Site Isolation:

Process Separation for Web Sites within the Browser

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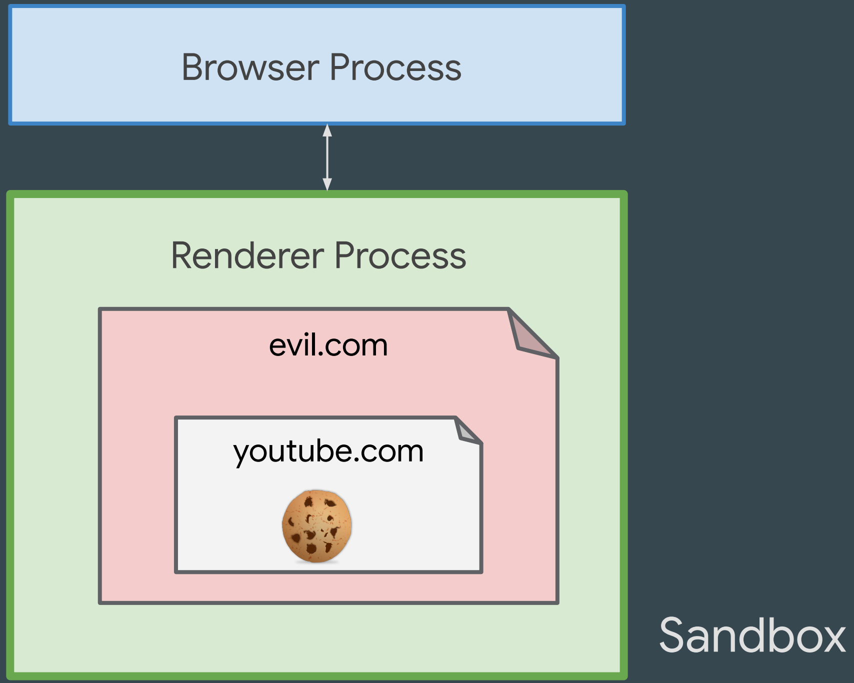
Protecting Web Sites against Strong Attackers

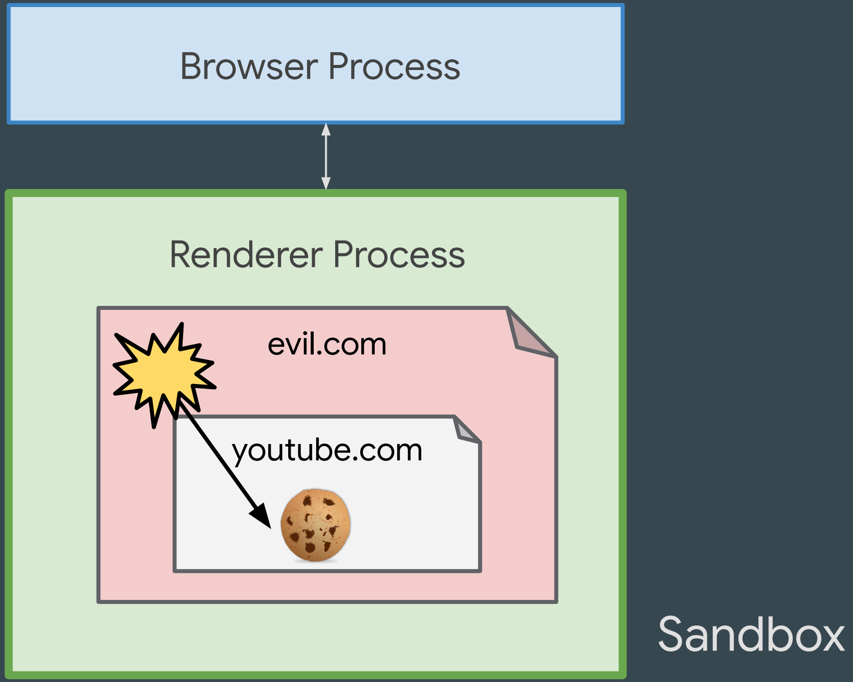
- Rendering engine vulnerabilities are common
- Spectre / transient execution attacks work in the browser

- **Shipped Site Isolation to all Chrome desktop users as mitigation**
  - Overcame challenges beyond prior research browsers
  - Practical to deploy: compatibility, performance
  - Some limitations, but offers the best path to protection

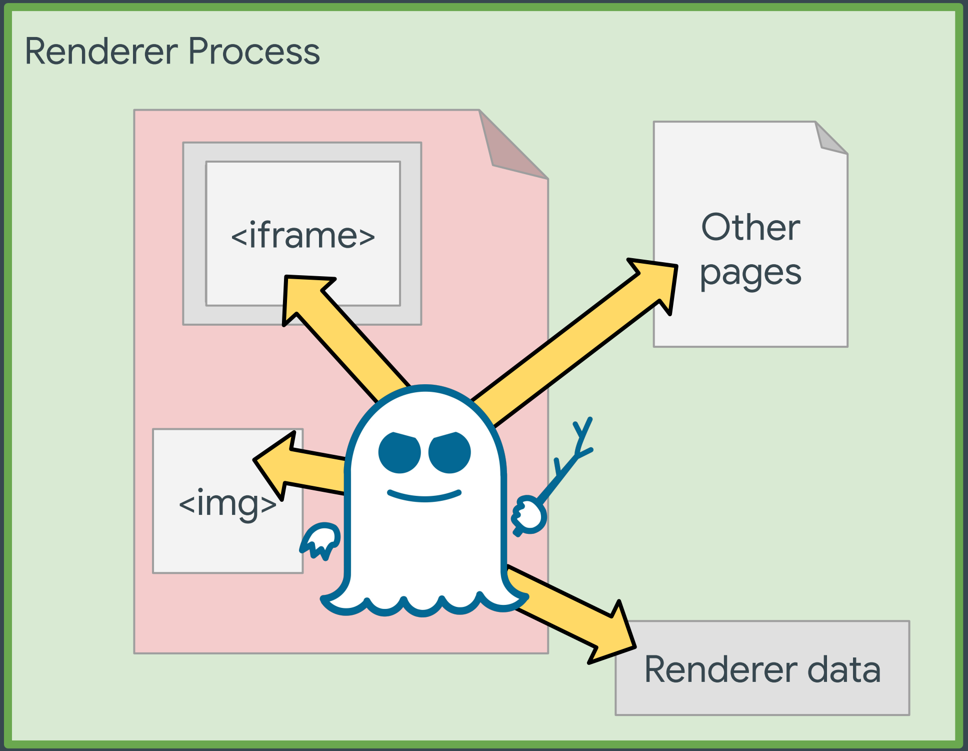
Multi-Process Web Browsers



1. Renderer Exploit Attacker



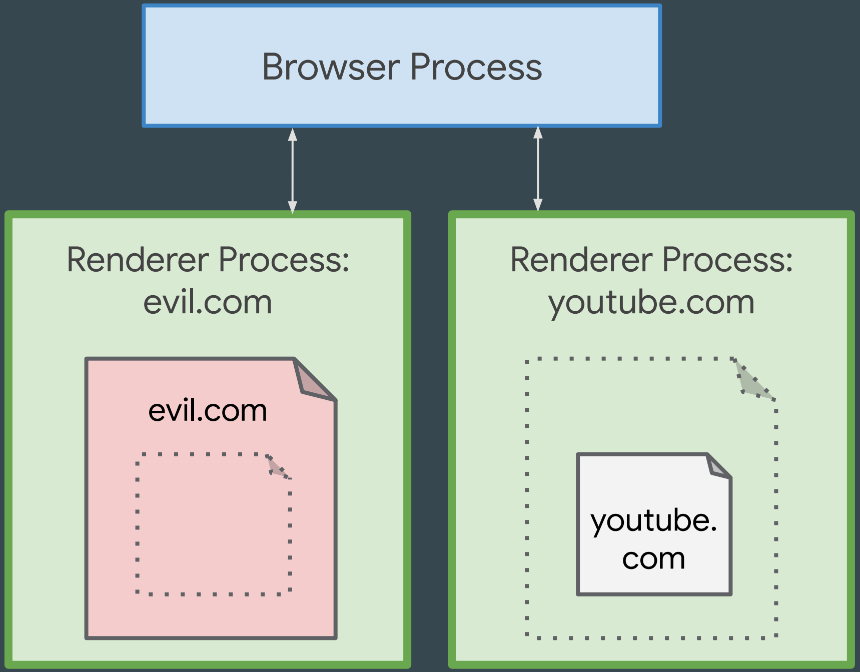
2. Memory Disclosure Attacker



Site Isolation

Site Isolation Architecture

Site-Dedicated Processes



Browser Process

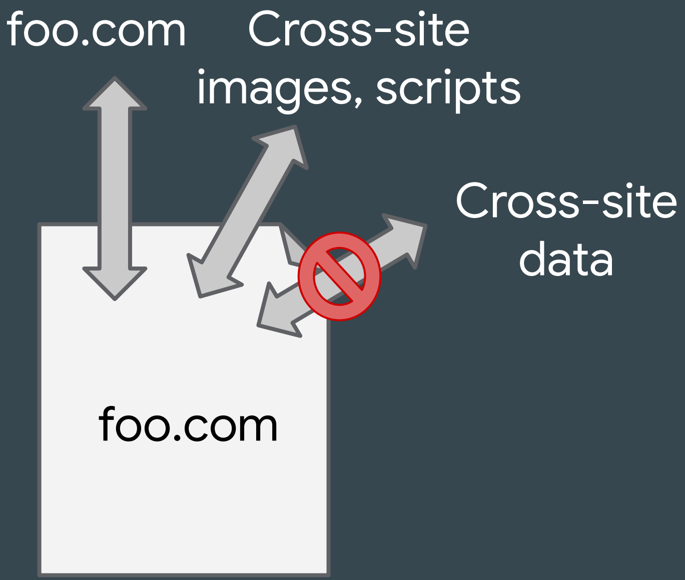
Renderer Process:
evil.com

evil.com

Renderer Process:
youtube.com

youtube.
com

Cross-Origin Read Blocking (CORB)



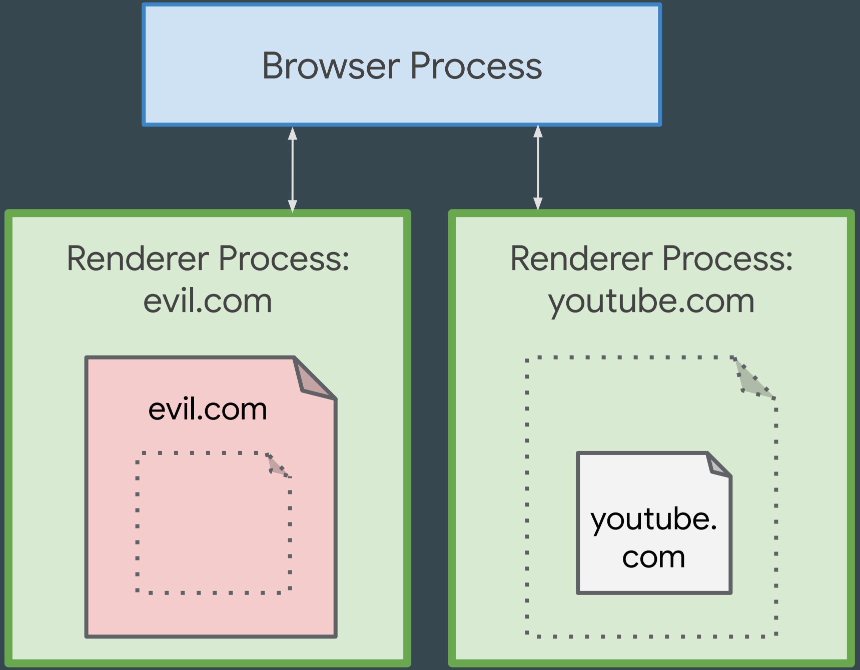
foo.com

Cross-site
images, scripts

Cross-site
data

foo.com

Out-of-process iframes

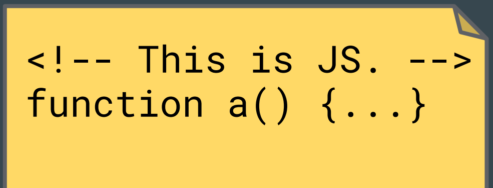


- Challenging to support web platform
  - Secure compositing
  - Frame proxies
  - State replication
  - Many affected features (e.g., find-in-page)

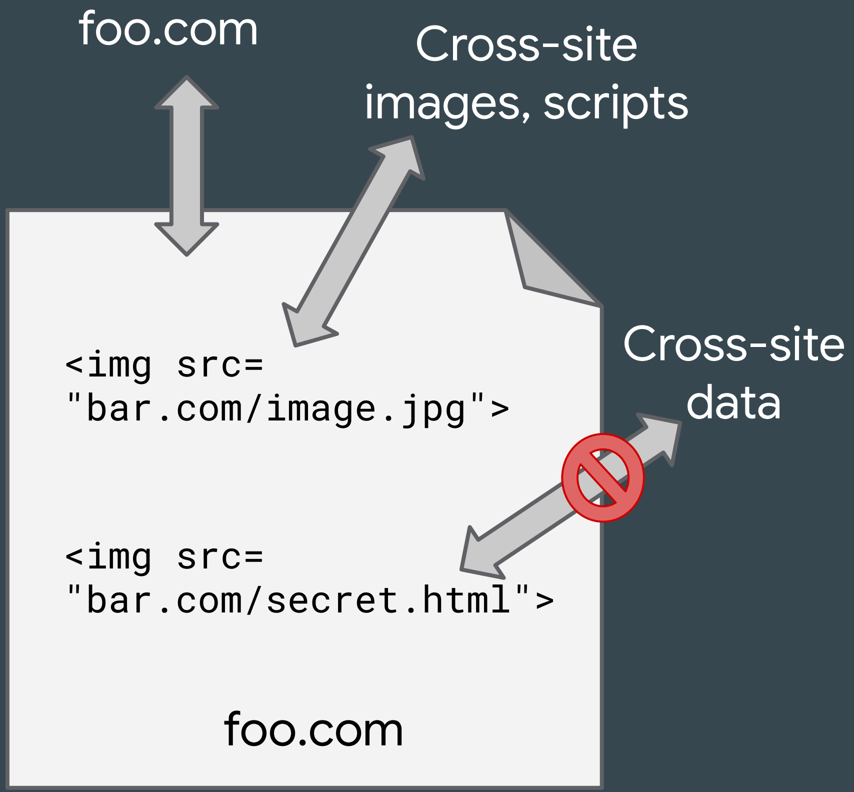
Cross-Origin Read Blocking

- 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() {...}
```



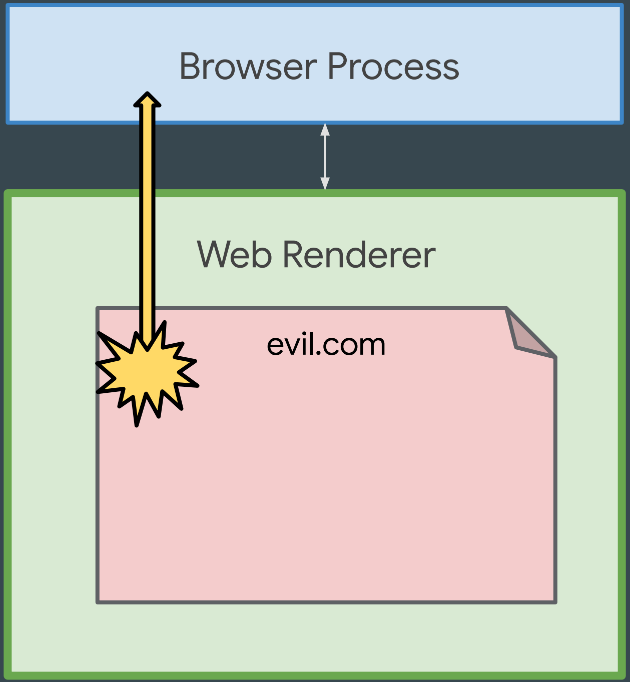
```
<img src=
"bar.com/image.jpg">

<img src=
"bar.com/secret.html">
```

Enforcements

- Catch malicious IPC messages
  - Limit access to site data
  - Terminate misbehaving processes

- Matters for renderer exploits



Evaluation

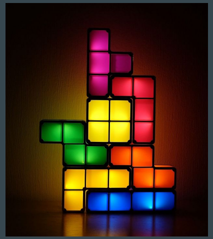
Mitigating Renderer Exploits

- Renderer vulnerabilities matter in practice
  - 94 UXSS-like bugs in 2014-2018

- Web developer practices now robust to renderer exploits:
  - Authentication
  - Confidential data in HTML/XML/JSON
  - Cross-Origin Messaging
  - Anti-Clickjacking
  - Use of storage and permissions

Transient Execution Attacks: Mitigation Strategies

- **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

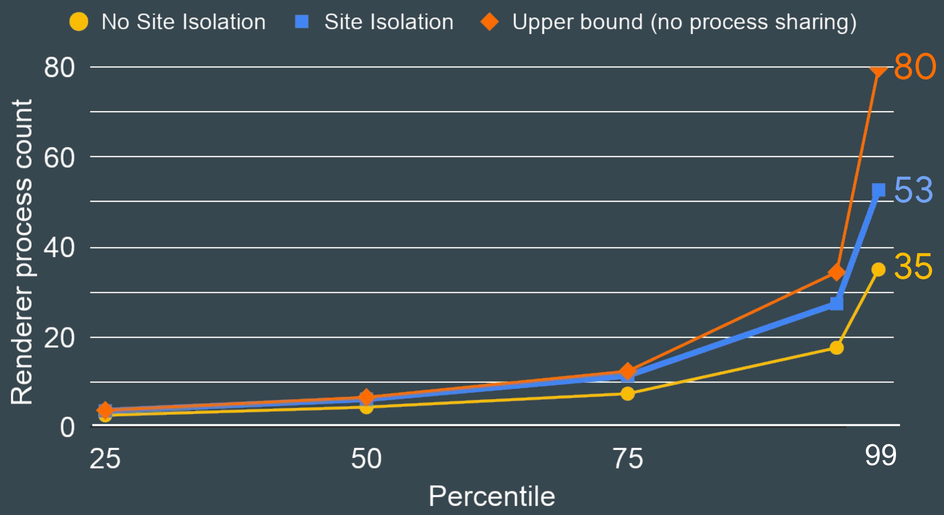
- **3. Site Isolation**
    - Put data worth stealing out of reach
    - Effective for **same-process** variants
    - Combine with OS/HW mitigations for cross-process

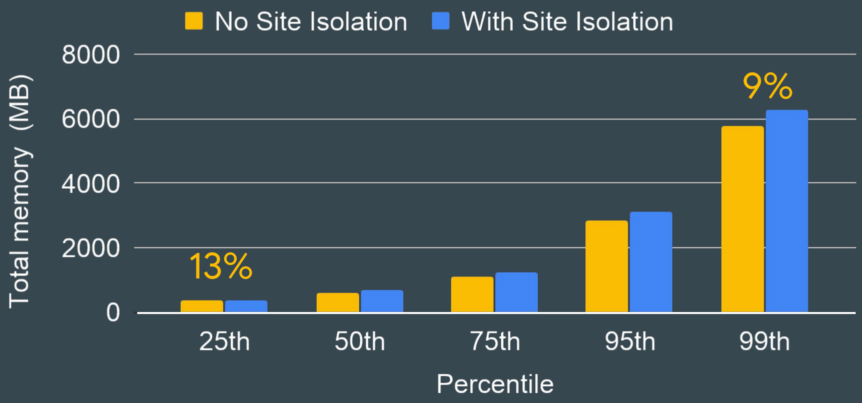
Addressing Limitations

- Sites vs Origins
    - **https://google.com** vs https://mail.google.com:443 (due to document.domain)
    - Opt-in origin isolation
- Many data types are not yet protected
    - Opt-in header, more CORB-protected types, SameSite cookie defaults
- Cross-process transient execution attacks (e.g., MDS)
    - Combine with OS/HW mitigations
- Not yet deployed on mobile devices
    - Preparing to isolate a subset of sites on Android

Practical to Deploy

- Performance Optimizations
  - Reduced potential process count and total memory overhead
  - Reduced latency for navigations and input





Conclusion

- Transient execution attacks change the web threat model

- Site Isolation offers best path to protection
  - Don't leak data to renderer exploits or Spectre attacks
  - Practical to deploy to all Chrome desktop users
  - Need to push further to protect more types of data

- Other systems may want to revisit their architectures
  - Not safe to run untrustworthy code in same process as sensitive data