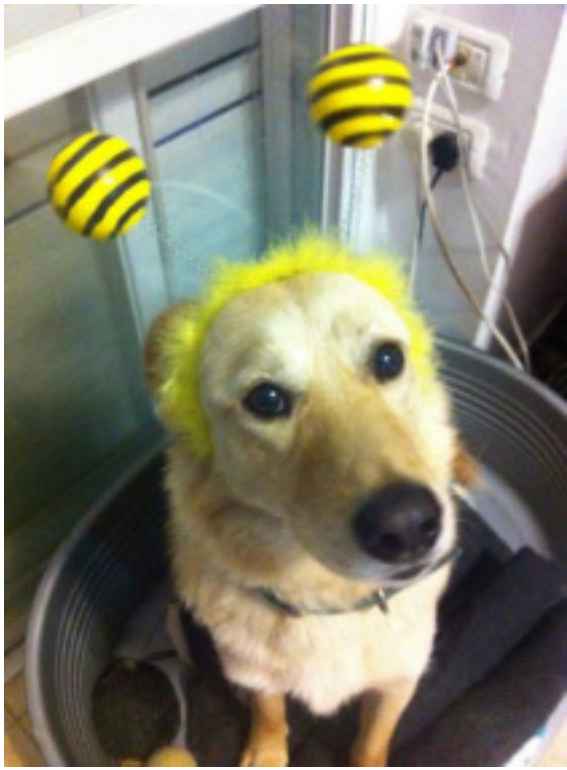
Exploring the Debugger Protocol for Test Authoring

Benjamin Gruenbaum

About me



Sinon.JS

testim

מגיימים
תכנית הסייבר הלאומית

then

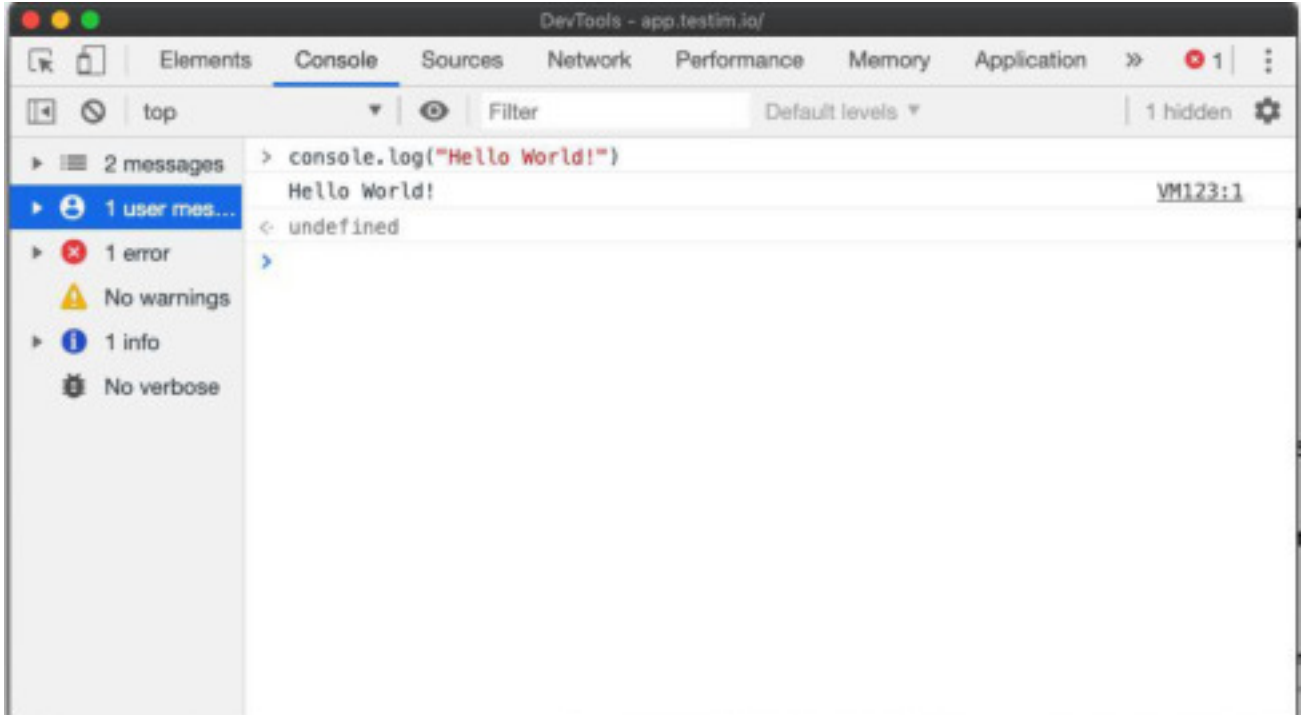
Disclaimer

C++ Ahead
Not a lot, stay with me.

Disclaimer

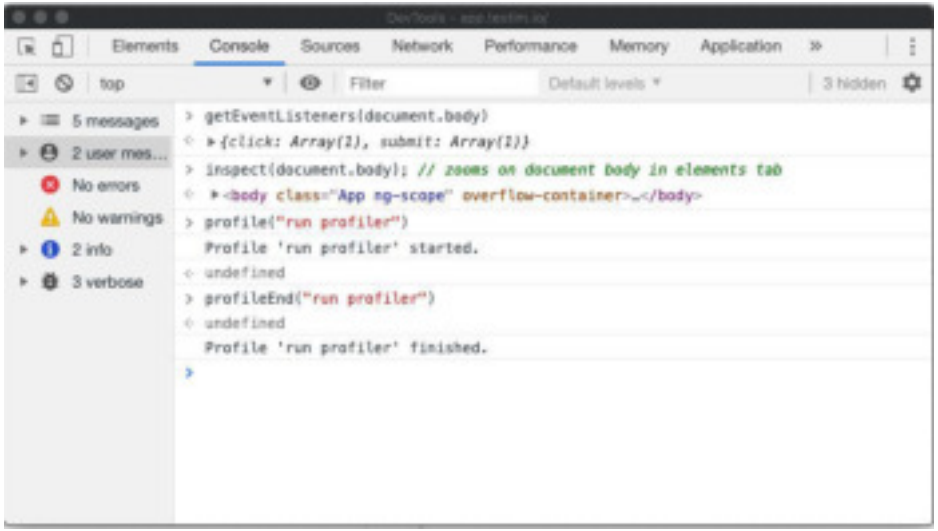
The code ahead has been modified for brevity (logging removed etc)

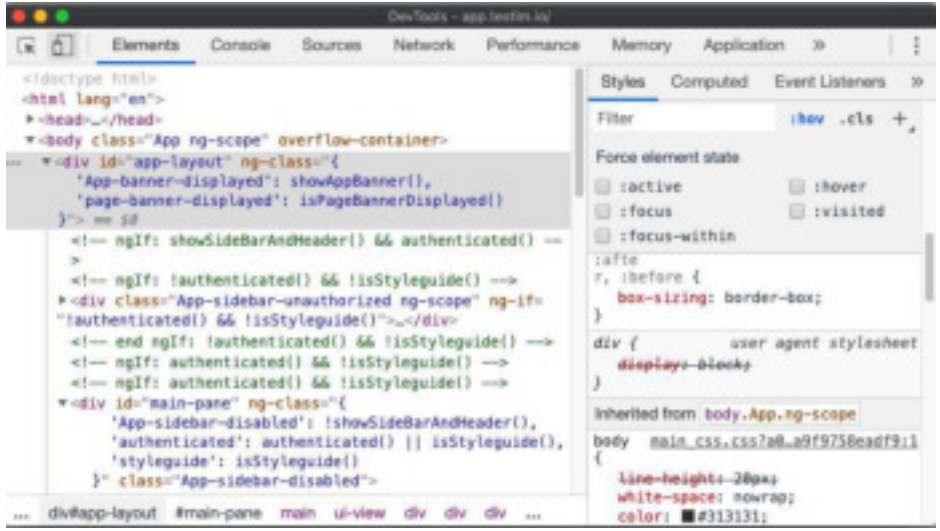
The DevTools



What happens when you enter a command in the devtools?

The Devtools has superpowers!

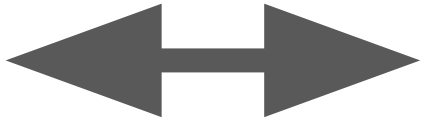




How does it work?

Chrome Extension that lives in Chromium

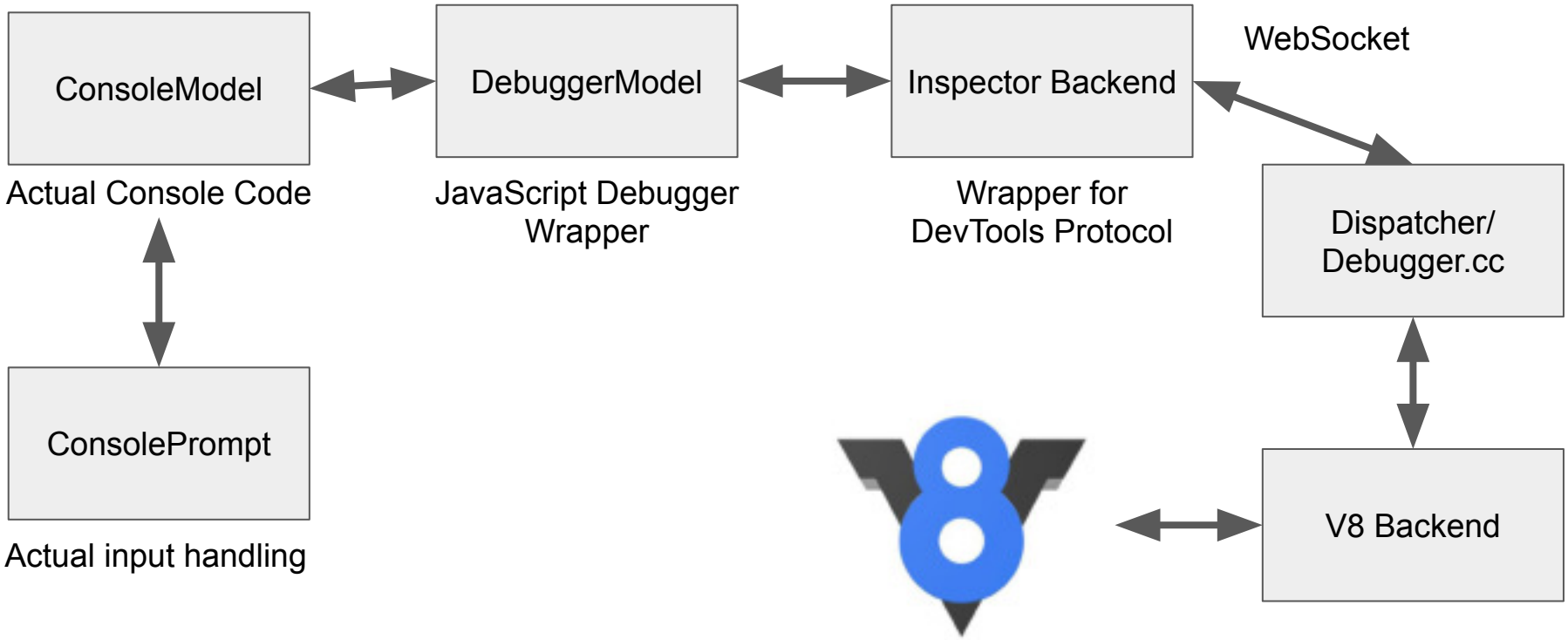
WebSocket



Page Context

So what actually happens?

How does it work?

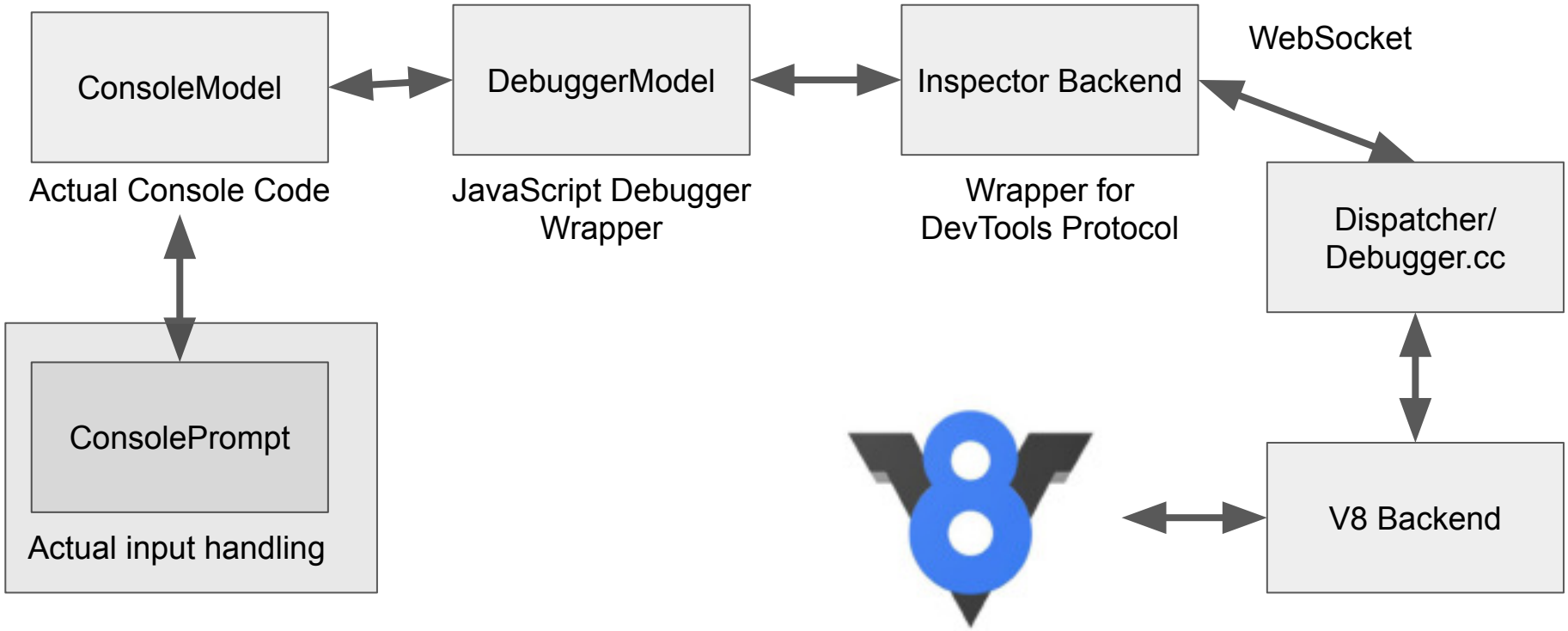


Why not “eval?”

You enter a command and press “enter”

- The devtools is itself a Chrome extension
- Its source lives in the Chromium repo like most of Chrome, which is open source
- Its source code is accessible, there are instructions for hacking on it in a google doc and it’s easy to get started locally.
- There is a GitHub mirror for ease of usage since Chromium is a large and “scary” project

How does it work?



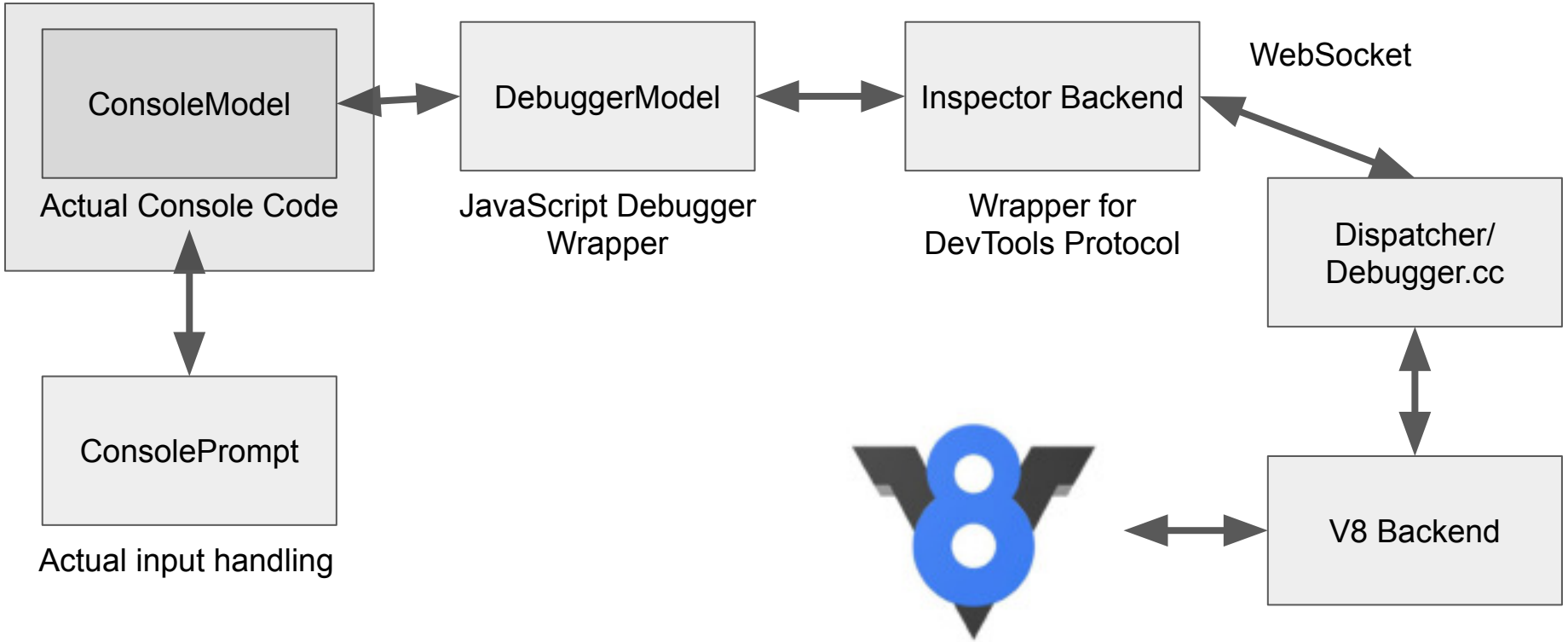
You enter a command and press “enter”

```
async _enterKeyPressed(event) {
  ...
  ...
  if (await this._enterWillEvaluate())
    await this._appendCommand(str, true);
  else
    this._editor.newlineAndIndent();
  this._enterProcessedForTest();
}
```

You enter a command and press “enter”

```
async _appendCommand(text, useCommandLineAPI) {
    this.setText('');
    const currentExecutionContext = flavor(SDK.ExecutionContext);
    const message = addCommandMessage(executionContext, text);
    const wrappedResult = await preprocessExpression(text);
    evaluateCommandInConsole(executionContext, message,
wrappedResult.text, useCommandLineAPI, /* awaitPromise */
wrappedResult.preprocessed);
}
```

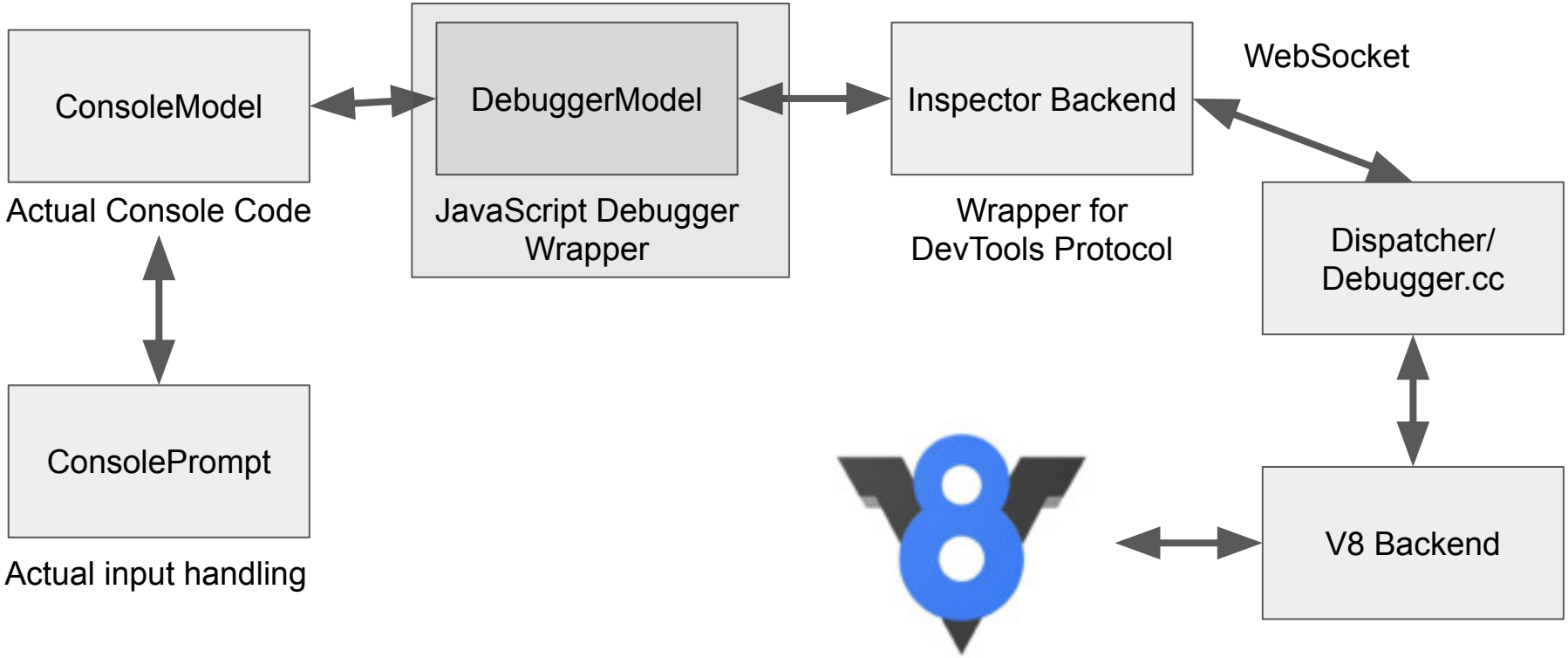
How does it work?



You enter a command and press “enter”

```
async evaluate(options) {
    const response = await this.invoke_evaluateOnCallFrame({
      expression: options.expression,
    });
    const error = response[Protocol.Error];
    if (error) {
      return {error: error};
    }
    return {object: runtimeModel.createRemoteObject(response.result),
exceptionDetails: response.exceptionDetails};
  }
```

How does it work?



You enter a command and press “enter”

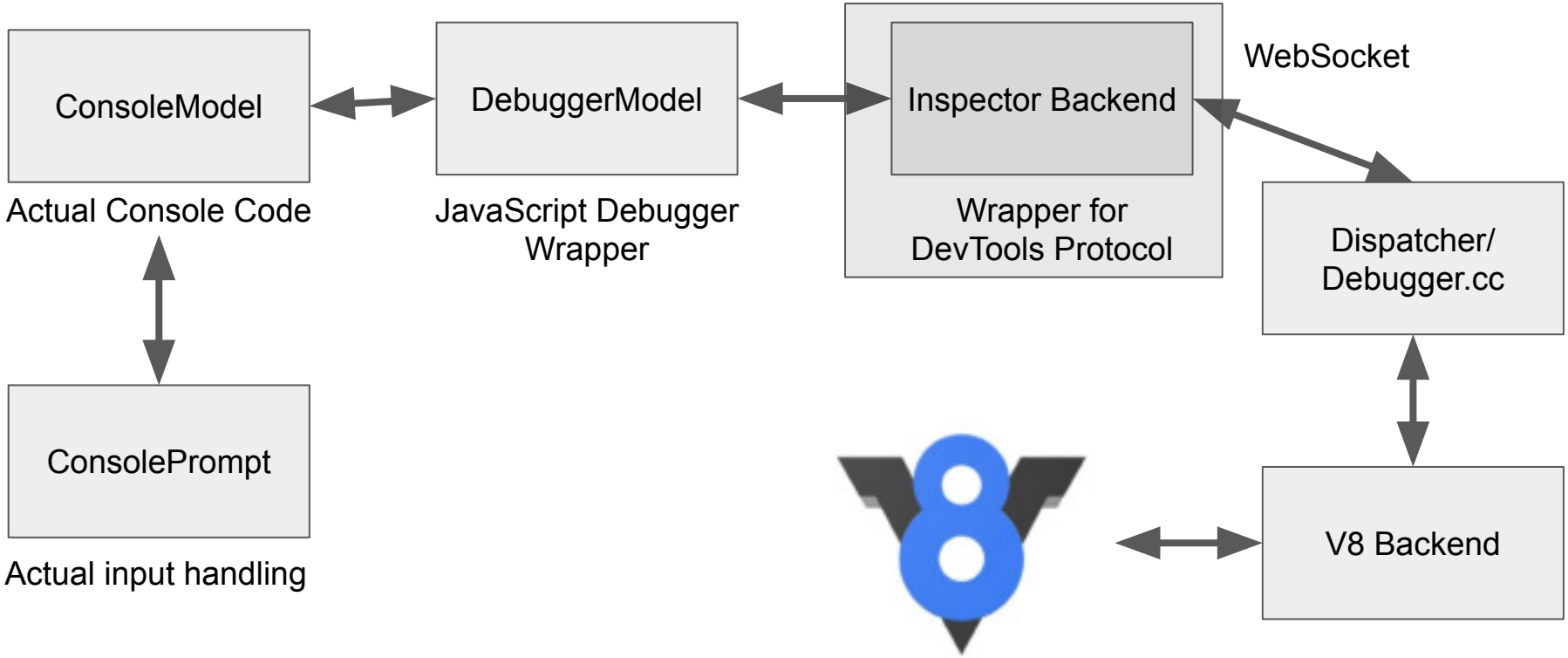
```
registerCommand(methodName, signature, replyArgs, hasErrorData) {
  // ...

  function invoke(request) {
    return this._invoke(methodName, request);
  }
  this['invoke_' + methodName] = invoke;
  this._replyArgs[domainAndMethod] = replyArgs;
}
```

You enter a command and press “enter”

```
sendMessage(sessionId, domain, method, params, callback) {
  const messageObject = {};
  const messageId = this._nextMessageId();
  messageObject.id = messageId;
  messageObject.method = method;
  messageObject.params = params;
  this._connection.sendRawMessage(JSON.stringify(messageObject));
}
```

How does it work?



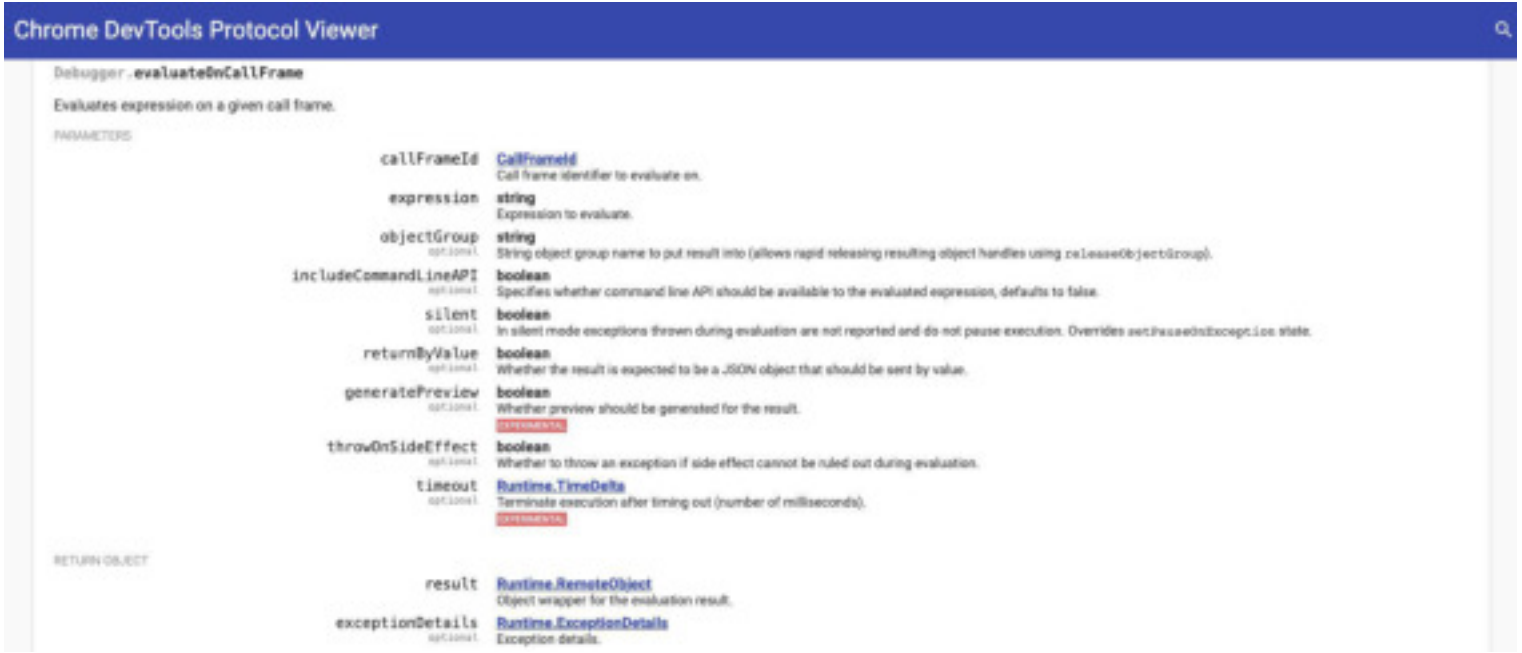
You enter a command and press “enter”

```
_invoke(method, request) {
   return new Promise(fulfill => {
     if (!this._target._router)
       return dispatchConnectionError(callback);
   this._target._router.sendMessage(sessionId, method, request,
fulfill);
   });
 }
```

You enter a command and press “enter”

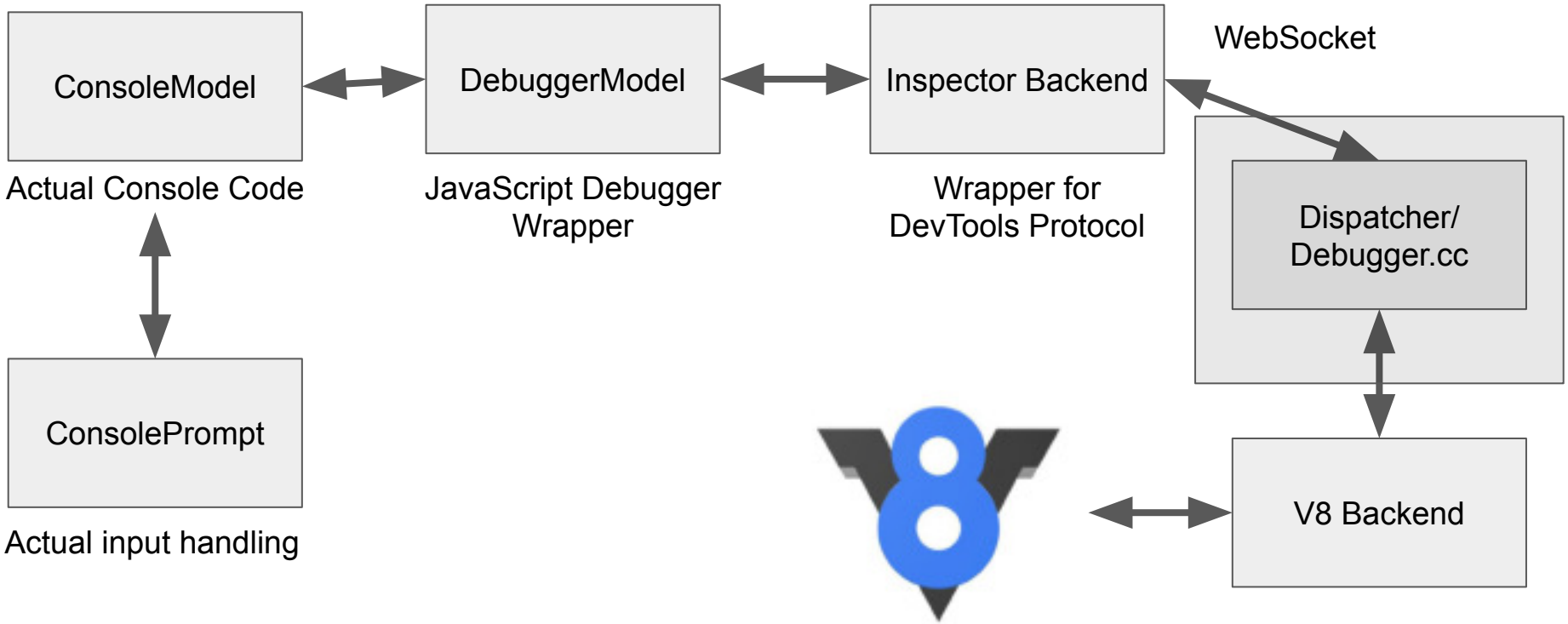
```
            "name": "evaluateOnCallFrame",
            "parameters": [
...
                {
                    "type": "string",
                    "name": "expression",
                    "description": "Expression to evaluate."
                },
                ...
```

You enter a command and press “enter”



https://chromedevtools.github.io/devtools-protocol/tot/Debugger/#method-evaluateOnCallFrame

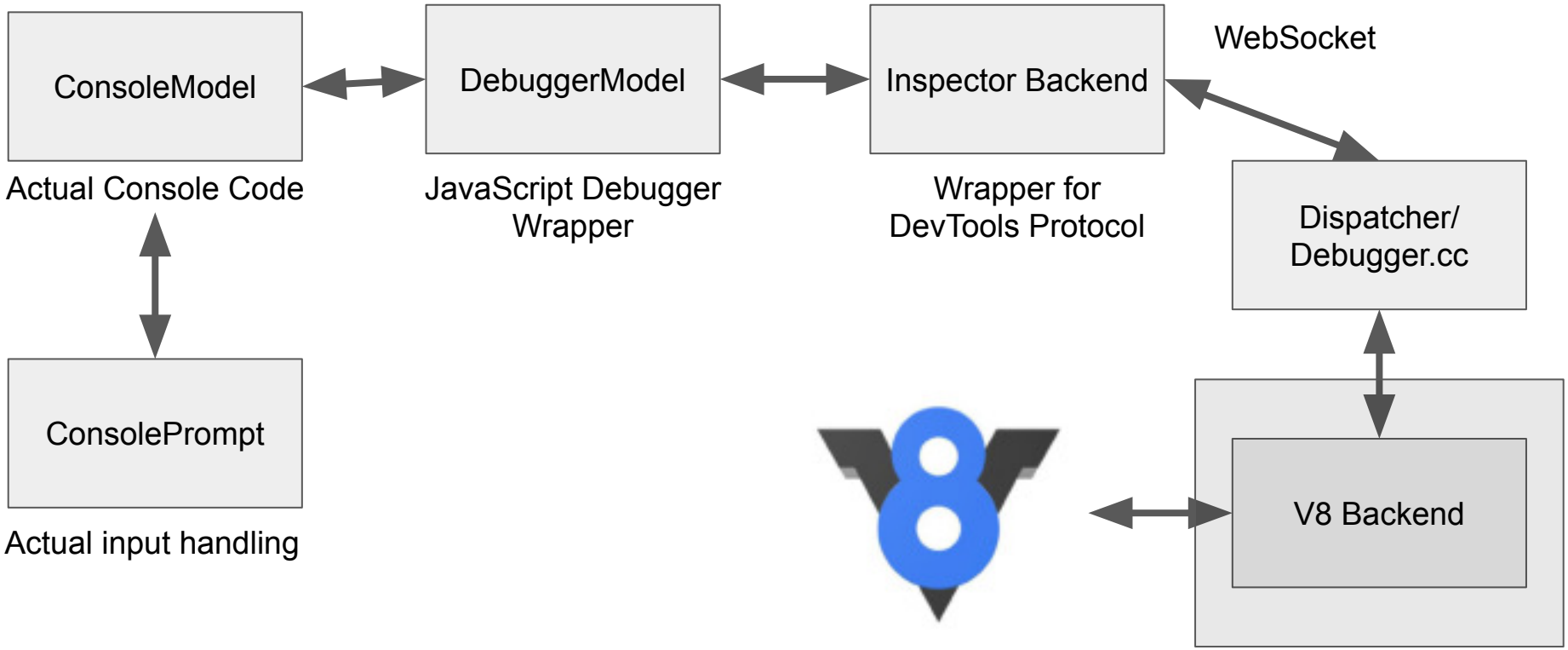
How does it work?



On the other end of the socket

```
   DispatcherImpl(FrontendChannel* frontendChannel, Backend*
backend): DispatcherBase(frontendChannel) {
        m_dispatchMap["Debugger.continueToLocation"] =
&DispatcherImpl::continueToLocation;
…
        m_dispatchMap["Debugger.evaluateOnCallFrame"] =
&DispatcherImpl::evaluateOnCallFrame;
…
}
```

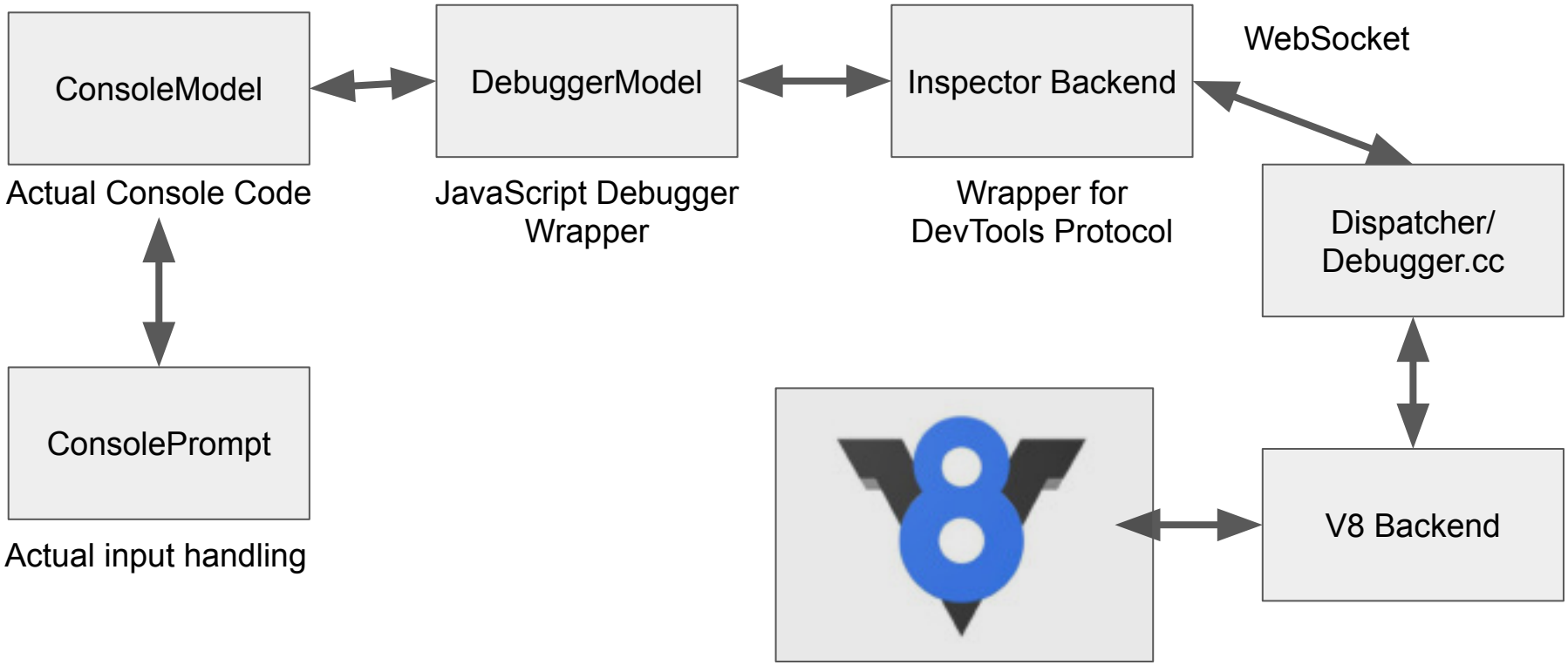
How does it work?



On the other end of the socket

```
void DispatcherImpl::evaluateOnCallFrame(const ProtocolMessage&
message, std::unique_ptr<DictionaryValue> requestMessageObject)
{
  // ...
   DispatchResponse response =
m_backend->evaluateOnCallFrame(in_expression, &out_result);
   // ...
}
```

How does it work?



On the other end of the socket

```
Response V8DebuggerAgentImpl::evaluateOnCallFrame(
    const String16& expression,
    std::unique_ptr<RemoteObject>* result) {
  InjectedScript::CallFrameScope scope(m_session, callFrameId);
  Response response = scope.initialize();
  v8::MaybeLocal<v8::Value> maybeResultValue;
  {
    V8InspectorImpl::EvaluateScope evaluateScope(scope);
      maybeResultValue = it->Evaluate(toV8String(m_isolate, expression),
                                      throwOnSideEffect.fromMaybe(false));
  }
  return scope.injectedScript()->wrapEvaluateResult(
      maybeResultValue, scope.tryCatch(), objectGroup.fromMaybe(""), mode,
      result, exceptionDetails);
}
```

You enter a command and press “enter”

```
async evaluateCommandInConsole(executionContext, expression) {
  const result = await executionContext.evaluate({
        expression: expression
      }, true, awaitPromise);
  await Common.console.showPromise();
  this.dispatchEventToListeners(CommandEvaluated,
      {result: result, exceptionDetails: result.exceptionDetails});
}
```

Evaluation result is printed

```
 _commandEvaluated(event) {
   const data = (event.data);
   this.history().pushHistoryItem(messageText);
   this._consoleHistorySetting.set(...);
   this._printResult(data.result, data.commandMessage,
data.exceptionDetails);
 }
```

And that’s how the devtools work

Now, why do we care?

Other than that it’s cool

testim

Selenium

- Most popular test automation tool.
- Basically just a specification - code belongs to browsers.
- HTTP server with a JSON REST API.
- In order to click an element you just POST a click and Chrome:

```
CommandMapping(kPost, "session/:sessionId/element/:id/click",
                      WrapToCommand("ClickElement"
base::BindRepeating(&ExecuteClickElement))),
```

- Can anyone guess how it works?

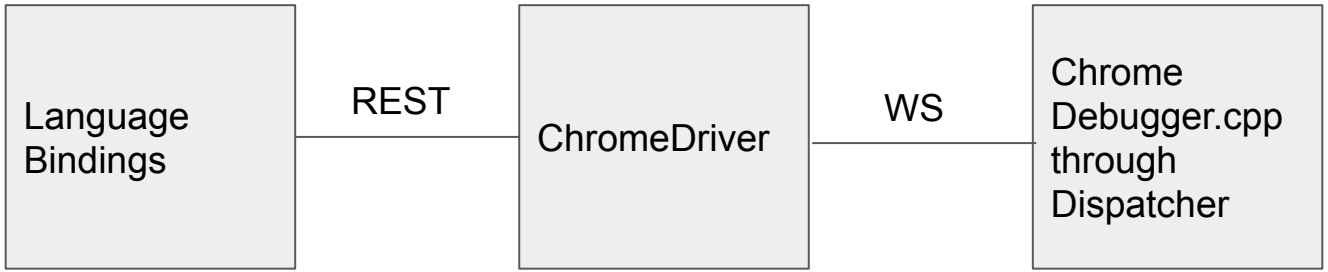
Selenium


```
Status ExecuteClickElement(...) {
  std::string tag_name;
  Status status = GetElementTagName(..., &tag_name);
  events.push_back(MouseEvent(kMovedMouse, kNoneMouseButton));
  events.push_back(MouseEvent(kPressedMouse, kLeftMouseButton);
  events.push_back(MouseEvent(kReleasedMouse, kLeftMouseButton);
  status = web_view->DispatchMouseEvents(events)
session->GetCurrentFrameId());
  return status;
}
```

It’s just the debugger protocol

```
Status WebViewImpl::DispatchMouseEvents(events) {
 for (auto it = events.begin(); it != events.end(); ++it) {
   params.SetString("type", GetAsString(it->type));// …
   status = client->SendCommand("Input.dispatchMouseEvent", params);
 }
 return Status(kOk);
}
```

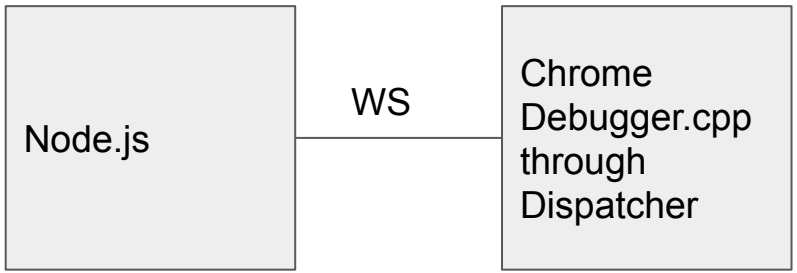
Selenium


Language Bindings
REST
ChromeDriver
WS
Chrome Debugger.cpp through Dispatcher

What about puppeteer?

- Popular “chrome only” test automation tool.
- Basically an even more direct client over the Devtools API
- Very tightly coupled to the protocol by design and to provides stability when running.
- Clicking does something similar

Puppeteer



Clicking with Puppeteer

```
async click(x, y, options = {}) {
   const {delay = null} = options;
   this.move(x, y);
   this.down(options);
   if (delay !== null)
     await new Promise(f => setTimeout(f, delay));
   await this.up(options);
 }
```

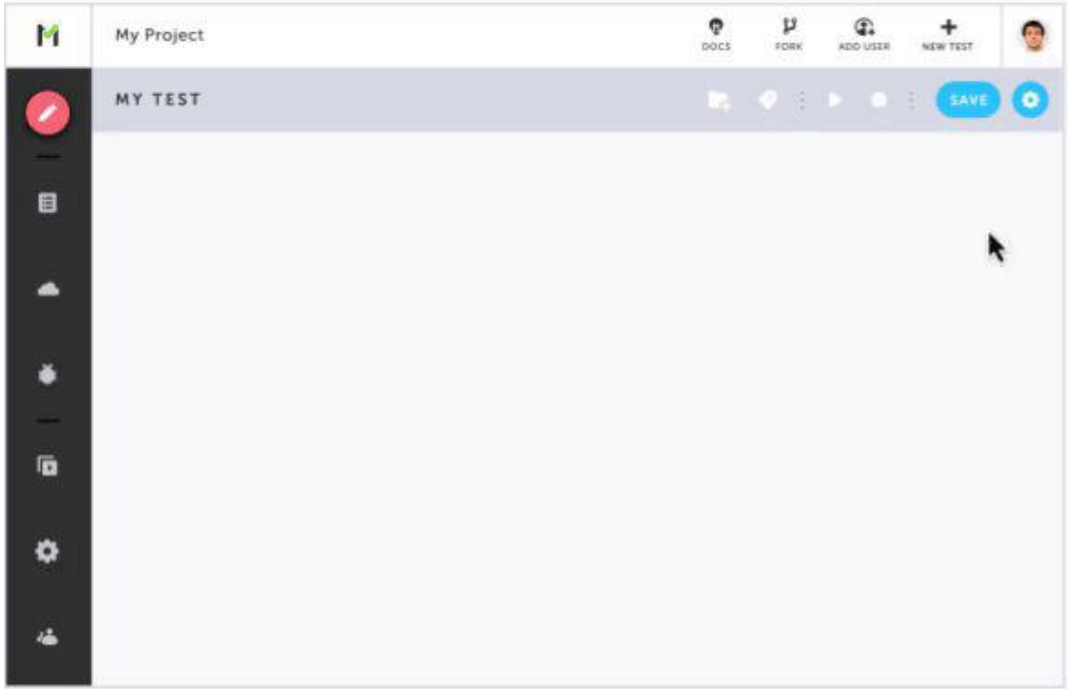
Clicking with Puppeteer

```
async down(options = {}) {
   const {button = 'left', clickCount = 1} = options;
   this._button = button;
   await this._client.send('Input.dispatchMouseEvent', {
     type: 'mousePressed',
     button,
     // ...
   });
 }
```

What about Testim?

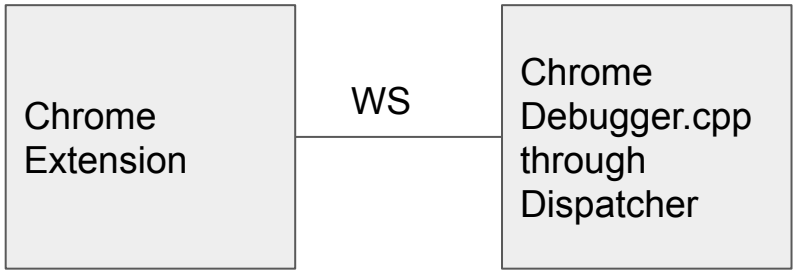
- Obviously the best test automation tool, and I'm not incredibly biased here 😉,
- Emphasis on stability.
- Connects to (**you guessed it**) the DevTools protocol protocol when playing in Chrome in a pretty tightly coupled way.
- Mostly `Input.dispatchMouseEvent`
- Lots of code to deal with edge cases of doing that to stabilize automation.

What about Testim?



What about Testim?

Similar to lighthouse or the DevTools



What about You?

- Let’s talk about how you can use the devtools protocol to your advantage.
- There are two primary ways to use the devtools protocol:
  - From extensions `chrome.debugger.attach`
  - From consoles `cdpSession.send(...)`

Some ideas for the protocol

- Simulate location `Emulation.setGeolocationOverride`
- Override timers with `Emulation.setVirtualTimePolicy`
  - Stability with pauseIfNetworkFetchesPending
- Warnings with `Log.startViolationsReport`
- Network cache clear with `Network.clearBrowserCache`
- Test accessibility with `Accessibility.getFullAXTree`
- Get code coverage with `Profiler.takePreciseCoverage`
- Force hover state with `CSS.forcePseudoState`

How to: boilerplate - CDP

```
const CDP = require('chrome-remote-interface');
const { launch } = require('chrome-launcher');


(async () => {
 const chrome = await launch({
   chromeFlags: ['--headless', '--disable-gpu']
 });
 const session = await CDP({ port: chrome.port });
 console.log(chrome, session);
})();
```

How to: boilerplate - chrome-launcher

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 });
 const session = await CDP({ port: chrome.port });
 console.log(chrome, session);
})();
```

How to: take screenshot directly

```
const { Page, Network } = session;
await Page.navigate({ url: "http://www.devdays.lt "});
const { data } = await Page.captureScreenshot();
await fs.writeFile("screenshot.png", Buffer.from(data, "base64"));
```

How to: take screenshot directly

```
await Page.navigate({ url: "http://www.devdays.lt "});
await new Promise(resolve => {
 timer = setTimeout(resolve, 2000);
 Network.requestWillBeSent(params => {
   clearTimeout(timer);
   timer = setTimeout(resolve, 2000);
 });
});
const { data } =
  await Page.captureScreenshot();
```

A quick utility library

- Starts express server, chrome and devtools connection
- Calls passed code into it using a disposer pattern
- Lets me run arbitrary chrome commands
- If anyone wants, I will put this on NPM

Some examples - using the library

```
use(`
 function fib(n) {  return n < 2 ? 1 : fib(n-1) + fib(n-2); }
 function bar() {}`, async ({Page, Runtime, Profiler}) => {
 const { result } = await Runtime.evaluate({
   expression: 'fib(10)'
 });
 console.log(result.value); // 89
});
```

Some examples - coverage without nyc

```
 await Profiler.enable();
 await Profiler.startPreciseCoverage();
 await Runtime.evaluate({ expression: 'fib(10)' });
 const { result } = await Profiler.takePreciseCoverage();
 const { ranges } = result[0].functions
                                .find(x => x.functionName === 'fib');
console.log(ranges);
```

If anyone wants to get into Node.js - please shoot me an email at benjamingr@gmail.com

Thank You!