Improving Chrome's Security Architecture

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Web: Safe to visit any site!

Despite...

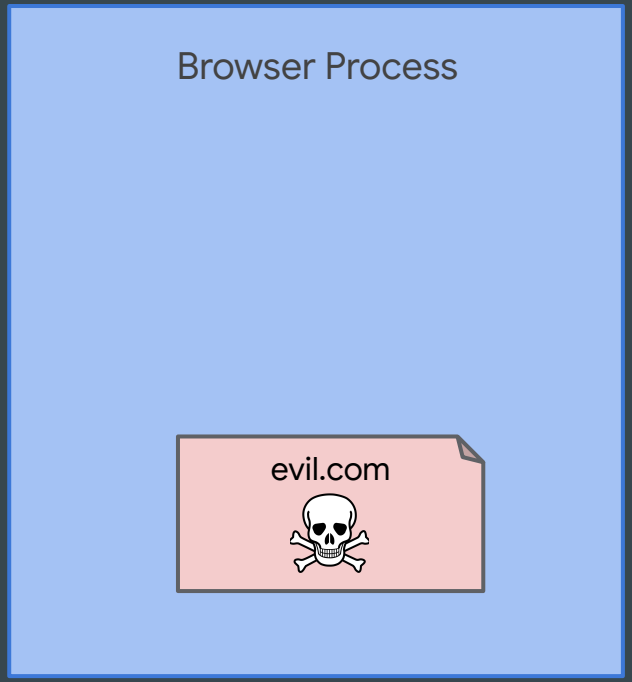
- Running untrustworthy code
- Compiled to native code
- Complex formats to parse
- Built in unsafe C++
- With frequently added APIs

There will be bugs

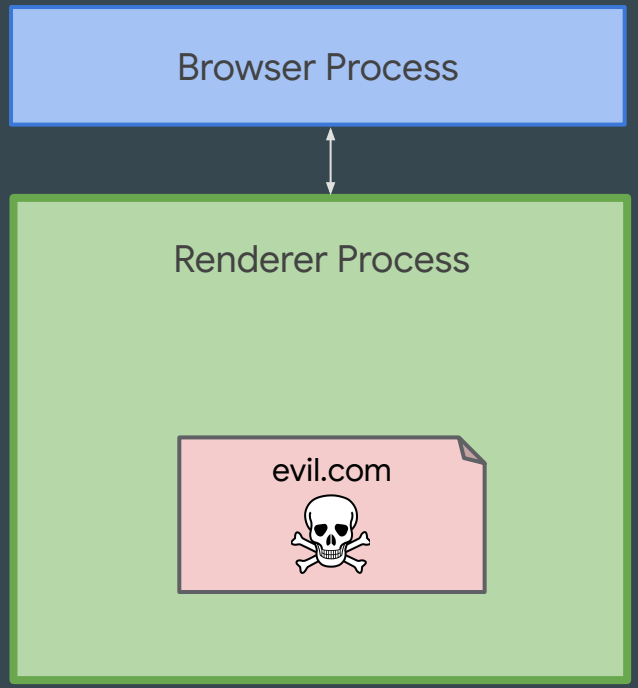
- Finding and fixing bugs is important
  - Fuzzing, VRPs, analysis, etc
  - Automated triage, extensive testing, auto-updates
- **Limiting the damage is equally important**

System Architecture Matters

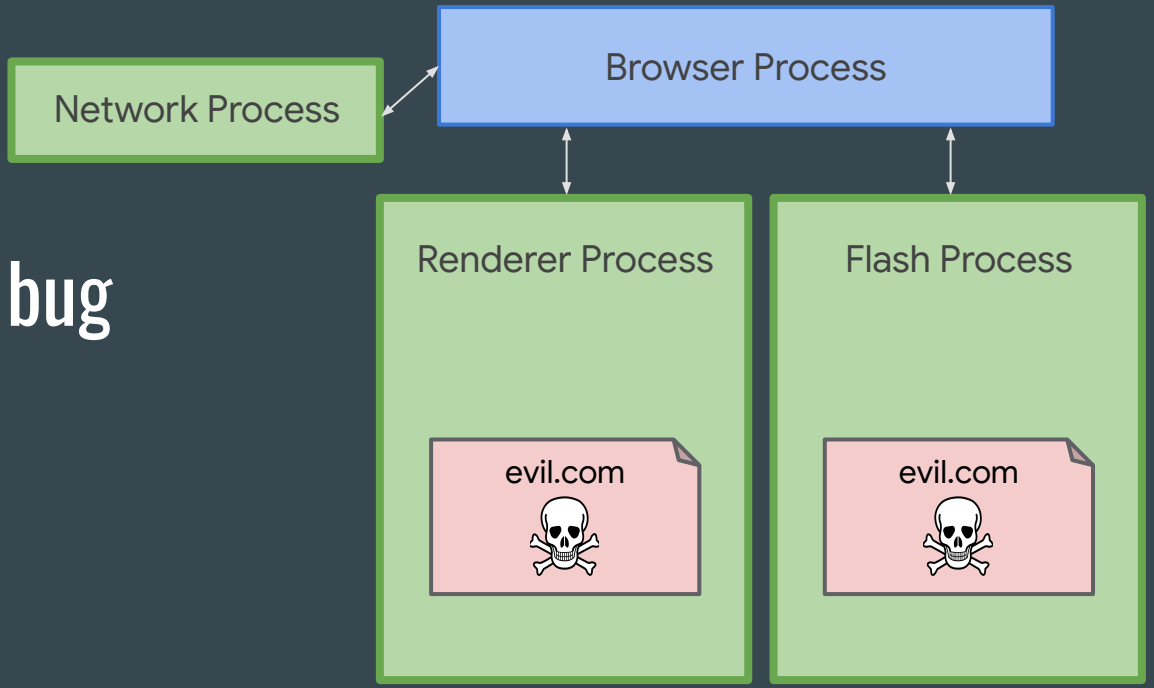
Sandboxes reduce bug severity



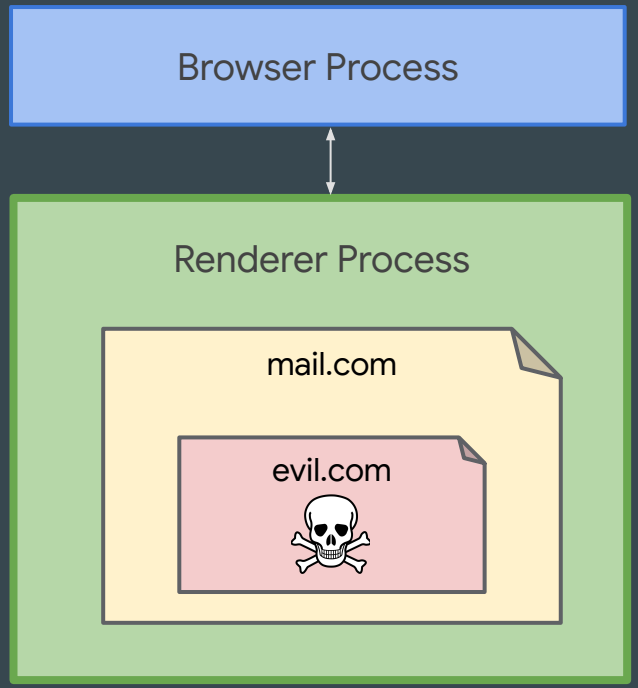
Sandboxes reduce bug severity



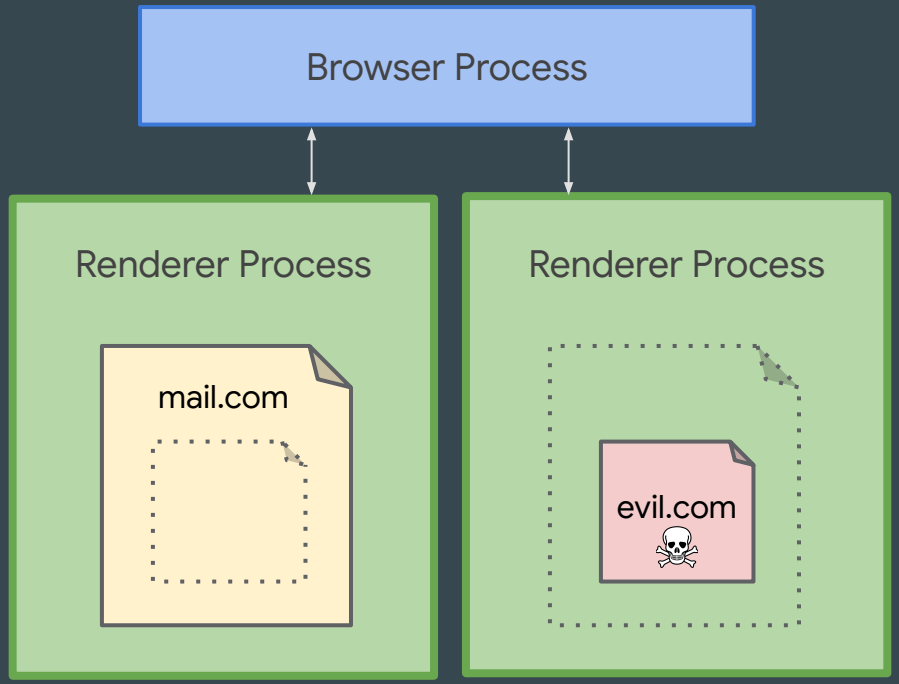
Sandboxes reduce bug severity



Still not a match for web's security model

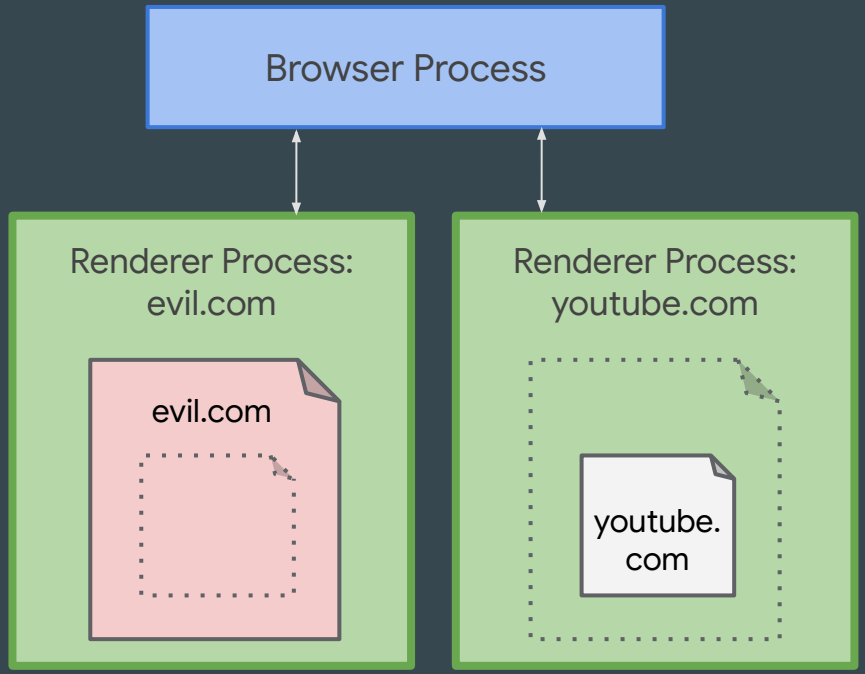


Site Isolation: Multi-principal architecture



Research ⟶ Production

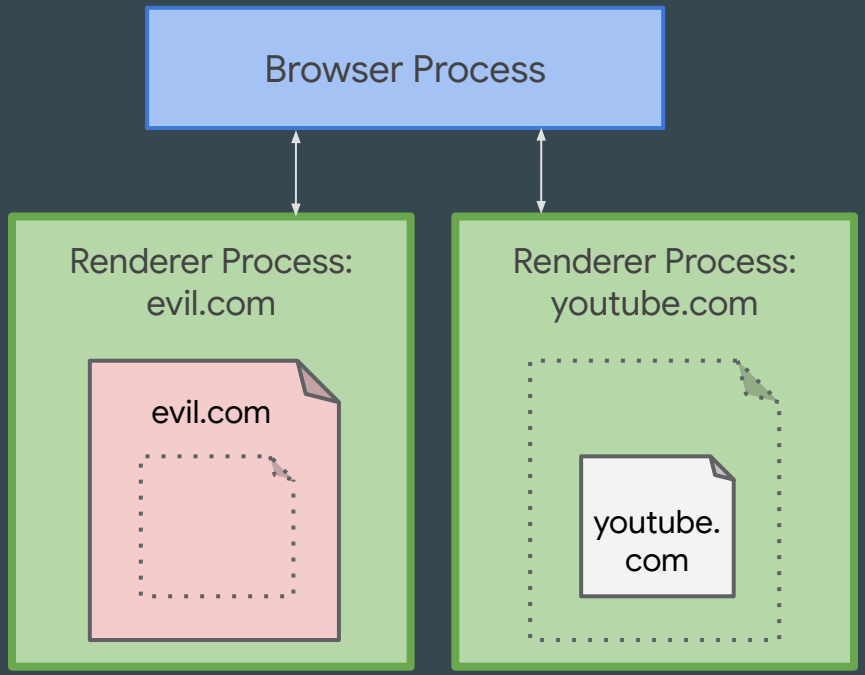
Out-of-process iframes



- Challenging to support web platform
  - Secure compositing
  - Frame proxies
  - State replication

- Accessibility
- Developer tools
- Drag and drop
- Extensions
- Find-in-page
- Focus
- Form autofill
- Fullscreen
- IME
- Input gestures
- JavaScript dialogs
- Mixed content handling
- Multiple monitor and device scale factor
- Password manager
- Pointer Lock API
- Printing
- Task manager
- Resource optimizations
- Malware and phishing detection
- Save page to disk
- Screen Orientation API
- Scroll bubbling
- Session restore
- Spellcheck
- Tooltips
- Unresponsive renderer detector and dialog
- User gesture tracking
- View source
- Visibility APIs
- Webdriver automation
- Zoom

Dedicated renderer processes

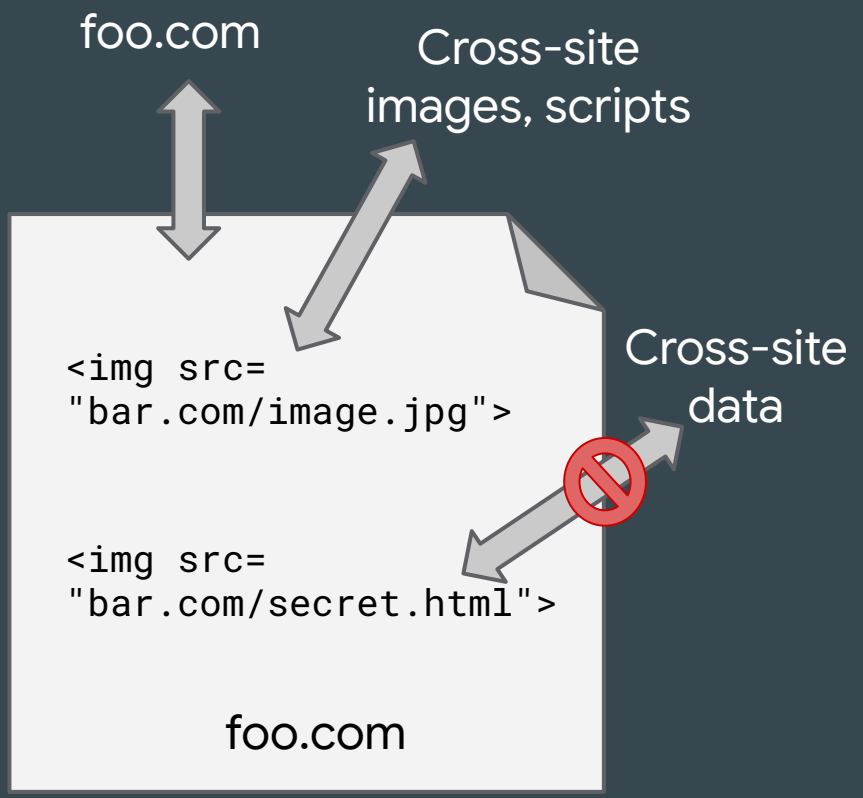


Cross-Origin Read Blocking

- Must allow subresources
- Want to protect sensitive data (HTML, XML, JSON)
- Mislabeled Content-Types
  - Custom sniffing
  - Must allow responses like:

```
Content-Type: text/html
```

```
<!-- This is JS. -->
function a() {...}
```



Site Isolation: Most renderer bugs less harmful

- **Shipped on desktop for all sites** (2018)
- **Shipped on Android for some sites** (2019)
  - More memory constraints on mobile

- Compromised renderers can't access most cross-site valuable data!

- Still some tradeoffs and gaps (e.g., Android WebView)
  - Not ready to lower actual severity of renderer compromise bugs yet

Align with OS

Spectre upends assumptions

- CPU's predictive behavior leaks secrets via cache
- Breaks rules of safe languages
  - Can access any address
- No shortage of transient execution attack types
- Works from JavaScript

Difficult to mitigate Spectre in browser

- **1. Remove precise timers?** (e.g., SharedArrayBuffers)
  - Not effective: Coarse timers can be amplified
  - Harmful to Web Platform

- **2. Compiler/Runtime mitigations?**
  - Not effective: Can't handle all variants

Have to assume access to full address space

- **Site Isolation**
  - Put data worth stealing out of reach
  - Effective for **same-process** variants

- **Align security model with OS/HW enforcements**
  - Hard to trust software boundaries without OS support
  - Reliant on OS/HW mitigations for cross-process variants

Evolve Platform APIs

Push platform towards better security

- HTTPS
  - Encourage adoption
  - Required for powerful features
- Flash deprecation
- Better security APIs

Site Isolation: Constrained by Compatibility

- Site vs Origin
  - **https://google.com** vs https://mail.google.com:443
  - document.domain isn't quite gone yet

- Protecting Cross-Site Data
  - Have to allow through ambiguous resources, for compatibility
  - Not easy to confirm something is JavaScript

Headers, eventually safer defaults

- **Cross-Origin-Opener-Policy**
  - No cross-window scripting. Easier process isolation.
- **Cross-Origin-Resource-Policy**
  - Better hints about what data is accessible cross-origin.
- **Cross-Origin-Embedder-Policy**
  - Enable powerful features (Shared Array Buffers).
  - Don't allow any cross-origin data without opt-in.

Conclusion

- Site Isolation: research to users
  - Compromises needed, but offers best path to protection
- Align security model with OS/HW
- Must push platform forward

- Calls to action:
  - Revisit your architectures
  - Help secure the Web