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The Past, Present and Future of XSS Defense

Jim Manico

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Jim Manico

- Managing Partner, Infrared Security
- Web Developer, 15+ Years

- OWASP Connections Committee Chair
- OWASP ESAPI Project Manager
- OWASP Podcast Series Producer/Host

- Kauai/Hawaii Resident with wife Tracey

XSS Defense, Past Exploitable Defenses

- **Input Validation Alone**
  - Sometimes the applications needs to support

    < ' " &

    … and other "dangerous" characters
  - Can be very difficult
    - File upload input
    - HTML inputs

- **HTML Entity Encoding Alone**
  - Works well for untrusted data placed in HTML "normal" contexts
  - Does not stop XSS in unquoted HTML attribute and other contexts

XSS Defense Today: Quite Challenging

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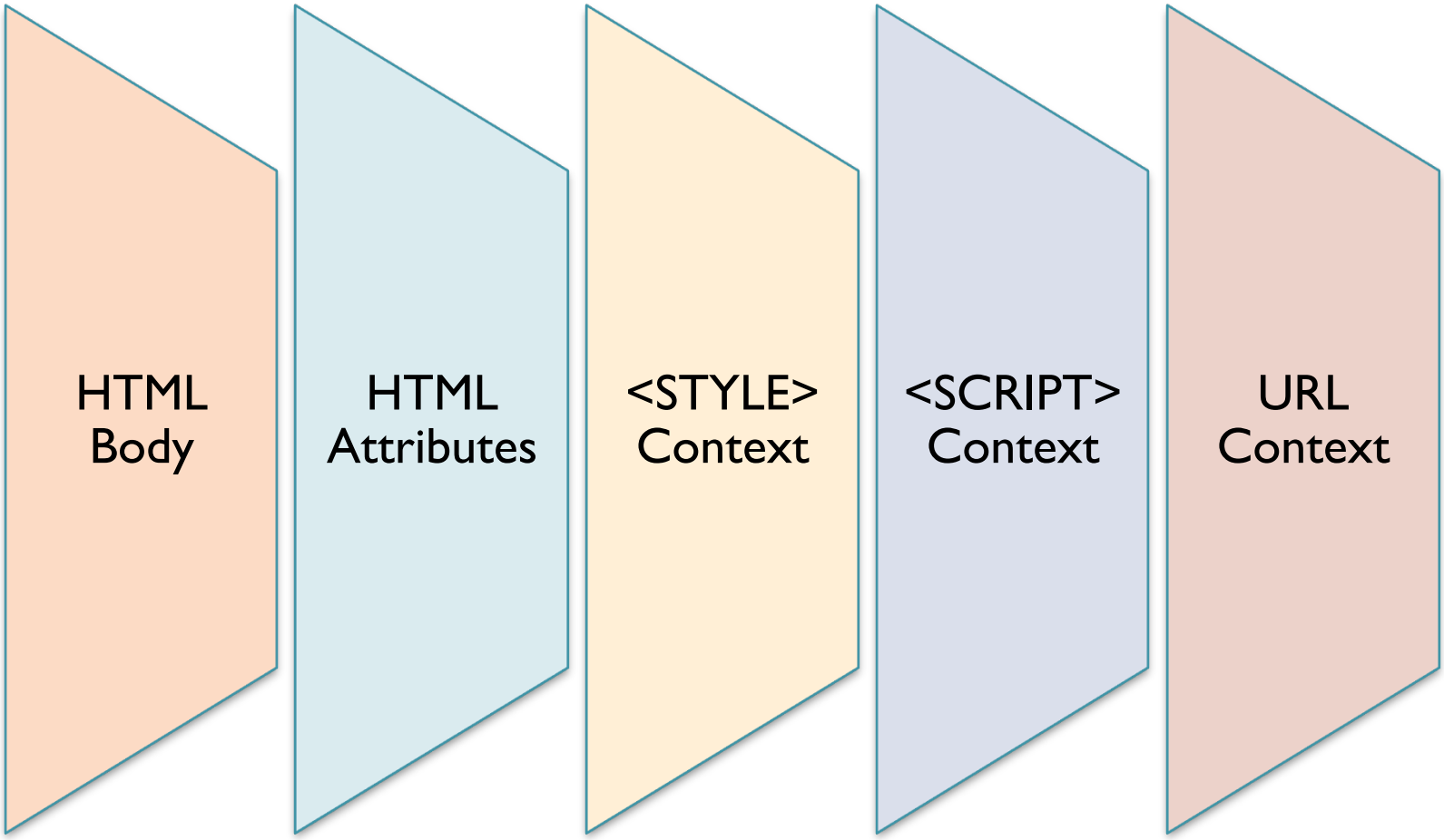
1. **All untrusted data must first be canonicalized**
   Reduced to simplest form

2. **All untrusted data must be validated**
   Positive Regular Expression Rule
   Blacklist Validation

3. **Untrusted data must be contextually sanitized/ encoded**
   - HTML Body
   - HTML Attribute
   - URI Resource Locator
   - Style Tag
   - Event handler
   - Within Script tag

Danger: Multiple Contexts

Browsers have multiple contexts that must be considered!



(1) Auto-Escaping Template Technologies

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- **XHP from Facebook**
  - Makes PHP understand XML document fragments similar to what E4X does for ECMAScript
- **Context-Sensitive Auto-Sanitization (CSAS) from Google**
  - Runs during the compilation stage of the Google Closure Templates to add proper sanitization and runtime checks to ensure the correct sanitization.
- **Java XML Templates (JXT) from OWASP**
  - Fast and secure XHTML-compliant context-aware auto-encoding template language that runs on a model similar to JSP.

Context-aware Auto-escaping Tradeoffs

- **Developers need to write highly compliant templates**
  - No "free and loose" coding like JSP
  - Requires extra time, but increased quality
- **These technologies often do not support complex contexts**
  - Some choose to let developers disable auto-escaping on a case-by-case basis (really bad decision)
  - Some choose to encode wrong (bad decision)
  - Some choose to reject the template (better decision)

(2) Javascript Sandboxing

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- **Capabilities JavaScript (CAJA) from Google**
  - Applies an advanced security concept, capabilities, to define a version of JavaScript that can be safer than the sandbox
- **JSReg by Gareth Heyes**
  - Javascript sandbox which converts code using regular expressions
  - The goal is to produce safe Javascript from a untrusted source
- **ECMAScript 5**
  - Object.seal(obj)
    Object.isSealed(obj)
  - Sealing an object prevents other code from deleting, or changing the descriptors of, any of the object's properties

Google CAJA: Subset of JavaScript

- Caja sanitizes JavaScript into *Cajoled* JavaScript

- Caja uses multiple sanitization techniques
  - Caja uses STATIC ANALYSIS when it can
  - Caja modifies JavaScript to include additional run-time checks for additional defense

CAJA workflow

- The web app loads the Caja runtime library, which is written in JavaScript
- All un-trusted scripts must be provided as Caja source code, to be statically verified and cajoled by the Caja sanitizer
- The sanitizer's output is either included directly in the containing web page or loaded by the Caja runtime engine

CAJA Compliant Applications

- **A Caja-compliant JavaScript program is** one which
  - is statically accepted by the Caja sanitizer
  - does not provoke Caja-induced failures when run cajoled

- **Such a program should have the same semantics whether run *cajoled* or not**

#@$(This

- **Most of Caja's complexity is needed to defend against JavaScript's rules regarding the binding of "this".**
- **JavaScript's rules for binding "this" depends** on whether a function is invoked
  - by construction
  - by method call
  - by function call
  - or by reflection
- If a function written to be called in one way is instead called in another way, its **"this" might be rebound to a different object** or even to the global environment.

JSReg: Protecting JavaScript with JavaScript

- **JavaScript re-writing**
  - Parses untrusted HTML and returns trusted HTML
  - Utilizes the browser JS engine and regular expressions
  - No third-party code

- **First layer is an iframe** used as a safe throw away box
- **The entire JavaScript objects/properties list was whitelisted** by forcing all methods to use suffix/prefix of "$"
- **Each variable assignment was then localized** using var to force local variables
- Each object was also checked to ensure it didn't contain a window reference

(3) Browser Protections

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- **Content Security Policy**
  - JavaScript policy standard
- **Reflective Defense XSS in Chrome**
- **IE 8 Cross-Site Scripting Filter**
  - Blacklist browser-based URL filters
  - Early versions of IE8's browser-based filter actually made XSS possible on sites that did not even have XSS vulns due to errors in MS's filter

Awesomeness: Content Security Policy

- **Externalize all JavaScript within web pages**
  - No inline script tag
  - No inline JavaScript for onclick or other handling events
  - Push all JavaScript to formal .js files using event binding
- **Define the policy for your site** and whitelist the allowed domains where the externalized JavaScript is located
- **Add the X-Content-Security-Policy response header** to instruct the browser that CSP is in use
- **Will take 3-5 years** for wide adoption and support

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THANK YOU!

jim@owasp.org

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