```
nodses the documentation and code related to the
                                  - 3 cc Circline OS, respectively. This site
                      Chromium projects and is intended for developers
                      interested in learning about and contributing to the
                     </div>
                   </div>
                    <table cellspacing="0"
                            class="sites-layout-hbox">
                       <td class=
                             "sites-layout-tile sites-tile-name-content-1">
                                <div dir="ltr">
                                   <b><a href=
                                   "http://www.chromium.org/Home"><span style=
                                    "font-size:large">Chromium<|span><|a> <|b>
                                     Chromium is an open-source browser proje
Headless
                                      aims to build a safer, faster, and mor
                                      way for all users to experience the
                                        site contains design documents, an
                                         OVETViews, testing information,
Chrome
                                          You learn to build and work wi
                                           source code.
```

skyostil@ / alexclarke@ BlinkOn 6

Headless mode

- Browser without a UI
- Able to run in a server environment
- Intended for testing and automation

Out of scope:

Not an embeddable browser widget

Motivation

- Existing solutions
 - Regular browser using virtual framebuffer (xvfb)
 - PhantomJS, NW.js (node-webkit)
 - Frameworks such as Chromium Embedded Framework, QtWebEngine, etc.

Clients

- Selenium & WebDriver
- Karma test runner
- Chromium Telemetry, layout test runner

Motivation

Problems

- High resource usage
- Painful to set up
- No support for modern web features (e.g., ES6, Service Workers, WebGL, ...)
- No auto-updates
- Non-deterministic behavior
- May have less security isolation





Headless Chrome is coming so soon 4!!! Say goodbye to the myriad of hacks to run Chrome and phantom on CI.

bugs.chromium.org/p/chromium/iss ...

1,706 1,944 **1 2 3 3 4 5 5 6 9**

11:47 am - 4 Jun 2016









Headless Chrome is coming so soon $\stackrel{.}{\longrightarrow}$!!! Say goodbye to the myriad of hacks to run Chrome and phantom on CI. C

bugs.chromium.org/p/chromium/iss ...

RETWEETS LIKES 1.706 1,944

11:47 am - 4 Jun 2016

Mountain View, CA

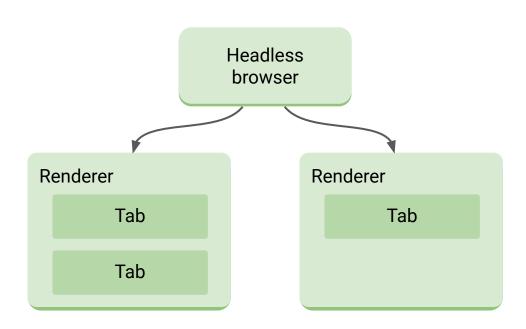
1.7K **1.9**K

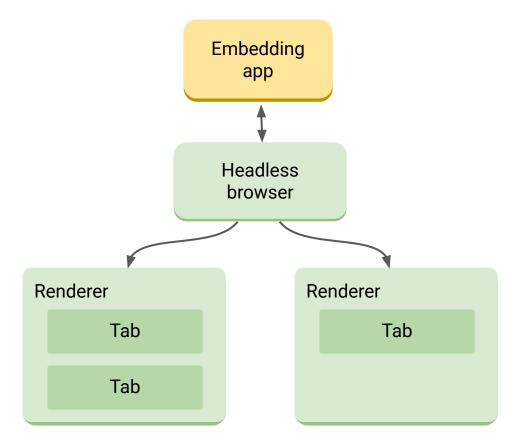


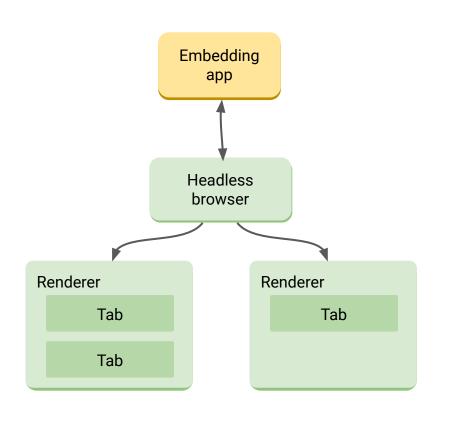
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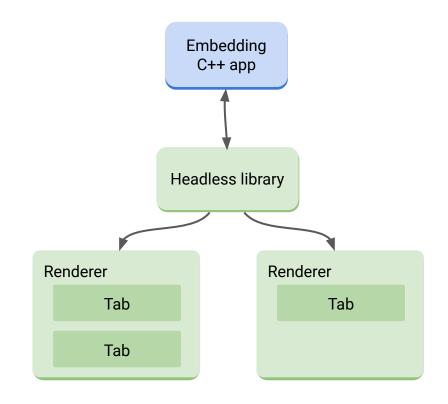
Starred by 169 users

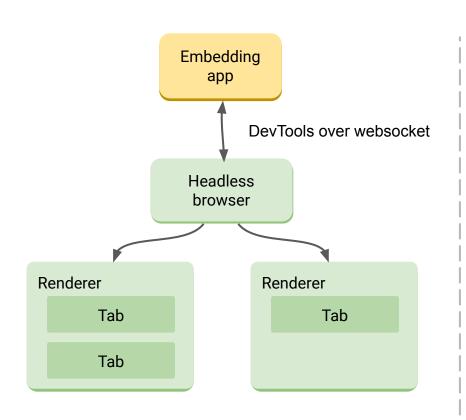
Headless browser

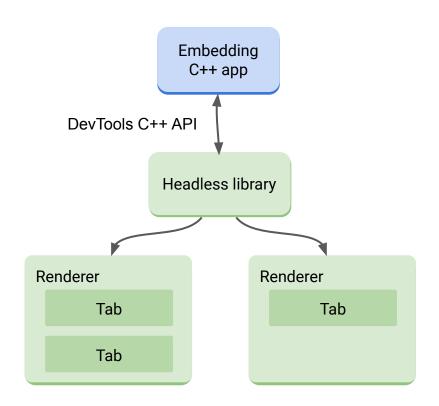


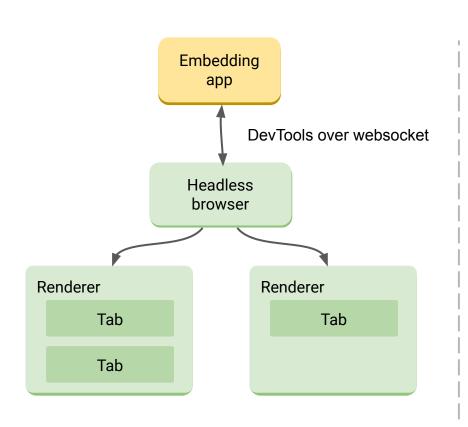


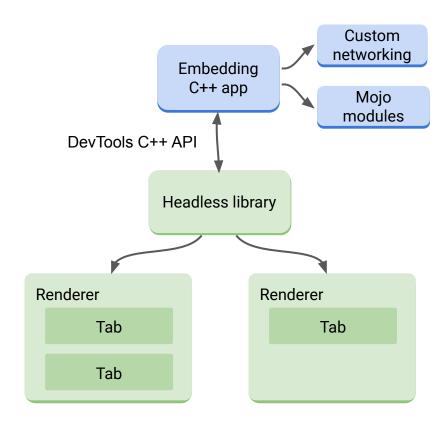




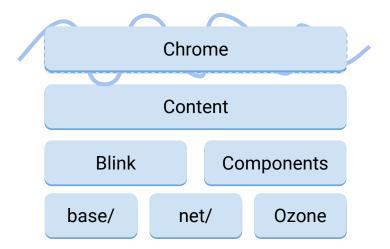




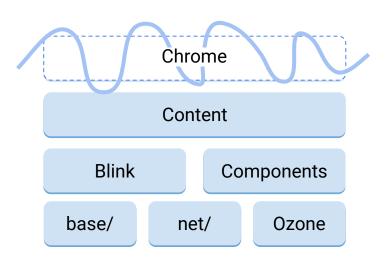




- Differences from regular Chrome
 - No Chrome-level features (e.g., profiles, sync, safe browsing, ...)
 - No UI -- offscreen software rendering
 - No extensions (for now)
 - No audio



- Differences from regular Chrome
 - No Chrome-level features (e.g., profiles, sync, safe browsing, ...)
 - No UI -- offscreen software rendering
 - No extensions (for now)
 - No audio
- What you do get:
 - Everything below the content layer
 - Blink with the latest web platform awesomeness
 - Profiling and introspection tools (DevTools UI, tracing, etc.)



Headless additions

- More DevTools API capabilities for everyone
 - Web data extraction
 - DevTools forwarding
 - Opening and closing tabs
- Determinism
 - Session isolation
 - Virtual time
 - Deterministic time, date, random numbers, etc.
- DevTools bindings for C++ and Javascript
- Network customization (C++)
- Mojo modules (C++)

Web data extraction

- More flexible screenshots
 - Layout & visual viewport controls
- DOM dumping
 - Atomic snapshotting of the DOM for the entire page
- Chrome traces
- Resource fetches
- More data about the layout tree

For other uses, see Headless Horseman (disambiguation).

This article's introduction section may not adequately summarize its contents. To comply with Wikipedia's lead section guidelines, please consider modifying the lead to provide an accessible overview of the article's key points in such a way that it can stand on its own as a concise version of the article. (discuss), (December 2014)

The headless horseman has been a most of European folklore since at least the Middle Ages

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In Celtic folklore rear The Irish dullahan or dulachán ("dark man") is a headless fairy, usually riding a black horse and carrying his head under his inner

2 In German folklore 3 In American tolkion 4. In popular culture 4.2 Television 5 See also 6 Notes

lower thigh (or holding it high to see at great distance). He wields a whip made from a human corpse's spine. When the dullahan stops riding, a death occurs. The dullahan calls out a name, at which point the named person immediately dies.[7] In another version, he is the headless driver of a black carriage. [3] A similar figure, the gan ceann ("without a head"), can be frightened away by wearing a gold object or putting one in his path.[4] The most prominent Scotlish tale of the headless horseman concerns a man named Ewen decapitated in a clan battle at Glen Cainnir on the Isle of Mull. The battle denied him any chance to be a chieflain, and both he and his horse are headless in accounts of his haunting of the area.[5]

Sir Gawain and the Green Knight is a Middle English poem that involves a decapitation myth. (Killimproper synthesis?)

In German folklore

The German Legends of the Brothers Grimm (Deutsche Sagen) recount two German folk tales of a headless horseman being

One is set near Dresden in Saxony. In this tale, a woman from Dresden goes out early one Sunday morning to gather acoms in a forest. At a place called "Lost Waters", she hears a hunting horn. When she hears it again, she turns around and she sees a headless man in a long grey coat sitting on a grey horse

In another German tale, set in Brunswick in Lower Savony, a headless horseman called "the wild hurbaman" blows a horn to warn hunters not to ride the next day, because they will meet with an accident.

In some German versions of the headless horseman, he seeks out the perpetrators of capital crimes. In others, he has a pack of

In American folklore [edt]

Main article: Headless Horseman (Legend of Sleepy Hollow)

The Headless Horseman is a fictional character from the short story "The Legend of Silvery Hollow" by American author Washington Irving, The story, from Irving's collection of short stories entitled The Sketch Book of Geoffrey Crayon, Gent., has worked itself into known American folklore/legend through literature and film.

The legand of the Headless Horseman begins in Sleepy Hollow, New York, during the American Revolutionary War. Traditional folklore holds that the Horseman was a Hessian artilleryman who was killed during the Battle of White Plains in 1776. He was decapitated by an American cannonball, and the shattered remains of his head were left on the battlefield while his comrades hastily carried his body away. Eventually they buried him in the cemetery of the Old Dutch Church of Sleepy Hollow, from which each Halloween night be rises as a malevolent phost, furiously seeking his lost head [7]

In popular culture [set]

The comic book series Chopper, written by Martin Shapiro, is a modern-day reimagining of the headless horseman. It features a headless outlaw biker on a motorcycle who collects the sculs of sinners. The only people who can see him are those who have consumed a strange new Eostasy-like drug that triggers their sixth sense and opens a gateway to the afferlife. During the hallucinogenic high, any characters who have committed significant sins are hunted by the headless chost. Once the drug wears of the victim is safe and beyond the headless horseman's ghostly reach, [8][9][10]



The Kolchak: The Night Staker episode "Chopper" (initially broadcast on January 31, 1975)^[11] features a headless motorcyclin who enacts revenge for the loss of his head on a rival biker gang, [12][13] 20 years after his murder.[14]

In the Midsomer Murders episode "The Dark Rider", a killer lures several victims to their deaths by massuerading as a headless horseman from local legend [15]

See also [out]

- . cephalophore, beheaded Christian martyred saints . Saints Gemolo and Himerius of Bosto
- . Dullahan, a similar figure from Irish Folklore
- . Mandana Mala, a character in Brazilian folklore
- . List of abosts

. List of abost films

Notes [edt] 1. A "Headless Horseman" @ Muthical Creatures Guide

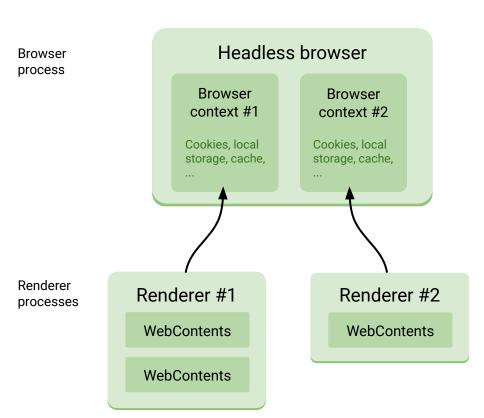
- 2. * The Dullahan Ireland's Headless Horsemany at Scary For Kids 3. A The Dullahan of at Shee-eire.com
- 4. A McKBion, James & Dictionary of Ceitic Mathoiney, 2004, cited at ear coasts 6
- 5. * Fox, David The Headless Horsemang at Federated Caledonian Societies South Africa 6. A "Sir Gawain And The Green Knight", Page 194, The Norton Anthology of English Literature, 9 Ed., Volume A: The Middle Ages 7. * Steiner, Henry John (24 January 2014). "A Phantom is Born? 235 Years Ago" & River Journal (Tarrytown, NY: River Journal Inc.)
- Retrieved 14 October 2011.
- 9. A "Chopper" g. CornicBookDB.com. Retrieved 2013-03-11.



- 8. A Shapiro, Martin (2011), Chooper, Asulum Press, ISBN 978-1-61724-110-9

Determinism: Session isolation

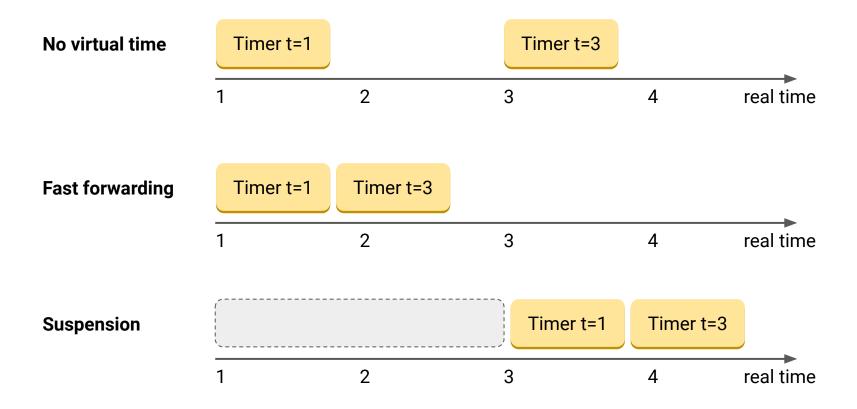
- Save resources by running parallel sessions in a single browser
- Each session gets unique
 - Cache
 - Cookies
 - Local storage
 - 0 ...
- Session serialization
 - Avoids need to restart browser or mess with file system to get a clean state



Determinism: Virtual time

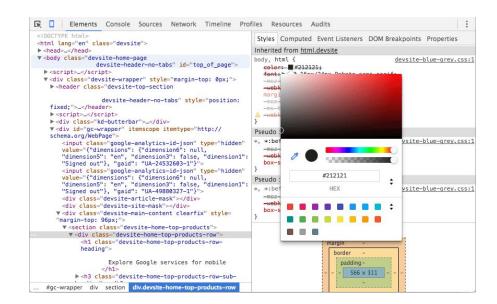
- Timers can use virtual time instead of real time
- Examples
 - Fast-forward time to speed up page loading
 - Stop time while network requests are pending
 - Suspend and resume renderer

Determinism: Virtual time

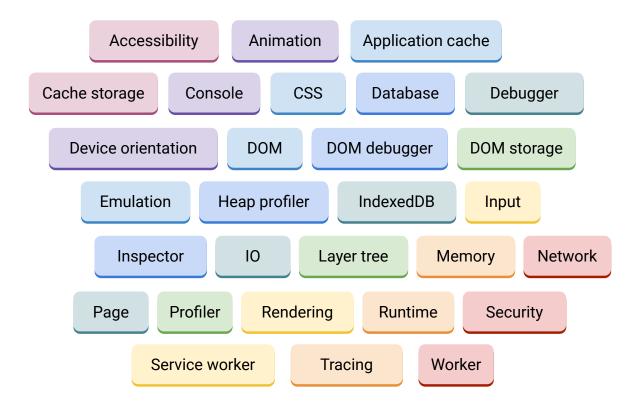


Controlling the browser: DevTools protocol

- Magic behind Chrome Developer Tools
- Allows controlling, inspecting and debugging pages
- Commands, events



Controlling the browser: DevTools protocol



DevTools client

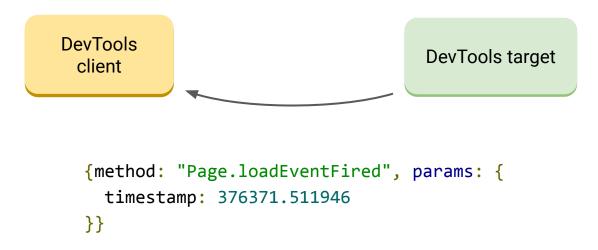
DevTools target

```
{id: 1, method: "Runtime.evaluate", params: {
    expression: "1 + 1"
}}

DevTools
client

DevTools target
```

```
{id: 1, method: "Runtime.evaluate", params: {
    expression: "1 + 1"
 }}
  DevTools
                                       DevTools target
   client
{id:1, result: {
   result: {
     type: "number", value: 2, description: "2"
   },
  wasThrown: false
}}
```



- Two flavors
 - o C++
 - Javascript
- Type-safe
- Generated for a specific protocol version
 - Backwards compatible
- Stable and experimental APIs

```
C++
```

```
client->GetRuntime()->Evaluate("1 + 1", base::Bind(&OnResult));

void OnResult(std::unique_ptr<headless::runtime::EvaluateResult> result) {
    std::string value;
    result->GetResult()->GetValue()->GetAsString(&value);
    std::cout << value << std::endl;
}</pre>
```

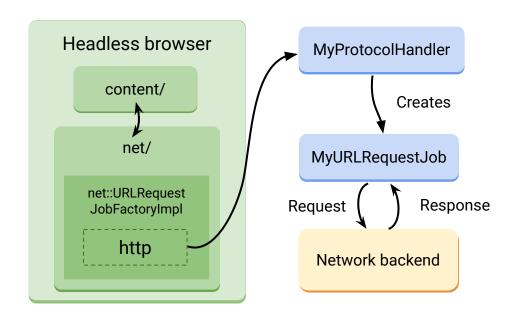
```
C++
       client->GetRuntime()->Evaluate("1 + 1", base::Bind(&OnResult));
       void OnResult(std::unique ptr<headless::runtime::EvaluateResult> result) {
           std::string value;
           result->GetResult()->GetValue()->GetAsString(&value);
           std::cout << value << std::endl;</pre>
       client.runtime.evaluate("1 + 1").then(response => {
JS
         console.log(response.result.value);
       });
```

```
C++
       client->GetRuntime()->Evaluate("1 + 1", base::Bind(&OnResult));
       void OnResult(std::unique ptr<headless::runtime::EvaluateResult> result) {
           std::string value;
           result->GetResult()->GetValue()->GetAsString(&value);
           std::cout << value << std::endl;</pre>
       let response = await client.runtime.evaluate("1 + 1");
ES6
       console.log(response.result.value);
```

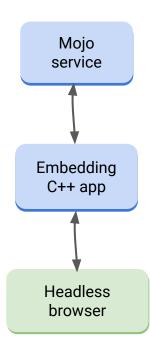
```
C++
       client->GetPage()->Enable();
       client->GetPage()->AddObserver(this);
       void MyObserver::OnLoadEventFired(
           std::unique ptr<page::LoadEventFiredParams> params) override {
         std::cout << params->GetTimestamp() << std::endl;</pre>
       client.page.enable();
JS
       client.page.addLoadEventFiredListener(params => {
         console.log(params.timestamp);
       });
```

Network customization (C++)

- Implement custom handlers for http://, https://, file://, ...
- Examples
 - Fetch pages from disk instead of the internet
 - Replace specific resources
 - Runtime generated response (e.g., for a test harness)



- Provide JS bindings to C++ objects
- Examples
 - Test runner objects (e.g., testRunner.dumpAsText())
 - Host OS interfaces (e.g., enabling airplane mode)



Mojo service

Renderer

```
module example;
MyService {
   SendTestResults(string result);
};
```

Mojo service

Renderer

```
module example;

MyService {
    SendTestResults(string result);
};

Mojo
    Renderer

Mojo.example.MyService.then(service => {
    service.sendTestResults("all passed");
});

Renderer
```

```
JS
 .mojom
                                           Mojo.example.MyService.then(service => {
module example;
                                             service.sendTestResults("all passed");
MyService {
                                           });
  SendTestResults(string result);
};
                        Mojo
                                                           Renderer
                        service
 C++
class MyServiceImpl : public example::MyService {
  void SendTestResult(const mojo::String& result) override {
    EXPECT EQ("all passed", result.get());
```

Distribution

Chrome in headless mode

```
$ chrome --headless --remote-debugging-port=9222
```

- Doesn't quite exist yet
- Experimental version: Headless Shell

- C++ library
 - Lives in headless/ in the Chromium repository
 - Distributed as source code (no stable ABI)
 - See headless/README.md (<u>bit.ly/23LR2pW</u>)

Future work

- Finish all the things we promised in these slides :)
- Test harness integration (WebDriver, Selenium)
- Windows & OSX macOS support
- Node.js package
- Reduce memory footprint
- WebGL (software rendering and/or offscreen GPU)
- Chrome extensions (maybe)
- Trace analysis for guiding performance optimization

Give it a try

```
$ mkdir -p out/Debug
$ echo 'import("//build/args/headless.gn")' > out/Debug/args.gn
$ gn gen out/Debug
$ ninja -C out/Debug headless_shell
$ out/Debug/headless shell https://www.chromium.org
```

Mailing list: headless-dev@chromium.org (bit.ly/1ZBcyLx)

Documentation: bit.ly/23LR2pW Bug label: Proj-Headless