Detecting Browser-Based Probing Attacks via Behavior Analysis

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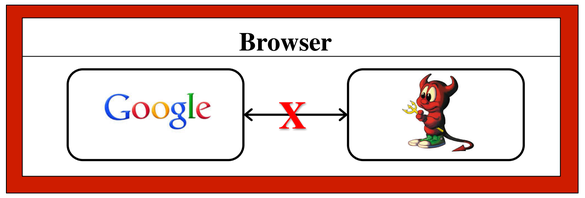
Protection Mechanisms in Browsers

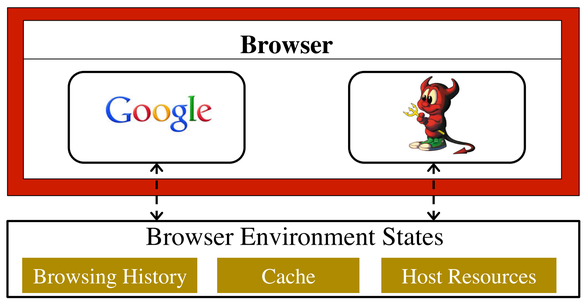
- Same Origin Policy (SOP).
  - Origin is defined by *(protocol, host, port)*
  - SOP prevents one origin from accessing resources in other origins.
- Sandbox confines accesses to browser resources



Preventing *direct* access made by malicious websites.

Indirect Probing of Sensitive Information

- Different origins share the same browser environment
- Sensitive information can be inferred from indirect probing



- History sniffing
- Cache sniffing
- Internal network probing

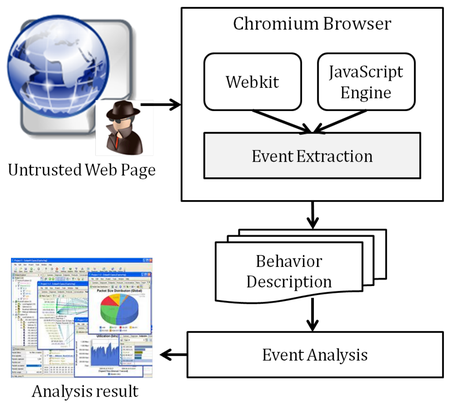
Our Observation

- The “data rate” obtained through probing is very low. Attackers thus need a large amount of repeated operations to extract useful information.
  - History sniffing:
    Repeated enumerating links and checking link color
  - Cache sniffing:
    Repeated accessing web resources
  - Internal network probing:
    Repeated requesting resources from local network

Approach Overview

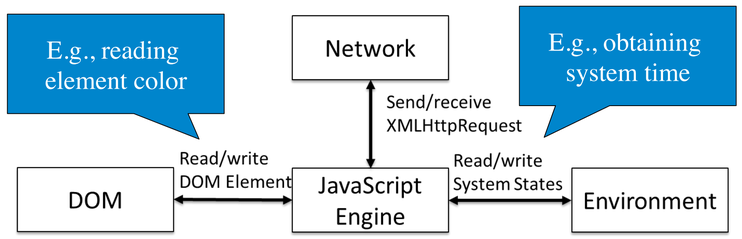
Monitoring untrusted web sites in an instrumented Chromium browser.

- Extracting browser behaviors
  - Security relevant events
  - Descriptive information
- Analysing behavior descriptions
  - Statistics from multiple dimensions
  - Identifying abnormal and unreasonable behaviors



Browser Events

- JavaScript: The driving force in browsers
- Focusing on JavaScript interactions with the rest of browser components
  - DOM, Network, Environment states



Analyzing Behaviors

- Simple statistical analysis on behavior descriptions
  - Number of the repetitive API calls
  - Identifying features distinguishing normal websites from probing ones
  - Challenge: difficulty in benign sites involving large amounts repetitive behaviors
- Multiple dimension analysis on behavior descriptions
  - Analyzing behavior descriptions in different dimensions, e.g., time, involved element, API properties, etc.
  - Establishing heat map representation on different dimensions to detect probing behaviors

Simple Statistics of Browser Events

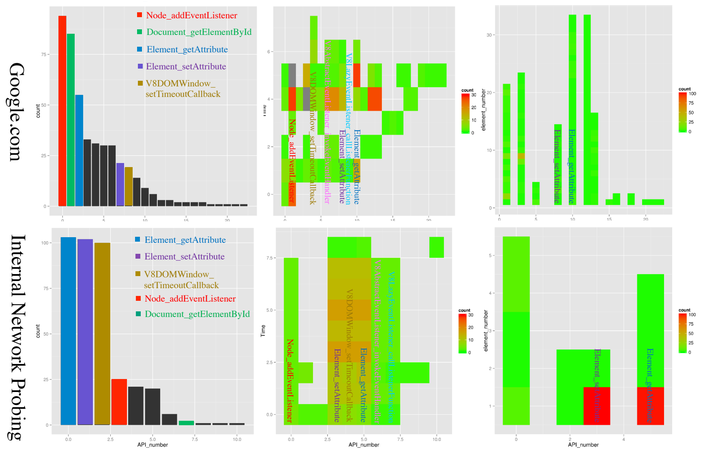
Google.com

API	count
Node_addEventListener	94
Document_getElementById	85
Element_getAttribute	55
HTMLDocument_createElement	33
V8AbstractEventListener_invokeEventHandler	31
V8EventListener_getListenerFunction	30
Node_appendChild	30
Element_setAttribute	21
...	...

Internal Network Probing

API	count
Element_getAttribute	103
Element_setAttribute	102
V8DOMWindow_setTimeoutCallback	100
Node_addEventListener	25
V8AbstractEventListener_invokeEventHandler	21
V8LazyEventListener_callListenerFunction	20
ScriptController_evaluate	6
Document_getElementById	2
...	...

Heat Map View of Results



API-count API-time-count API-element-count

	Google.com	Internal Network Probing
API-count	Some APIs are called much more frequently than the others in both test scenarios	
API-time-count	APIs are called discretely over time	APIs are called continuously over time
API-element-count	APIs spread out on many elements	APIs concentrate on a few elements

Conclusion

- Indirect probing extracts sensitive information in browser environment, with a low “data rate.”
- Detecting browser-based probing behaviors via multiple dimension analysis of browser events.

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