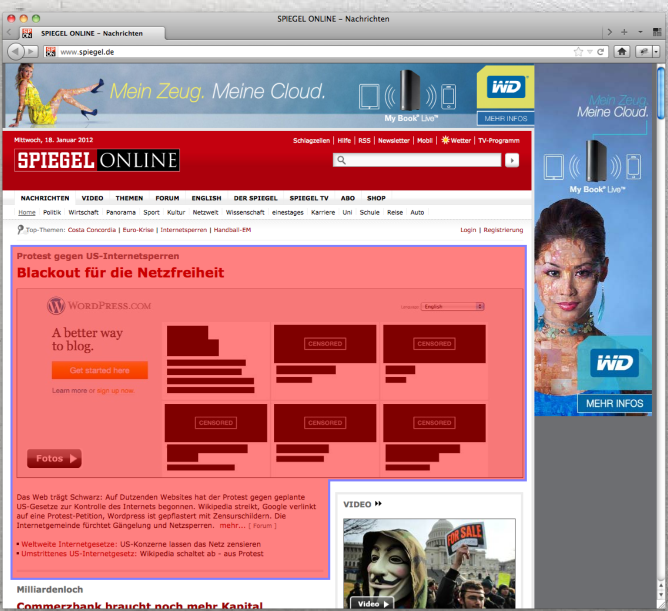
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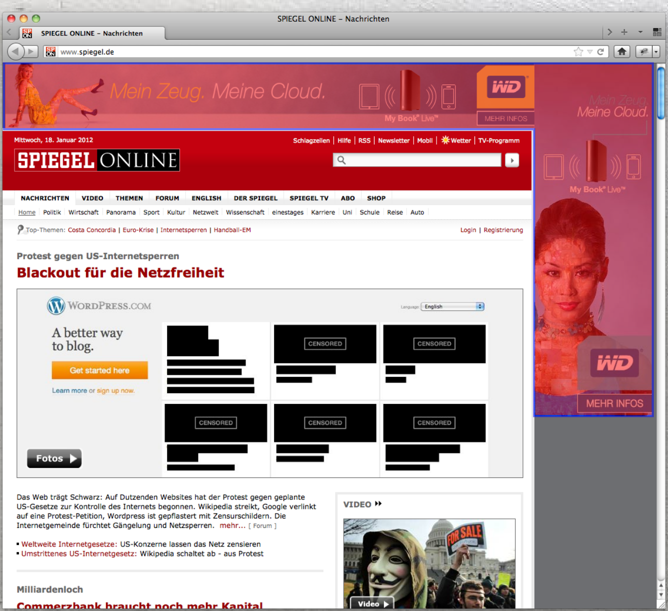

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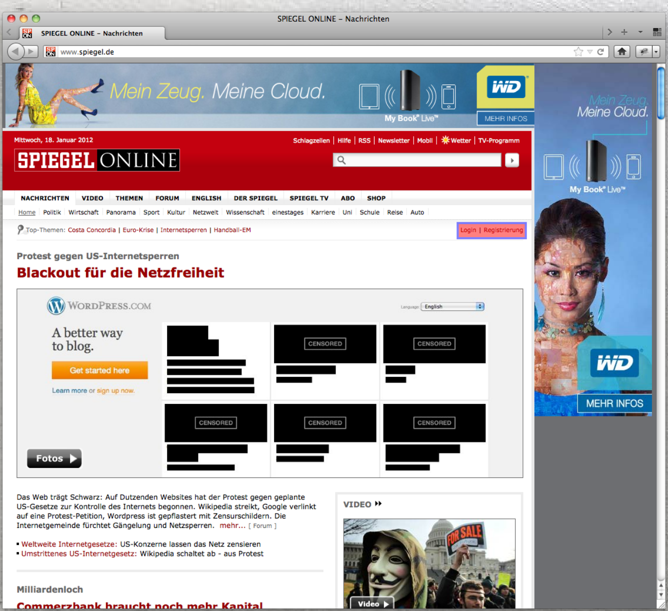

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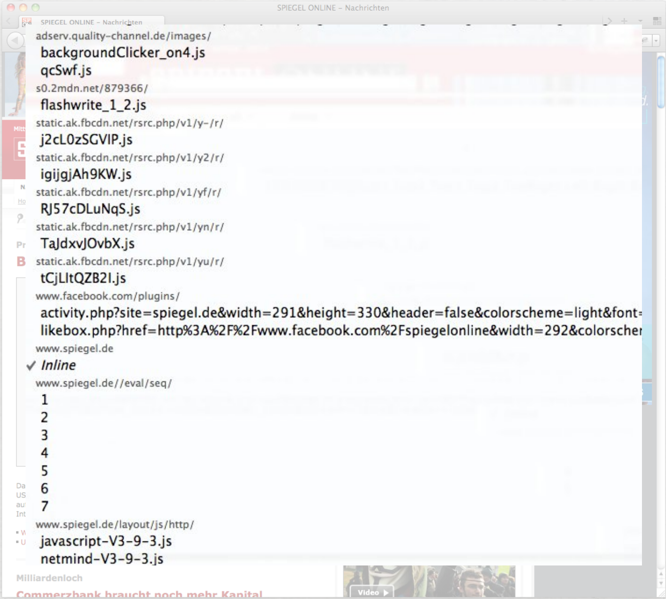

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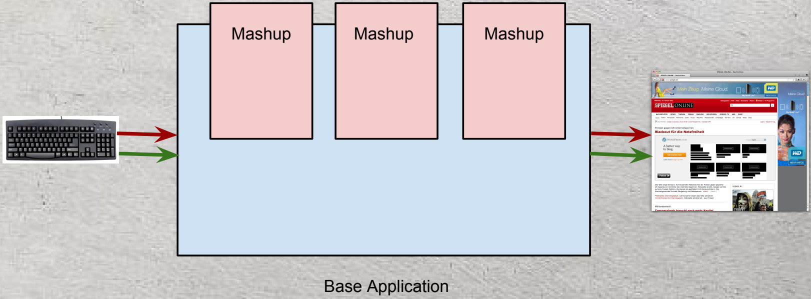
Visualization of the Code



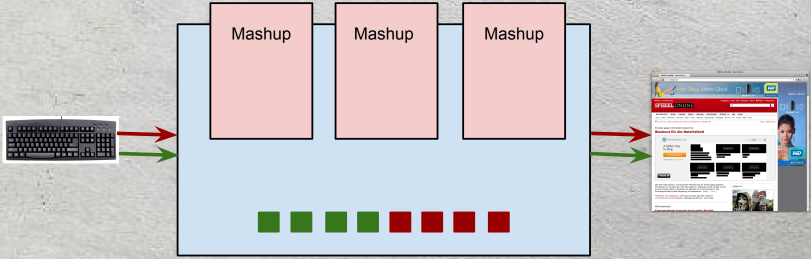
Mashup

Mashup

Mashup

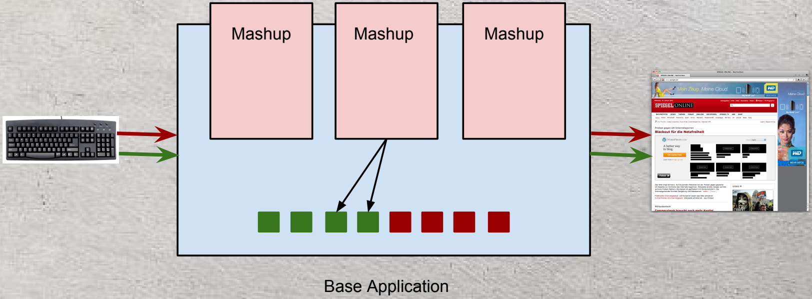
Base Application

Visualization of the Code

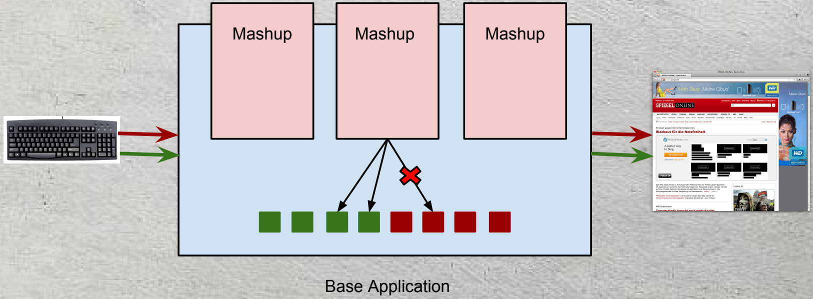


Base Application

Visualization of the Code



Visualization of the Code



Mashup

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Base Application

Problem

(Mandatory) Access Control for Mashups

- No access to private data of the client
- No access to sensitive resources

Problem

(Mandatory) Access Control for Mashups

- No access to private data of the client
- No access to sensitive resources

What is Needed?

- Demarcation between trusted and untrusted code
- Mashup-specific access-control policies
- Enforcement of these policies

Observation

In JavaScript, every resource is controlled by reading or writing a property in scope.

Examples

- `document.location`, `document.cookie`, ...
- `document.write()`, ...
- `window.onload`, `window.onkeypress`, ...
- `window.alert()`, `window.open()`, ...
- `node.data`, `node.innerHtml`, ...
- `myData.contacts.JohnDoe.email`, ...

Controlling Access to Properties is Key!

Access Permissions — sets of object references

```
Perm (document, "location|cookie|write");
Perm (window, "/on.*/");
Perm (window, "alert|open");
Perm (document.documentElement, "*./data|innerHtml/");
Perm (myData, "*.email");
```

Controlling Access to Properties is Key!

Access Permissions — sets of object references

```
Perm (document, "location|cookie|write");
Perm (window, "/on.*/");
Perm (window, "alert|open");
Perm (document.documentElement, "*./data|innerHtml/");
Perm (myData, "*.email");
```

Building blocks

$$
\begin{array}{rcll}
p & ::= & \mathtt{Perm}(e, \mathit{path}) & \text{anchored path set} \\
 & | & p \cup p \mid p \cap p \mid \neg p & \text{boolean operations} \\
 & | & \Omega & \text{universal permission}
\end{array}
$$

Enforcing Restrictions

Enforcing Restrictions

```
ENFORCE( Deny (Perm (...), Perm (...)),
  function () {
    // scope of enforcement
  });
```

Alternative: Permitted Accesses

Access Permissions

```
/* constructor for person */
function Person(nick, pass, mail) {
  this.nickname = nick;
  this.password = pass;
  this.email    = mail;
}

function base_functionality() {
  var p = new Person("honda", "t243v3r", "mh@t2.com");
  ...
  ENFORCE( Allow (Perm (p, "nickname")),
    function() { mashup1 (p); });
  ...
  var out = document.getElementById("for_mashup");
  ENFORCE( Allow (Perm (out, "*")),
    function() { mashup2 (out, ...); });
}
```

Discussion: Scope of Enforcement

```
function mash(x, my) {
  ... my.secret ...
}

var r = ENFORCE(
  Deny(my, "secret"),
  function() {
    mash(x, my);
  });
```

Discussion: Scope of Enforcement

```
function mash(x, my) {
  ... my.secret ...
}

var r = ENFORCE(
  Deny(my, "secret"),
  function() {
    mash(x, my);
  });
```

Lexical Scope

- Restriction applies only to subphrases of `mash(x, my)`
- **Does not impose proper demarcation**: untrusted body of `mash` runs without restriction.

Discussion: Scope of Enforcement

```
function mash(x, my) {
  ... my.secret ...
}

var r = ENFORCE(
  Deny(my, "secret"),
  function() {
    mash(x, my);
  });
```

Dynamic Scope

- Restriction applies throughout execution of `mash`.
- Semantics of access permission contracts [POPL2012]

Discussion: Scope of Enforcement

```
function mash(x, my) {
  return function() {
    ... my.secret ...
  }
}

var r = ENFORCE(
  Deny(my, "secret"),
  function() {
    mash(x, my);
  });

r();// may access my.secret
```

Dynamic Scope

- Restriction applies throughout execution of `mash`.
- Semantics of access permission contracts [POPL2012]
- **Does not impose proper demarcation**:
  If the untrusted `mash` returned a function, then `r()`, i.e., code produced by `mash`, would run without restriction.

Discussion: Scope of Enforcement

```
function mash(x, my) {
  return function() {
  ... my.secret ...
  }
}

var r = ENFORCE(
  Deny(my, "secret"),
  function() {
    mash(x, my);
  });

r();
// no access to my.secret
```

Wrapper Semantics

- The restriction applies to the execution of `mash(x, y)` and to all functions and objects produced by it, recursively.
- If `mash(x, y)` returns a function, then the function call `r()` runs with (at least) the same restriction as `mash`.
- **Fits the requirements.**

Discussion: Scope of Enforcement

```
function mash(x, my) {
  ...  x()  ...
}

var r = ENFORCE(
  Deny(my, "secret"),
  function() {
    mash(x, my);
  });

// @syscall
function x() {
  ...  my.secret  ...
}
```

Wrapper Semantics for Higher-Order Functions

- Suppose `x` is a function, which is called in `mash`'s body.
- Which restriction applies to the execution of `x(...)`?
- Choice#1 (system call): `x`'s creation-time restriction

Discussion: Scope of Enforcement

```
function mash(x, my) {
  ... x()...
}

var r = ENFORCE(
  Deny(my, "secret"),
  function() {
    mash(x, my);
  });

// @callback
function x() {
  ... my.secret ...
}
```

Wrapper Semantics for Higher-Order Functions

- Suppose `x` is a function, which is called in `mash`'s body.
- Which restriction applies to the execution of `x(...)`?
- Choice#1 (system call): `x`'s creation-time restriction
- Choice#2 (callback): same plus the call-site's restriction

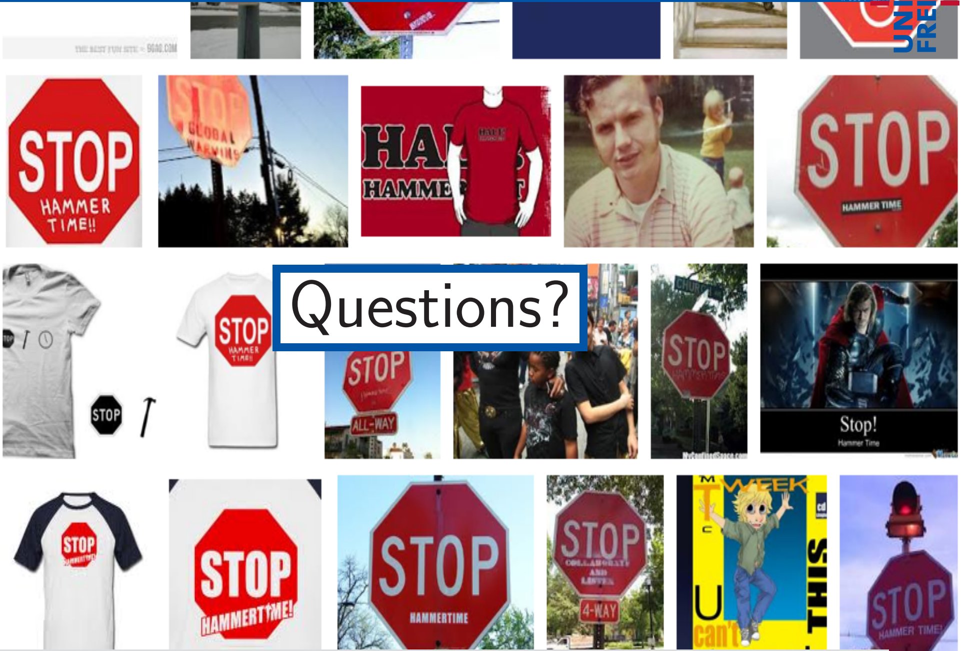
Who Should Use Access Restrictions?

- Implementer of base application wants to restrict mashups to guarantee confidentiality of the end user's data.
  - Explicit.
  - Instrumenting script tags.
- End user wants to restrict applications.
  - Global restriction.
  - Mapping: URL → restrictions.
  - Mapping prepared by third party; might be too complicated / tedious for end user.
- Implementer of mashup provides access restrictions: run time can check compatibility before executing

Project Status

- Formal, mechanized semantics
  - Properties of the semantics
  - Correctness of implementation
- Ongoing implementations in Rhino & Firefox
  - Security application requires total interposition
  - Only achievable in the JS engine (Thank you, eval & friends!)
- Corresponding gradual type system

The End



Questions?