Full Stack Application Development

Client Side Scripting

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Frontend technologies

- What happens when you load your webpage in the browser?
- The code (the HTML, CSS, and JavaScript) are running inside an execution environment (the browser).
- HTML is the markup language that we use to structure and give meaning to our web content.
- CSS is a language of style rules that we use to apply styling to our HTML content, for example, setting background colors and fonts and laying out our content in multiple columns.
- JavaScript is a scripting language that enables you to create dynamically updating content and adds interactivity to your webpage.

Javascript

- JavaScript is the programming language of the web.
- JavaScript is a programming language that adds interactivity to websites.
- JavaScript is a single-threaded interpreted language.
- Every browser has its own JavaScript engine. Google Chrome has the V8 engine, Mozilla Firefox has SpiderMonkey.
- The core client-side JavaScript language consists of some common programming features like variables, objects, functions etc.,

Host Environment

- Browsers- Initially only implemented in web browsers
- Now it can be used on Server Side

Client Side(Browser)	Server Side(NodeJS)
• Different browsers provide their own JS engines • Allows interaction with web page(HTML and CSS) • Interact with browser API s (History, Location)	• Google' s V8 was extracted to run anywhere- Node.js • Node is a fast C++-based JavaScript interpreter • Work with file systems, Web servers • Knowledge Reuse

JavaScript implementations

- Mozilla's SpiderMonkey is used in Firefox. Other non-browser usage includes MongoDB, CouchDB, and more. This was the first ever JavaScript engine, created by Brendan Eich at Netscape.
- Google's V8, used in Chrome and Chromium-based browsers such as Opera. Other non-browser usage includes Node.js, Deno, Electron, and more.
- Apple's JavaScriptCore (also known as SquirrelFish/Nitro), used in Safari and other WebKit-based browsers.

Execution in Javascript

JavaScript is a single-threaded programming language.

An Execution Context is an abstract concept of an environment where the JavaScript code is evaluated and executed.

JavaScript execution requires the cooperation of two pieces of software: the JavaScript engine and the host environment.

Execution in Javascript

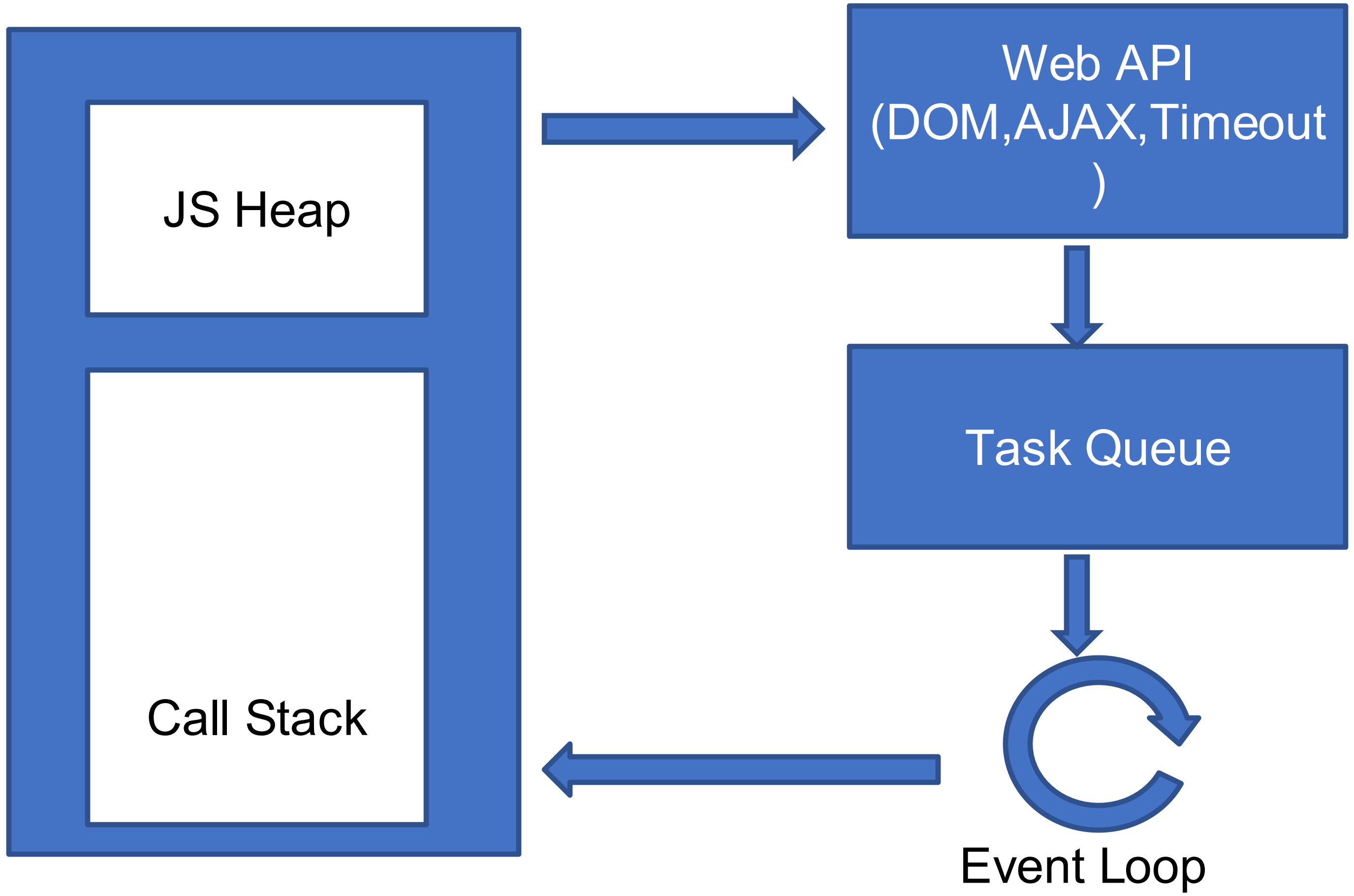
The JavaScript Engine consists of two main components:

Memory Heap: this is where the memory allocation happens

Call Stack: this is where your stack frames are as your code executes. As its name implies, the call stack has a LIFO (Last in, First out) structure, which stores all the execution context created during the code execution.

JavaScript Execution in browser

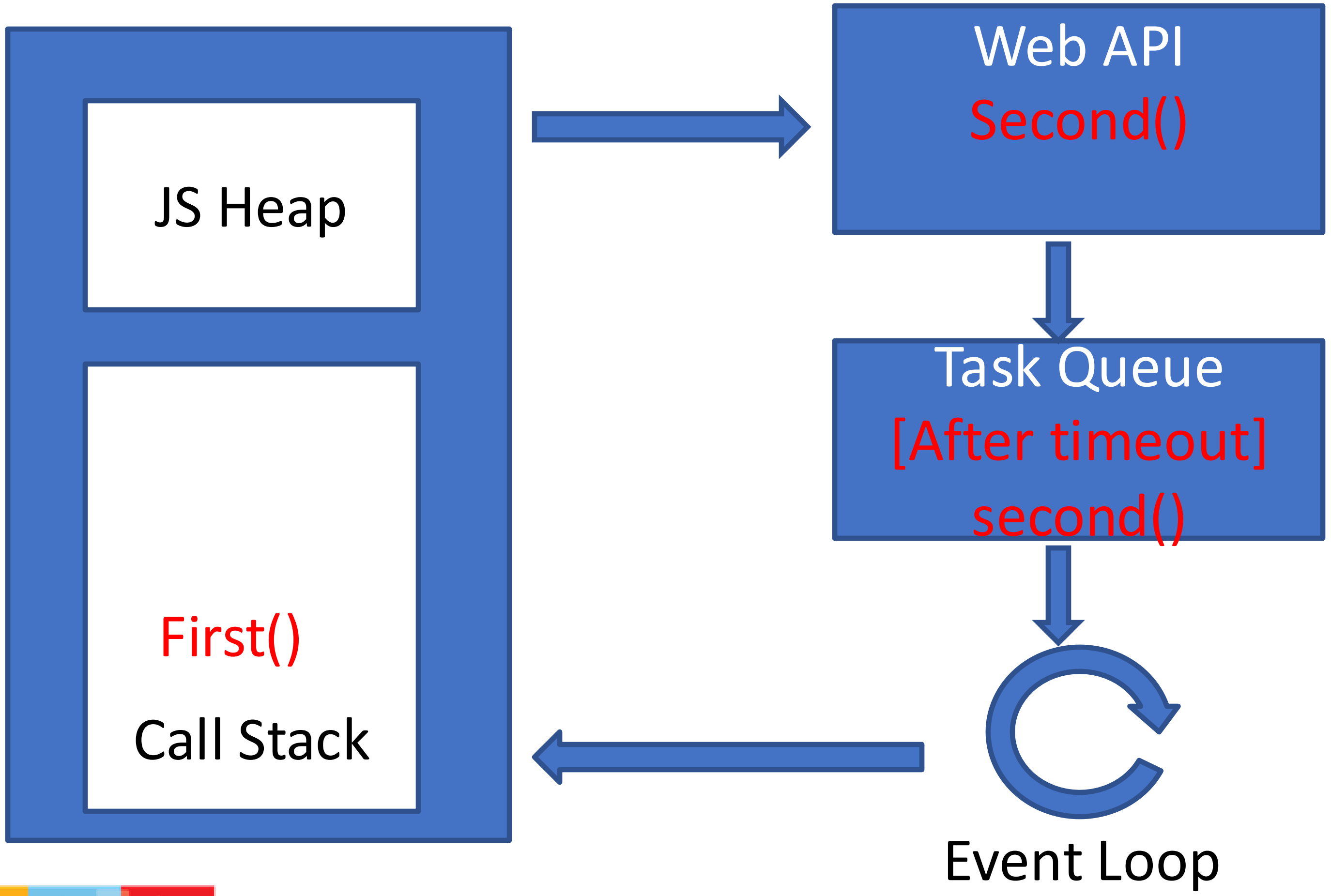
- Synchronous Execution



```
<script>
        const second = () => {
            console.log('Hello there!');
        }
        const first = () => {
            console.log('Hi there!');
            second();
            console.log('The End');
        }
        first();
    </script>
```

JavaScript Execution in browser

- Asynchronous Execution

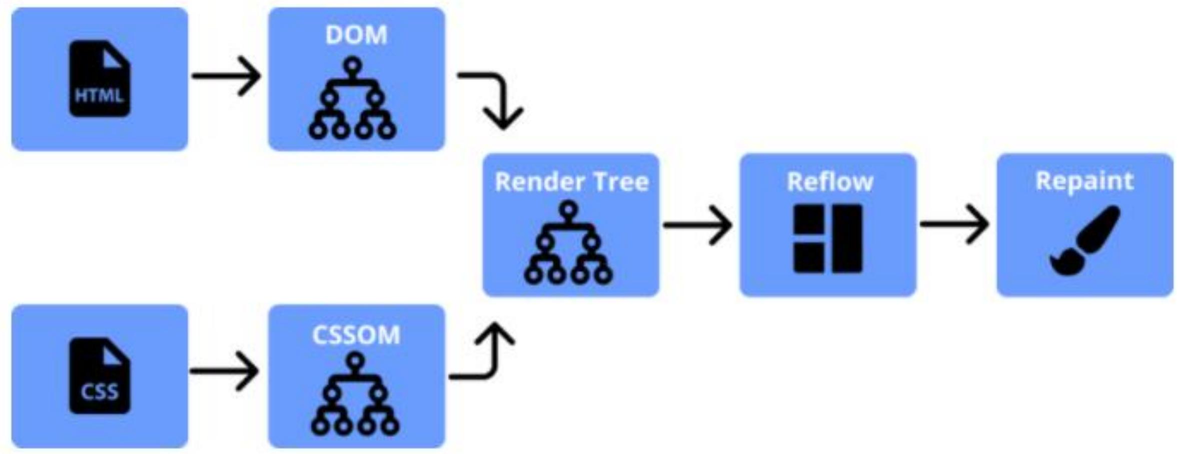


```
<script>
        const second = () => {
            console.log('Hello there!');
        }
        const first = () => {
            console.log('Hi there!');
            setTimeout(second, 1000);
            console.log('The End');
        }
        first();
    </script>
```

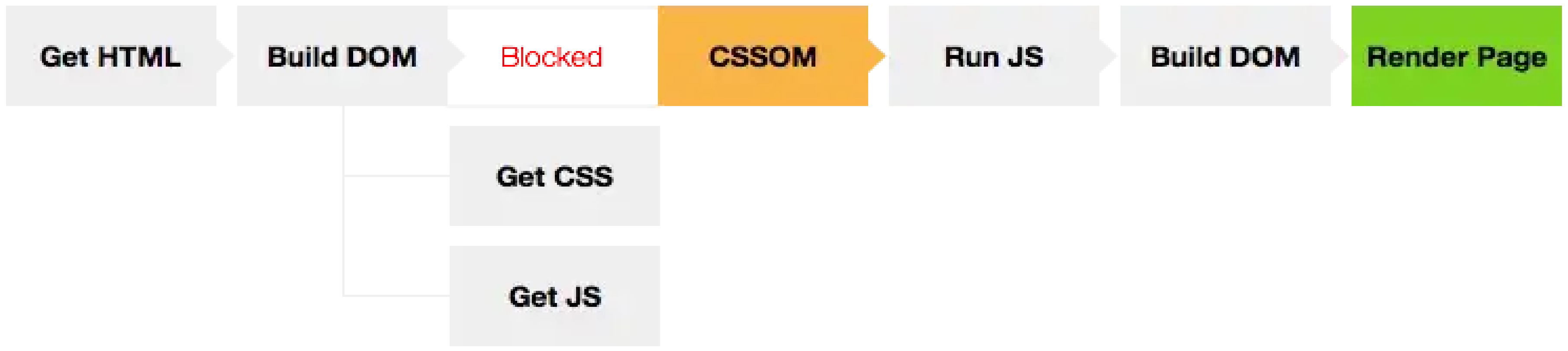
Visualization

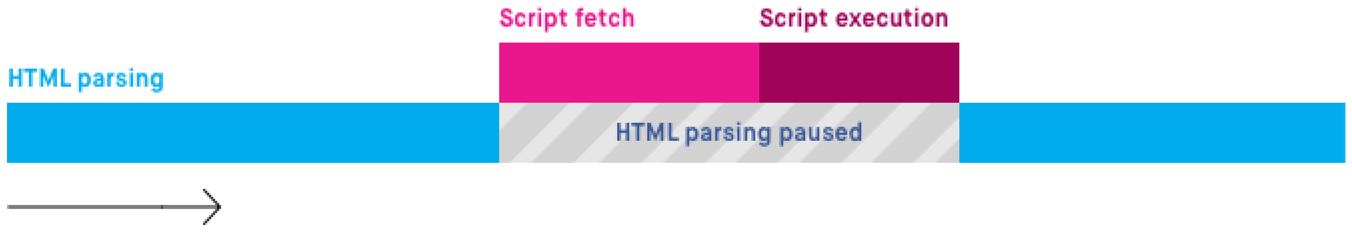
- https://www.jsv9000.app/

The Critical Rendering Path

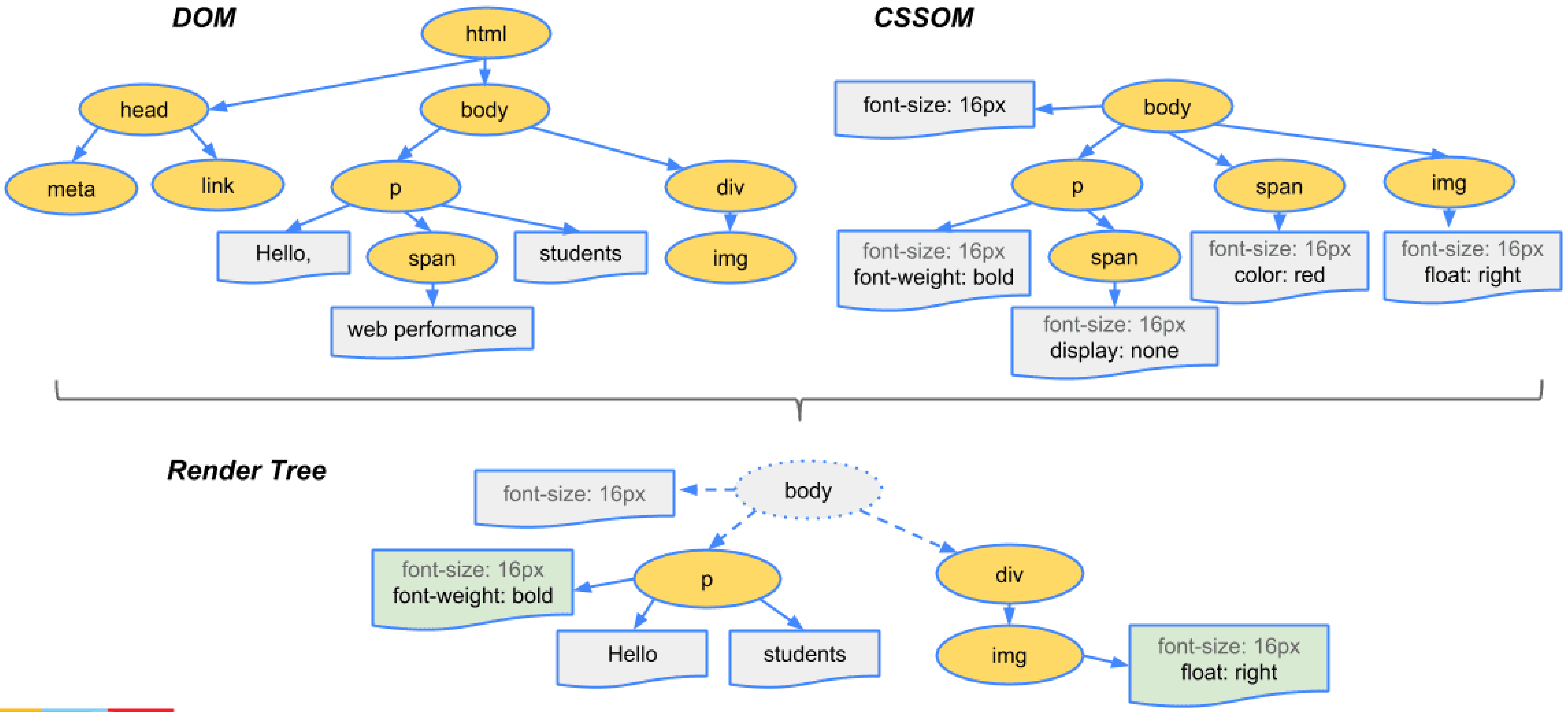


Critical Rendering Path





CRP



https://web.dev/articles/critical-rendering-path/render-tree-construction

Performance Metrics

- First Paint: The time to start of first paint operation. Note that this change may not be visible; it can be a simple background color update or something even less noticeable.
- First Contentful Paint (FCP): The time until first significant rendering (e.g., of text, foreground or background image, canvas or SVG, etc.). Note that this content is not necessarily useful or meaningful.
- First Meaningful Paint (FMP): The time at which useful content is rendered to the screen.
- Largest Contentful Paint (LCP):The render time of the largest content element visible in the viewport.
- Speed index: Measures the average time for pixels on the visible screen to be painted.
- Time to interactive: Time until the UI is available for user interaction (i.e., the last long task of the load process finishes).

Placement of <script> tag

<script> tag:

When placed in Head:

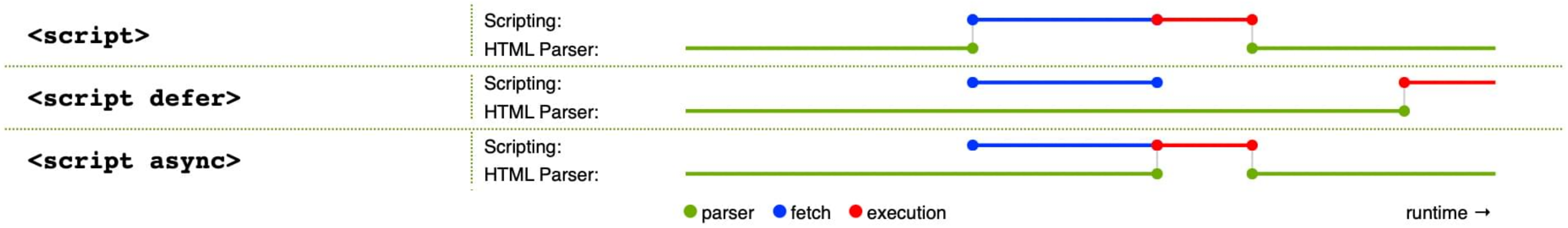
when the parser finds this line, it goes to fetch the script and executes it

Blocks the DOM construction

Introduces a lot of delay in loading the HTML

A very common solution to this issue is to put the script tag at the bottom of the page, just before the closing </body> tag.

Defer and Aysnc



This image is from the HTML spec,

Async

When to NOT use the async attribute for loading scripts

- Loading scripts that want to access the DOM with async should therefore be used with caution.
- Load several scripts with async, but they are actually interdependent — so it is important in which order they should be executed, because e.g. one of the two scripts is a library that the second script wants to access.

When to use the async attribute for loading scripts

- When we load external JavaScripts from another server, analysis tool like google analytics
- Applies to all other scripts that cannot directly access the DOM

Defer

When to use the defer attribute for loading scripts

this attribute is ideal for all scripts that are guaranteed to access the DOM

if we have several scripts that access each other, they must be executed in the order in which we want them to be

Reflow and Repaint

- The Repaint occurs when changes are made to the appearance of the elements that change the visibility, but doesn't affect the layout

  Eg: Visibility, background color, outline
- Reflow means re-calculating the positions and geometries of elements in the document. The Reflow happens when changes are made to the elements, that affect the layout of the partial or whole page.
- Resizing the window
- Changing the font
- Adding or removing a stylesheet
- Content changes, such as a user typing text in
- an input box

Example

```
var bodyStyle = document.body.style;
bodyStyle.padding = "20px";                    // reflow, repaint
bodyStyle.border = "10px solid red";      // reflow, repaint

bodyStyle.color = "blue";                        // repaint only, no dimensions changed
bstyle.backgroundColor = "#cc0000"; // repaint
bodyStyle.fontSize = "2em";         // reflow, repaint
// new DOM element - reflow, repaint
document.body.appendChild(document.createTextNode('Hello!'));
```

Minimize Repaint and Reflow

Don't change individual styles, one by one.

Don't ask for computed styles excessively. If you need to work with a computed value, take it once, cache to a local var and work with the local copy

Batch DOM changes together

Optimizing the CRP

The process of website performance optimization involves changes to the website that reduce:

1) The amount of data that has to be transferred
2) The number of resources the browser has to download (especially the blocking ones)
3) The length of CRP

WebAPIs

Client-side JavaScript API

- Client-side JavaScript has many APIs available.
- They are not part of the JavaScript language itself.
- But they are built on top of the core JavaScript language.
- Client-side JavaScript API s fall into two categories
  - Browser APIs
  - Third Party APIs

Browser API

- A Browser API can extend the functionality of a web browser.
- All browsers have a set of built-in Web APIs to support complex operations, and to help accessing data.
- For example, the Web Audio API, Geolocation API

Third-party APIs

- **Third-party APIs** are not built into the browser by default.
- Third-party APIs are constructs built into third-party platforms (e.g. Google Maps API, Facebook APIs)
- They allow you to use some of those platform's functionality in your own web pages

Common APIs

- **APIs for manipulating documents**
  - Example: DOM API
- **APIs that fetch data from the server**
  - Example: Fetch API
- **APIs for drawing and manipulating graphics**
  - Example Canvas API
- **Audio and Video APIs**
  - Example: Web Audio API
- **Device APIs**
  - Example: Geolocation API
- **Client-side storage APIs**
  - Example: Web Storage API

Client-side storage

- There are numerous methods for storing data locally in the users' browser
  - Cookies
  - Web Storage (Local and Session Storage)
  - IndexedDB
  - Centralized data store ; State management libraries can be used.

Cookies

- A cookie is a small piece of data that a server sends to the user's web browser.
- The browser may store it and send it back with the next request to the same server.
- It remembers stateful information for the stateless HTTP protocol.
- They're the earliest form of client-side storage commonly used on the web.

Web Storage API

- The Web Storage API provides mechanisms by which browsers can store key/value pairs

- The two mechanisms within Web Storage are as follows:
  - sessionStorage maintains a separate storage area for each given origin that's available for the duration of the page session
  - localStorage does the same thing, but persists even when the browser is closed and reopened.

- The two types of storage areas are accessed through global objects named “window.localStorage” and “window.sessionStorage”.

Web Storage API

- Data is stored as key/value pairs, and all data is stored in string form.
- Data is added to storage using the setItem() method.
- setItem() takes a key and value as arguments.
- If the key does not already exist in storage, then the key/value pair is added.
- If the key is already present, then the value is updated.
- sessionStorage.setItem("foo", 3.14);
- localStorage.setItem("bar", true);

Reading Stored Data

- To read data from storage, the getItem() method is used.
- getItem() takes a lookup key as its sole argument. If the key exists in storage, then the corresponding value is returned.
- If the key does not exist, then null is returned.

- var number = sessionStorage.getItem("foo");
- var boolean = localStorage.getItem("bar");

Removing Stored Data

- To delete individual key/value pairs from storage, the removeItem() method is used.
- The removeItem() method takes the key to be deleted as its only parameter.
- If the key is not present then nothing will happen.
- sessionStorage.removeItem("foo");
- localStorage.removeItem("bar");

The storage Event

- A user can potentially have several instances of the same site open at any given time.
- Changes made to a storage area in one instance need to be reflected in the other instances for the same domain.
- The Web Storage API accomplishes this synchronization using the “storage” event.
- When a storage area is changed, a “storage” event is fired for any other tabs/windows that are sharing the storage area.
- Note that a “storage” event is *not* fired for the tab/window that changes the storage area.

Indexed DB

- IndexedDB is a transactional database embedded in the browser.
- The database is organized around the concept of collections of JSON objects similar to NoSQL databases
- IndexedDB is useful for applications that store a large amount of data (for example, a catalog of DVDs in a lending library) and applications that don't need persistent internet connectivity to work (for example, mail clients, to-do lists, and notepads).
- Each IndexedDB database is unique to an origin
- IndexedDB is built on a transactional database model.

Indexed DB

- Database - This is the highest level of IndexedDB. It contains the object stores, which in turn contain the data you would like to persist.
- Object store - An object store is an individual bucket to store data. Similar to tables in traditional relational databases.
- Operation - An interaction with the database.
- Transaction - A transaction is wrapper around an operation, or group of operations, that ensures database integrity.

Node Ecosystem

Node JS Ecosystem

- **Node.js Core**
- Node.js was built using the V8 JavaScript Engine
- Compiles JavaScript to machine code

- **Node.js Runtime**
- event-driven, non-blocking I/O model

- **NPM (Node Package Manager)**
- Command-line tool
- Manages Dependencies

- **Express.js**
- Express.js is a popular, minimalistic web application framework for Node.js.

Node JS Ecosystem

- **Webpack** is a powerful **module bundler**
- **Webpack** is a tool that takes your **source code** (JavaScript, CSS, images, etc.) and **bundles** it into a single file (or multiple files) that can be easily deployed to a web server.
- Its main purpose is to **optimize** and **organize** your code, making it

Transpiling

- Transpiling refers to the process of converting ECMAScript 6 (ES6) code or the latest code into an older version of JavaScript that is more widely supported by browsers and environments.
- **Babel** is the most popular transpiler for ES6.

References

- https://www.jsv9000.app/
- https://eloquentjavascript.net/11_async.html
- https://developer.mozilla.org/en-US/docs/Web/JavaScript/Event_loop

Thank You!