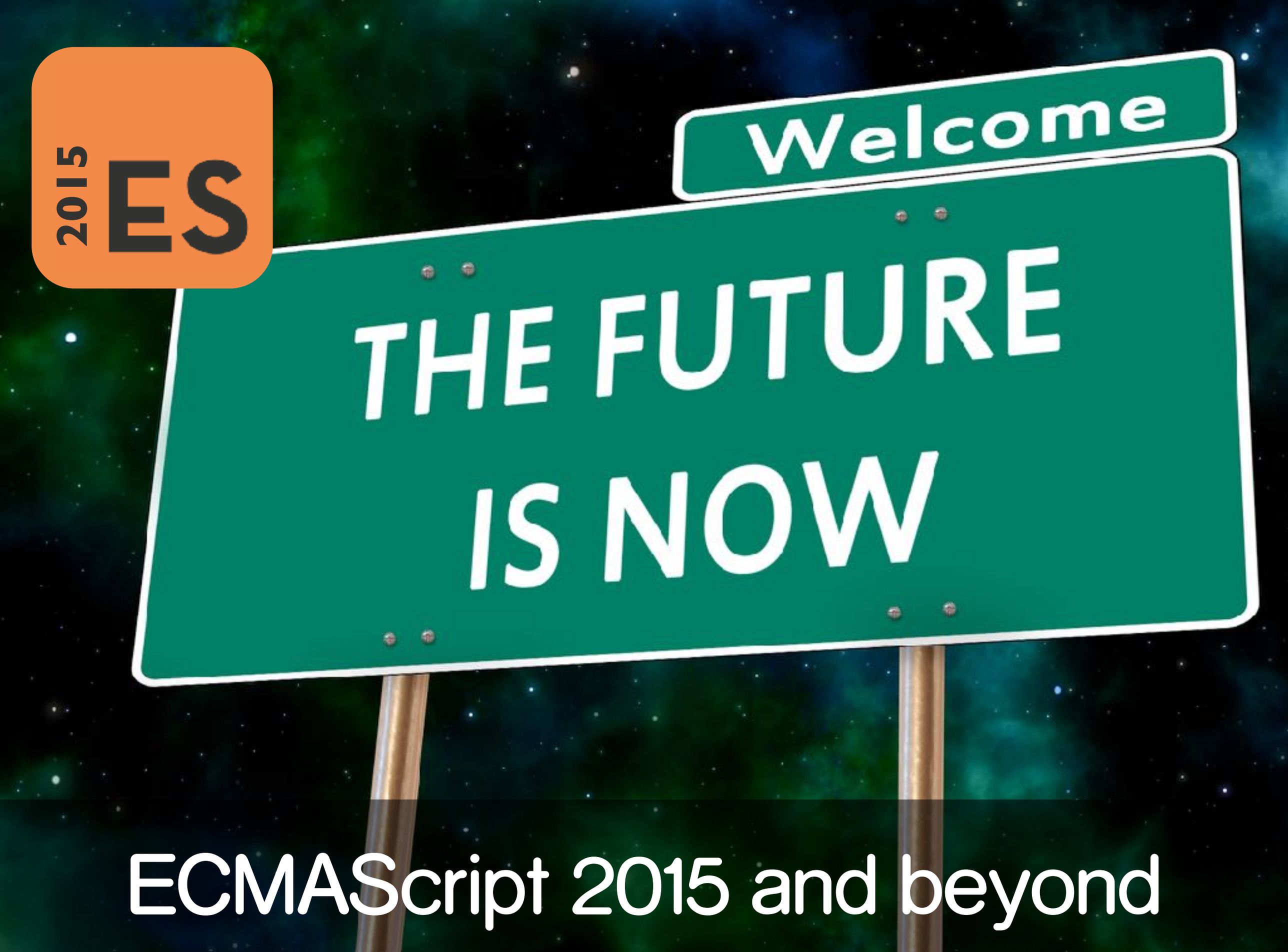
2015 ES



ECMAScript 2015 and beyond

ES 2015 Features

`const & let`

for…of & iterators

Template Strings

Arrow Functions

Default Parameters

Rest Parameters

Enhanced Object Literals

Destructuring

Spread

Classes

Modules

Generators

Promises

Set, Map, WeakSet, WeakMap

Proxies

Symbols

Reflect API

Language Feature (syntax)

Built-In Objects (runtime)

(list is not complete …)

https://babeljs.io/docs/learn-es2015/

https://github.com/lukehoban/es6features

Classes

```
class Counter {

  constructor(){
   this.count = 0;
  }

  increase(){
    this.count++;
  }
}

let counter = new Counter();
counter.increase()
console.log(counter.count)
```

Classes are syntactic sugar on top of constructor functions and prototypal inheritance.

ES2015 introduced classes.
Every modern browser supports this today.

Arrow Functions: ()=>{...}

ES5 JS

```
var square = function(x){
   return x * x;
}

var add = function(a, b){
   console.log('Adding ...');
   return a + b;
}

var pi = function(){
   return 3.1415;
}

var obj = function(){
   return {props: '!!'};
}
```

2015 ES

```
const square = x => x * x;
const add = (a, b) => a + b;
const pi = () => 3.1415;

const add2 = (a, b) => {
   console.log('Adding ...');
   return a + b;
}

const obj = () => ({prop: '!!'});
```

Modules

```
import { Component } from '@angular/core';

@Component({
   selector: 'app-counter',
   template: 'counter.component.html'
})
export class CounterComponent {
  constructor(){
    this.count = 0;
  }
  increase(){
    this.count++;
  }
}
```

Modules have their own scope.
Sharing constructs is explicit with import & export.

The specification for modules is finished, but only most recent browsers support modules natively.
To use modules today a module bundler/loader is needed.

ESnext: Decorators

```
@Component({
   selector: 'app-counter',
   template: 'counter.component.html'
})
class CounterComponent {
  constructor(){
    this.count = 0;
  }
  increase(){
    this.count++;
  }
}
```

Decorators can be used to attach metadata to classes.
Frameworks can then use this metadata.

The specification for decorators is not yet finished.
Browsers do not yet supports decorators.
To use decorators today, they have to be compiled to JavaScript.

decorators are supported in TypeScript and Babel

https://github.com/tc39/proposal-unified-class-features

ESnext: Class Fields

```
class Counter {

  count = 0;

  increase = () => {
    this.count++;
  }
}

let counter = new Counter();
counter.increase()
console.log(counter.count)
```

Declaring properties of a class increases readability.

Declaring methods as arrow functions avoids issues with `this` binding.

But the function does not exist on the prototype and can't be called via `super` in a derived class.

The specification class fields is not yet finished.
Browsers do not yet supports class fields natively.

class fields are supported in
TypeScript and Babel

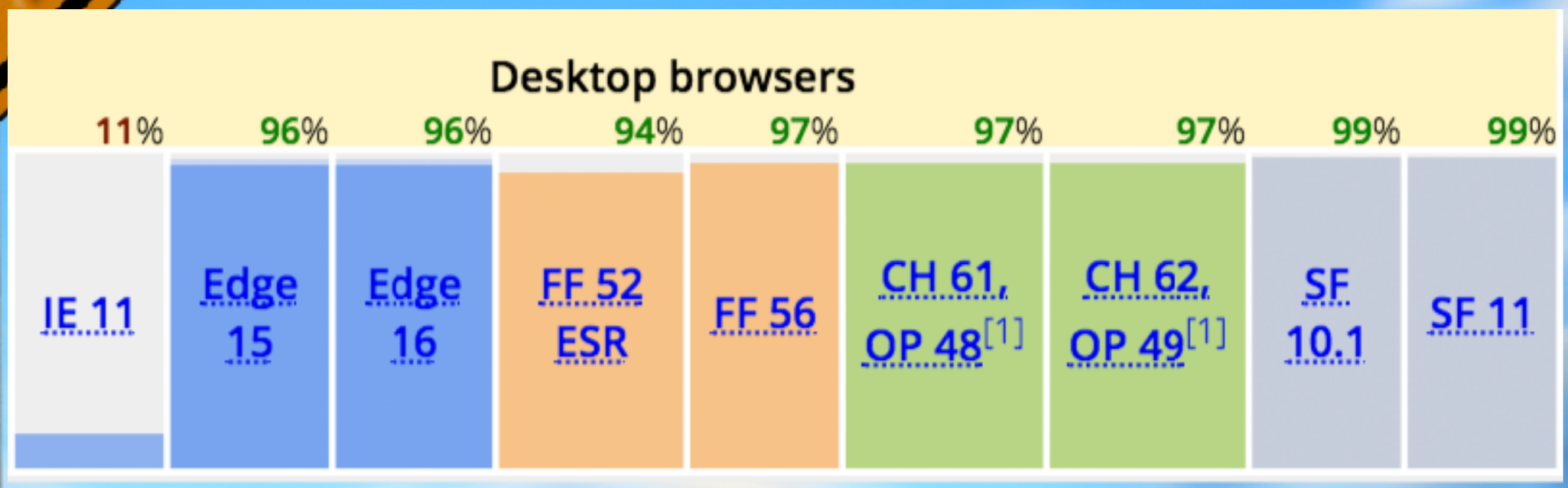
https://github.com/tc39/proposal-unified-class-features

Static Typing & Access Modifiers

```
class Counter {

  private count = 0;

  increase(amount: number){
    this.count += amount;
  }
  getValue(): number {
    return this.count;
  }
}

let counter = new Counter();
counter.increase(2)
console.log(counter.getValue())
```

Static typing and access modifiers are not part of JavaScript. The TypeScript compiler removes this information at build time.

ES2015 browser support:



https://kangax.github.io/compat-table/es6/

ES2015 Modules

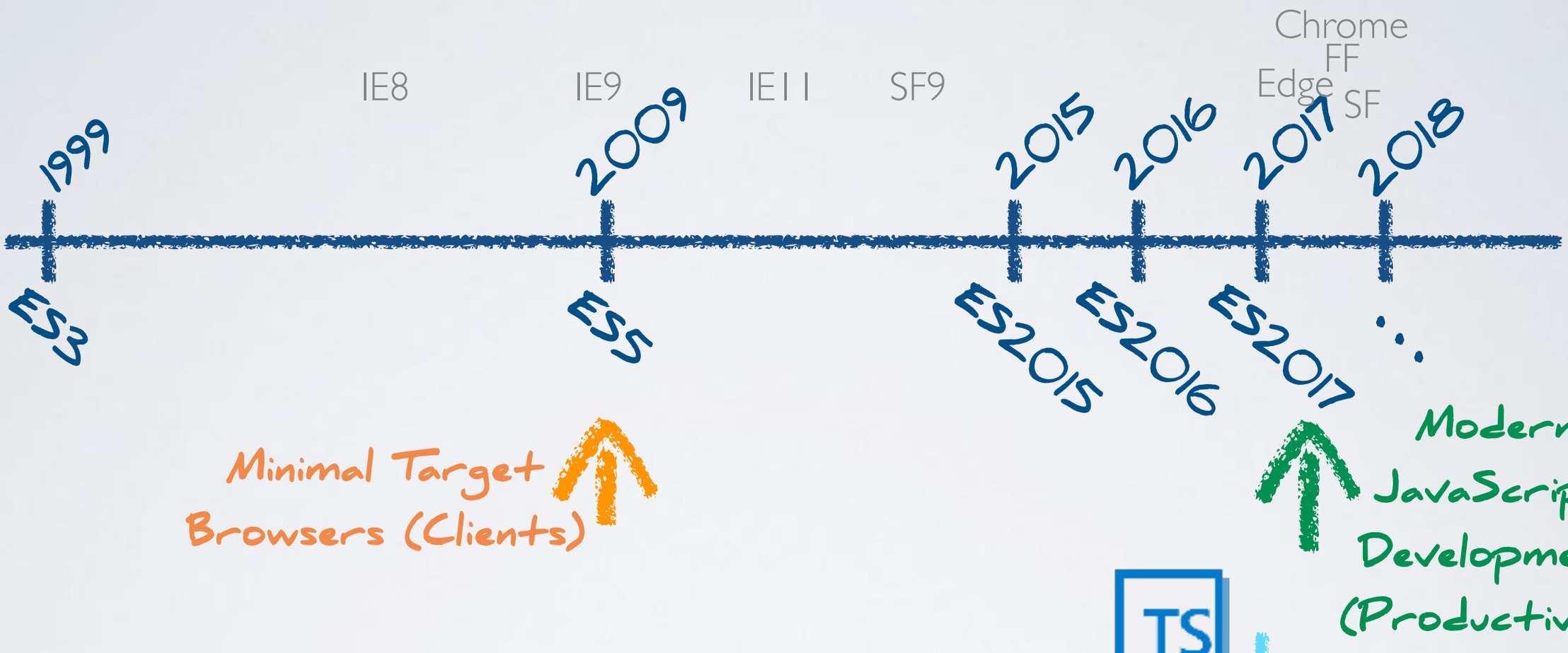
- New JavaScript syntax for `import` and `export` is part of the ES2015 spec.
- Module loading is not part of the ES2015 spec. There is a separate WhatWG loader spec.
- Native browser support for modules is still lacking
  - Official support in Safari 10.1, Chrome 61, Edge 16
  - Preview in Firefox 54+,

http://caniuse.com/#feat=es6-module

https://medium.com/dev-channel/es6-modules-in-chrome-canary-m60-ba588dfb8ab7

Addressing the Feature Gap

JavaScript has evolved rapidly in the past few years.



TypeScript is a language that compiles down to JavaScript.

Babel is a modular JavaScript compiler that can compile future features to a current ES version.

Transpiler

A transpiler is a scource-code to source-code compiler.

TypeScript language features and most ES2015+ features can be written in plain ES5.

```
class Person {
  private name: string;
  constructor(name: string){
    this.name = name;
  }
}

const pers: Person = new
Person('John');
```

```
var Person = (function () {
    function Person(name) {
        this.name = name;
    }
    return Person;
}());
var pers = new Person();
```

https://babeljs.io/repl/
https://www.typescriptlang.org/play/index.html

TypeScript is a superset of JavaScript

Angular 2: Why TypeScript?: https://vsavkin.com/writing-angular-2-in-typescript-1fa77c78d8e8#.qf7up1nj7

The original goal of TypeScript

on top of ES5

new (future)
language features

↓

modules, classes, ...

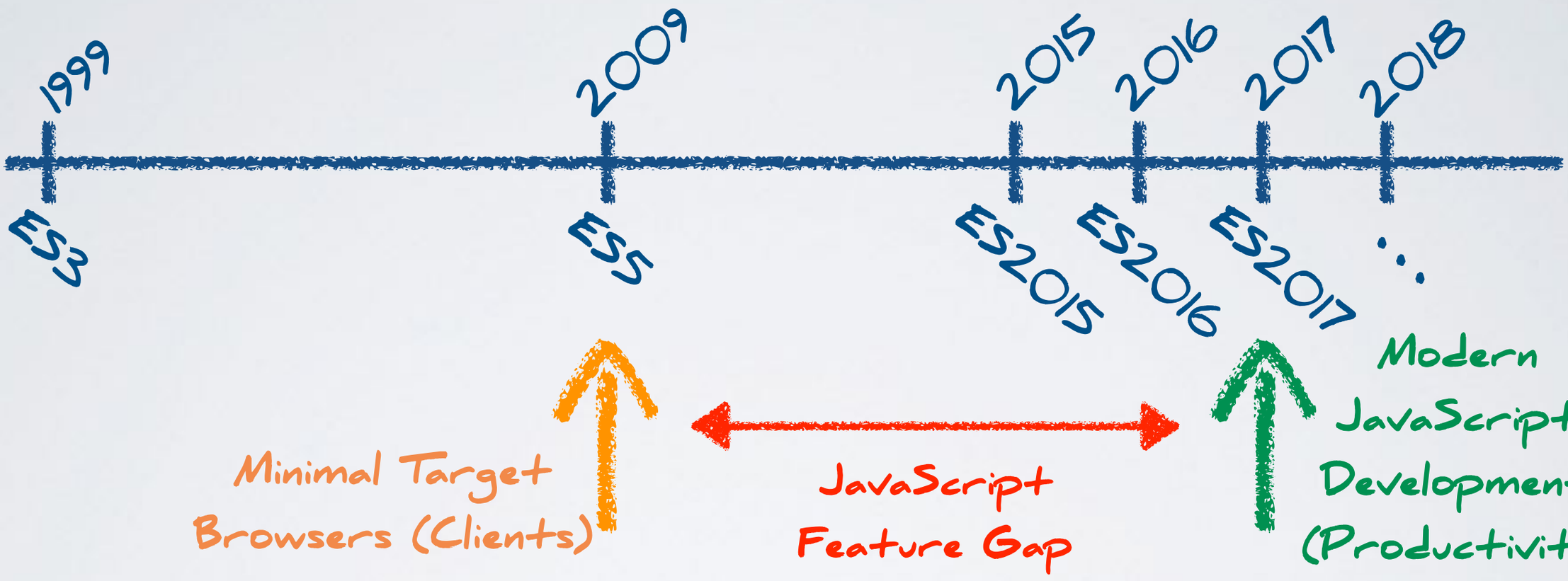
static types

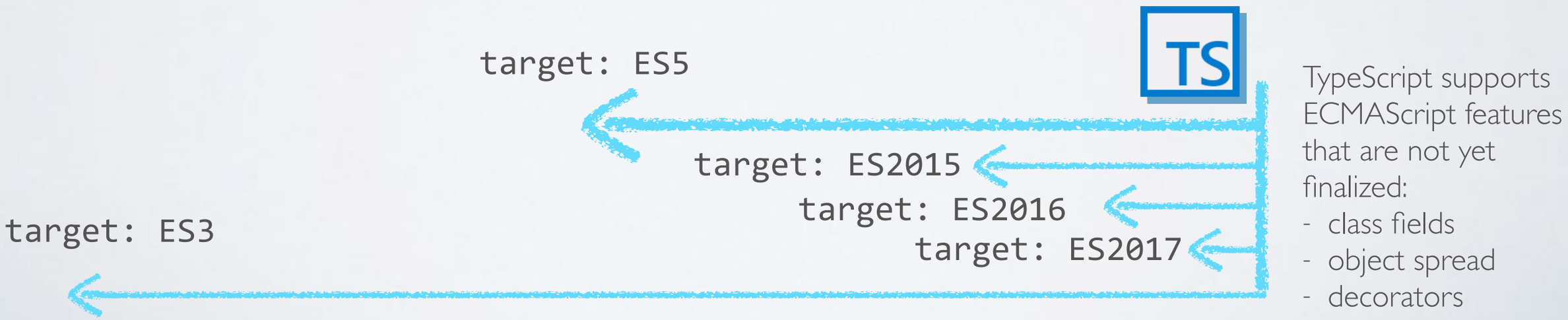
↓

enables tools

Transpilation

TypeScript is a language that compiles down to JavaScript.



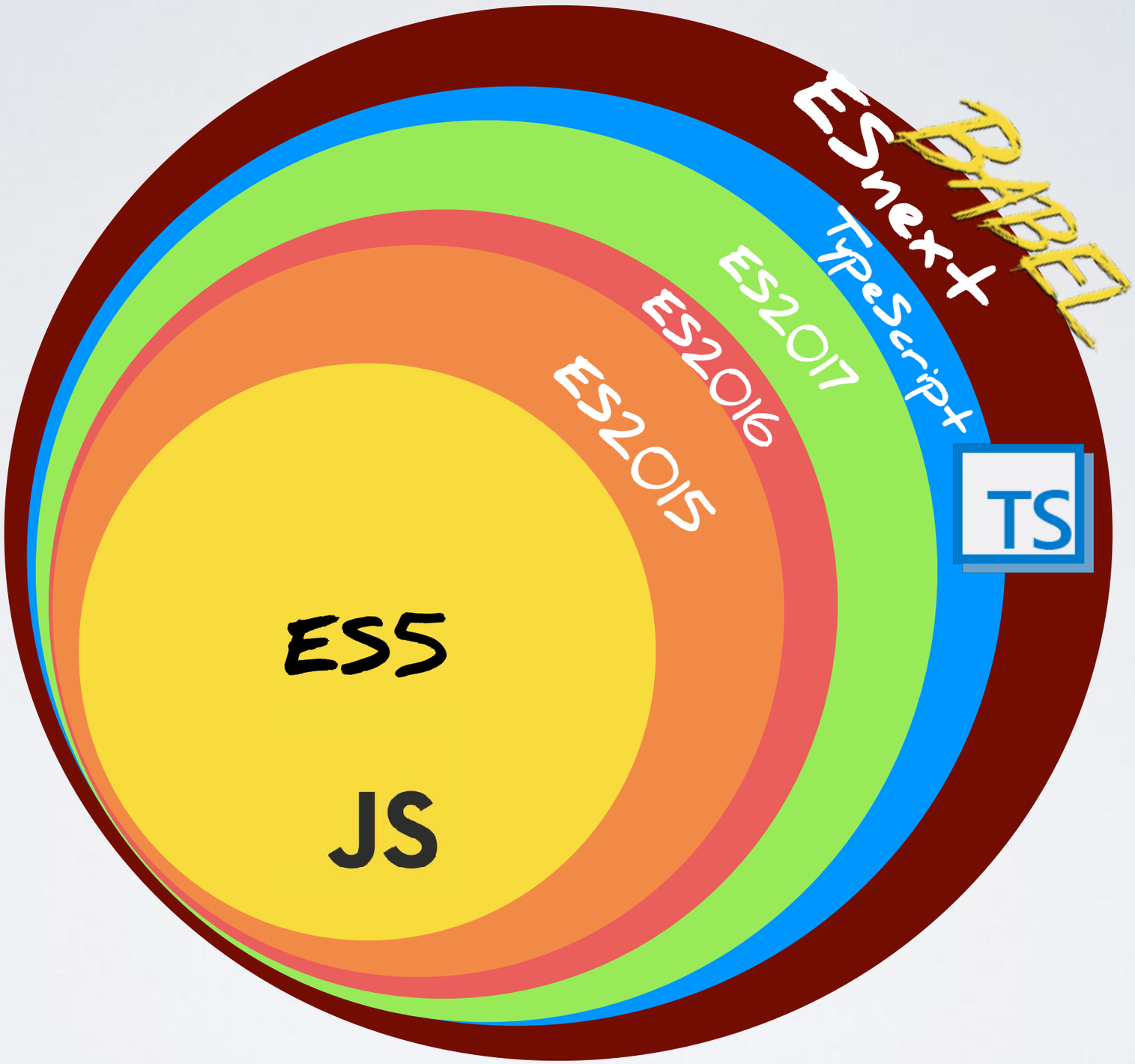


TypeScript supports ECMAScript features that are not yet finalized:

- class fields
- object spread
- decorators

https://www.typescriptlang.org/docs/handbook/compiler-options.html

Supporting JavaScript Features with a

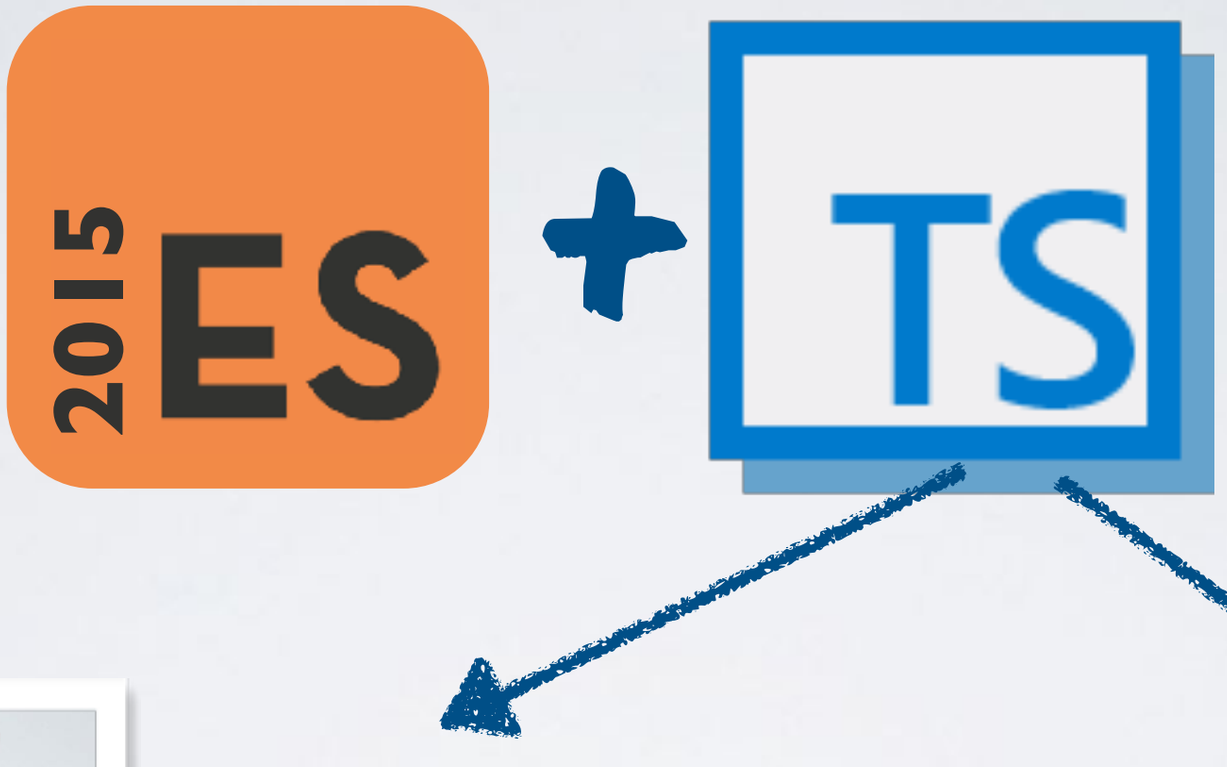


Static Typing & Access Modifiers

```
class Counter {

  private count = 0;

  increase(amount: number){
    this.count += amount;
  }
  getValue(): number {
    return this.count;
  }
}

let counter = new Counter();
counter.increase(2)
console.log(counter.getValue())
```

Static typing and access modifiers are not part of JavaScript. The compiler removes this information at build time.

TypeScript Today



new (future) language features

modules, classes, ...

static types

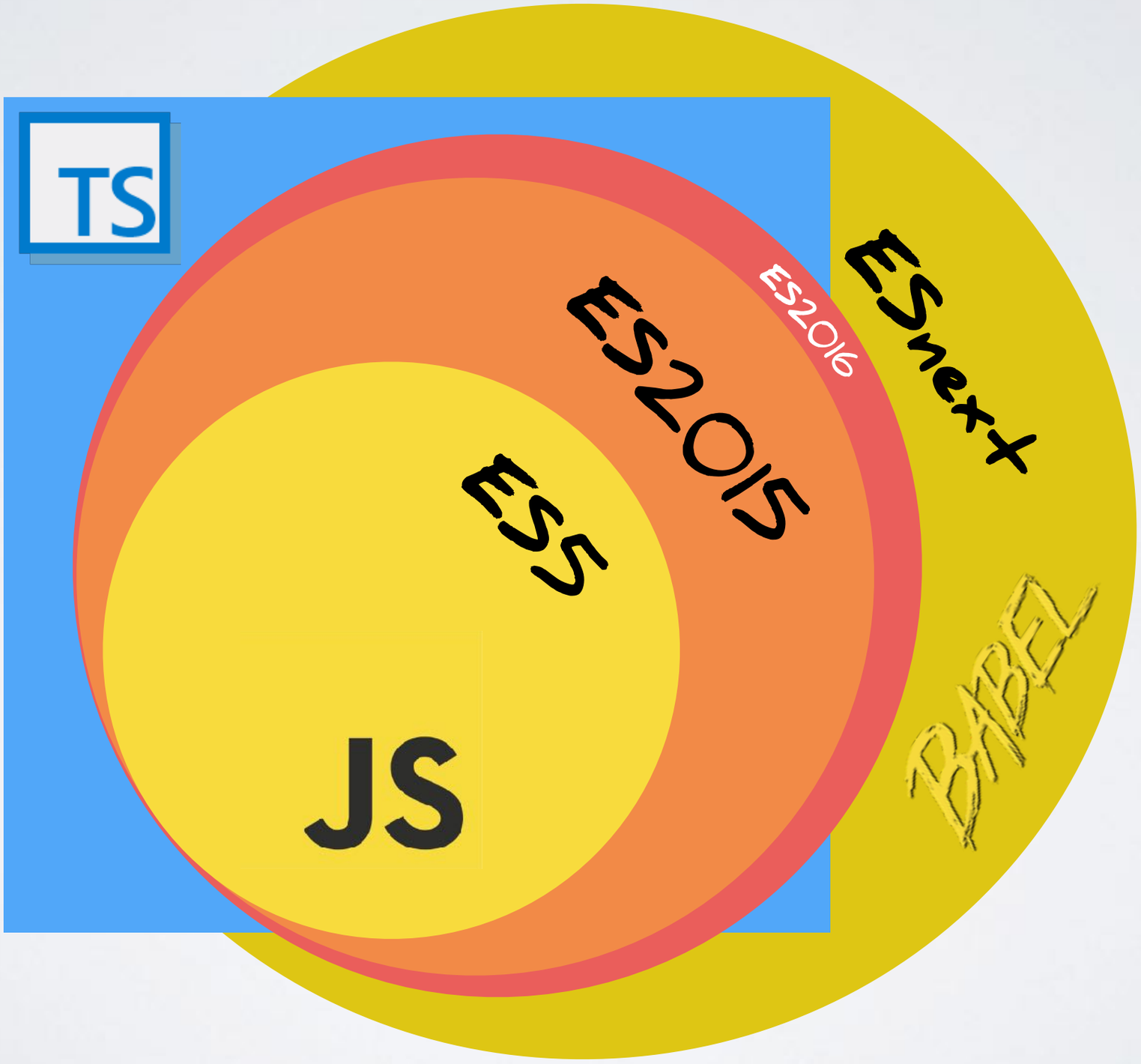
enables tools

TypeScript still provides some future language features on top of ES2015...

... but it provides less future language features compared with Babel.

Superset?

TypeScript has compile-time language constructs that are not valid JS (enums, generics, ...).
TypeScript has an optional compile-time static type system on top of JS and the browser APIs.



http://blog.jonasbandi.net/2016/10/myth-of-superset.html

JavaScript

Language (Syntax)

Runtime

JavaScript Runtime Built-In Objects

Browser Built-In Objects & APIs (DOM, AJAX ...)

ES2015 Today: Transpiler & Polyfills

New Language Features (Syntax)

transpiling to ES5 for older browsers

TypeScript

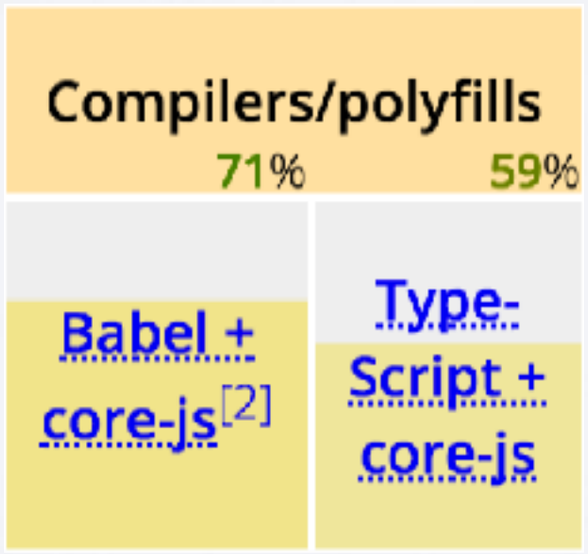
BABEL

New Built-In Functionality (Runtime Objects)

polyfills for older browsers

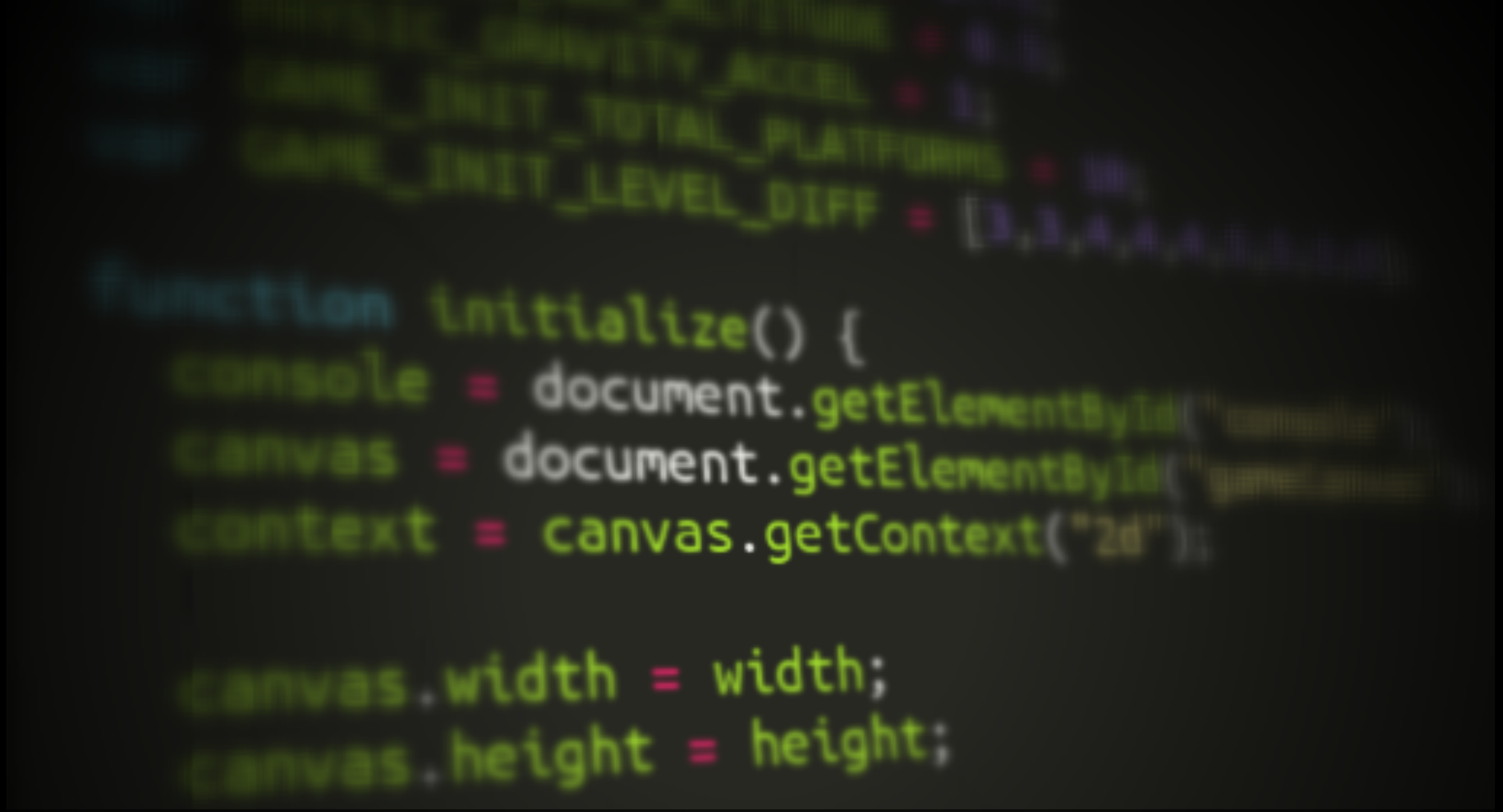
A polyfill is a a JavaScript library that implements a missing browser feature.

core-js
babel-polyfill
polyfill.io



https://kangax.github.io/compat-table/es6/

https://github.com/zloirock/core-js
https://polyfill.io/v2/docs/examples



JavaScript Basics

JavaScript

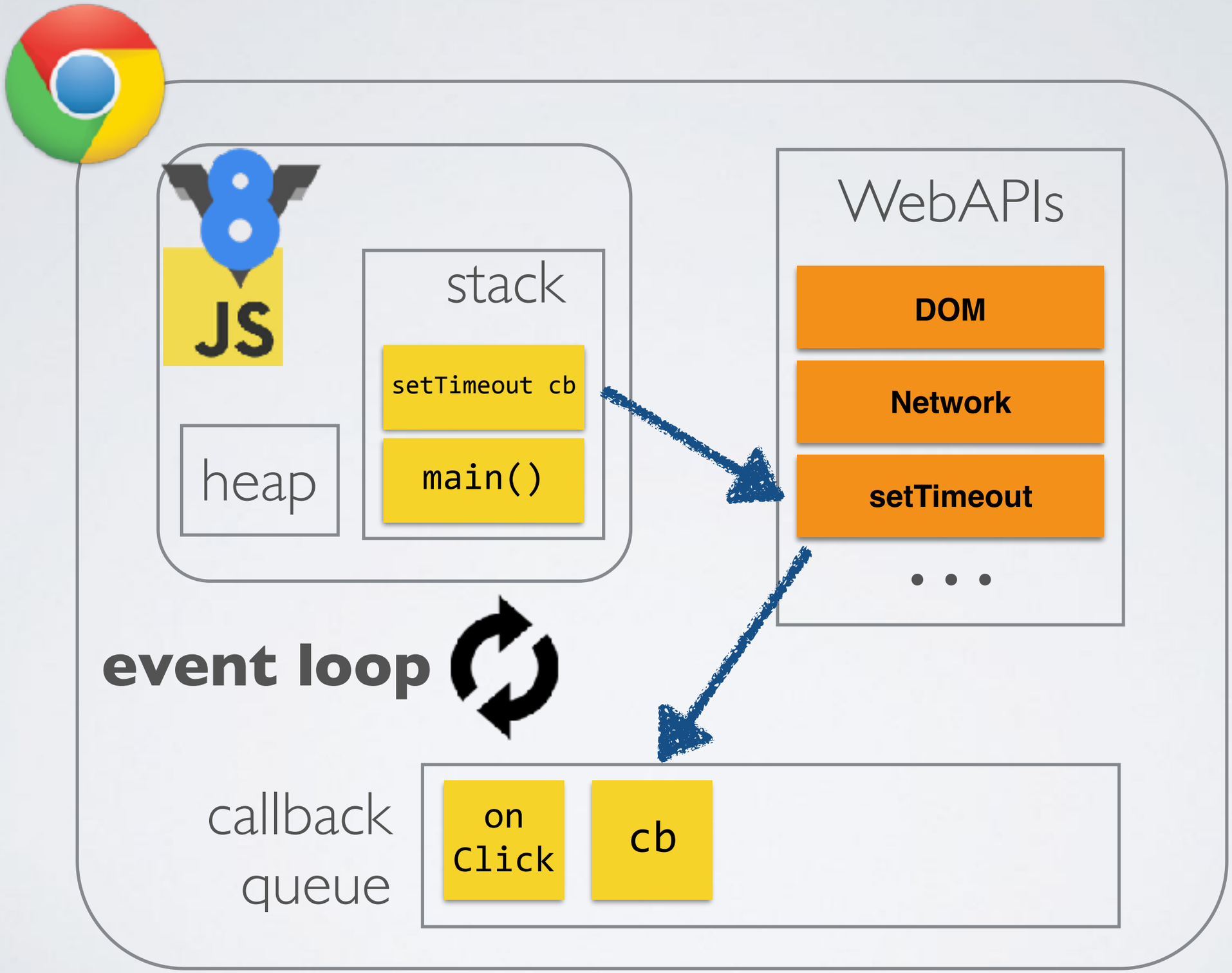
Language (Syntax)

Runtime

JavaScript Runtime Built-In Objects

Browser Built-In Objects & APIs (DOM, AJAX ...)

Event Loop



What the heck is the event loop anyway? https://www.youtube.com/watch?v=8aGhZQkoFbQ

The Variable `this`

- `this` is the context of a function. The value of this is determined by *how a function is called*:
    1. If the function is called as a constructor with the `new` keyword, `this` is a new object
    2. If the method is called via call() or apply(), `this` is explicitly passed
    3. If the function is called as a method of an object, `this` points to that object
    4. If none of the above are used, `this` is the global object (or `undefined` in strict mode).

- Especially for callbacks it might be tricky to find out the value of `this.`

Higher Order Functions

- Higher order functions operate on functions
  - functions as parameters
  - functions as return values
- Callback Functions
- Partial Application

```
$("#myBtn").on('click', function() {
  alert("Button Clicked!");
});
```

```
function arrayForEach(array, func) {
  for (var i = 0; i < array.length; i++) {
    func(array[i]);
  }
};
arrayForEach([1,2,3,4,5],
     function(msg){console.log(msg)});
```

```
var add = function(first, second) {
  return first + second;
};

var splitCall = function(first, func){
    return function(second){
        return func(first, second);
    }
}

var addOne = splitCall(1, add);
addOne(22); // -> 23
```

ES5: bind()

```
function print(){console.log(this.message);};
var controller = {message: 'Hello!', greet: print};
setTimeout(controller.greet); // Does not work!
```

Manual explicit binding:

```
function bind(fn, object){
  return function(){
    fn.apply(object)
  }
}
```

```
setTimeout(bind(print, controller));
```

ES5 provides the **`bind`** method:

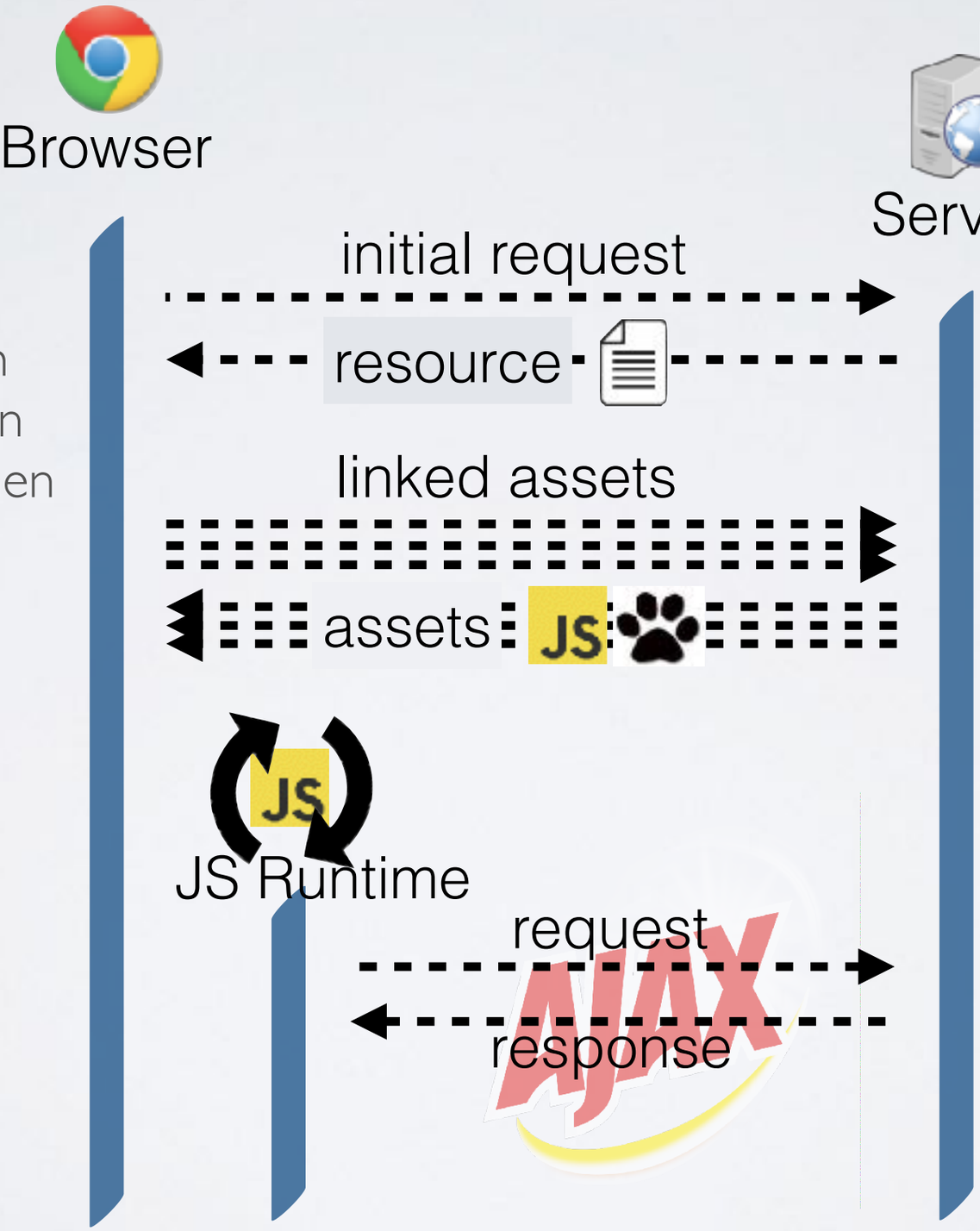
```
setTimeout(print.bind(controller));
```

Demo: 11-This

AJAX & Async JavaScript

Browsers & Network Access

Browsers can perform network requests when loading resources or when submitting forms.



The JavaScript runtime can perform network requests triggered by scripts.
These are called AJAX requests.

XMLHttpRequest

The underlying technology for AJAX.

```
var req = new XMLHttpRequest();
req.addEventListener("load", done);
req.addEventListener("error", failed); // only fired on network-level events
req.addEventListener("readystatechange", stateChanged);
req.open("GET", "http://localhost:3001/comments");
req.send();

function stateChanged(){
    if (this.readyState === 4) {
        if (this.status === 200) {
            console.log('success state', this.responseText)
        } else {
            console.log('error state', this.statusText);
        }
    }
}

function done() {
    console.log('DONE', this.responseText);
}

function failed() {
    console.log('ERROR', this.statusText);
}
```

The API is low-level, complicated and verbose.

https://developer.mozilla.org/en/docs/Web/API/XMLHttpRequest/Using_XMLHttpRequest

AJAX with Callbacks

Using jQuery

```
$.get('http://localhost:3001/comments', function (data) {
    console.log(data);
});
```

```
$.post('http://localhost:3001/comments',
       {text: 'test - ' + new Date()},
       function () {
          console.log('POST!');
});
```

fetch: a modern AJAX alternative

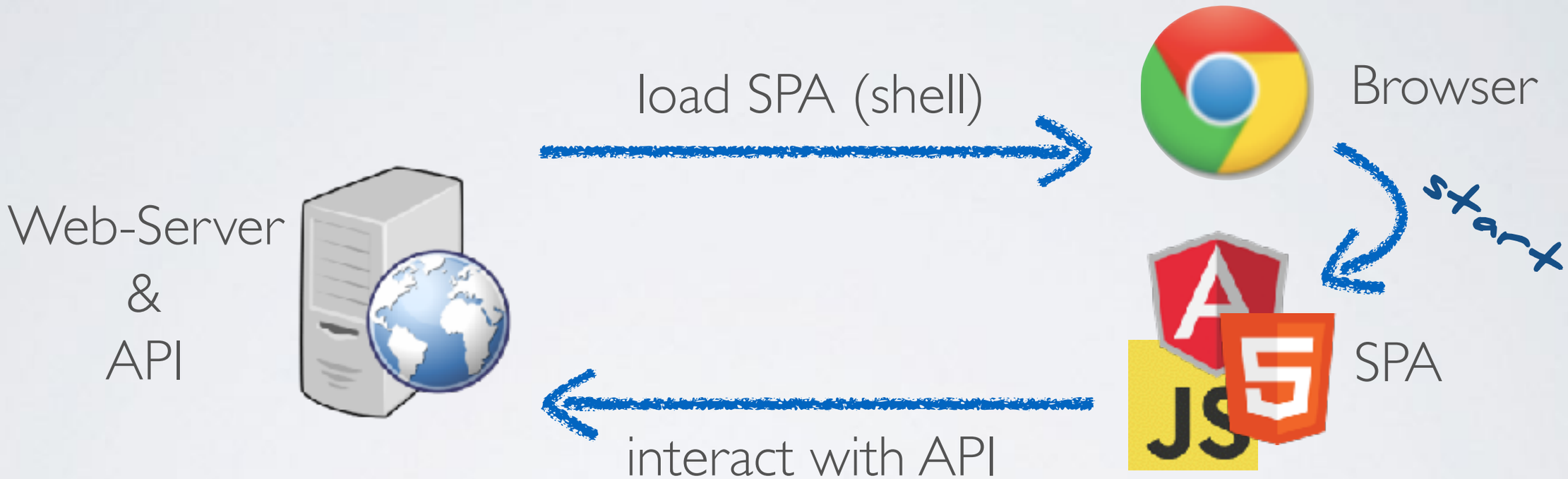
`fetch` is a new API available in modern browsers that is more elegant than **`XMLHttpRequest`**.

```
fetch('http://localhost:3001/comments2')
    .then(response => response.json())
    .then(data => console.log('SUCCESS', data))
    .catch(error => console.log('ERROR:', error));
```

https://developer.mozilla.org/en-US/docs/Web/API/Fetch_API/Using_Fetch
https://fetch.spec.whatwg.org/#fetch-api
https://jakearchibald.com/2015/thats-so-fetch/
https://github.com/github/fetch

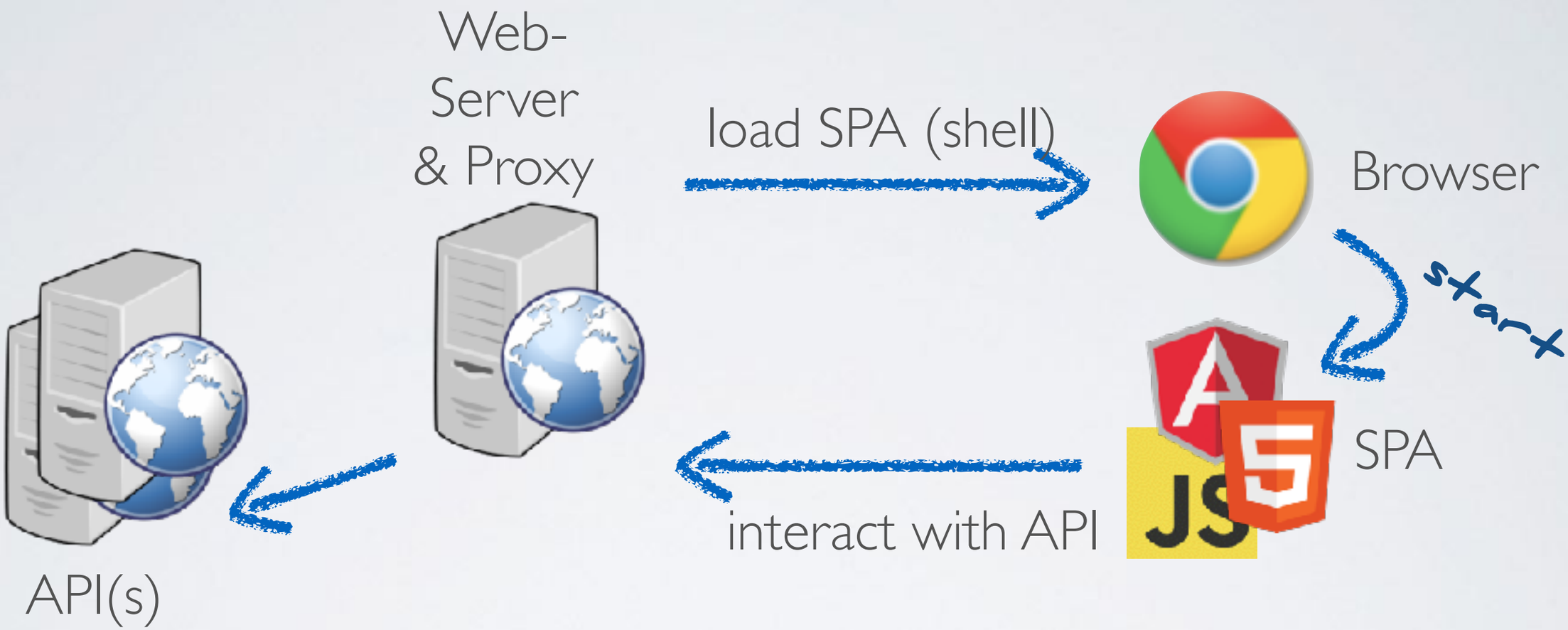
Browser support:
http://caniuse.com/#search=fetch

"Traditional Web-App"



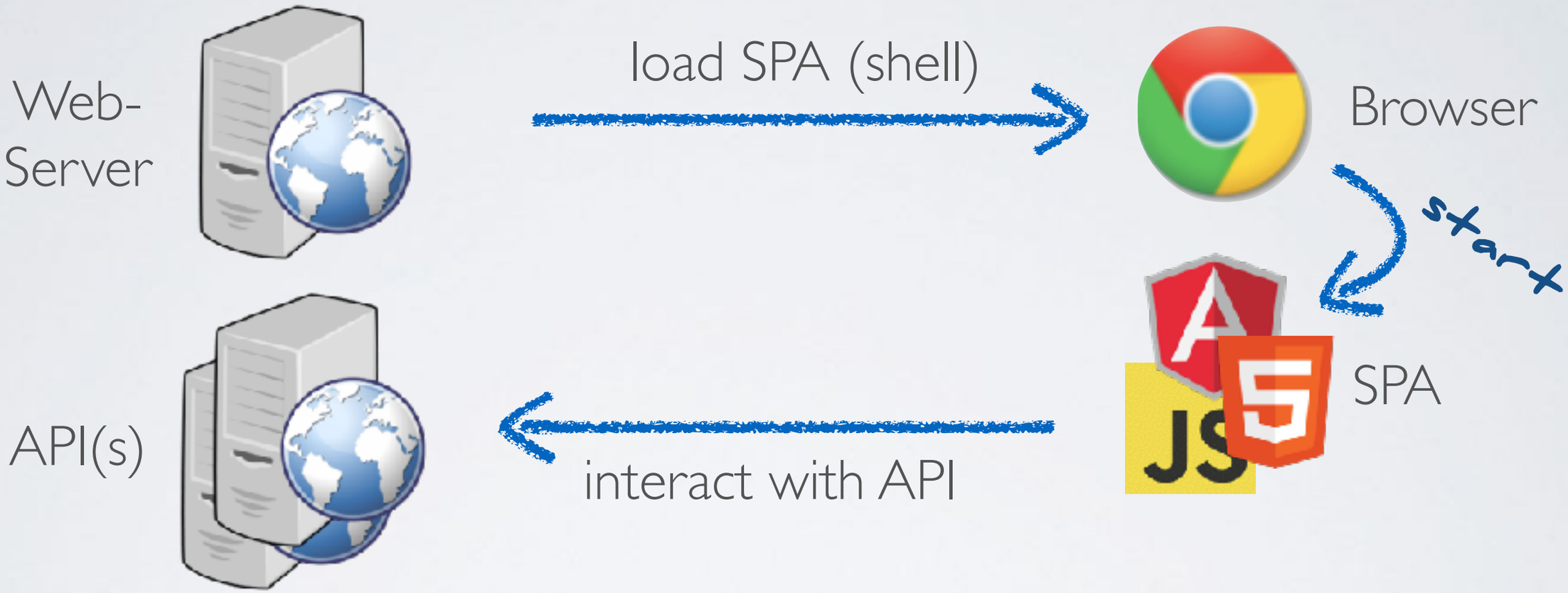
- Shell can be static or dynamic (rendered on the server)
- Same origin for all resources (shell & API)
- Often combined technologies on the Server (MVC & WebAPI, JSF & JAX-RS)
- "Monolithic", Advantages: Authentication/Authorization, Deployment ...

Web + Proxy + API-Backend



- One central entry point for the application
- Same origin for all resources (shell & API)
- Distributed / independent services ("SOA", "Microservices" ...)
- Advantages: logging, transactions, authentication

Web + API-Backend



- Shell is typically static (simple web-server or CDN)
- Different origin for shell & API resources
- Distributed / independent services ("SOA", "Microservices" ...)

Same Origin Policy (SOP)

The same-origin policy restricts how a document or script loaded from one origin can interact with a resource from another origin.

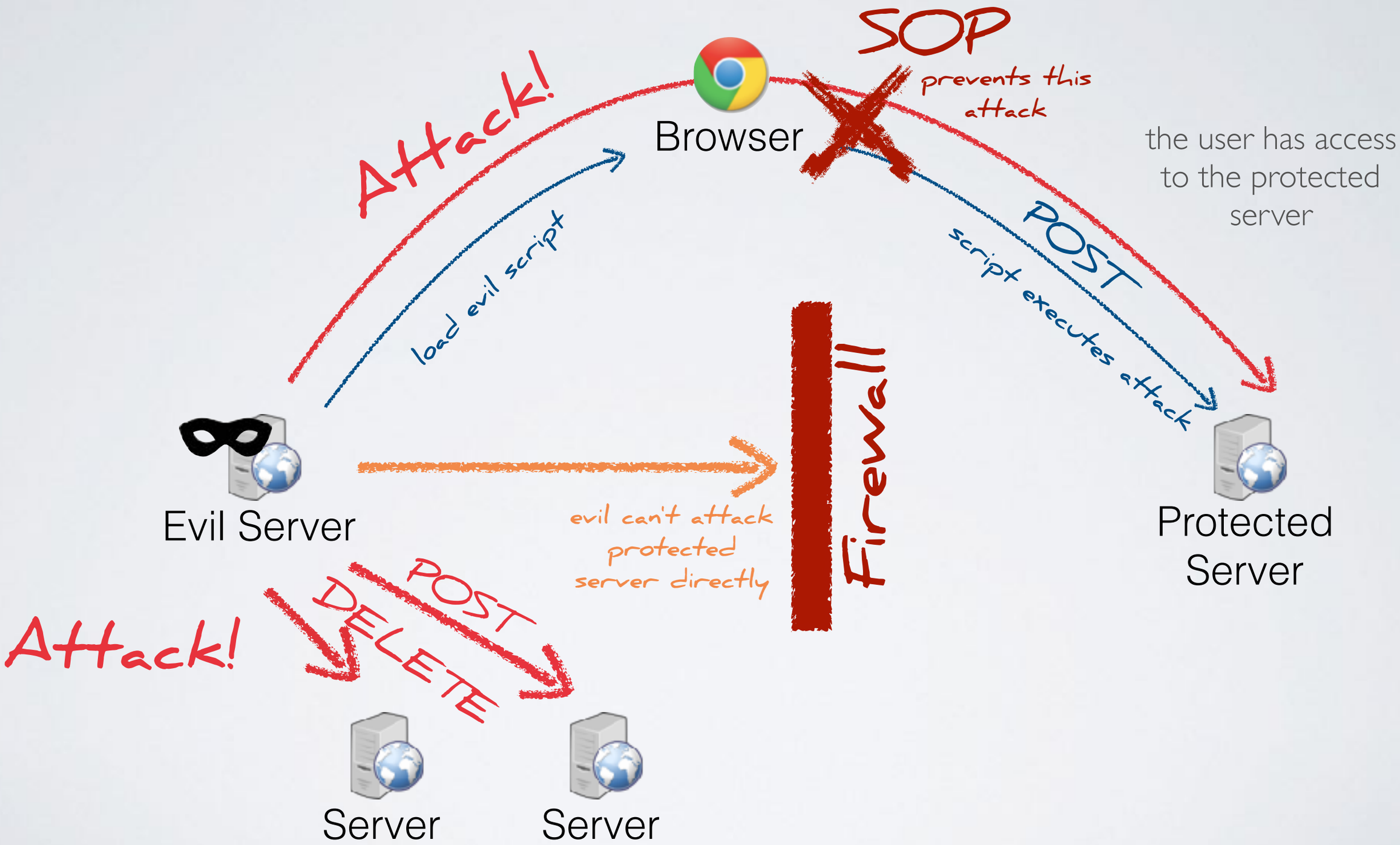
- A page can't access data on another page
- A script can only make AJAX calls to resources from the origin it was loaded from
- Example: A script from "example.com" can't read or write your emails from "gmail.com"

The SOP protects the client not the server!

The SOP prevents "distributed APIs"!

https://developer.mozilla.org/en-US/docs/Web/Security/Same-origin_policy

SOP



https://annevankesteren.nl/2015/02/same-origin-policy

Cross Origin Resource Sharing (CORS)

CORS allows to circumvent the SOP to implement "distributed APIs".

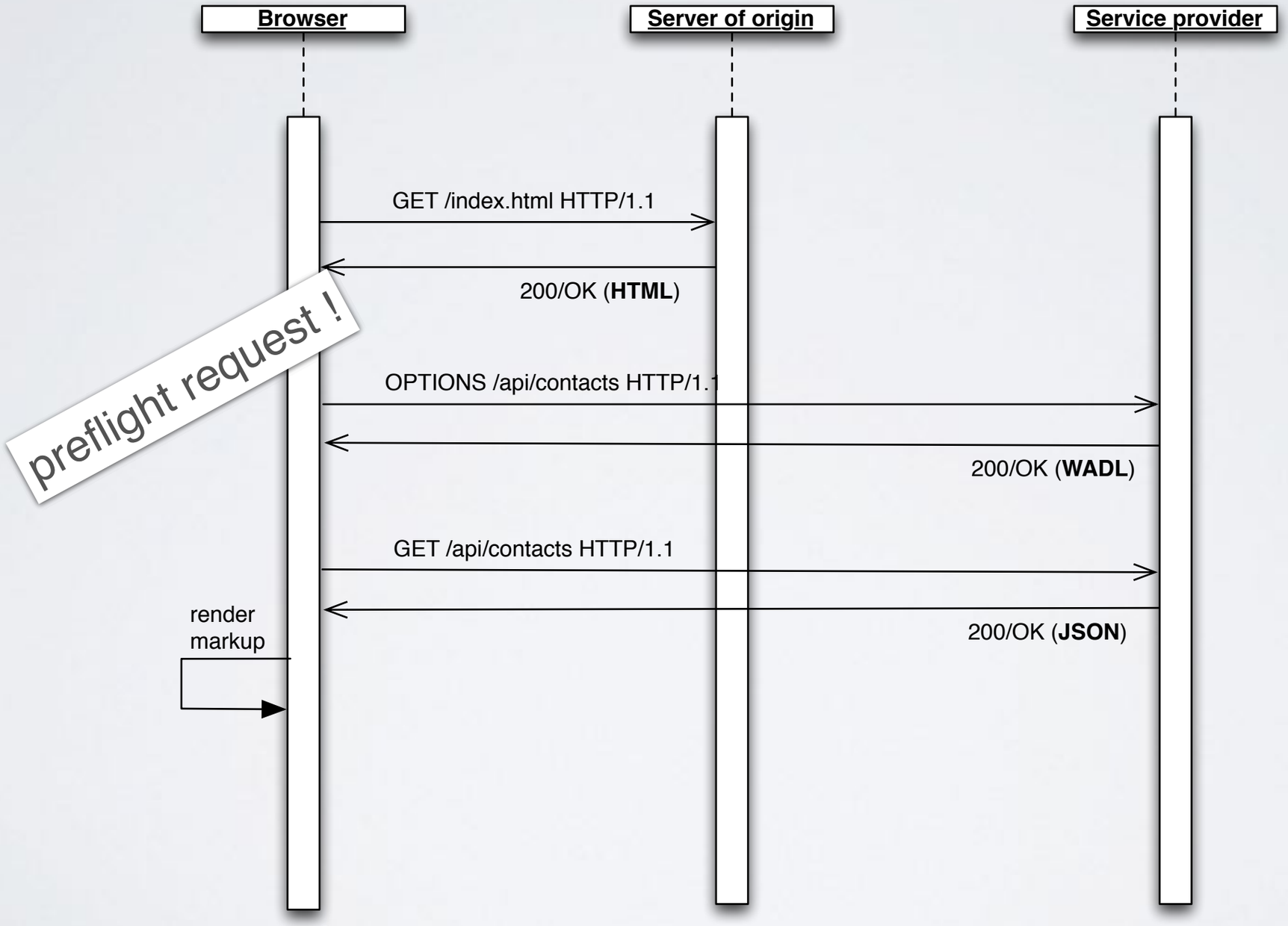
- A server API can define that its resources can be accessed from other origins.
- Browsers then allow scripts to make AJAX calls to that API.

CORS is implemented on the server but affects the behaviour of the browsers.

CORS only affects browser clients. Other clients (i.e. mobile) are not affected.

https://developer.mozilla.org/en-US/docs/Web/HTTP/Access_control_CORS

CORS: Preflight Request



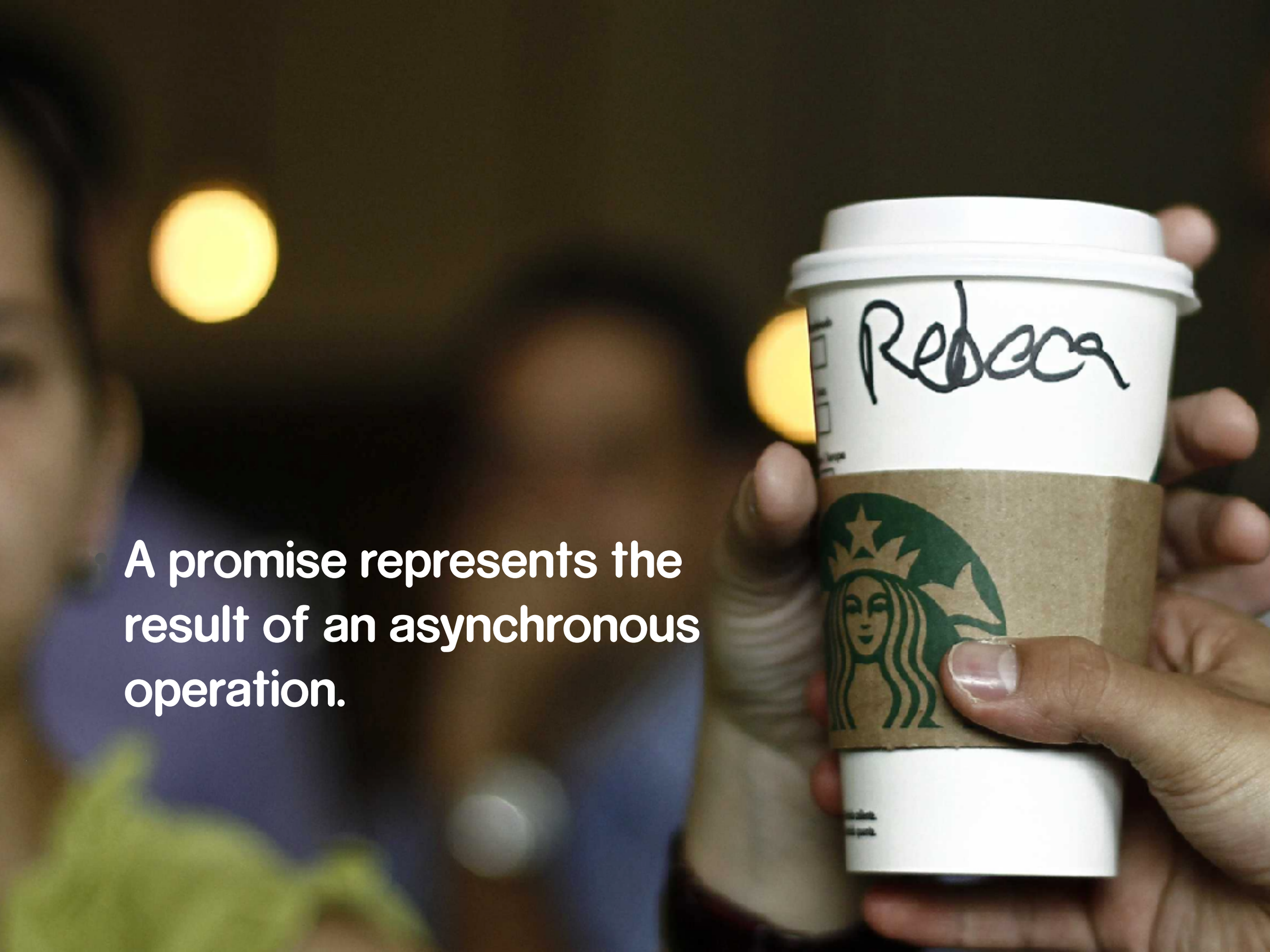
https://www.w3.org/TR/cors/#cross-origin-request-with-preflight-0

Setting CORS Headers

JEE WebFilter

```
@WebFilter(filterName = "CorsFilter", urlPatterns = {"/rest/ratings-cors/*"})
public class CorsFilter implements Filter{

@Override
public void doFilter(ServletRequest servletRequest, ServletResponse servletResponse,
                     FilterChain filterChain) throws IOException, ServletException {
    final HttpServletRequest httpRequest = (HttpServletRequest)servletRequest;
    final HttpServletResponse httpResponse = (HttpServletResponse)servletResponse;

    httpResponse.addHeader("Access-Control-Allow-Origin", "*");
    httpResponse.addHeader("Access-Control-Allow-Methods",
                                  "GET, POST, PUT, DELETE, OPTIONS");
    httpResponse.addHeader("Access-Control-Allow-Headers",
       "content-type, x-requested-with, accept, origin, authorization, X-PINGOTHER");
...
}
```

Promises



A promise represents the result of an asynchronous operation.

Promises

- A promise represents the result of an asynchronous operation.
  - Counterparts: Future<> in Java or Task<> in .NET (TPL)
- Promises enable another programming model for asynchronous functions than the callback programming model.
  - Asynchronous functions can return a value without blocking (so they look much more like synchronous functions)
  - The return value is a promise that represents the final value that is possibly not yet known

Using Promises

Consume a promise:

```
var promise = startAsyncOperation();
promise.then(function (value) {
        // success handler
    })
    .catch(function (error) {
      // error handler
    });
```

Provide a promise (ECMAScript 2015):

```
function startAsyncOperation(){
  var promise = new Promise(function (resolve, reject) {
     // resolve the promise later
      setTimeout(function () { resolve("Success!");}, 1000);
  });
  return promise;
}
```

Advantages of Promises: Chaining Async Operations

Callback-Hell:
(aka Pyramid of Doom)

```
api(function(result){
    api2(function(result2){
        api3(function(result3){
            // do work
        });
    });
});
```

Promise Chaining:

If a "then-callback" returns another promise, the next "then" waits until it is settled.

```
api().then(function(result){
    return api2();
}).then(function(result2){
    return api3();
}).then(function(result3){
     // do work
}).catch(function(error) {
     //handle any error
});
```

```
api().then(api2)
      .then(api3)
      .then(/* do work */);
```

Advantages of Promises: Combining Multiple Actions

```
var firstData = null, secondData = null;

var responseCallback = function() {
 if (!firstData || !secondData) return;
 // do something
}

getData("http://url/first", function(data) {
  firstData = data;
  responseCallback();
});

getData("http://url/second", function(data) {
  secondData = data;
  responseCallback();
});
```

```
var promise1 = getData("http://url/first");
var promise2 = getData("http://url/second");

Promise.all([promise1, promise2])
    .then(function(arrayOfResults) {…})
    .catch(function(errOfPromise) {…});

Promise.race([promise1, promise2])
    .then(function(valOfPromise) {…})
    .catch(function(errOfPromise) {…});
```

Promise Chaining

```
doSomething().then(function () {
  return doSomethingElse();
}).then(finalHandler);
```

```
doSomething().then(function () {
  doSomethingElse();
}).then(finalHandler);
```

```
doSomething()
   .then(doSomethingElse())
   .then(finalHandler);
```

```
doSomething()
   .then(doSomethingElse)
   .then(finalHandler);
```

https://pouchdb.com/2015/05/18/we-have-a-problem-with-promises.html

Observables

Observables

An observable represents a multi-value push protocol:

	Single	Multiple
Pull	`Function`	Iterator
Push	`Promise`	`Observable`

Typical scenario: an asynchronous stream of events.

```
const observable =
   Rx.Observable.fromEvent(
      document.getElementById('tick'),'click'
   );

observable.subscribe(x => console.log(x));
```

Observables in ECMAScript

RxJS 5 is the "de-facto" implementation of observables today.

http://reactivex.io/rxjs

Angular uses RxJS 5

RxJS 5 is a library for composing asynchronous and event-based programs by using observable sequences.

There is a proposal to standardize `Observable` as built-in type in a future version of ECMAScript.

There are different competing libraries with similar reactive programming concepts: Beacon.js, xstream, …

https://github.com/tc39/proposal-observable

https://baconjs.github.io/

http://staltz.com/xstream/

Using Observables

Consume an observable:

```
var stream = startAsyncOperation();
stream.subscribe(
  value => document.getElementById("content").innerText += value,
  error => console.log('Error: ' + error),
  () => console.log('Completed!')
);
```

Provide a observable (using RxJS):

```
function startAsyncOperation(){
  var stream = new Rx.Observable(
    observer => {
      setTimeout(() => observer.next("This is first value!"), 1000);
      setTimeout(() => observer.next("This is second value!"), 2000);
      setTimeout(() => observer.next("This is third value!"), 3000);
      setTimeout(() => observer.complete(), 3000);
    });
  return stream;
}
```

Observable Characteristics

- Represents any number of values over any amount of time
- Observables are able to deliver values either synchronously or asynchronously
- Observables are lazy
- Observables can be cancelled
- Observables can be composed with higher-order combinators

Observables vs. Promises

An observable can be an alternative to a promise:
a stream that pushes exactly one result.

```
const observable = new Rx.Observable(
   observer => setTimeout(
        () => {
             observer.next(42);
             observer.complete();
        },
        2000);
);

observable.subscribe(x => console.log(x));
```

Angular exposes observables for backend access via http service.

Observables vs. Promises

Angular promotes observables over promises as the programming model for backend access.

Promise	**Observable**
returns a single value	works with multiple values over time
not cancellable	cancellable
	supports powerful operators like map, filter & reduce ("lo-dash for async")

For AJAX calls observables do not provide a clear advantage. But observables are used consistently throughout Angular.

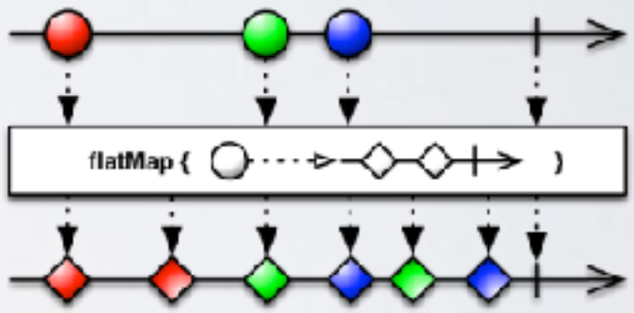
http://blog.thoughtram.io/angular/2016/01/06/taking-advantage-of-observables-in-angular2.html
Do Observables make sense for http? - https://github.com/angular/angular/issues/5876

Combining Observables

```
function api1(){
  return Rx.Observable.of(42).delay(2000);
}
function api2(){
  return Rx.Observable.of(43).delay(1000);
}
function api3(){
  return Rx.Observable.of(44).delay(500);
}

stream = Rx.Observable.from([api1, api2, api3]);
```

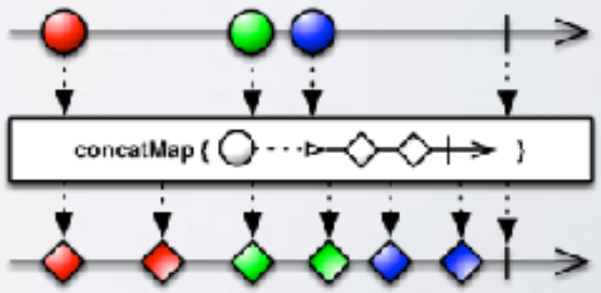
```
stream.flatMap(x => x())
      .subscribe(
          value => console.log(value)
      );
```

out:
44, 43, 42




```
stream.concatMap(x => x())
      .subscribe(
          value => console.log(value)
      );
```

out:
42, 43, 44



http://reactivex.io/documentation/operators


JS
15
CHROME VANADIUM
17
CHROME VANADIUM
13
CHROME VANADIUM
CHROME VANADIUM
8

Toolset

Dependency Management	Declare & Resolve project dependencies. Including transitive dependencies.	npm, yarn, Bower, jspm.io, pnpm (A next-generation package manager for the front-end.)
Build Automation	Infrastructure to implement and run build steps. Orchestrate other tools.	npm, Gulp, GRUNT, Brunch, Broccoli
Module Bundling	Build one or several javascript files for deployment. Resolve module dependencies. Concatenate and minify JavaScript files.	webpack (module bundler), browserify, jspm.io, PARCEL, require.js, rollup.js, splittable, FUSEBOX
Transpilation	Transform development sources (ES2015+ / TS / JSX) into ES5.	BABEL, TypeScript, tc
Linting / Static Type-System	Static code analysis. Compile-time checked static type-system	ESLint, TSLint, JSHint, JSLint, TypeScript, flow

Node Package Manager

npm is installed together with Node

npm offers:

- Dependency Management (global and local packages)
- Simple Build Tool

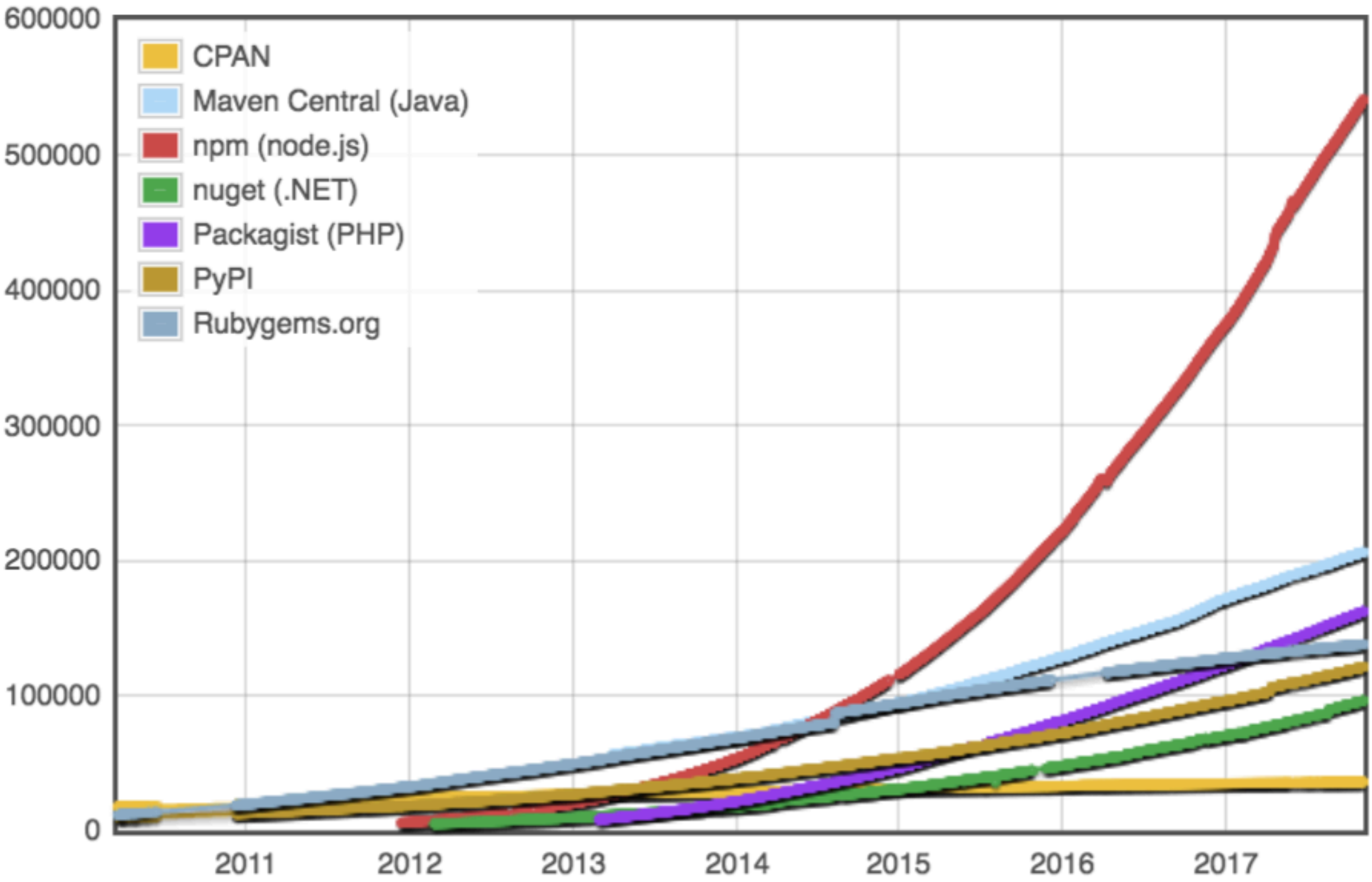
Active Ecosystem

www.npmjs.org

(Maven Central has
205,919 unique artifacts)

https://unpm.nodesource.com/
http://www.modulecounts.com/

Module Counts



http://www.modulecounts.com/

Node Package Manger

- Packages can be local (for the current project) or global
- `package.json` describes a package or project including it's dependencies
- packages are stored in `node_modules`
- hierarchical dependencies: dependencies can include their own dependencies
  (you can have several versions of a package in your project)
- Dependencies are versioned according to semantic versioning (https://semver.npmjs.com/)
- Starting from npm 5, exact versions are listed in `package-lock.json`
- Repository: npmjs.org (or private)
- Config: `.npmrc`

Tip: `npm config set save-exact true`

See: https://semver.npmjs.com/

Typical commands:

```
npm help
npm search
npm info
npm install
npm uninstall
npm list
npm update
npm init
npm root
npm config
```

Flags:

```
--global / -g
--help
--save / -S
--save-dev / -D
```

Enterprise Concerns

There are options for a private npm registry:

- Nexus
  http://books.sonatype.com/nexus-book/2.10/reference/npm.html
  (Nexus 2 does not support scoped packages, i.e. `@angular/core`)
- Artifactory
  http://www.jfrog.com/confluence/display/RTF/Npm+Repositories
- Visual Studio Team System:
  https://docs.microsoft.com/en-us/vsts/package/overview
- NPM Enterprise: https://www.npmjs.com/enterprise
- Gemfury: https://gemfury.com/
- verdaccio: http://www.verdaccio.org/

```
npm config list
npm config set registry <registry url>
```

Config files:
`<project>/.npmrc`
`$HOME/.npmrc`

yarn

…a better npm client.

npm@5 also introduced locking and speed similar to yarn

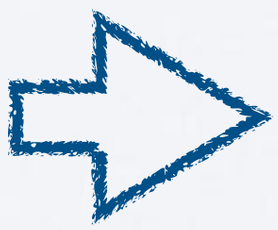
https://yarnpkg.com/

Yarn is faster and provides a reliable dependency management by pinning all dependencies (including transitive dependencies) with a lockfile (`yarn.lock`).

Recommended installation via installer.

deprecated: `npm install --global yarn`

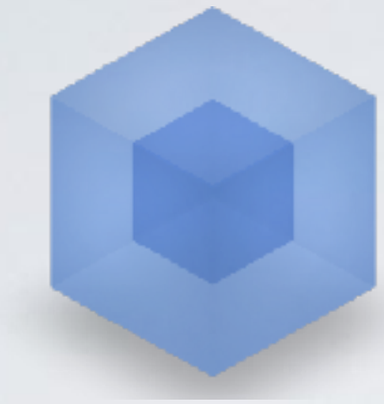
```
npm install
npm install --save [package]
npm install --save-dev [package]
npm run [script]
```



```
yarn
yarn add [package]
yarn add [package] --dev
yarn run [task]
```

Using yarn on CI
https://yarnpkg.com/blog/2016/11/24/offline-mirror/

https://yarnpkg.com/en/docs/migrating-from-npm
https://shift.infinite.red/npm-vs-yarn-cheat-sheet-8755b092e5cc



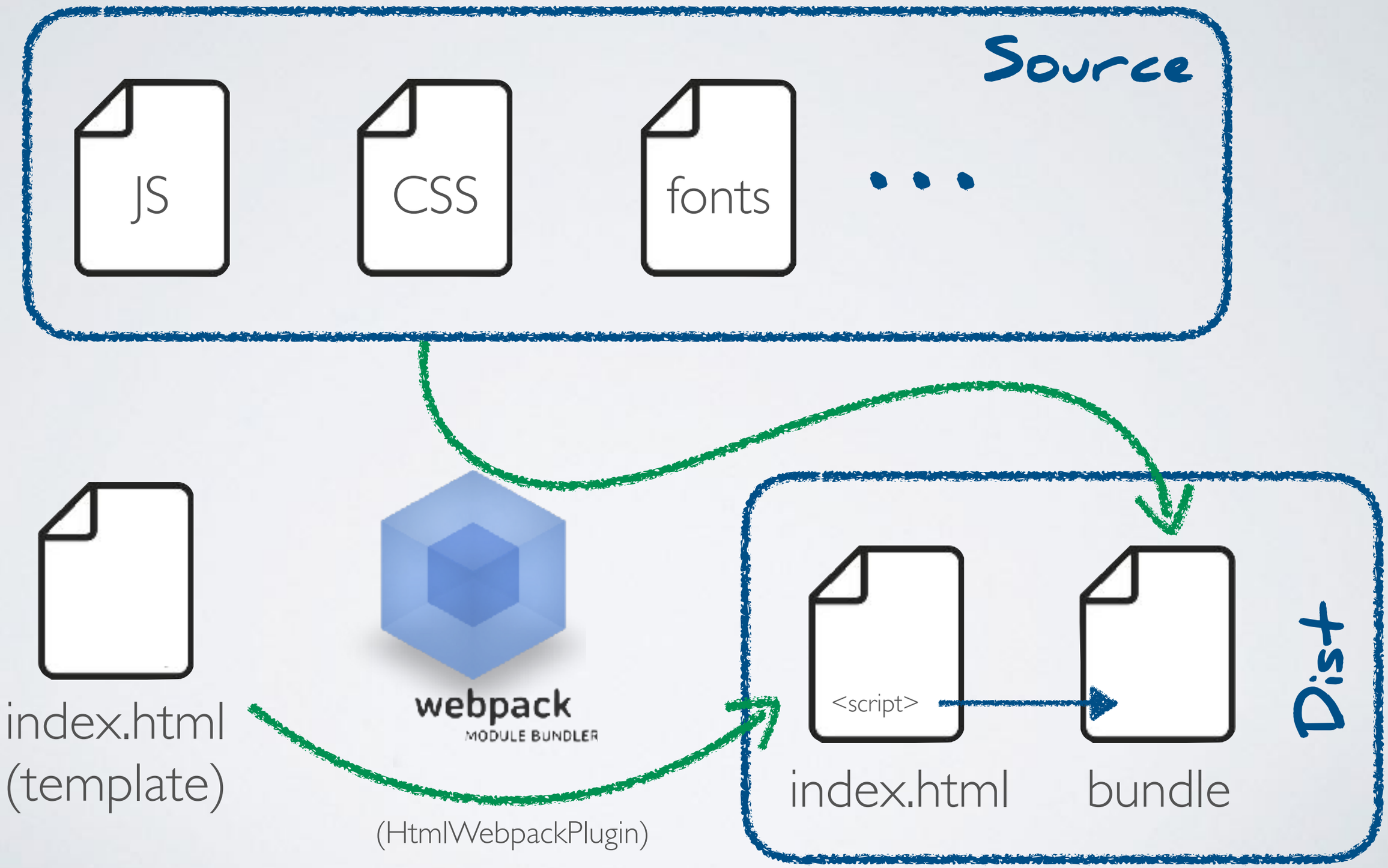
WebPack

Webpack is a bundler that bundles the fine grained assets of the application (primarily JavaScript and CSS) into one or several corse grained bundles at build time.
The contents of a bundle are defined by building a dependency graph (following imports).

Bundles are JavaScript files that are loaded by the browser at runtime.

https://webpack.js.org/

WebPack Build



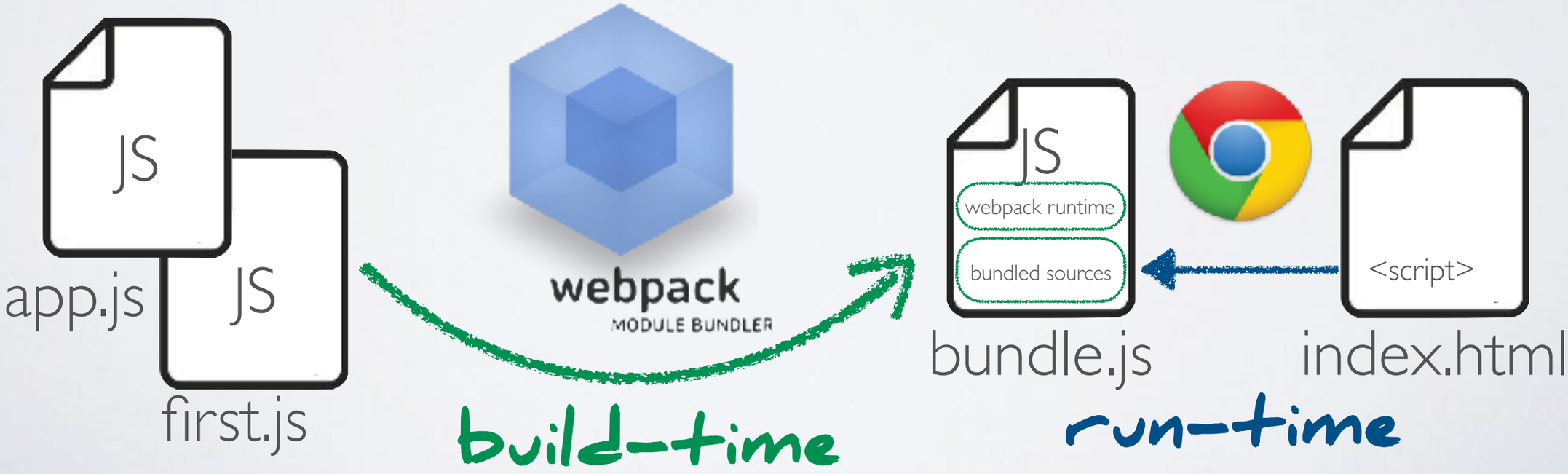
ES2015 Modules with WebPack

index.html

```
<script src="bundle.js"></script>
```

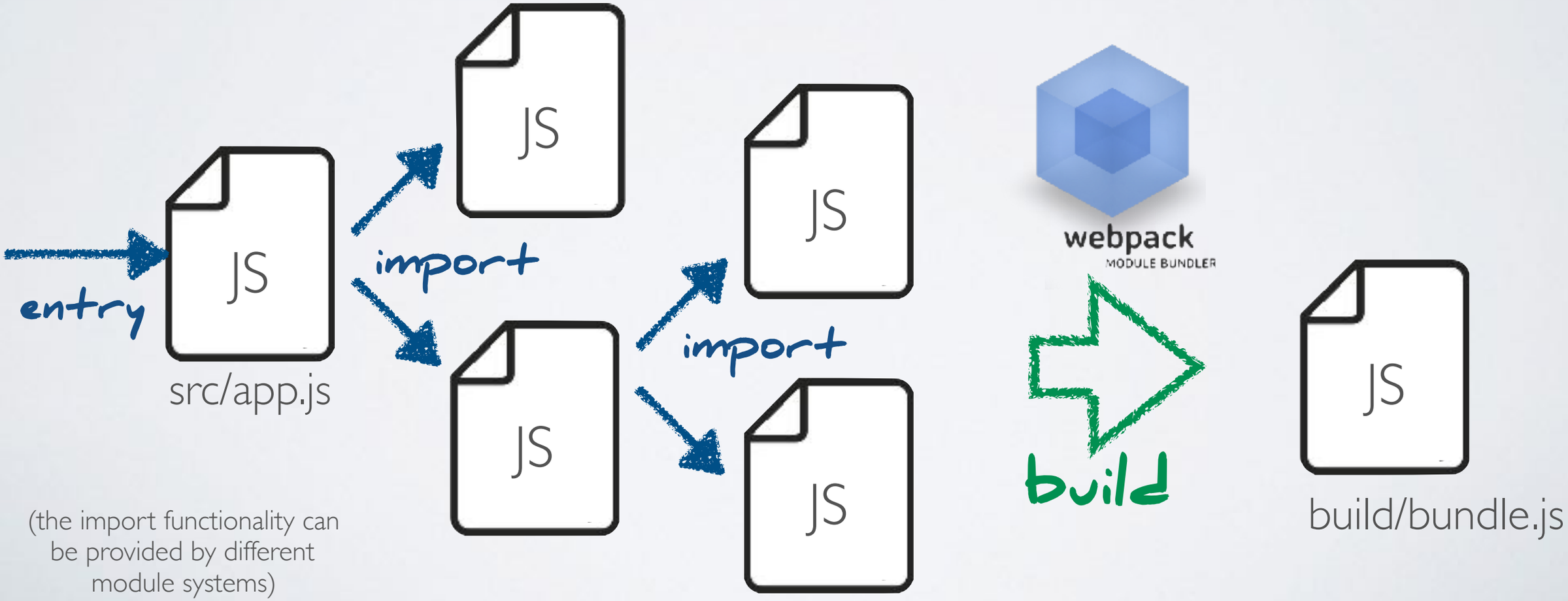
app.js

```
import './modules/first';
console.log("Hello from ES6 modules");
```



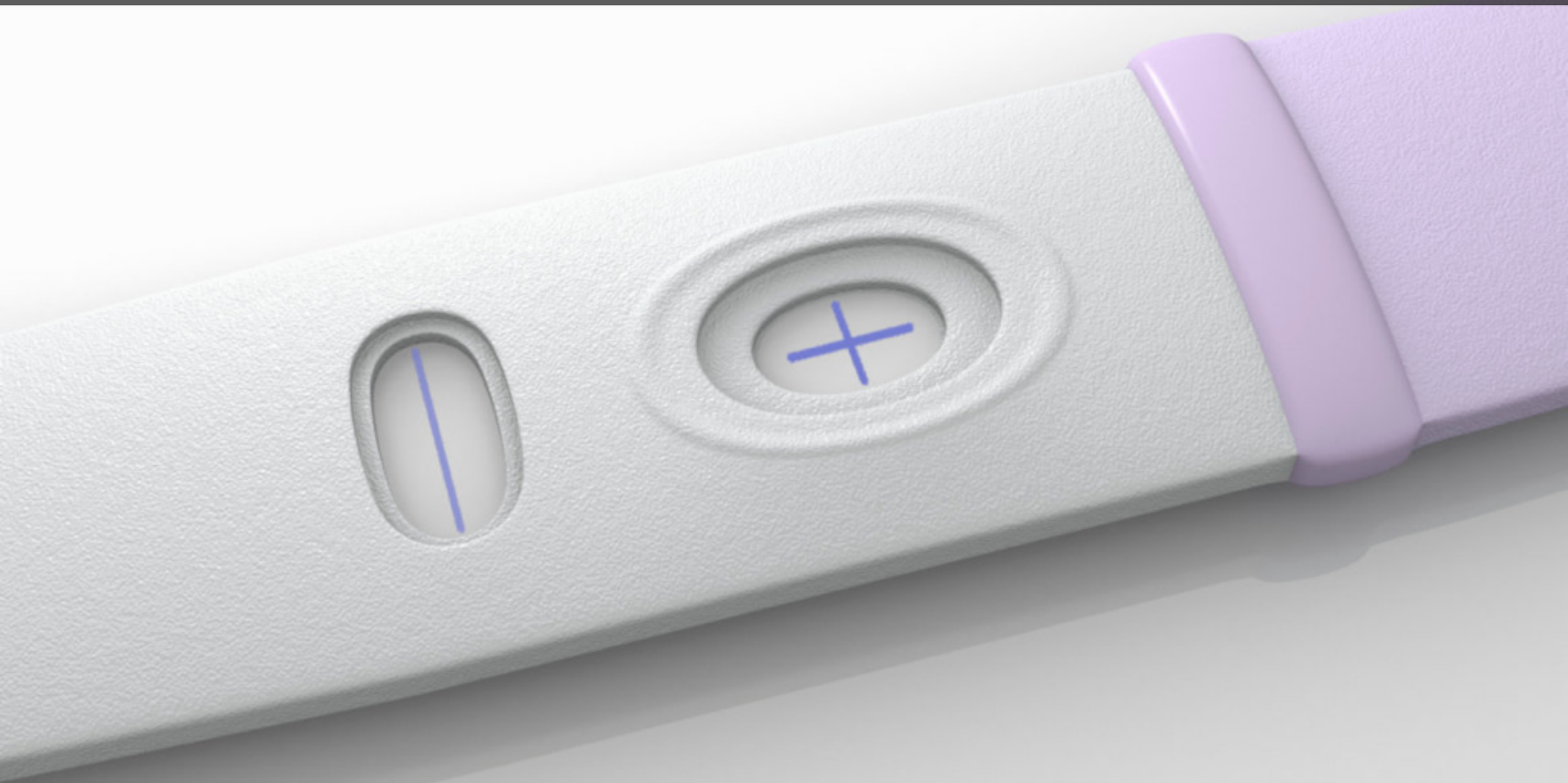
A minimal WebPack config

```
module.exports = {
    entry: './src/app/app.js',
    output: {
        filename: 'build/bundle.js'
    },
    devtool: 'source-map'
};
```



(the import functionality can be provided by different module systems)

Testing



Test Framework

Formulate tests in code.
Run the tests in the browser.

Jasmine, mocha, chai, QUnit, tape, Jest

Node based test-runner

Run JavaScript tests in Node.js
No DOM is provided.
(use jsdom as a DOM implementation for node)

Jasmine, mocha, Jest, tape

Advanced Test Runner

Run tests in multiple browsers (including PhantomJS)
Provide different reporters (coverage, junit …)
Run test continuously.
Automatically launch browsers.

KARMA, Testem

End-to-End Testing

Automate browsers via Selenium

Protractor (end to end testing for AngularJS), Nightwatch.js

JS Testing Scenarios

(where to run tests)

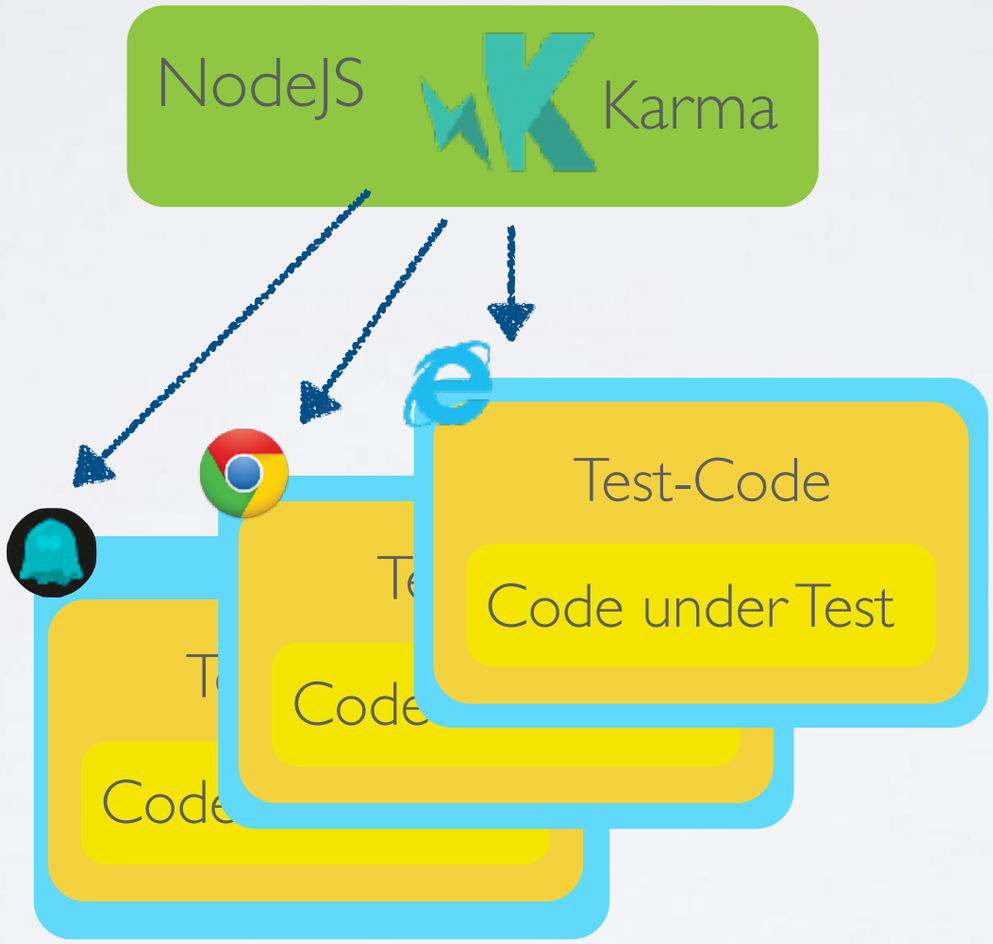
Pure Node-Testing

(unit-tests)

Run tests in node.
Optionally use jsdom
to fake DOM.

Karma

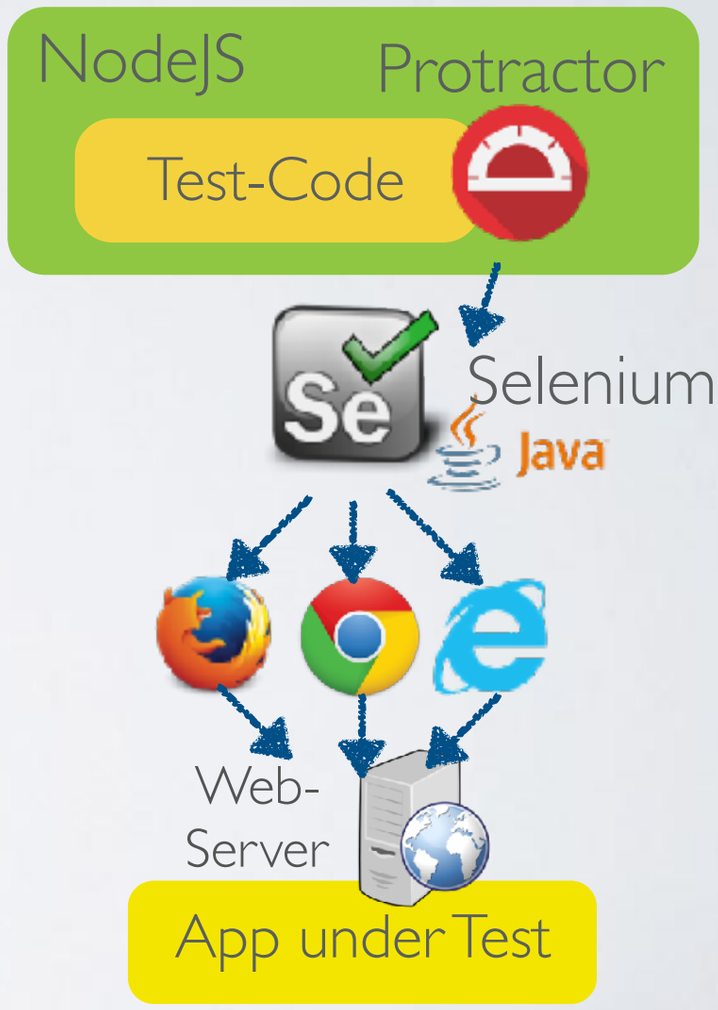
(unit-tests)



Run tests in the browser.
Optionally use as headless browser.

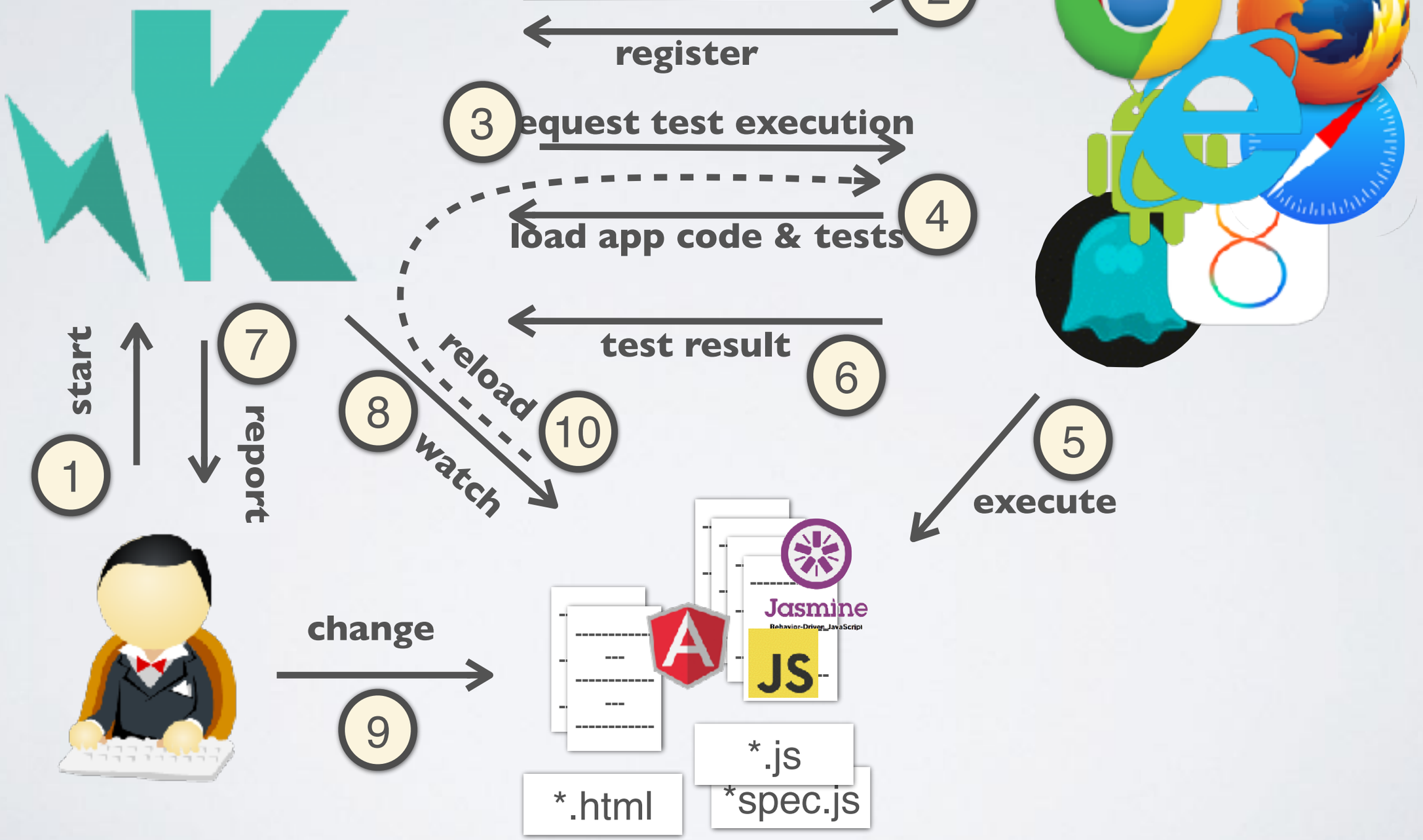
Protractor

(end-to-end tests, e2e)



Script a browser to interact
with a deployed app.

KARMA


(launch)
2
register
3
equest test execution
load app code & tests
4
test result
6
5
execute
reload
10
8
watch
7
report
start
1
change
9
Jasmine
JS
*.html
*.js
*spec.js

Protractor

end to end testing for AngularJS