Jigsaw: Efficient, Low-effort Mashup Isolation

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The joy of creating a new webapp
Mashup Security

- Isolate third-party code
- Control what you share with it
- And make it easy for developers!
Talk Outline

- Previous approaches
- Goals
- Design
- Implementation
- Evaluation
Previous approaches: do nothing

+ Ease of development

- Zero isolation
Previous approaches: iframes plus postMessage

+ Standardized
+ Strong isolation
+ Simple string-based programming model

- Asynchronous programming model
- Need to layer on top of postMessage
- Performance overhead of object marshaling
Previous approaches: mashup isolation framework

Caja, Object Views, ConScript, ...

+ Built with security in mind
- Policies tend to be complex
- Varying performance and compatibility implications
Goals

- Isolation by default
- Simplicity
- Efficient, synchronous sharing
- Fail-safe legacy code
Design: terminology

- *Principal* is an instance of content
- May include HTML, CSS, JS
- Top-level is *integrator*
- Each principal is placed in a *box*, the unit of isolation
What's in a box?

- JavaScript namespace
- DOM tree
- Event loop
- Visual region
- Network connection
- Local storage area
box != iframe

- Same-origin boxes isolated by default
  - Enables fault isolation, privilege separation

- Box permissions nest
  - e.g., monotonically decreasing network permission

- Synchronous communication
The horror of asynchrony

- N items to process with external library

```javascript
for i in 0 .. N-1
    processed[i] =
        externalLibrary.process(data[i])

function process(data, i) {
    if (i < N) {
        externalLibrary.process(data[i],
            function(result) {
                processed[i] = result
                process(data, i+1)
            }
        )
    }
}
process(data, 0)
```
Design: principal objects

- Each principal has a principal object
  - Defines the public interface
- Jigsaw.getParentPrincipal()
- Jigsaw.principals
Design: DOM tree and visual field

- Each box can have a DOM tree and associated visual field.
- Visual field: width, height, location (within parent), z-order
- Granted using CSS-style syntax
- Parent can change child visual field
- Child changes validated by parent
Design: network access

- Granted from parent to child
- Specified as a whitelist of accessible domains
- Wildcards allowed
  - e.g., *.foo.com or cache.*.bar.com
- Monotonically decreasing
Design: JavaScript namespace

- public/private visibility modifiers
- Define the subset of an object graph that crosses an isolation boundary
- private by default

Principal X passes

```
{public p: "foo",
 private q: "bar"}
```

to principal Y

Principal Y sees

```
{p: "foo"}
```
Design: Surrogate objects

- *Surrogate* objects enforce private/public
- Jigsaw passes surrogate, not raw object, between boxes
  - Initially empty object, with public properties added

- Getter for public \( p \) of \( obj \) returns
  \[
  \text{createSurrogate}(obj.p)
  \]
- Setter for public \( p \) of \( obj \) executes
  \[
  obj.p = \text{createSurrogate}(\text{newVal})
  \]
Design summary

- Isolation by default using boxes
- Principal object defines interface
- Only public properties traverse box boundary
- Resources (e.g., network, visual field) granted by parent to child
Implementation

- **Jigsaw-to-JavaScript compiler**
  - Translate private/public keywords into operations on per-object visibility metadata map
  - Adds calls to create surrogates
  - Maintain object ids and box ids

- **Client-side JavaScript library**
  - Defines management interface (e.g., `Jigsaw.createBox()`)
  - `eval`s box code in context with redefined globals
  - Redefined globals implement security checks

- **Current prototype implements most (but not all) of the design**
Evaluation: porting effort

- Many libraries already have a de facto principal object -- mark it as such
- Mark properties as public where appropriate
- Use a modified runtime to log private objects crossing boundaries, instead of disallowing them
- No explicit sanitization necessary
Evaluation: performance

- Serialize by value
- Surrogates

Time to Pass Object Graph (ms)

- Depth: 4, ObjBr: 2, FuncBr: 2
  - 155 nodes

- Depth: 5, ObjBr: 2, FuncBr: 2
  - 315 nodes

- Depth: 6, ObjBr: 2, FuncBr: 2
  - 635 nodes
Evaluation: performance

![Bar chart showing performance slowdown factors for JSON-RPC, DOM-SQL, AES encrypt, and Mousemove. The chart indicates that DOM-SQL has the highest slowdown factor, followed by AES encrypt and Mousemove, with JSON-RPC having the lowest.]
Related work

- ADsafe
- FBJS
- Dojo Secure
- Caja
- Secure ECMAScript
- PostMash
- Object Views
- ConScript
Conclusion

- Jigsaw: a new mashup isolation framework
- Policies are simple to write
  - public/private objects
  - high-level browser resources
- Synchronous programming model
- Automatic surrogates
Thank you

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