Asynchronous Programming and Promises

Fetch API, Promises, async/away

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Table of Contents

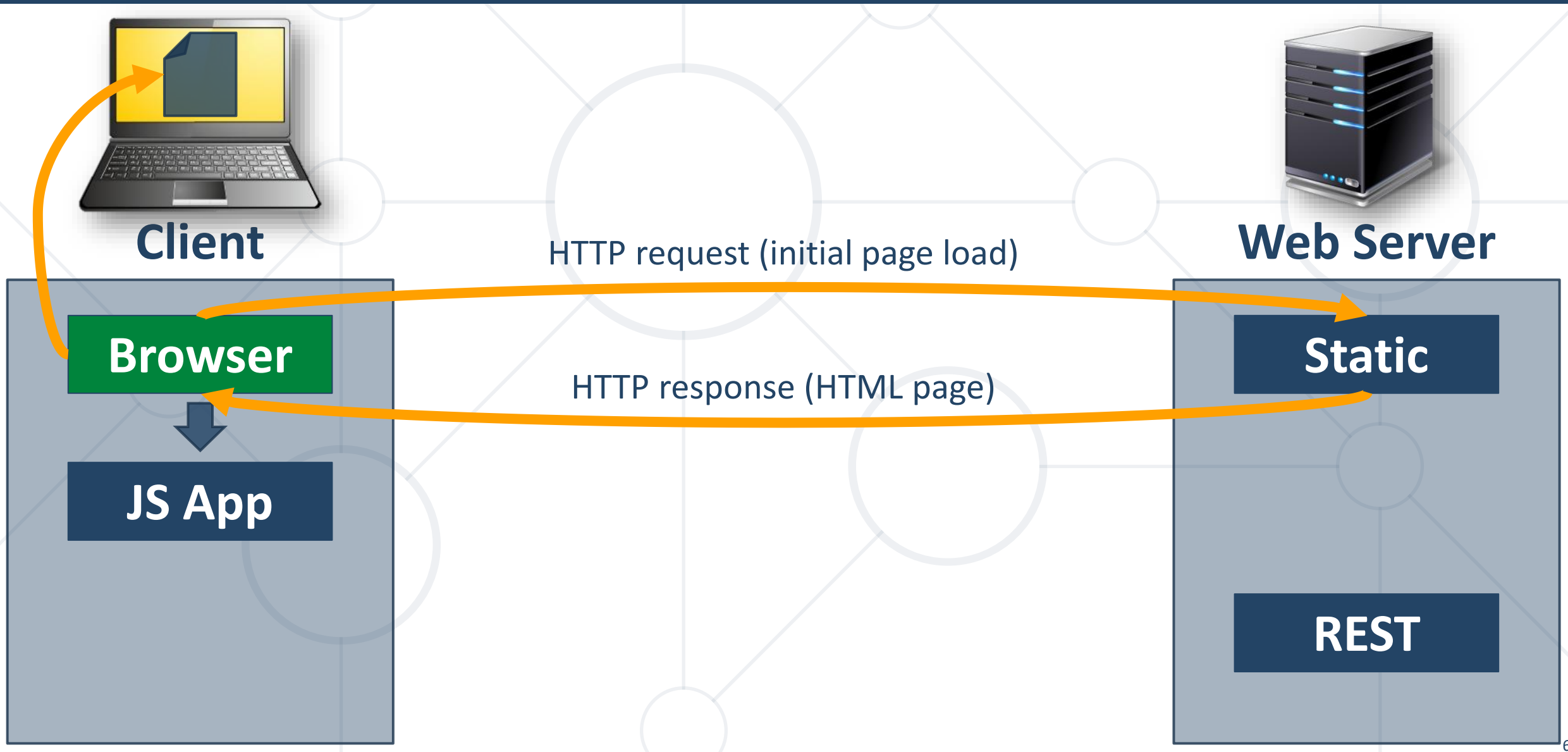
AJAX

Asynchronous JavaScript and XML

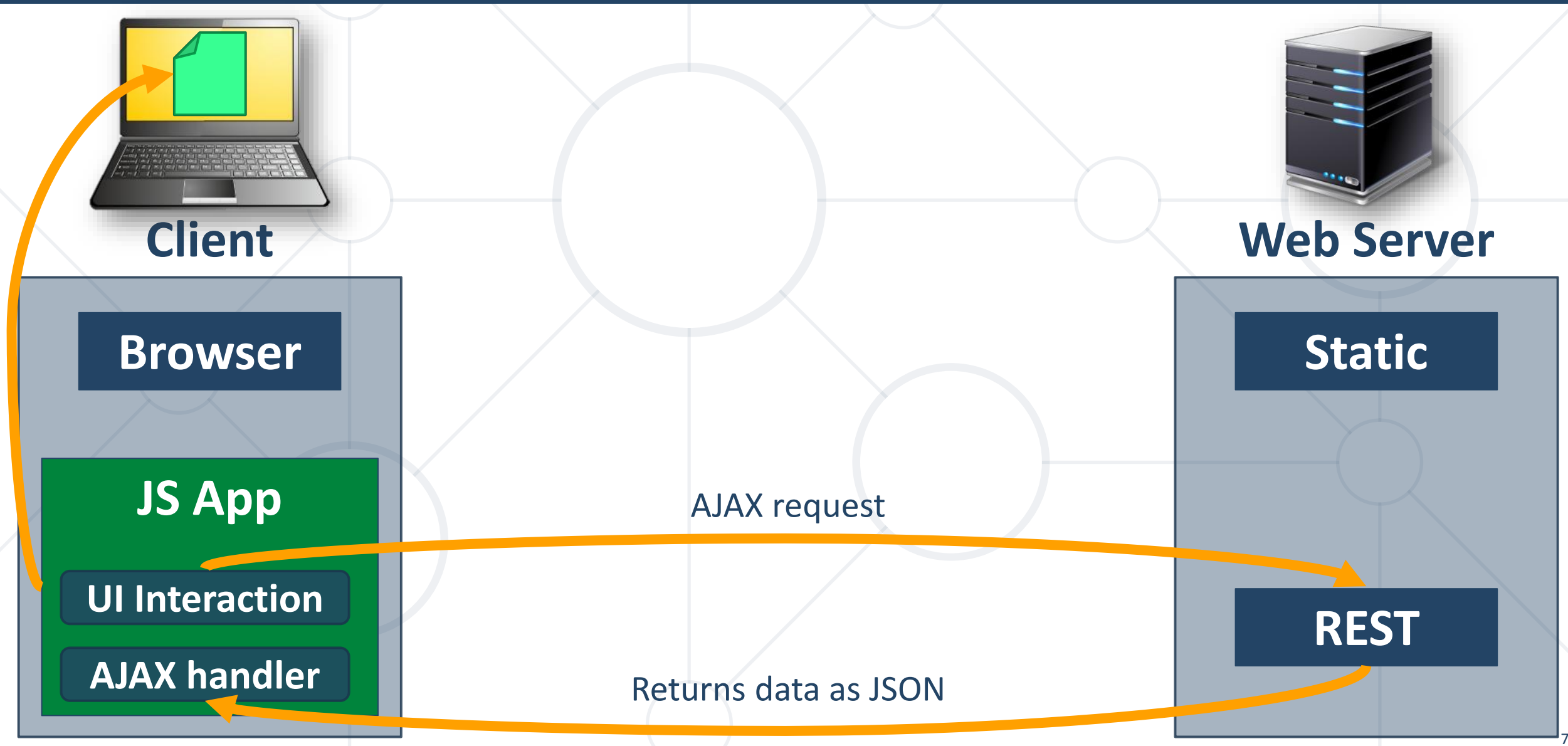
What is AJAX?

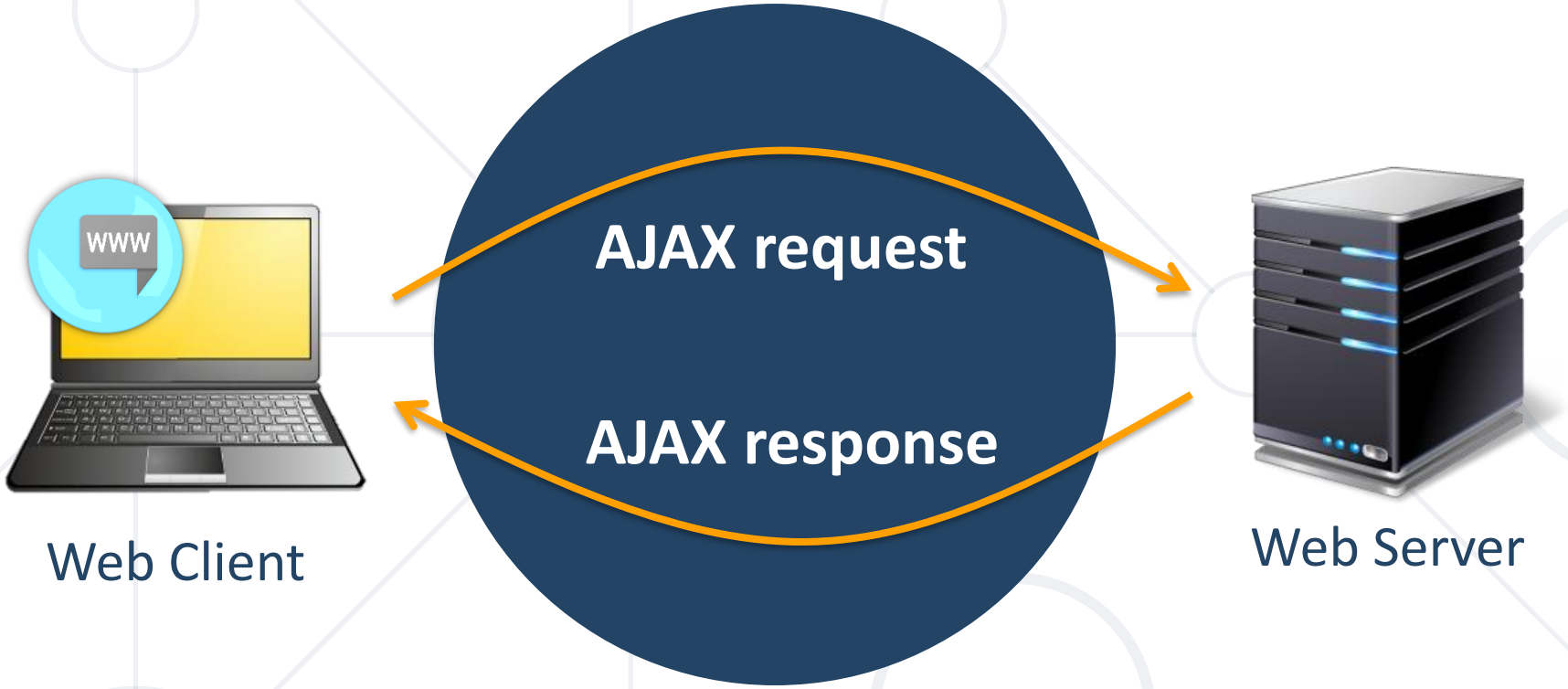
- **Asynchronous JavaScript And XML**
  - Background loading of **dynamic content/data**
  - Load data from the Web server and **render** it
- Some **examples** of AJAX usage:
  - **Partial page rendering**
    - Load HTML fragment + show it in a ** **
  - **JSON service**
    - Loads JSON object and displays it

AJAX: Workflow



AJAX: Workflow



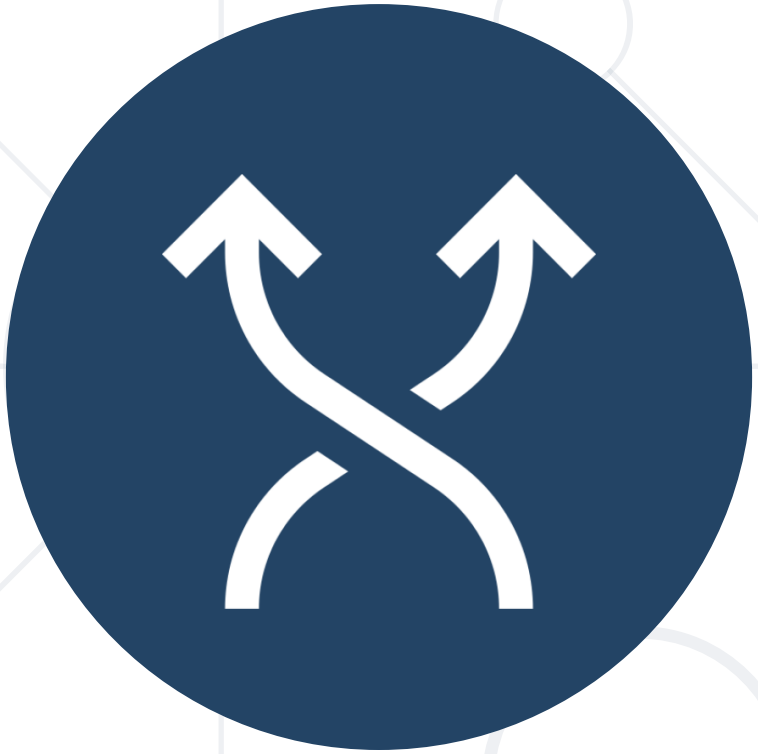


Using the XMLHttpRequest Object

XMLHttpRequest – Standard API for AJAX

```
<button id = "load">Load Repos</button>
<div id="res"></div>
```

```
let button = document.querySelector("#load");
button.addEventListener('click', function loadRepos() {
   let url = 'https://api.github.com/users/testnakov/repos';
   const httpRequest = new XMLHttpRequest();
   httpRequest.addEventListener('readystatechange', function () {
      if (httpRequest.readyState == 4 && httpRequest.status == 200) {
         document.getElementById("res").textContent = httpRequest.responseText;
      }
   });
   httpRequest.open("GET", url);
   httpRequest.send();
});
```



Synchronous vs Asynchronous

Asynchronous Programming

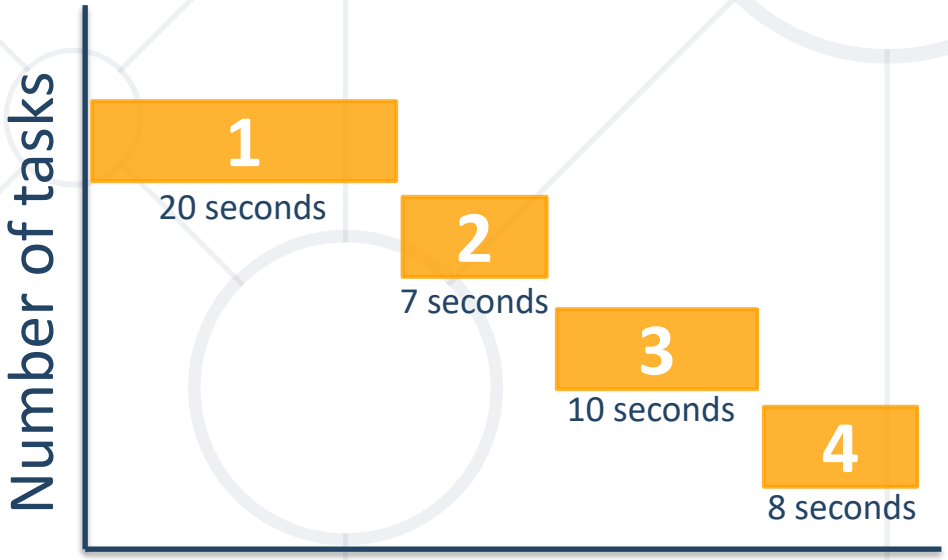
Asynchronous Programming in JS

- Structured using **callback functions**
- In current versions of JS there are:
  - **Callbacks**
  - **Promises**
  - **Async Functions**
- Not the same thing as **concurrent** or **multi-threaded**
- **JS code** is generally **single-threaded**

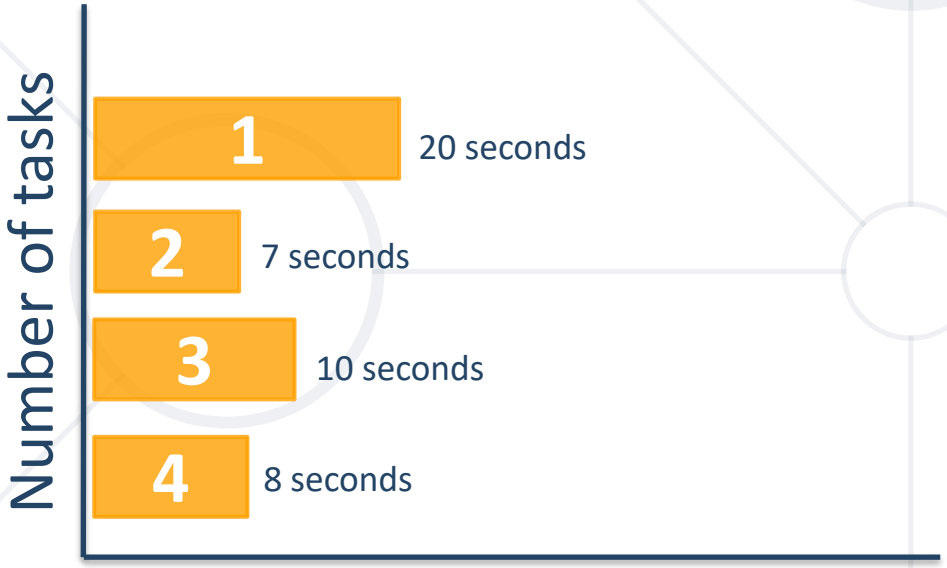
Asynchronous Programming

- Runs several tasks (pieces of code) in parallel, **at the same time**

Synchronous



Asynchronous



Asynchronous Programming – Example

- The following commands will be executed as follows:

```
console.log("Hello.");

setTimeout(function() {
  console.log("Goodbye!");
}, 2000);

console.log("Hello again!");
```

```
// Hello.
```

```
// Hello again!
```

```
// Goodbye!
```

Callbacks

- Function **passed** into another function as an **argument**
- Then **invoked** inside the outer function to complete some kind of routine or action

```
function running() {
    return "Running";
}
function category(run, type) {
    console.log(run() + " " + type);
}
category(running, "sprint"); //Running sprint
```

Callback function

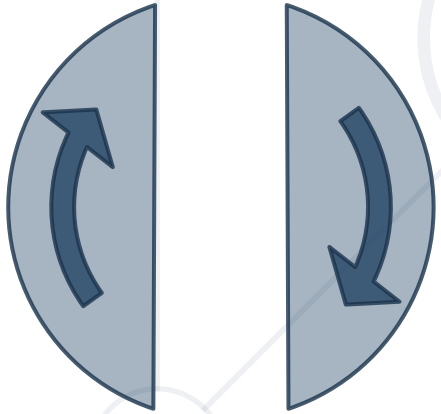
Event Loop Synchronization

Execution Stack

Code executing on the main thread

Event loop is paused during execution

Event Loop



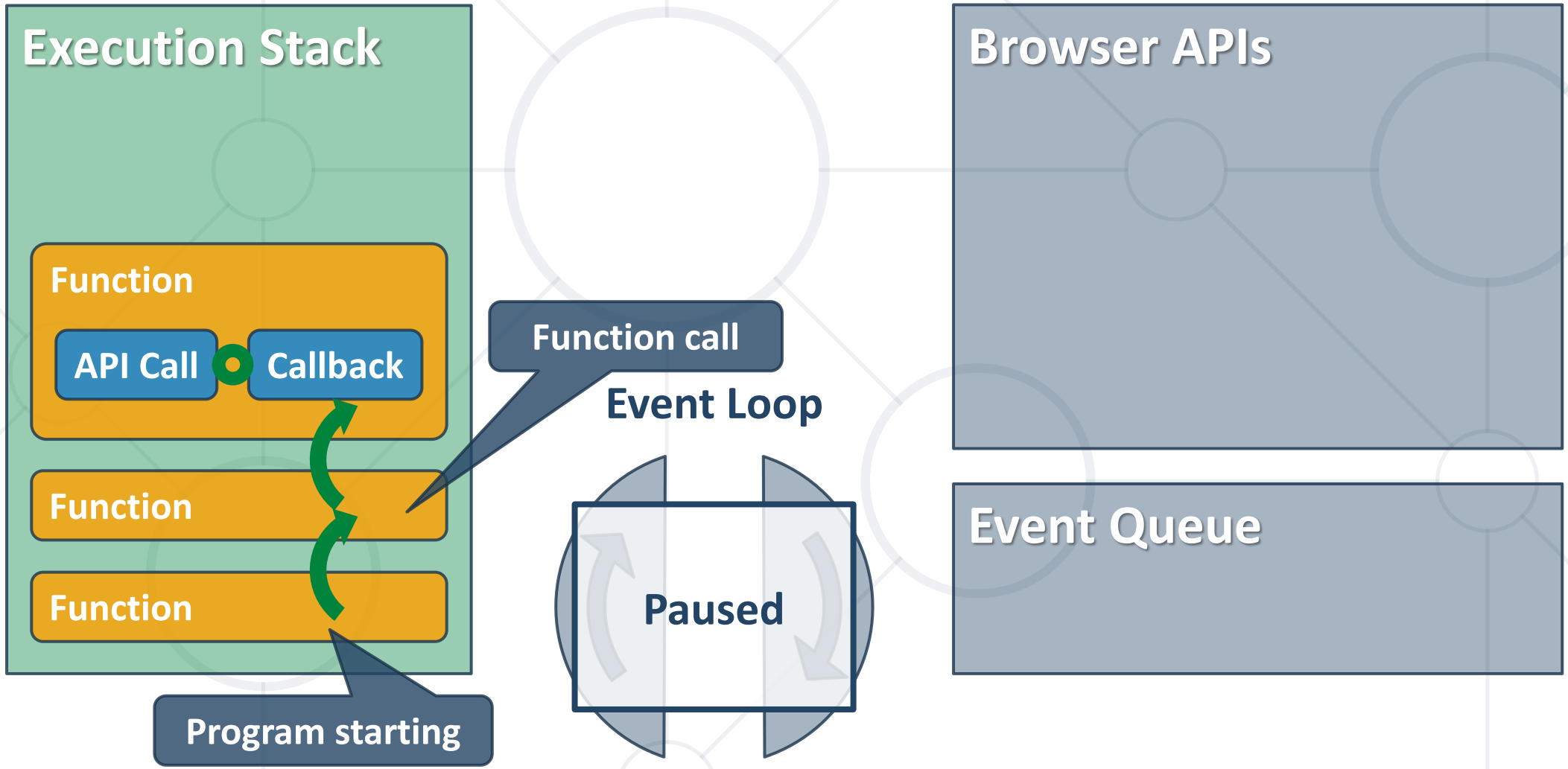
Browser APIs

APIs operate asynchronously

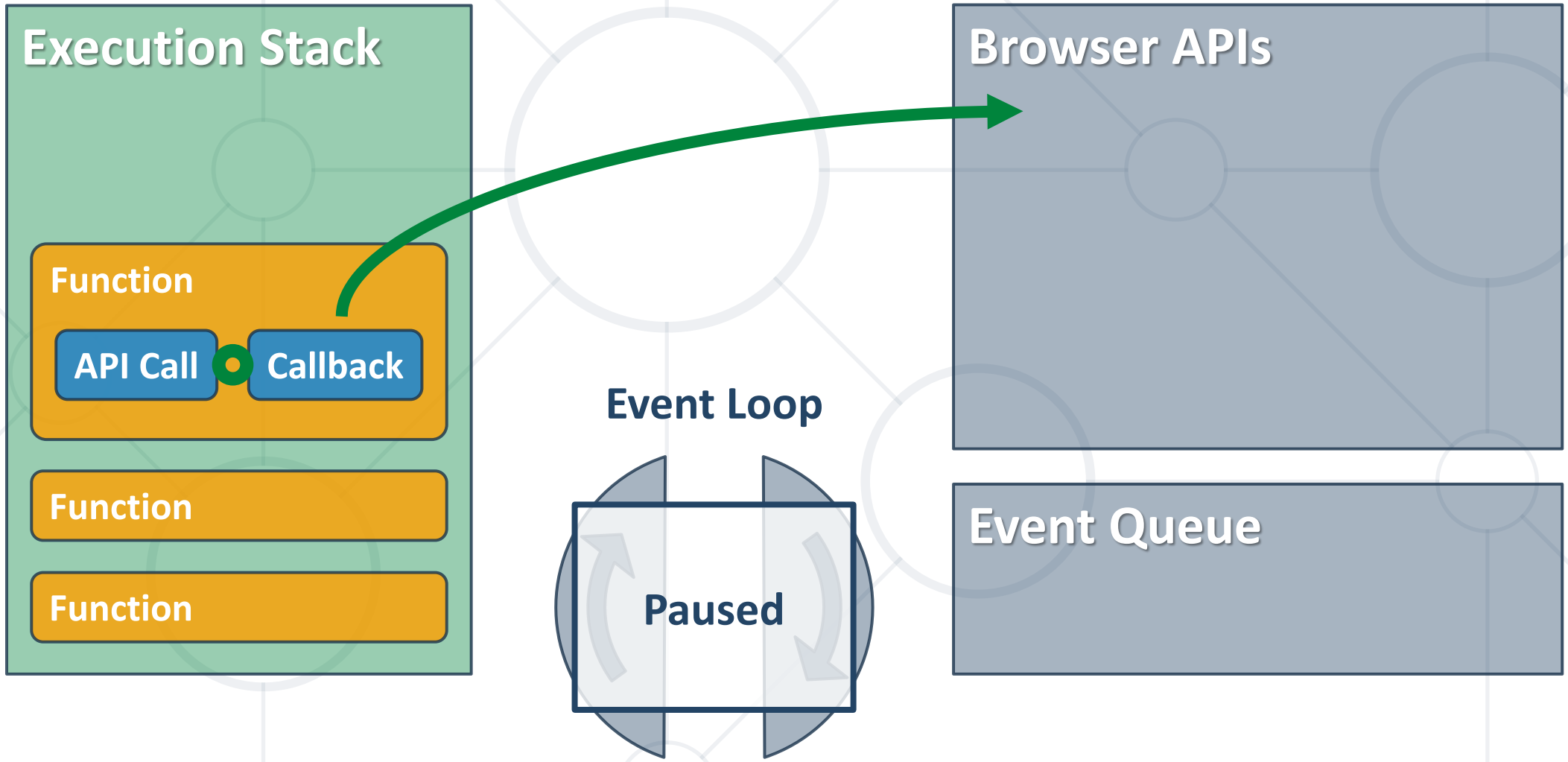
Event Queue

Callbacks wait in the queue

Event Loop Synchronization



Event Loop Synchronization



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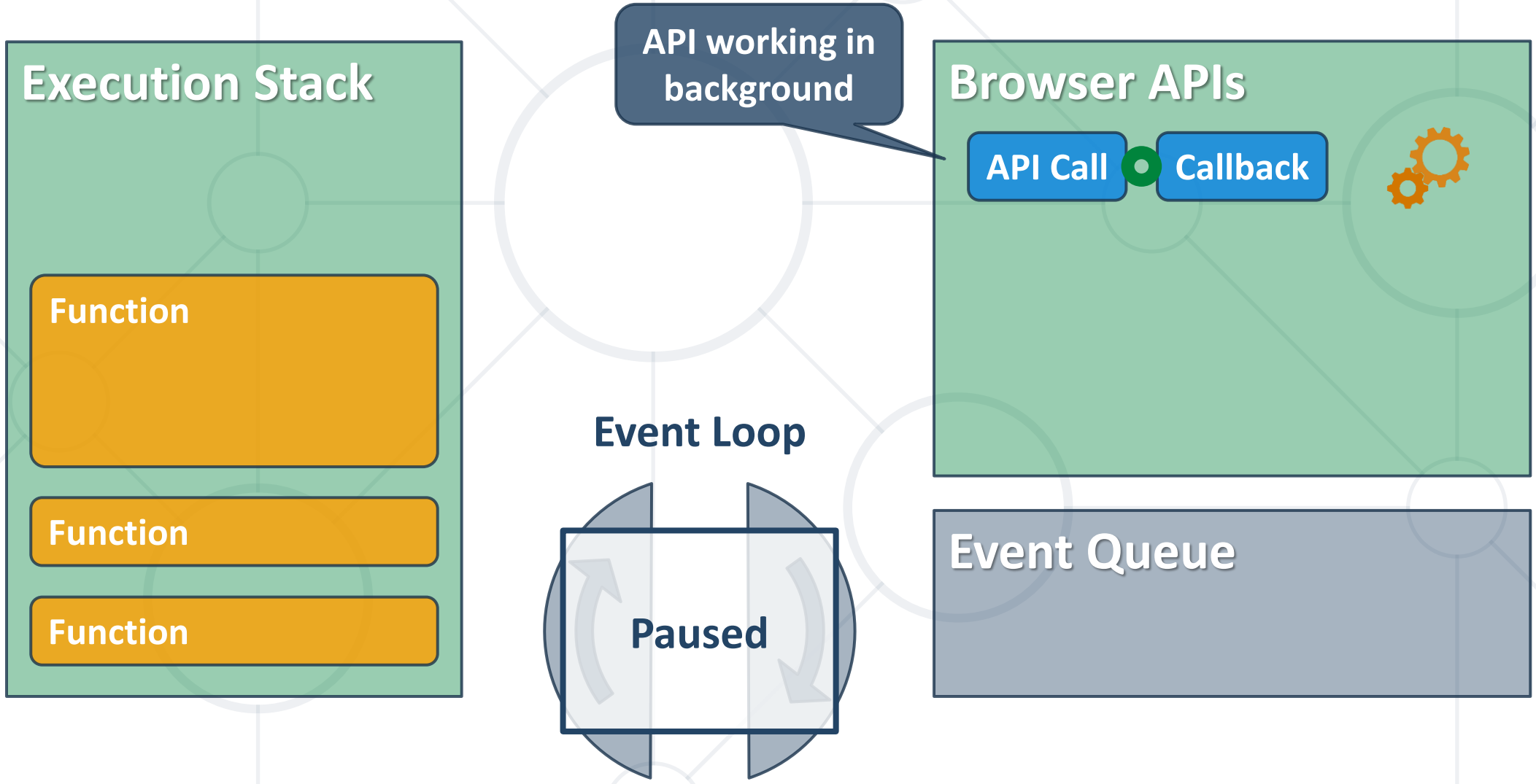

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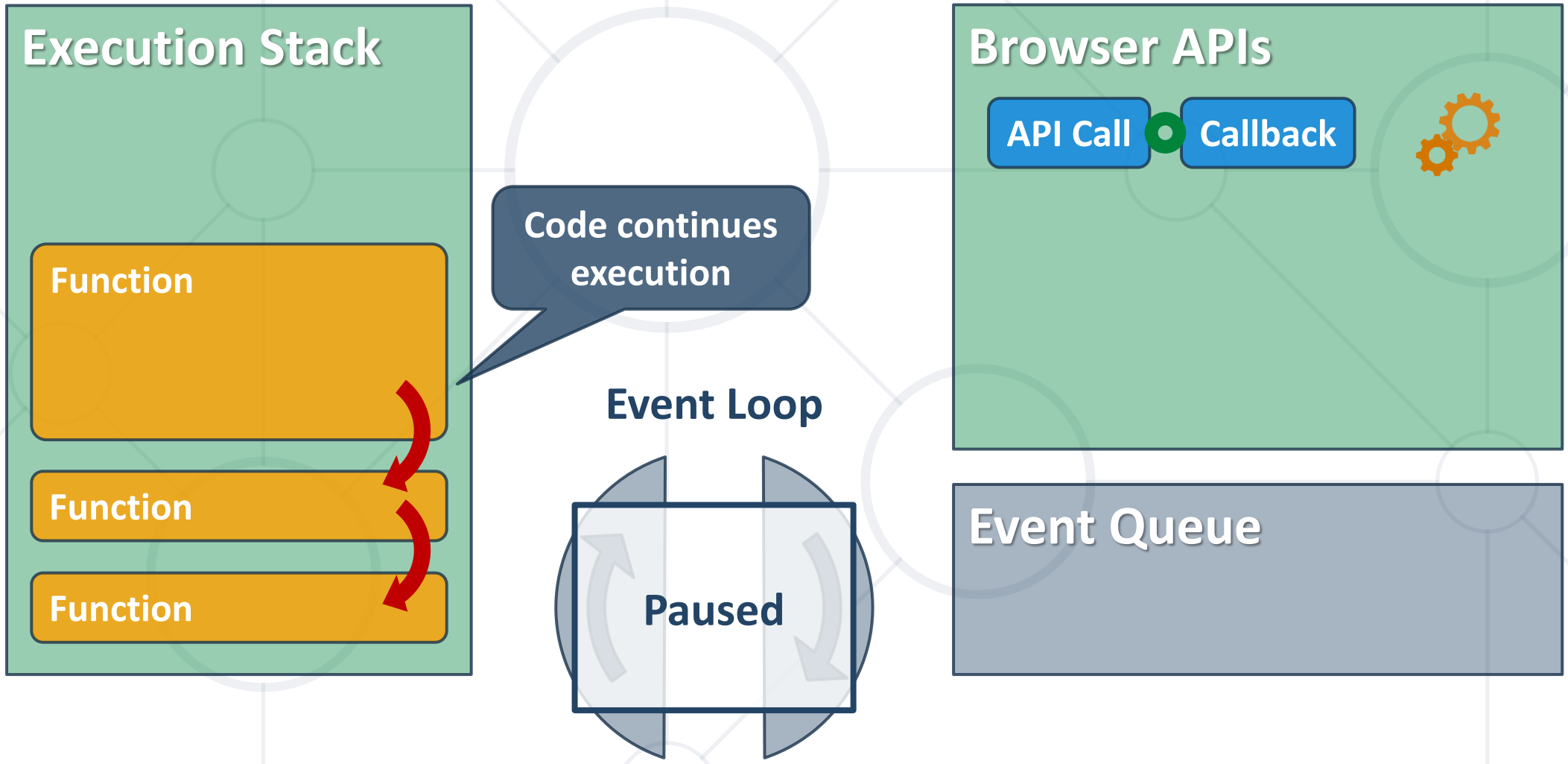

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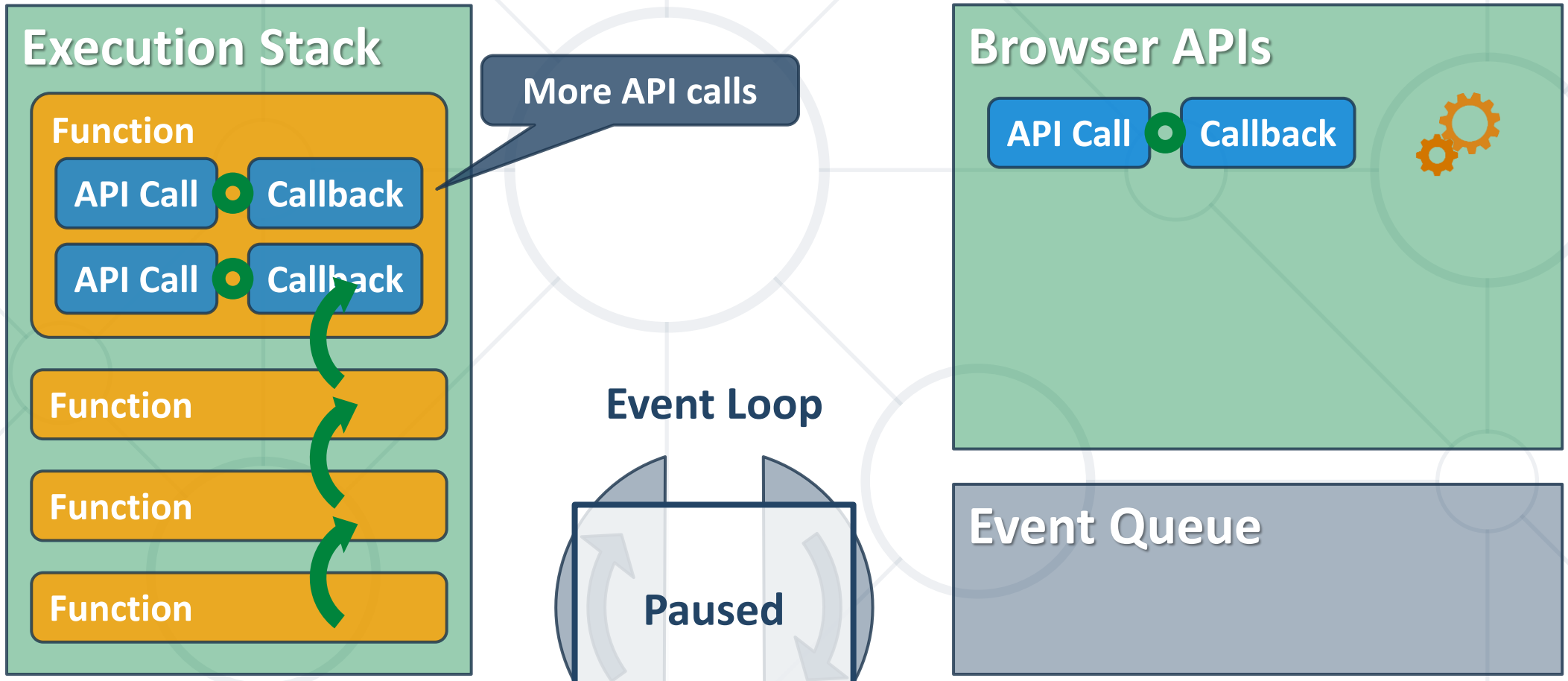

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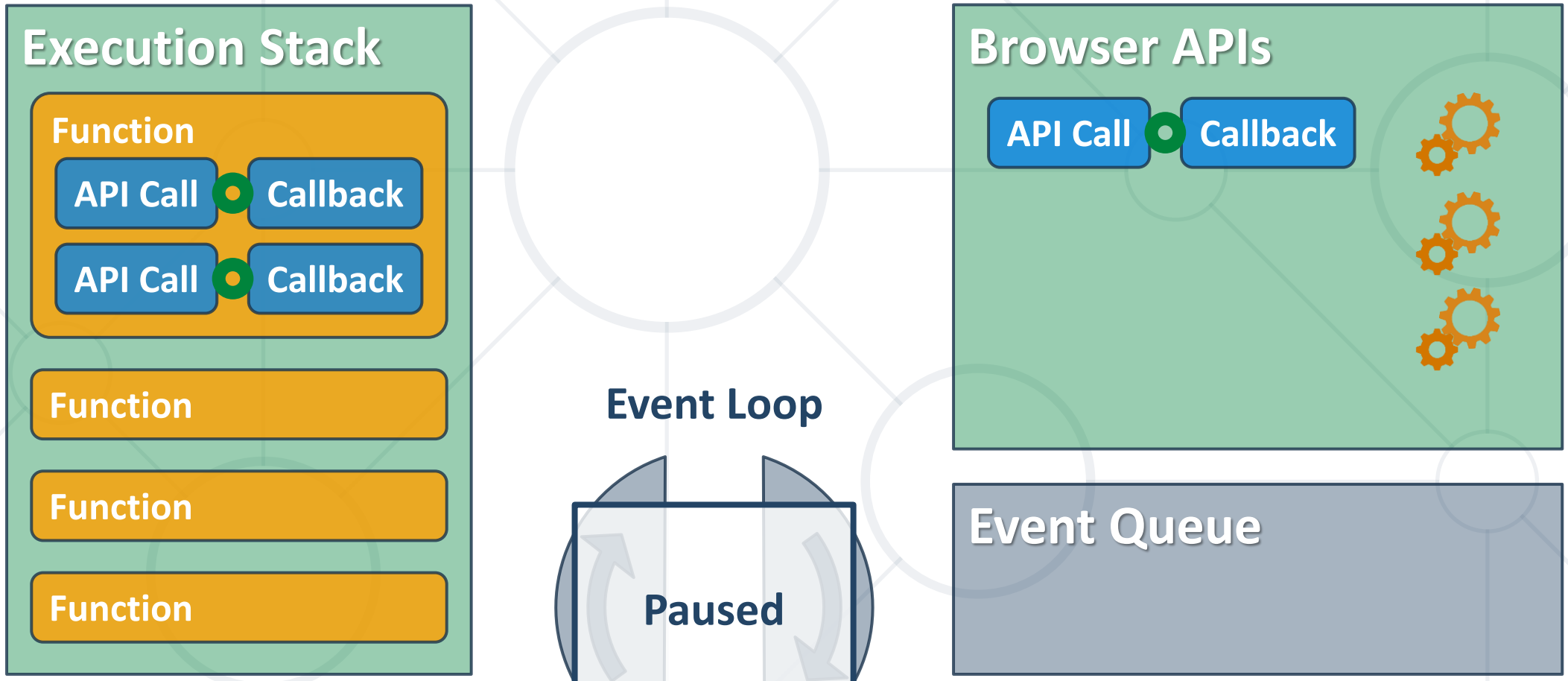

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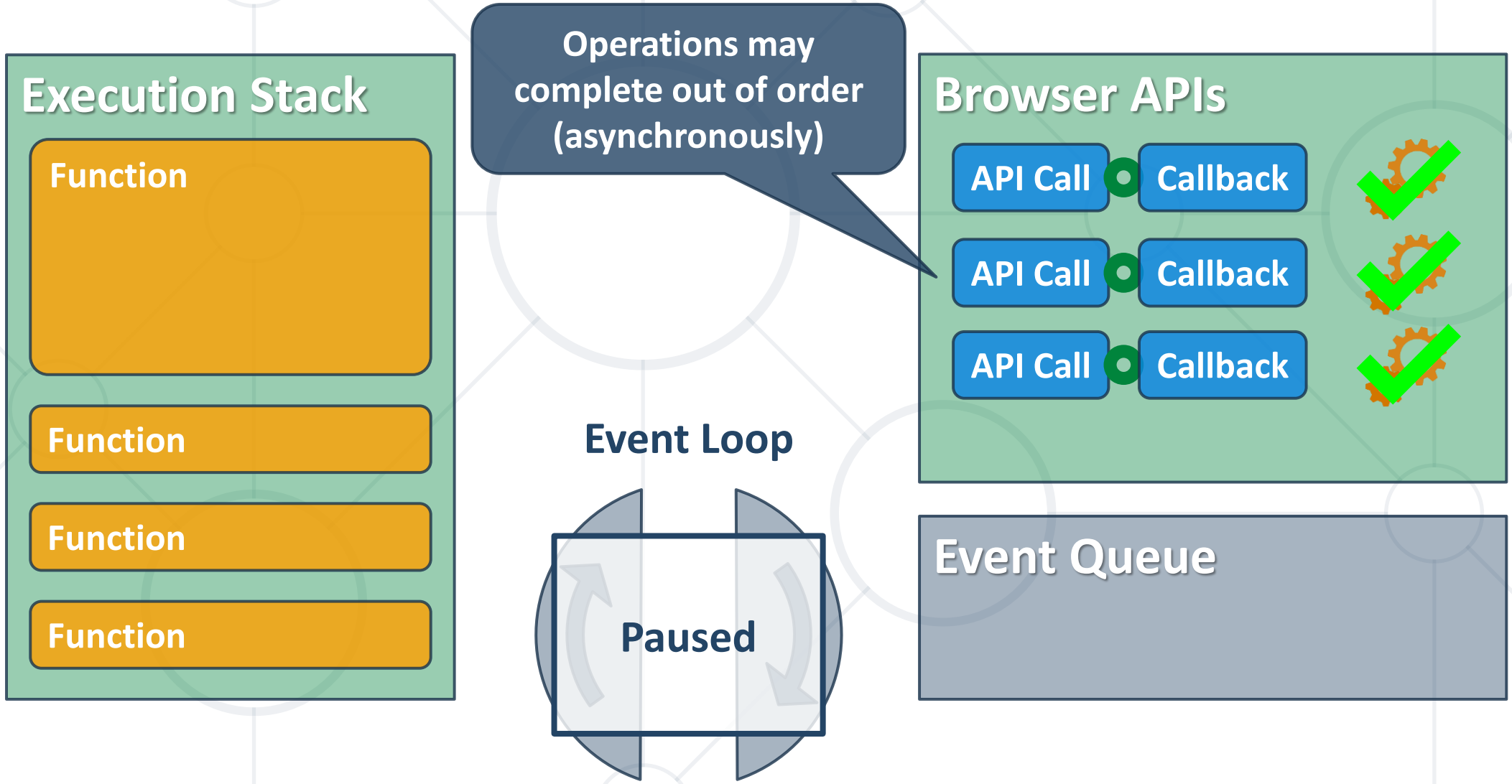

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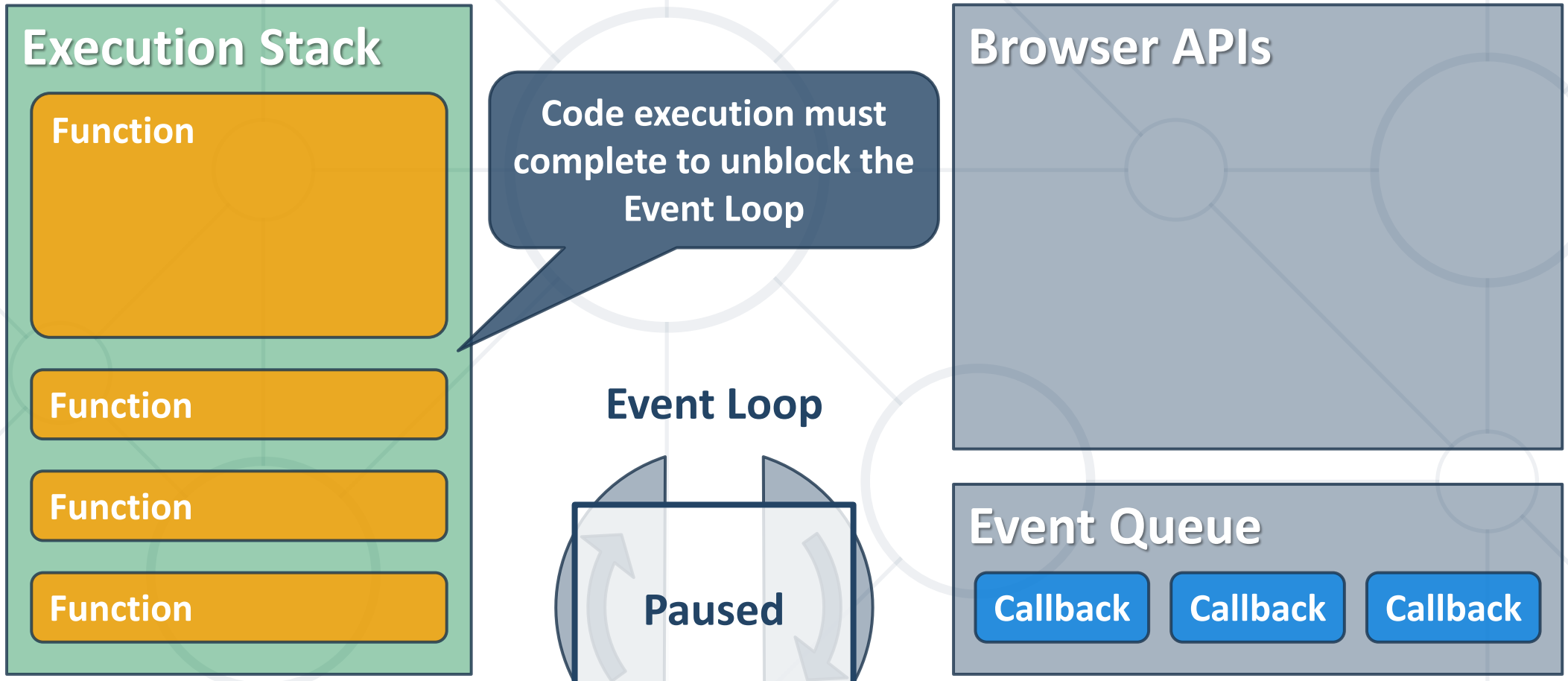

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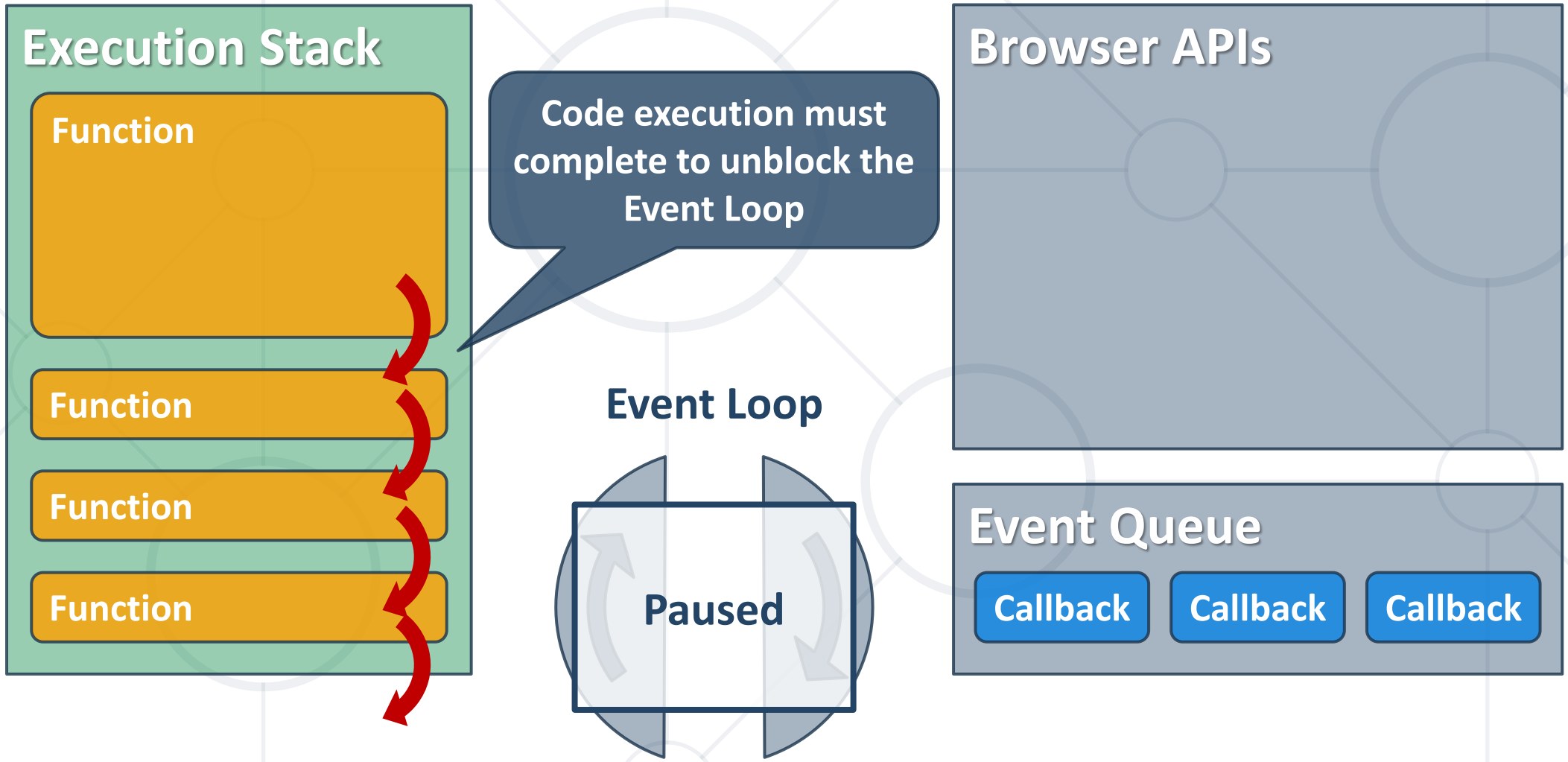

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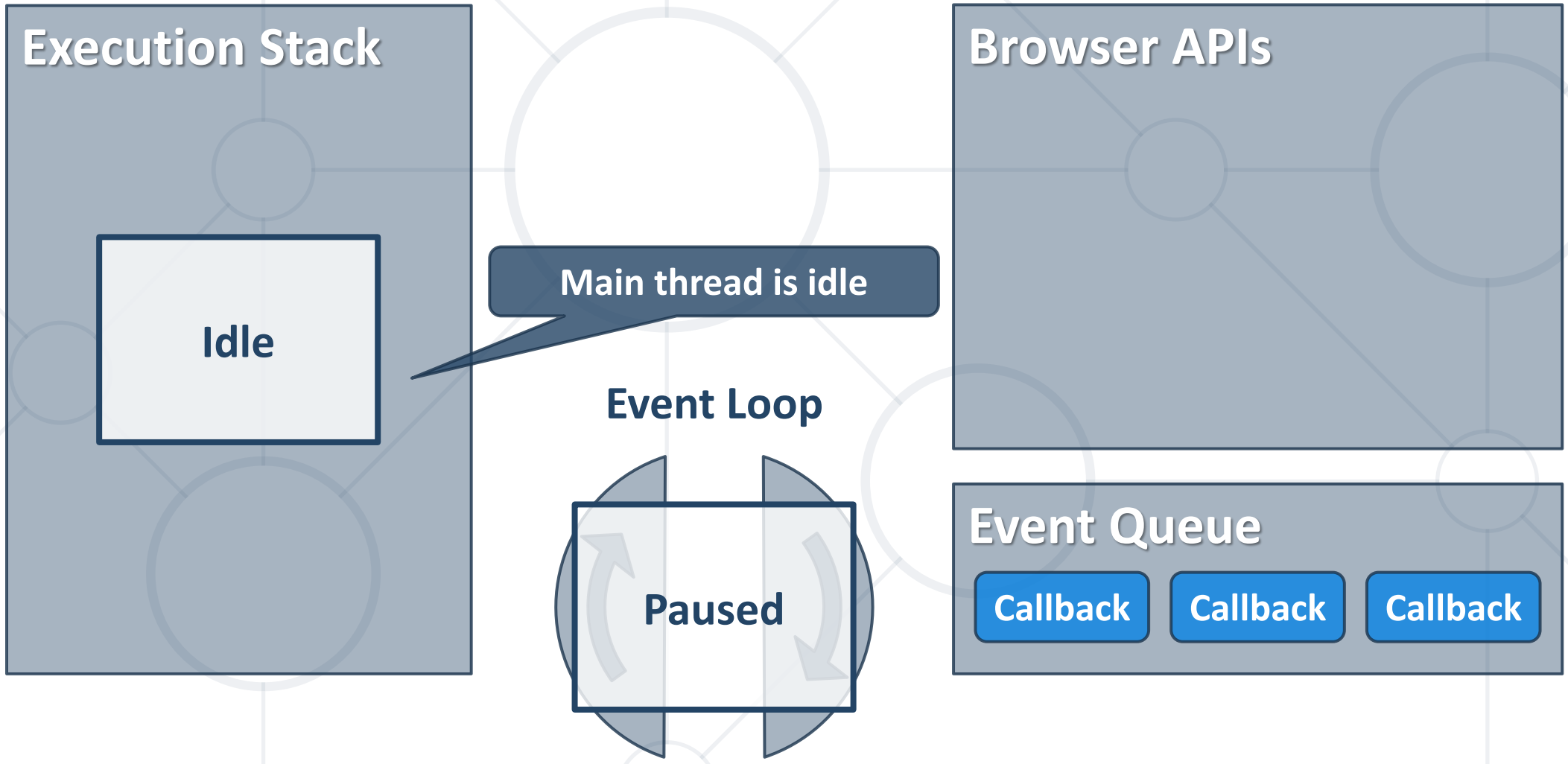

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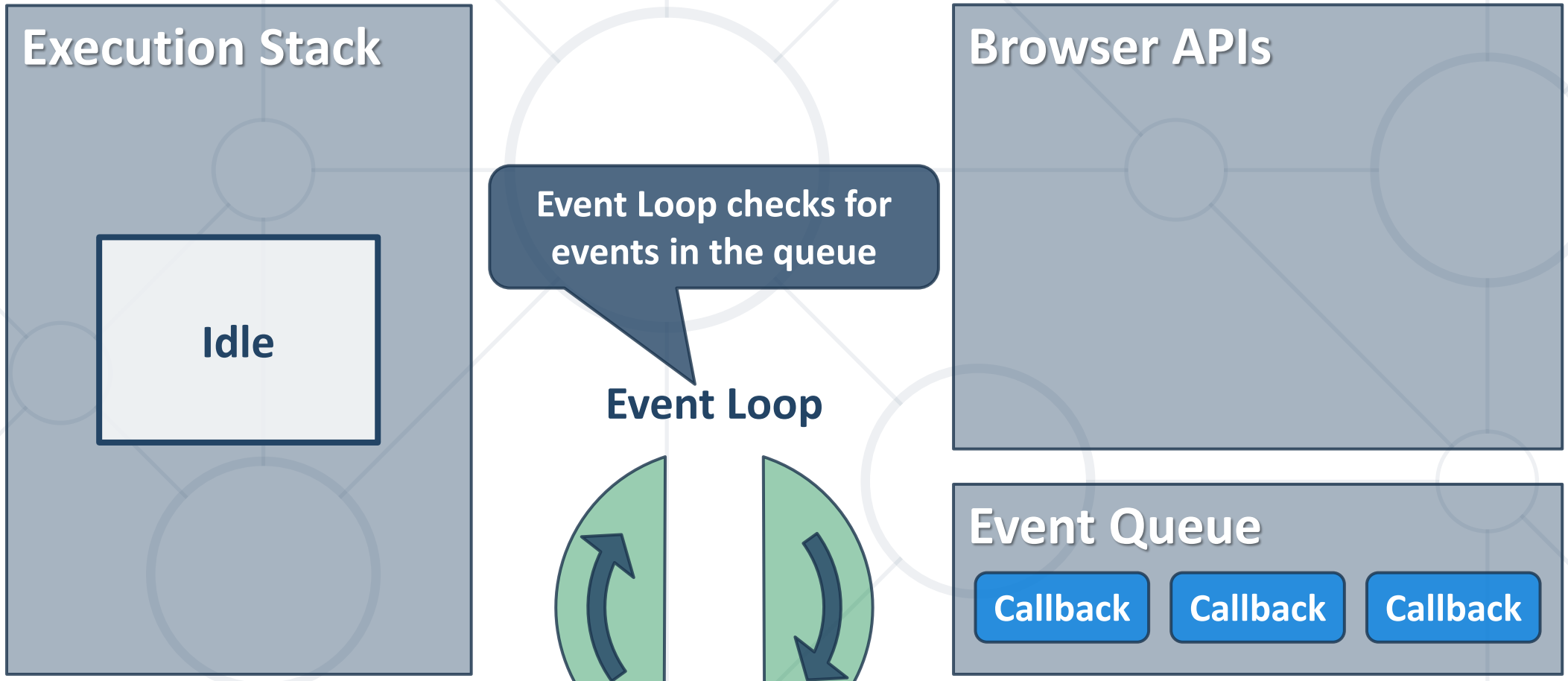

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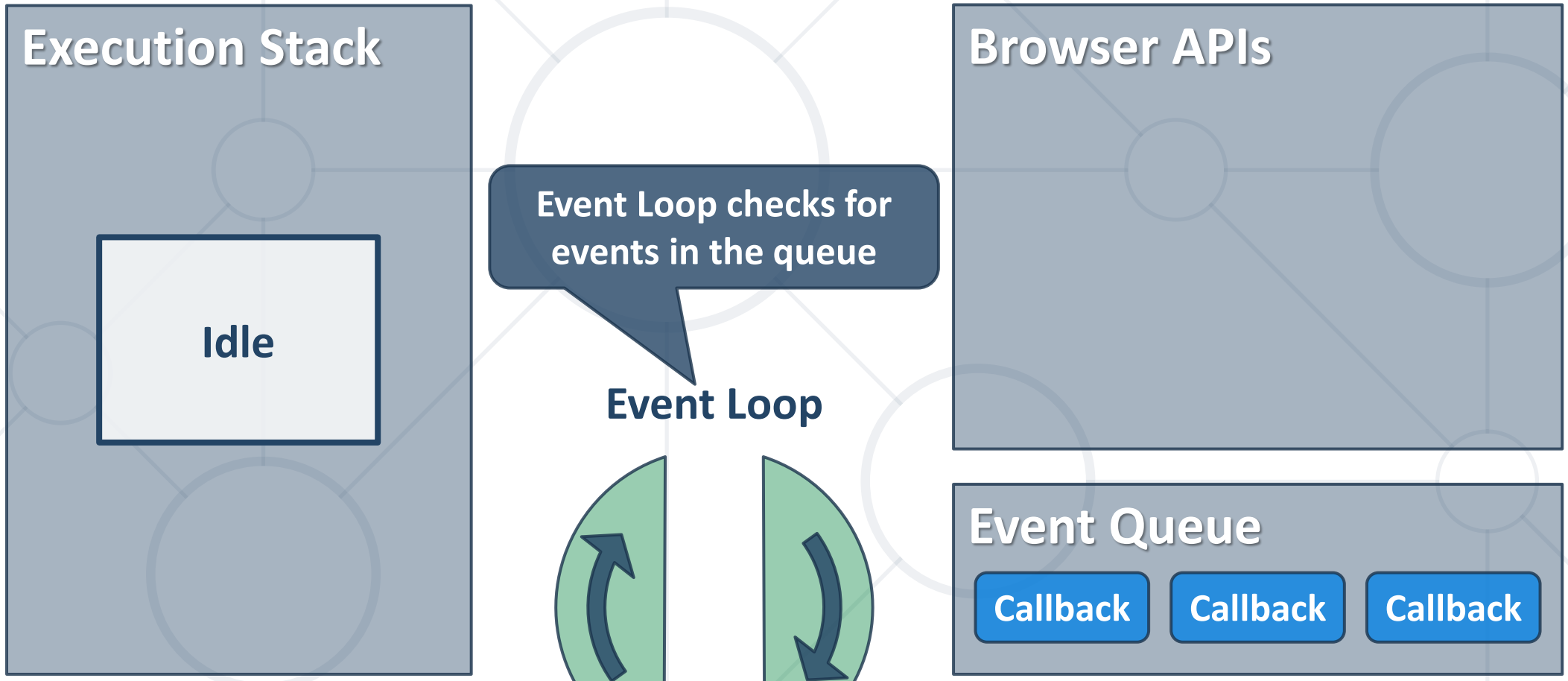

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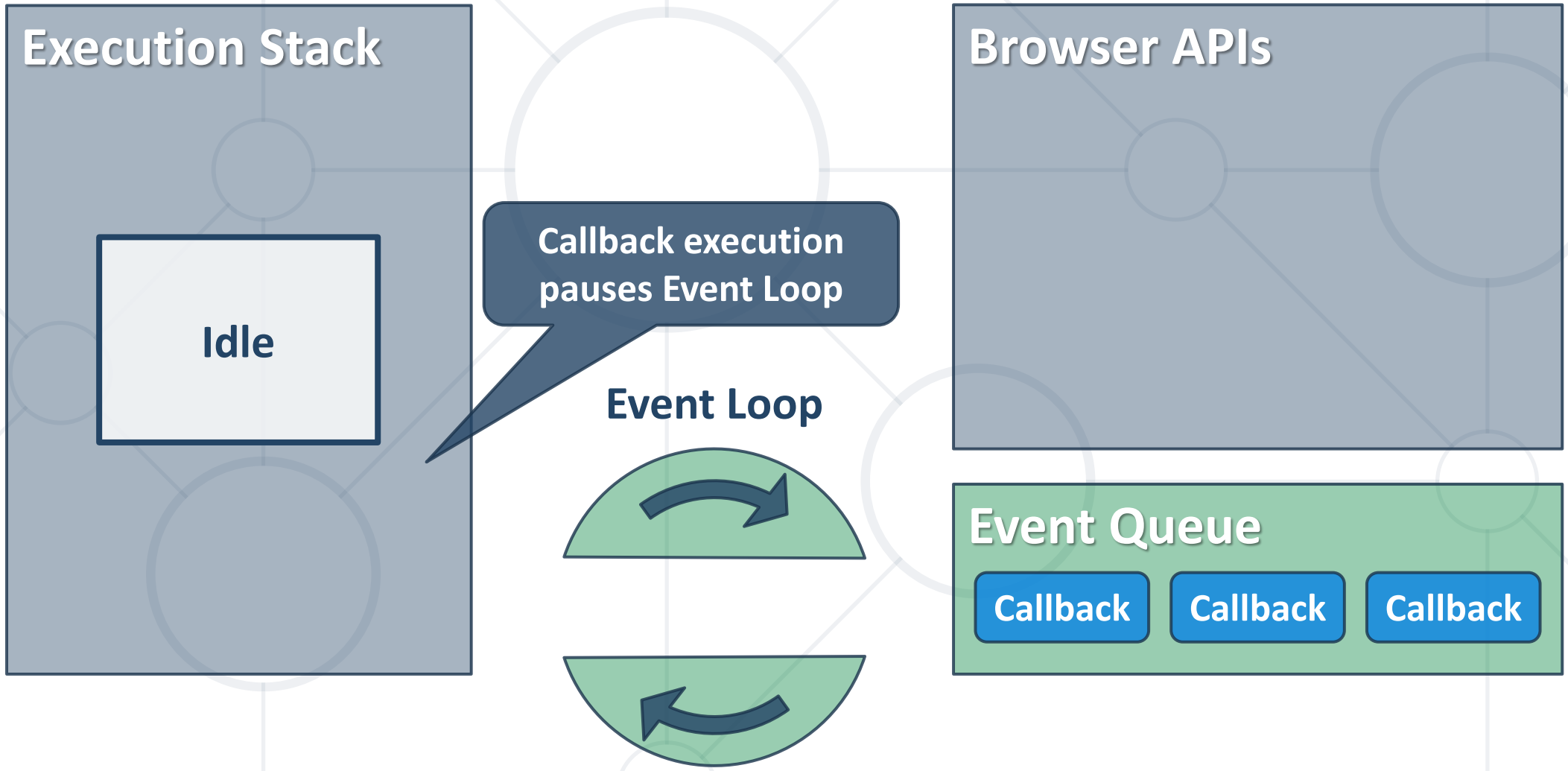

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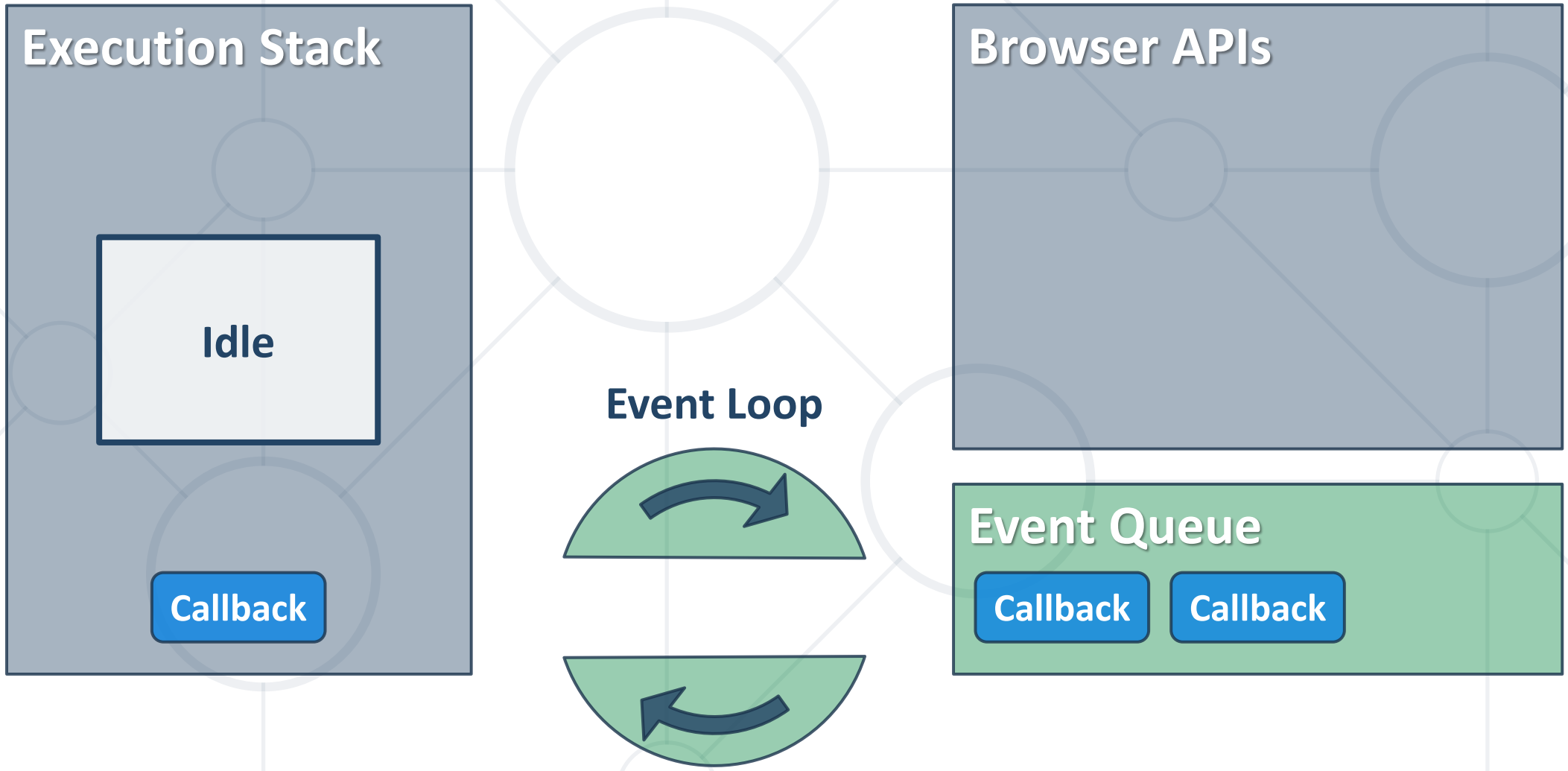

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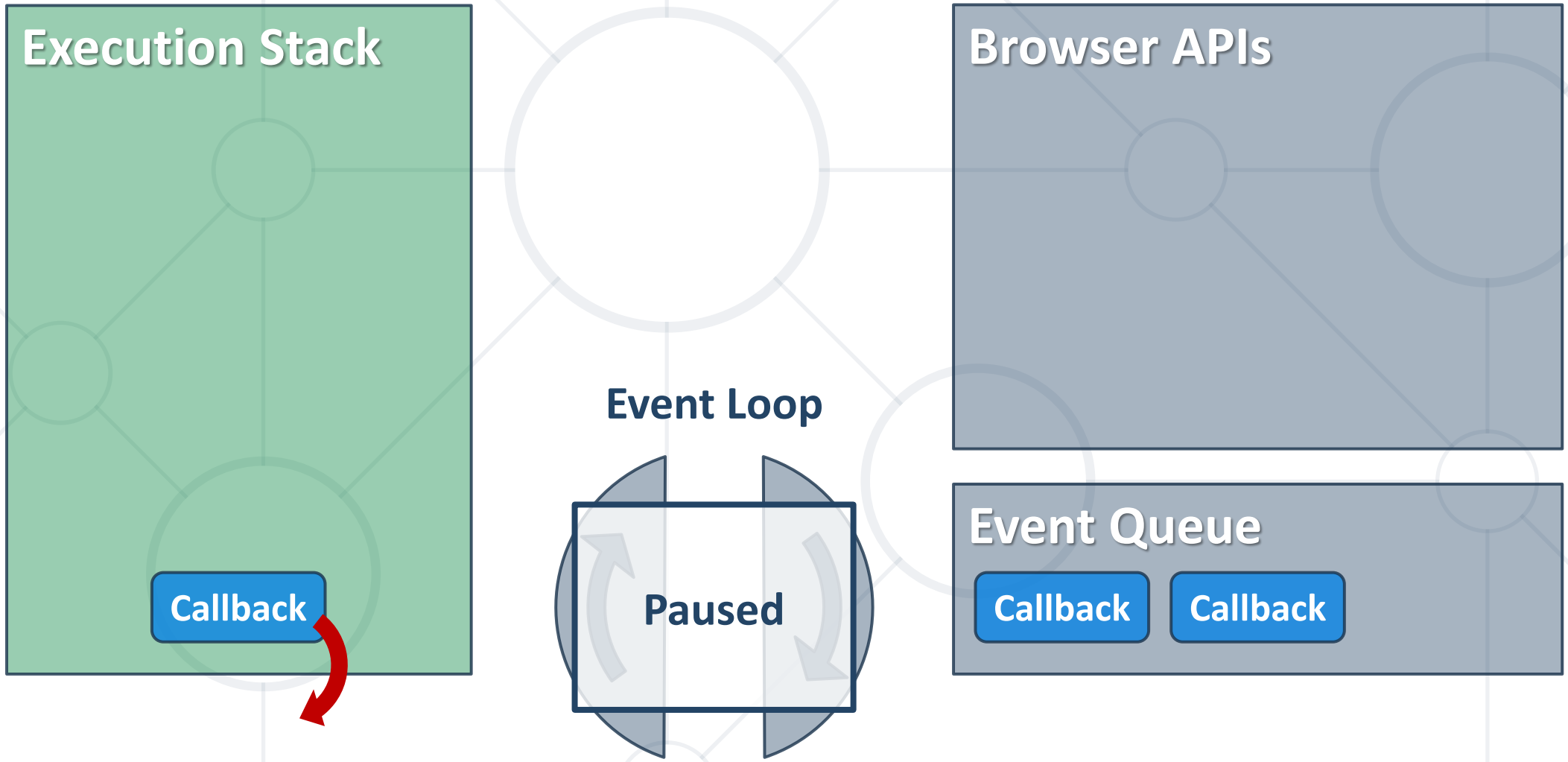

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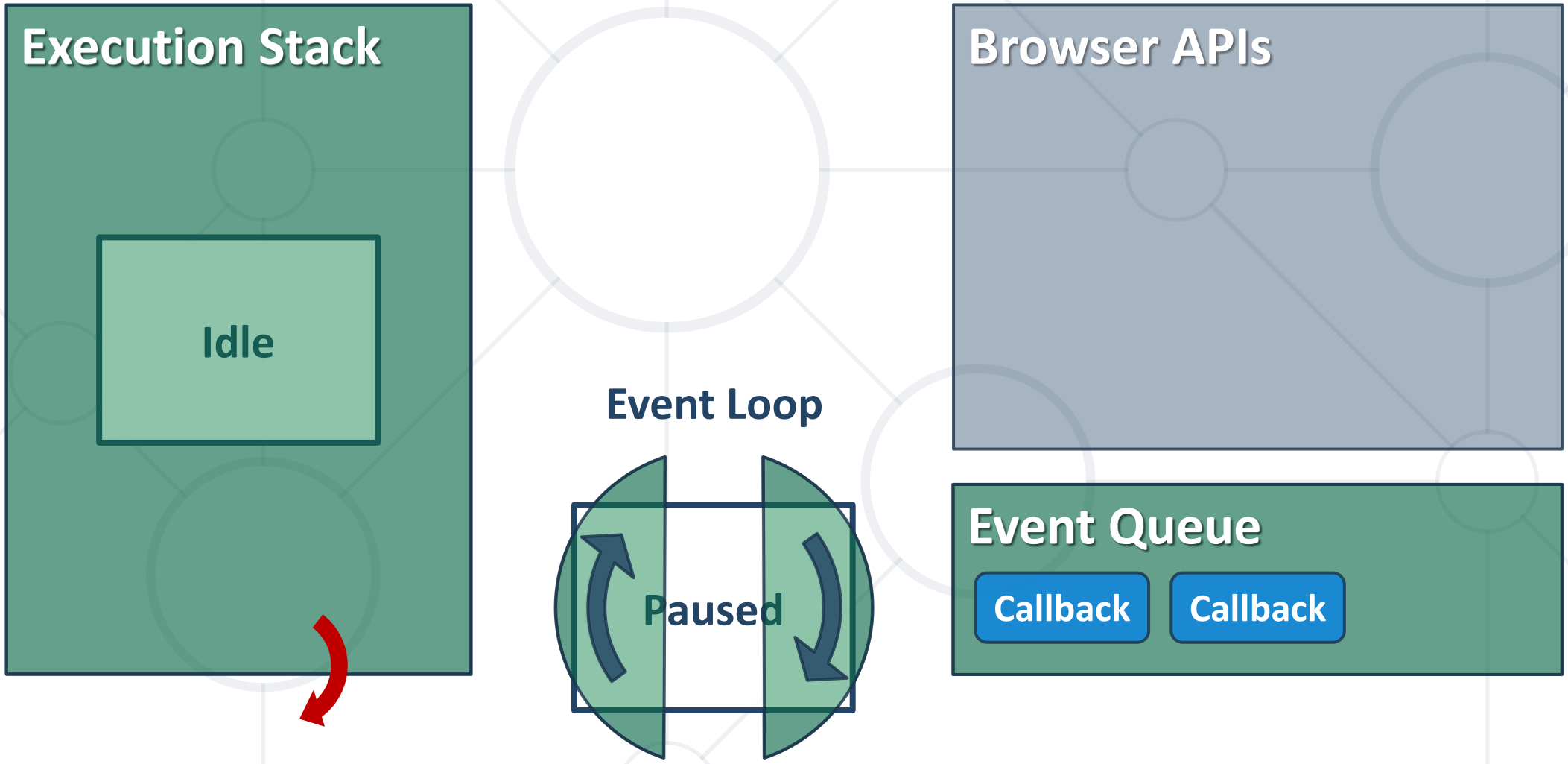

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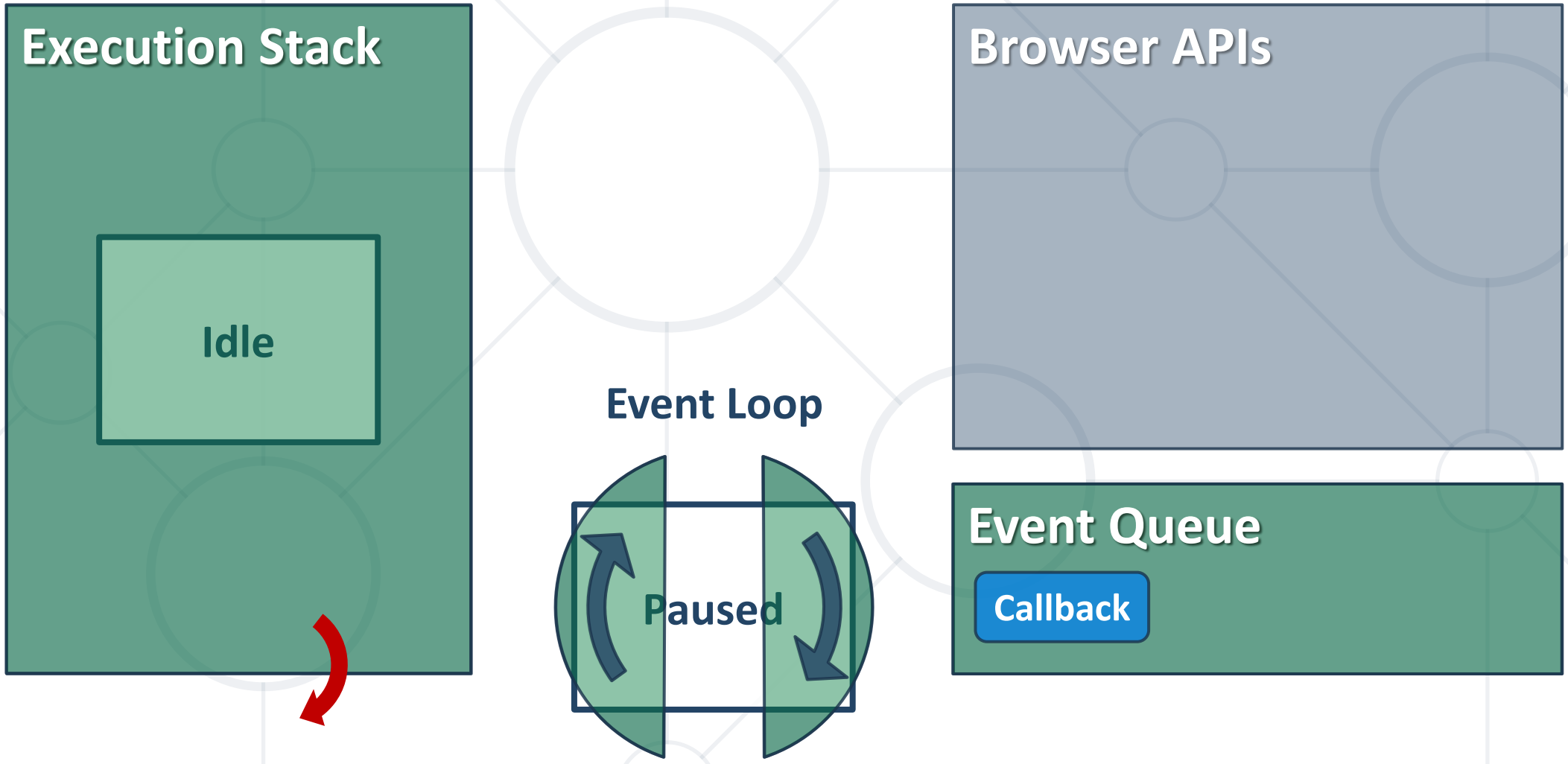

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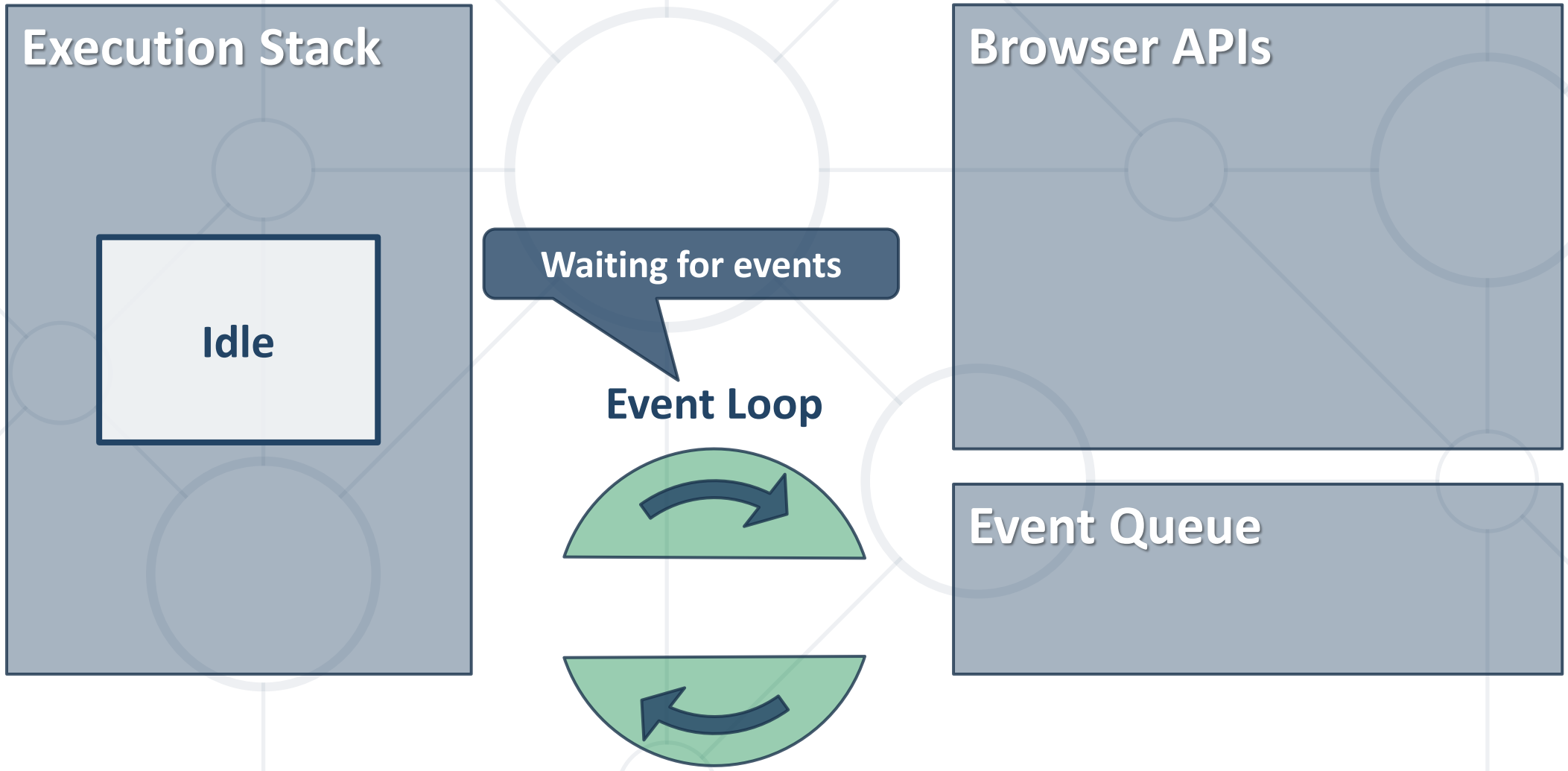


Promises

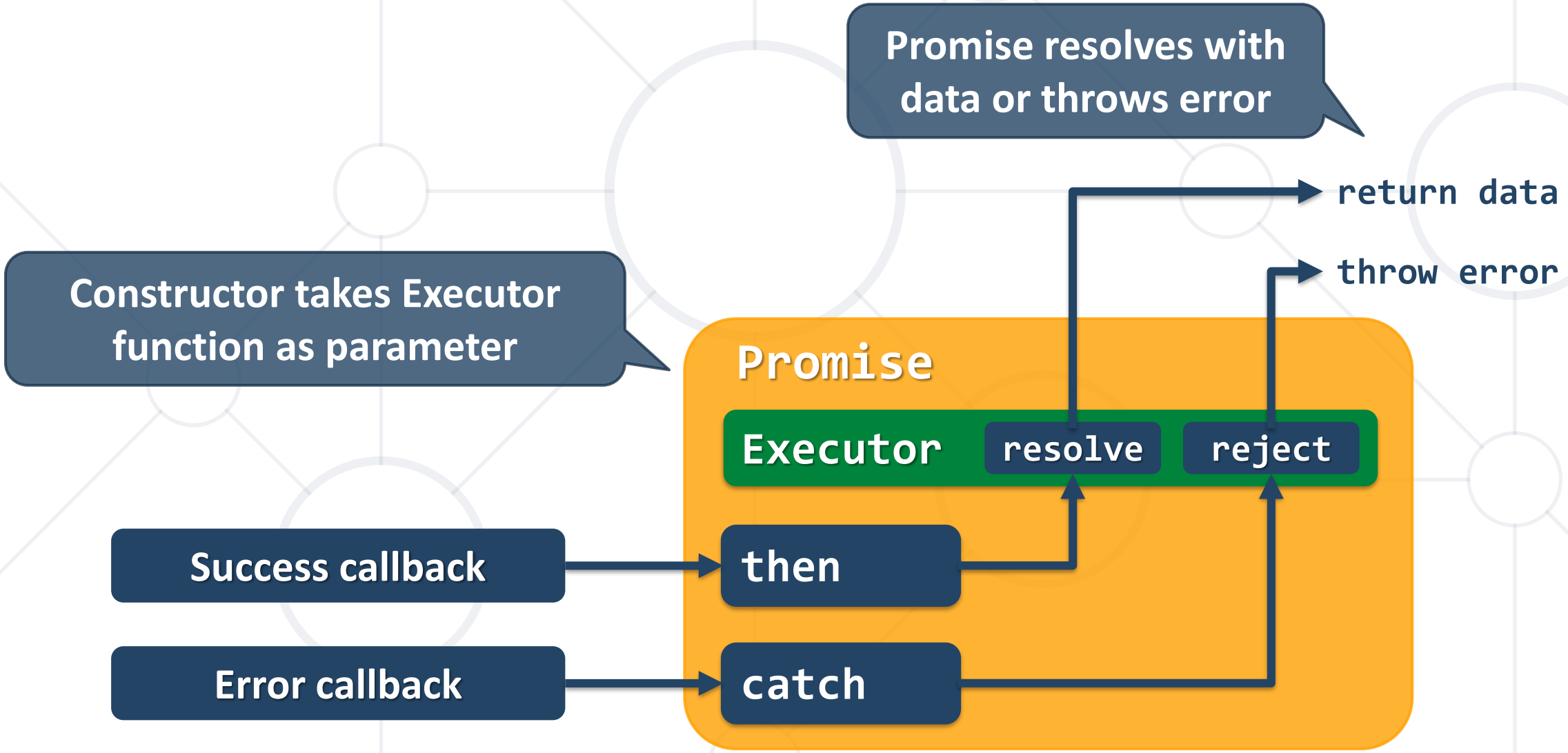
Objects Holding Asynchronous Operations

What is a Promise?

- A promise is an **asynchronous action** that **may complete** at some point and **produce a value**
- States:
  - **Pending** - operation still running (unfinished)
  - **Fulfilled** - operation finished (the result is available)
  - **Failed** - operation failed (an error is present)
- Promises use the **Promise class**

```
new Promise(executor);
```

Promise Flowchart



Promise.then() – Example

```
console.log('Before promise');
```

```
new Promise(function(resolve, reject) {
  setTimeout(function() {
    resolve('done');
  }, 500);
})
.then(function(res) {
  console.log('Then returned: ' + res);
});
```

Resolved after 500 ms

```
console.log('After promise');
```

```
// Before promise
```

```
// After promise
```

```
// Then returned: done
```

Promise.catch() – Example

```
console.log('Before promise');
```

```
new Promise(function (resolve, reject) {
  setTimeout(function () {
    reject('fail');
  }, 500);
})
  .then (function (result) { console.log(result); })
  .catch (function(error) { console.log(error); });
```

Rejected after 500 ms

```
console.log('After promise');
```

Promise Methods

- `Promise.reject`(reason)
  - Returns an **object** that is **rejected** with the given **reason**
- `Promise.resolve`(value)
  - Returns an object that is **resolved** with the given **value**
- `Promise.all`(iterable)
  - Returns a **promise**
    - Fulfills when **all** of the promises **have fulfilled**
    - Rejects as soon as **one** of them **rejects**

Promise Methods

- `Promise.allSettled`(iterable)
  - Wait until all promises have settled
- `Promise.race`(iterable)
  - Returns a promise that fulfills or rejects as soon as one of the promises in an iterable is settled
- `Promise.prototype.finally`()
  - The handler is called when the promise is settled

What is Fetch?

- The `fetch()` method allows making network requests
- It is similar to **XMLHttpRequest** (XHR). The main **difference** is that the **Fetch API**:
  - Uses **Promises**
  - Enables a **simpler** and **cleaner** API
  - Makes code more readable and maintainable

```
fetch('./api/some.json')
  .then(function(response) {…})
  .catch(function(err) {…})
```

Basic Fetch Request

- The response of a **`fetch()`** request is a **Stream** object
- The **reading** of the stream happens **asynchronously**
- When the **`json()`** method is called, a **Promise** is **returned**
  - The **response status** is checked (should be **200**) **before parsing** the response as **JSON**

```
if (response.status !== 200) {
  // handle error
}
response.json()
  .then(function(data) { console.log(data)})
```

GET Request

- **Fetch API** uses the **GET** method so that a direct call would be like this

```
fetch('https://api.github.com/users/testnakov/repos')
  .then((response) => response.json())
  .then((data) => console.log (data))
  .catch((error) => console.error(error))
```

POST Request

- To make a **POST** request, we can set the **method** and **body** parameters in the `fetch()` options

```
fetch('/url', {
    method: 'post',
    headers: { 'Content-type': 'application/json' },
    body: JSON.stringify(data),
})
```

Body Methods

- `clone()` create a clone of the response
- `json()` resolves the promise with JSON
- `redirect()` create new promise but with different URL
- `text()` resolves the promise with string
- `arrayBuffer()` resolve body with ArrayBuffer
- `blob()` resolve body with Blob (file, image, etc.)
- `formData()` resolve body with FormData

Response Types

- **`basic`** - normal, same origin response
- **`cors`** - response was received from a valid cross-origin request
- **`error`** - error network
- **`opaque`** - Response for "no-cors" request to cross-origin resource
- **`opaqueredirect`** - the fetch request was made with **redirect: "manual"**

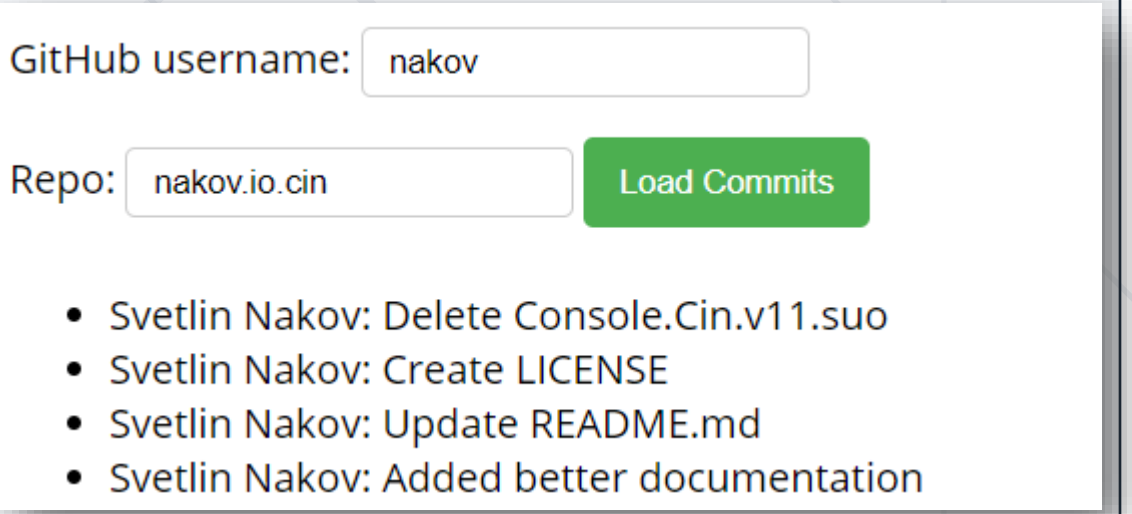
Chaining Promises

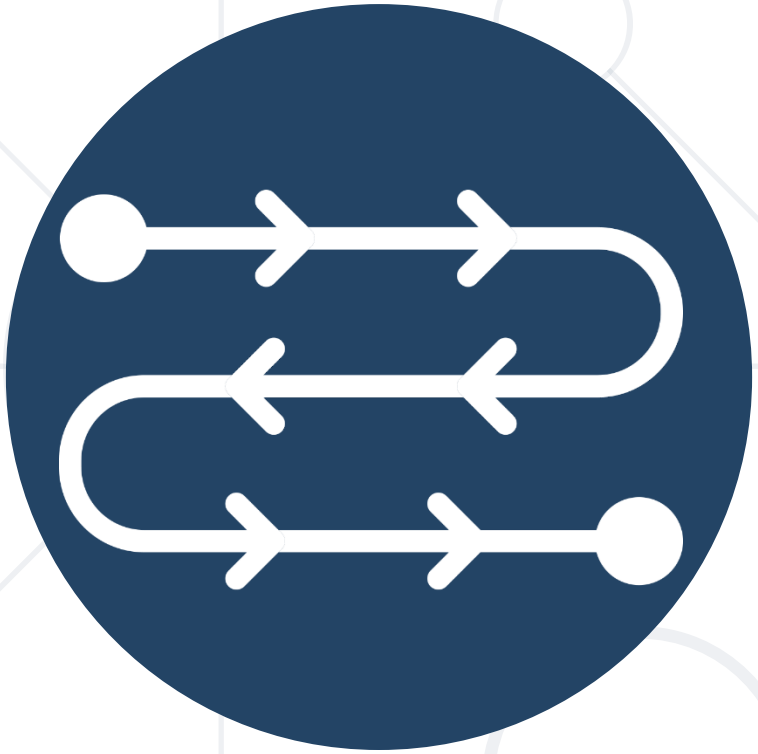
- When working with a JSON API, you can:
  - Define the **status** and **JSON parsing** in **separate functions**
  - The functions **return promises** which can be **chained**

```
fetch('users.json')
  .then(status)
  .then(json)
  .then(function(data) {…})
  .catch(function(error) {…});
```

Problem: Load GitHub Commits

```
GitHub username:
<input type="text" id="username" value="nakov" /> <br>
Repo: <input type="text" id="repo" value="nakov.io.cin" />
<button onclick="loadCommits()">Load Commits</button>
<ul id="commits"></ul>
<script>
  function loadCommits() {
    // Use Fetch API
  }
</script>
```





Async / Await

Simplified Promises

Async Functions

- Returns a **promise**, that can await other promises in a way that **looks synchronous**
- Operate **asynchronously** via the event loop
- Contains an **await** expression that:
  - Is **only valid** inside **async functions**
  - **Pauses** the execution of that function
  - Waits for the Promise's **resolution**

Async Functions

```
function resolveAfter2Seconds() {
  return new Promise(resolve => {
    setTimeout(() => {
      resolve('resolved');
    }, 2000);
  });
}
```

```
Expected output:
// calling
// resolved
```

```
async function asyncCall() {
  console.log('calling');
  let result = await resolveAfter2Seconds();
  console.log(result);
}
```

Async Functions

- Do not confuse `await` with `Promise.then()`
  - `await` is always used for a **single promise**
  - To **await two or more** promises in **parallel**, use `Promise.all()`
- If a promise resolves normally, then `await` promise **returns the result**
- In case of a rejection, it **throws an error**

Async/Await vs Promise.then

- Promise.then

```
function logFetch(url) {
  return fetch(url)
    .then(response => {
      return response.text()
    })
    .then(text => {
      console.log(text);
    })
    .catch(err => {
      console.error(err);
    });
}
```

- Async/Await

```
async function logFetch(url) {
  try {
    const response =
       await fetch(url);
    console.log(
      await response.text()
    );
  }
  catch (err) {
    console.log(err);
  }
}
```

Error Handling

```
async function f() {
  try {
    let response = await fetch();
    let user = await response.json();
  } catch (err) {
    // catches errors both in fetch andresponse.json
    alert(err);
  }}
```

```
async function f() {
  let response = await fetch();
}
// f() becomes a rejected promise
f().catch(alert);
```

Sequential Execution

- To execute different promise methods **one by one**, use **Async** /**Await**

```
function execute(x,sec) {
  return new Promise(resolve => {
  console.log('Start: ' + x);
    setTimeout(() => {
      console.log('End: ' + x);
      resolve(x);
  }, sec *1000); }); }
```

```
async function serialFlow() {
  let result1 = await execute(1, 1);
  let result2 = await execute(2, 2);
  let result3 = await execute(3, 3);
  let finalResult = result1 + result2 + result3;
  console.log(finalResult);
}
```

```
// Start: 1
// End: 1
// Start: 2
// End: 2
// Start: 3
// End: 3
// 6
```

Concurrent Execution

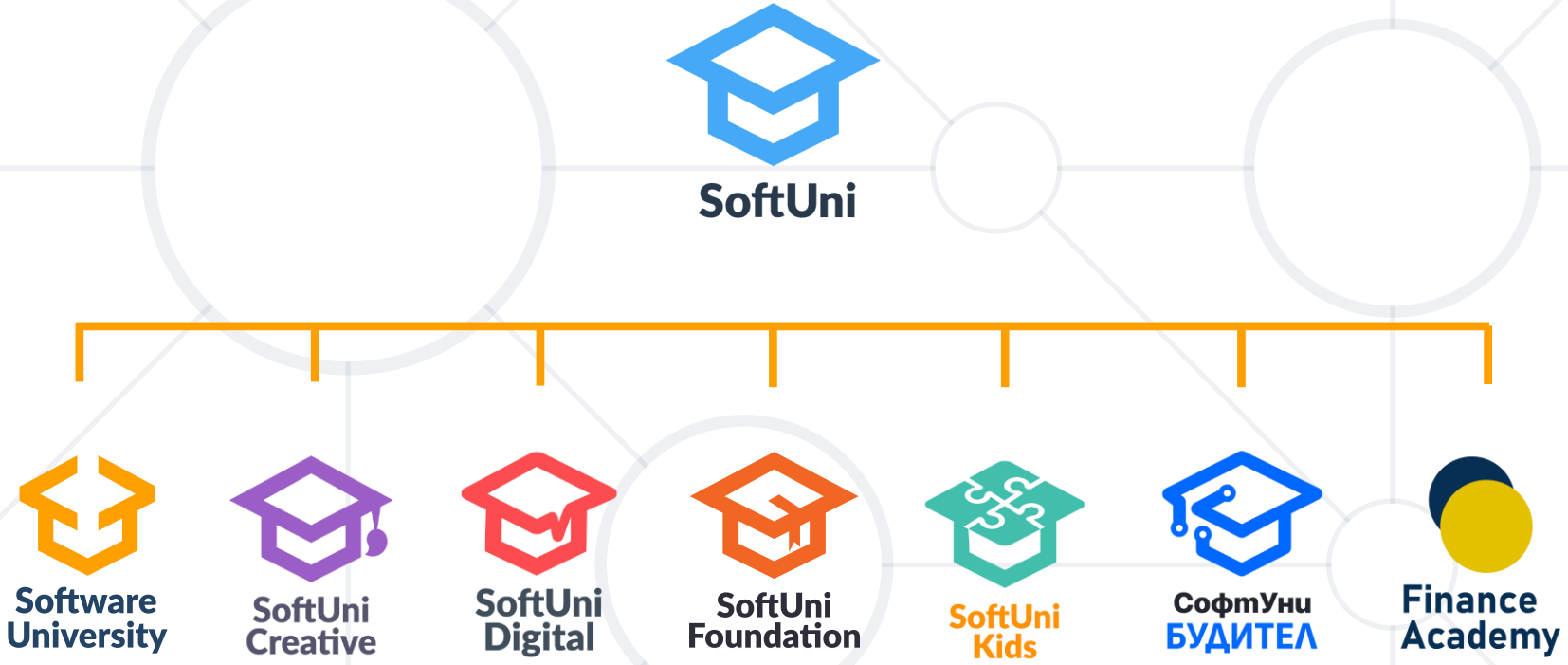
```
async function parallelFlow() {
  let result1 = execute(1,1);
  let result2 = execute(2,2);
  let result3 = execute(3,3);
  let finalResult = await result1 +
                    await result2 +
                    await result3;
  console.log(finalResult);
}
```

```
// Expected output:
// Start: 1
// Start: 2
// Start: 3
// End: 1
// End: 2
// End: 3
// 6
```

Summary

- Asynchronous programming
  - Runs several tasks in parallel, at the same time
- Promises hold operations
  - Can be `resolved` or `rejected`
- `Async` functions contain an `await` expression
  - Yields the execution
  - Waits for the Promise's resolution

Questions?



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