

Asynchronous Programming and Promises

Fetch API, Promises, async/await



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AJAX

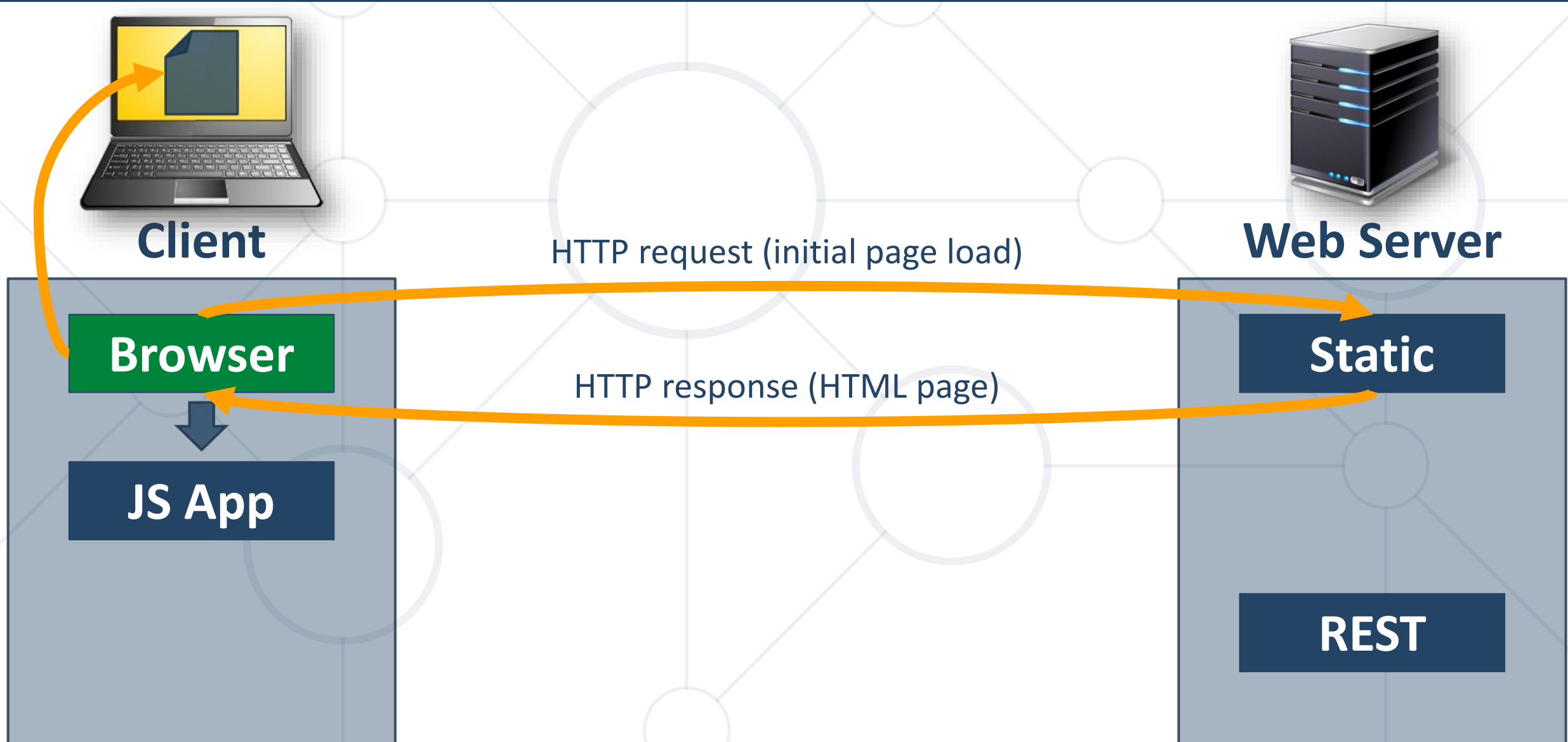
Asynchronous JavaScript and XML

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 **<div>**
 - **JSON service**
 - Loads JSON object and displays it

AJAX: Workflow

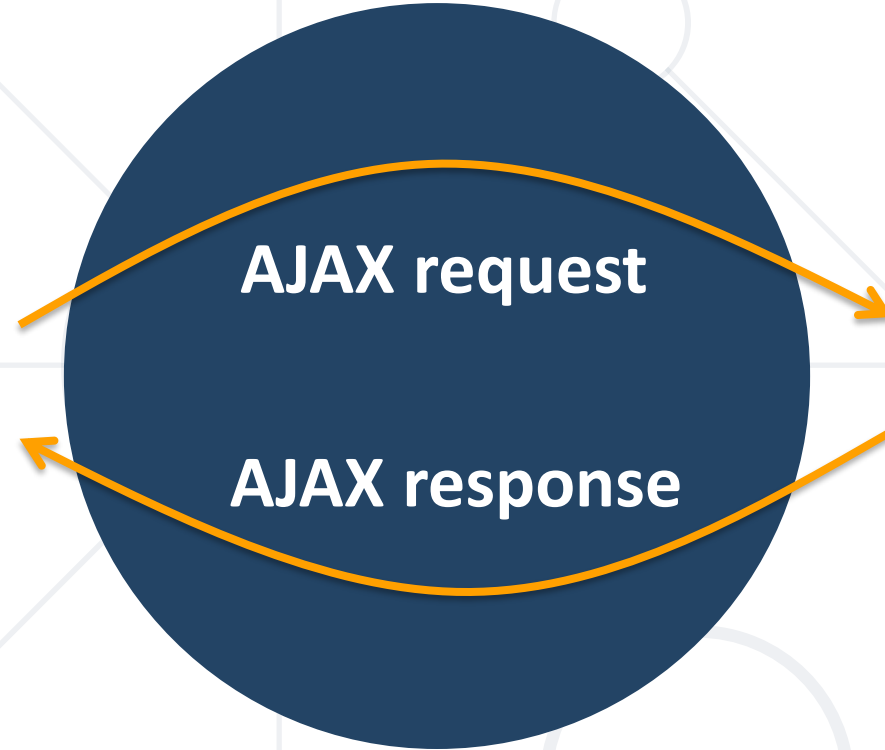


AJAX: Workflow





Web Client



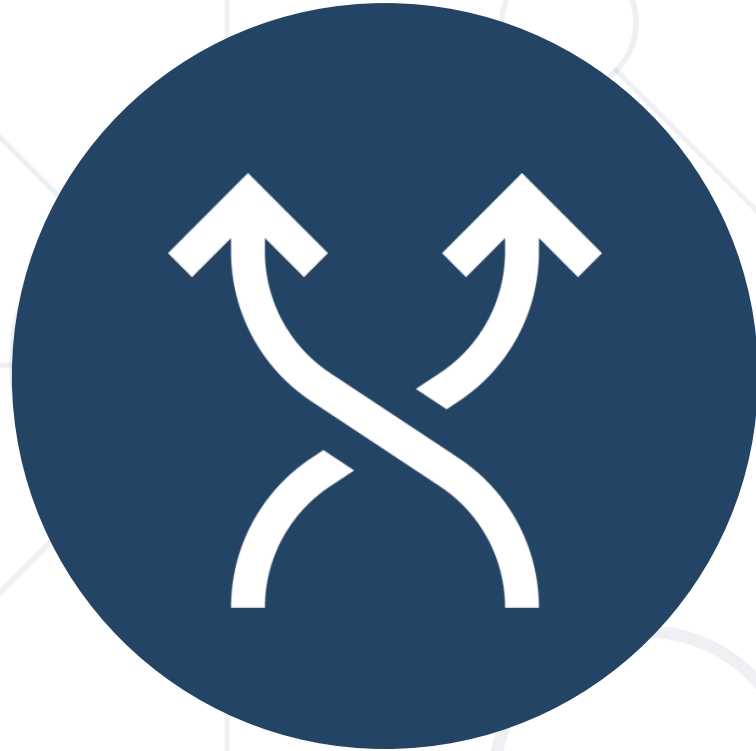
Web Server

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

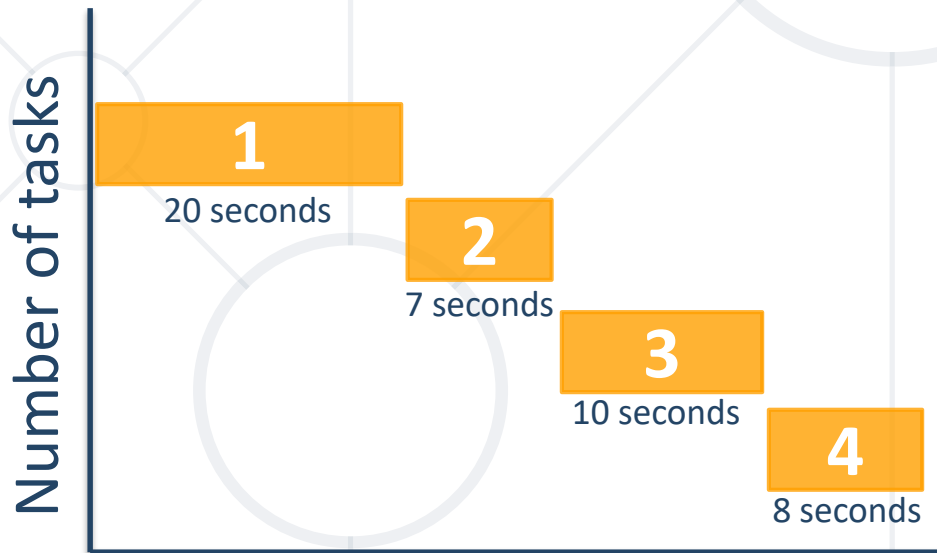
Asynchronous Programming in JS

- 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**

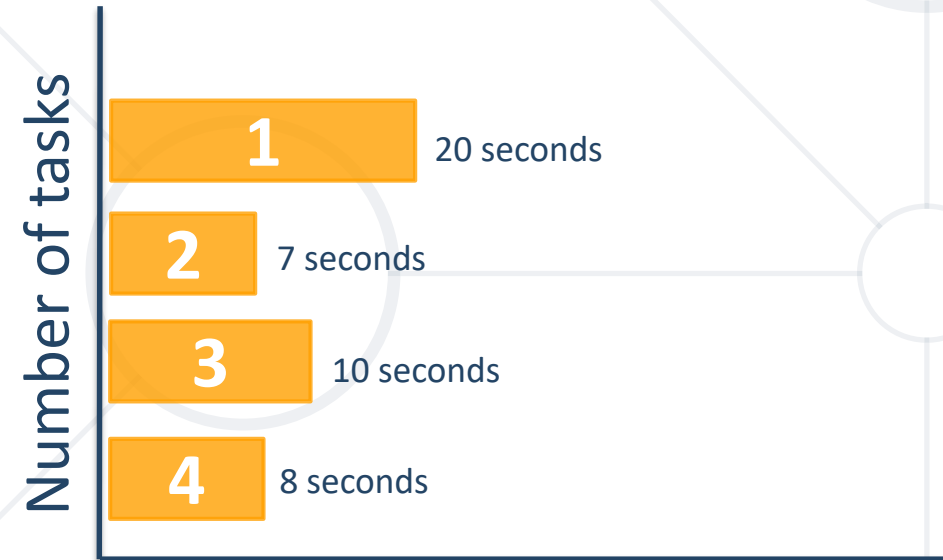


- Runs several tasks (pieces of code) in parallel, **at the same time**

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

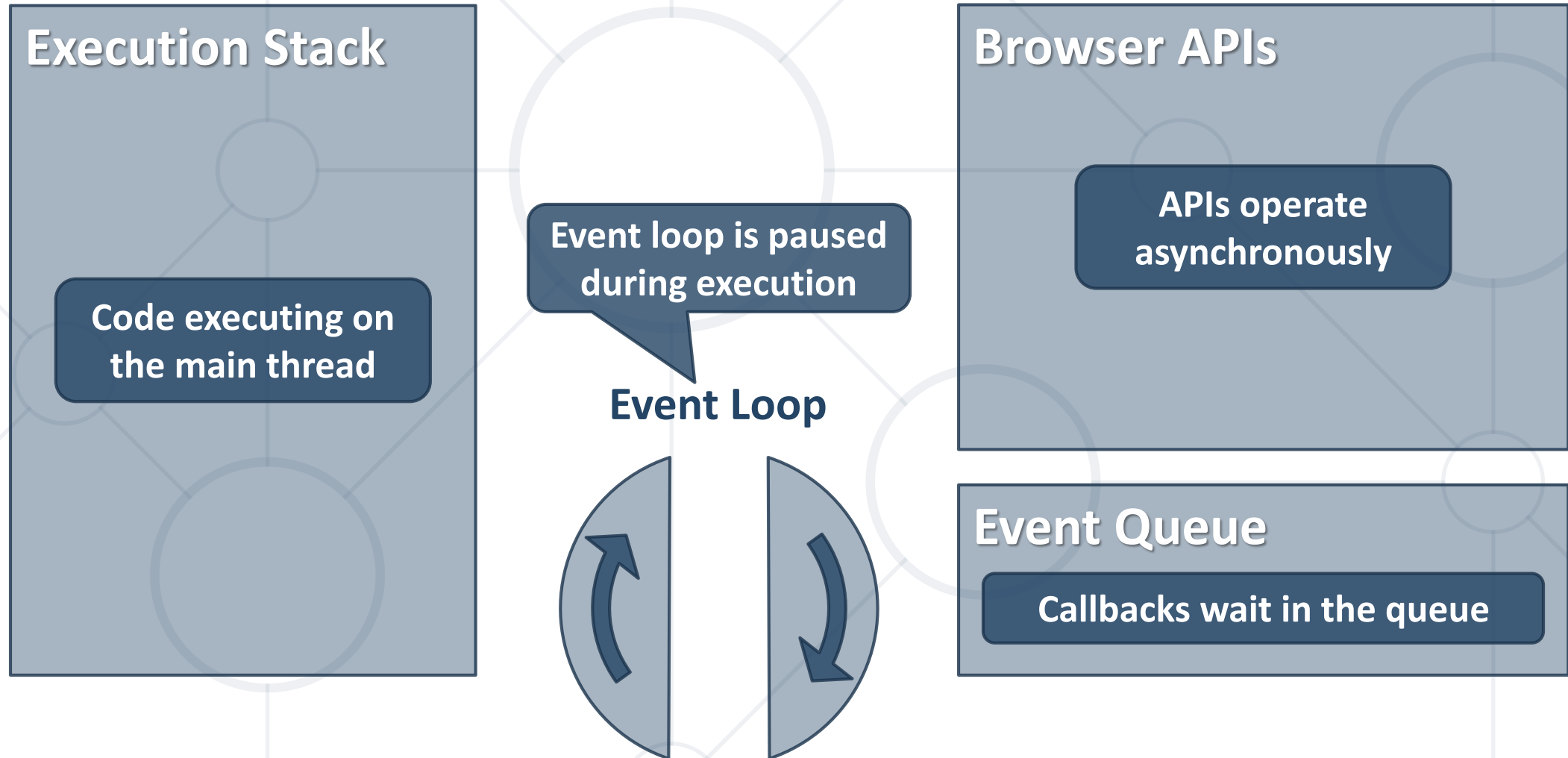
- Function **passed** into another function as an **argument**
- Then **invoked** inside the outer function to complete some kind of routine or action



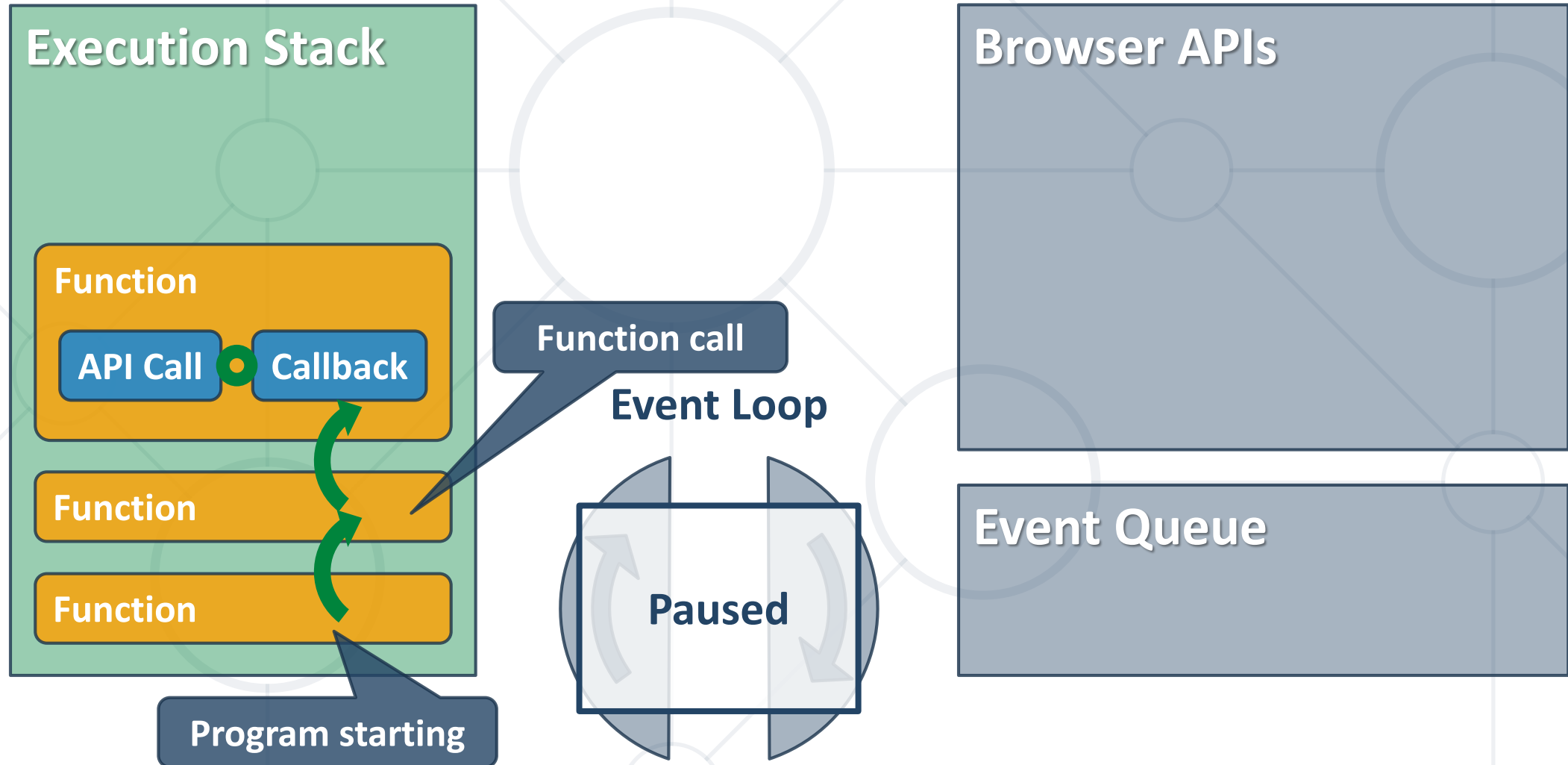
```
function running() {  
    return "Running";  
}  
function category(run, type) {  
    console.log(run() + " " + type);  
}  
category(running, "sprint"); //Running sprint
```

Callback function

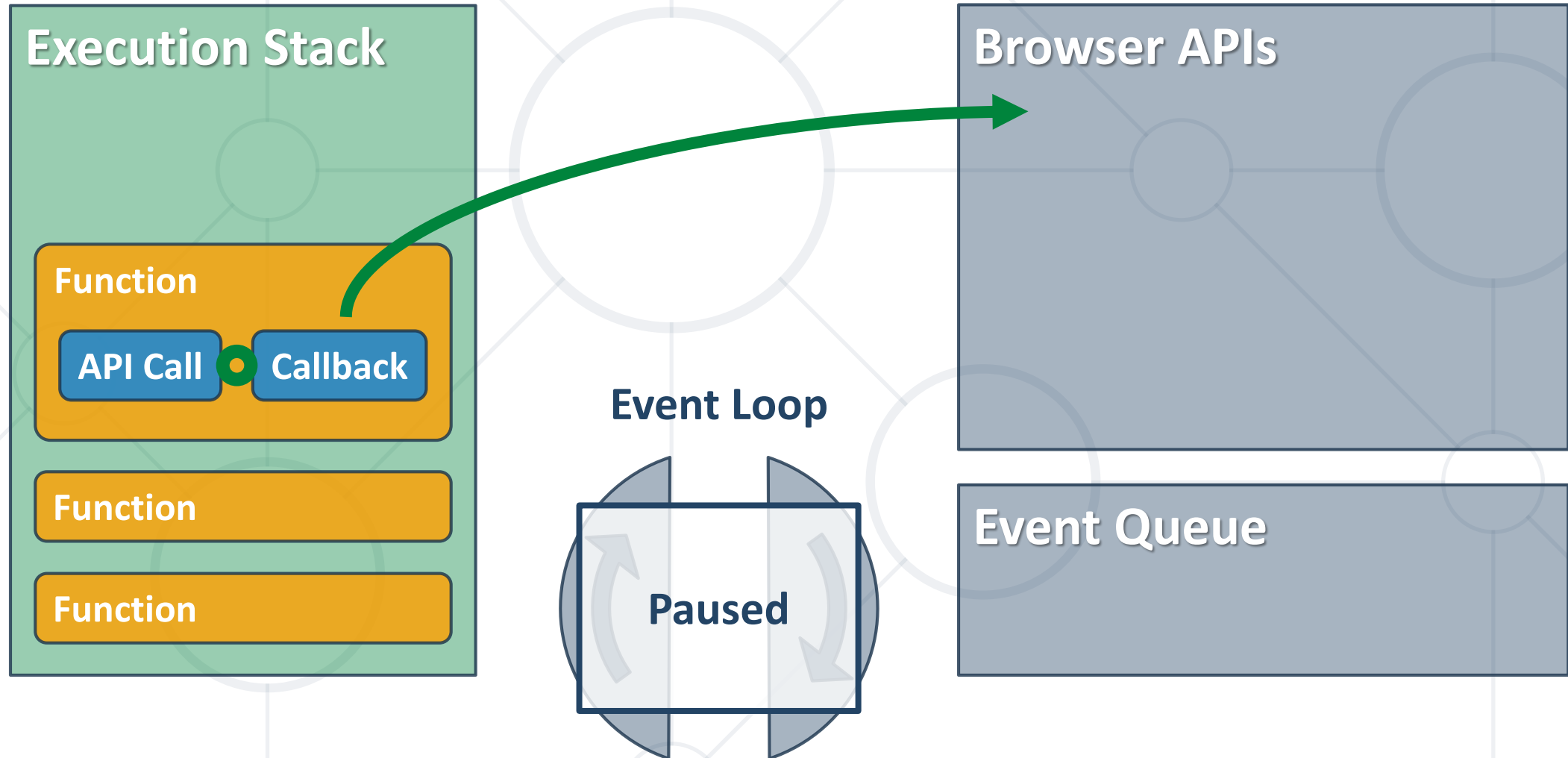
Event Loop Synchronization



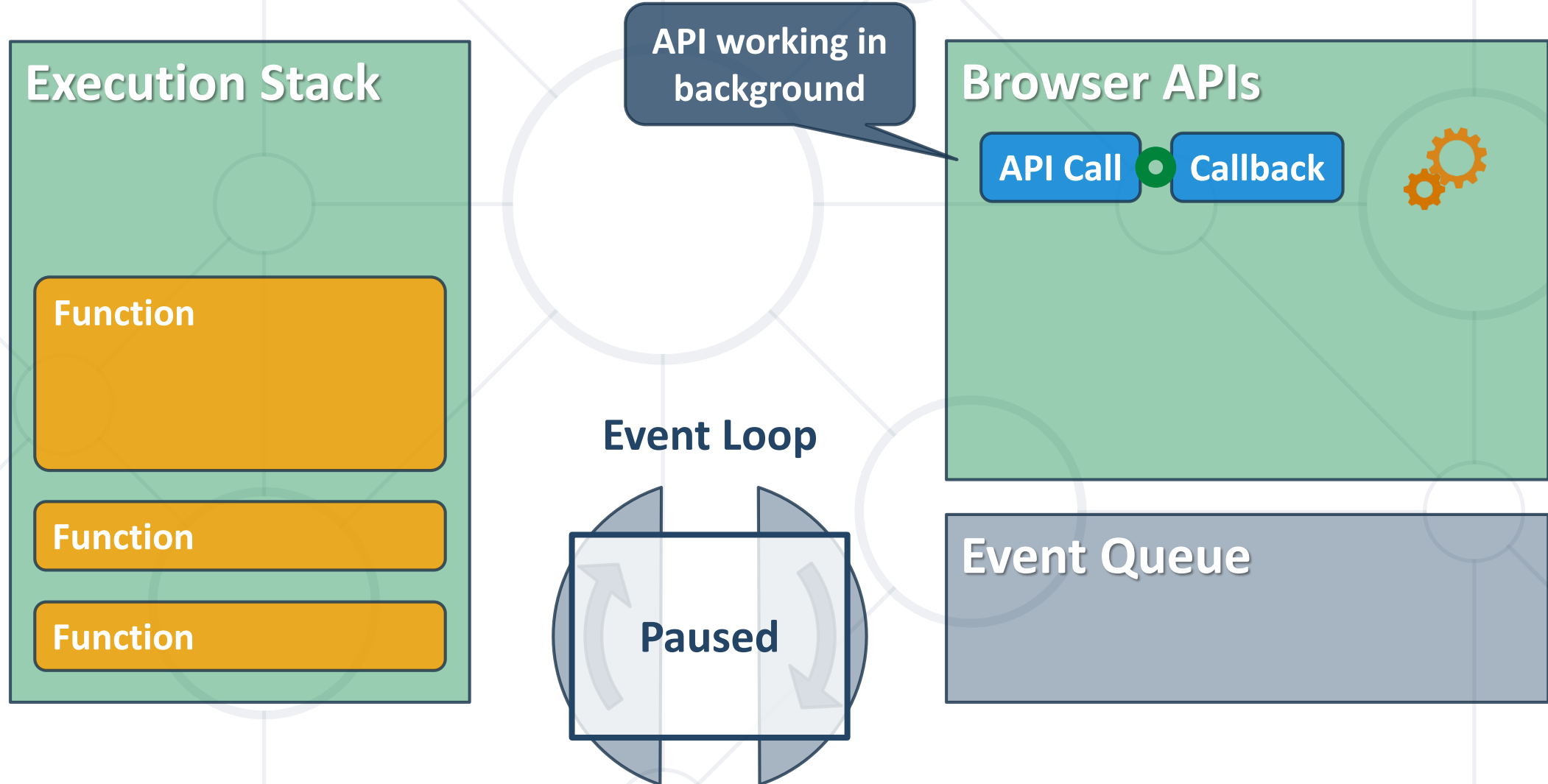
Event Loop Synchronization



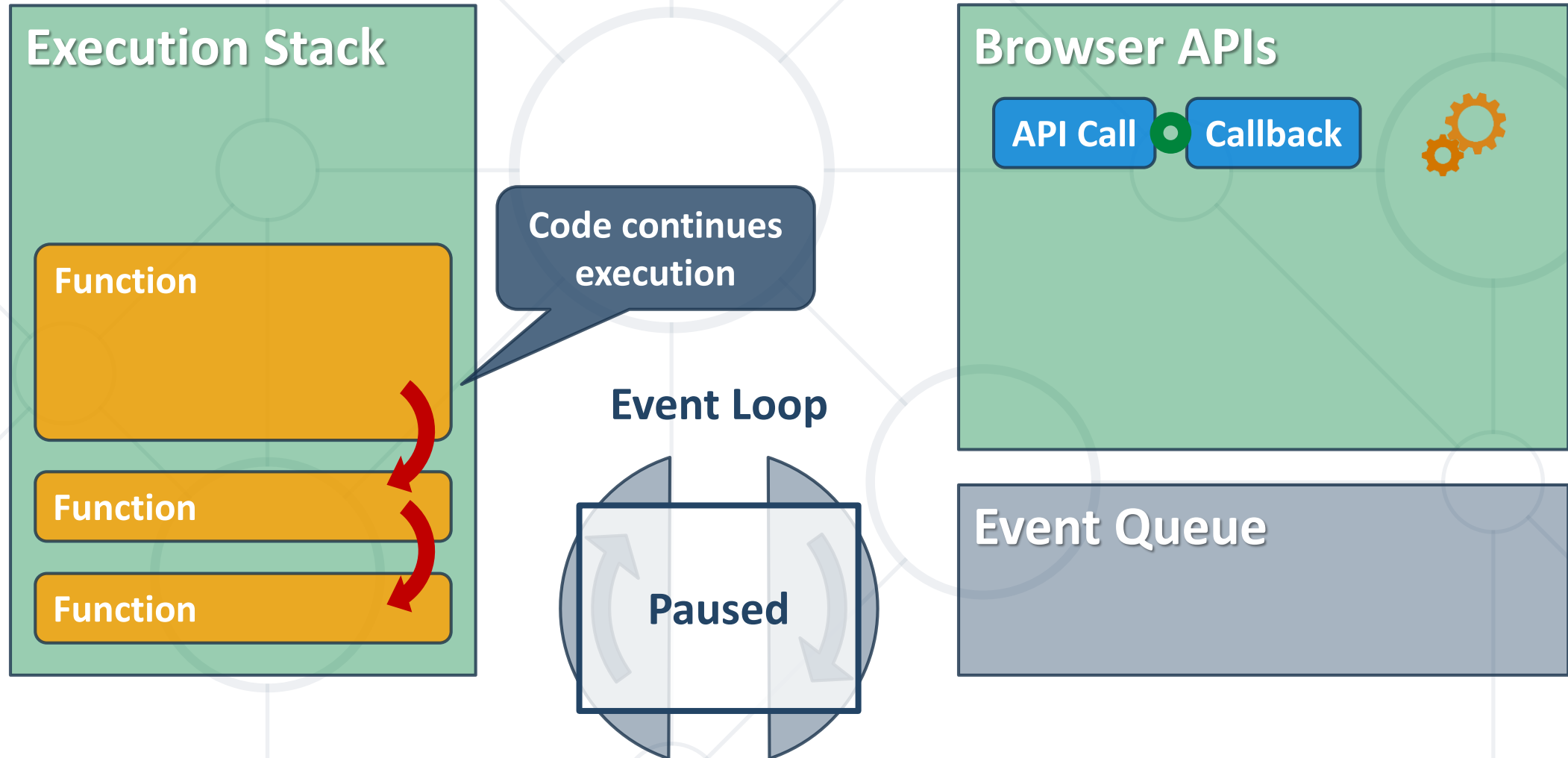
Event Loop Synchronization



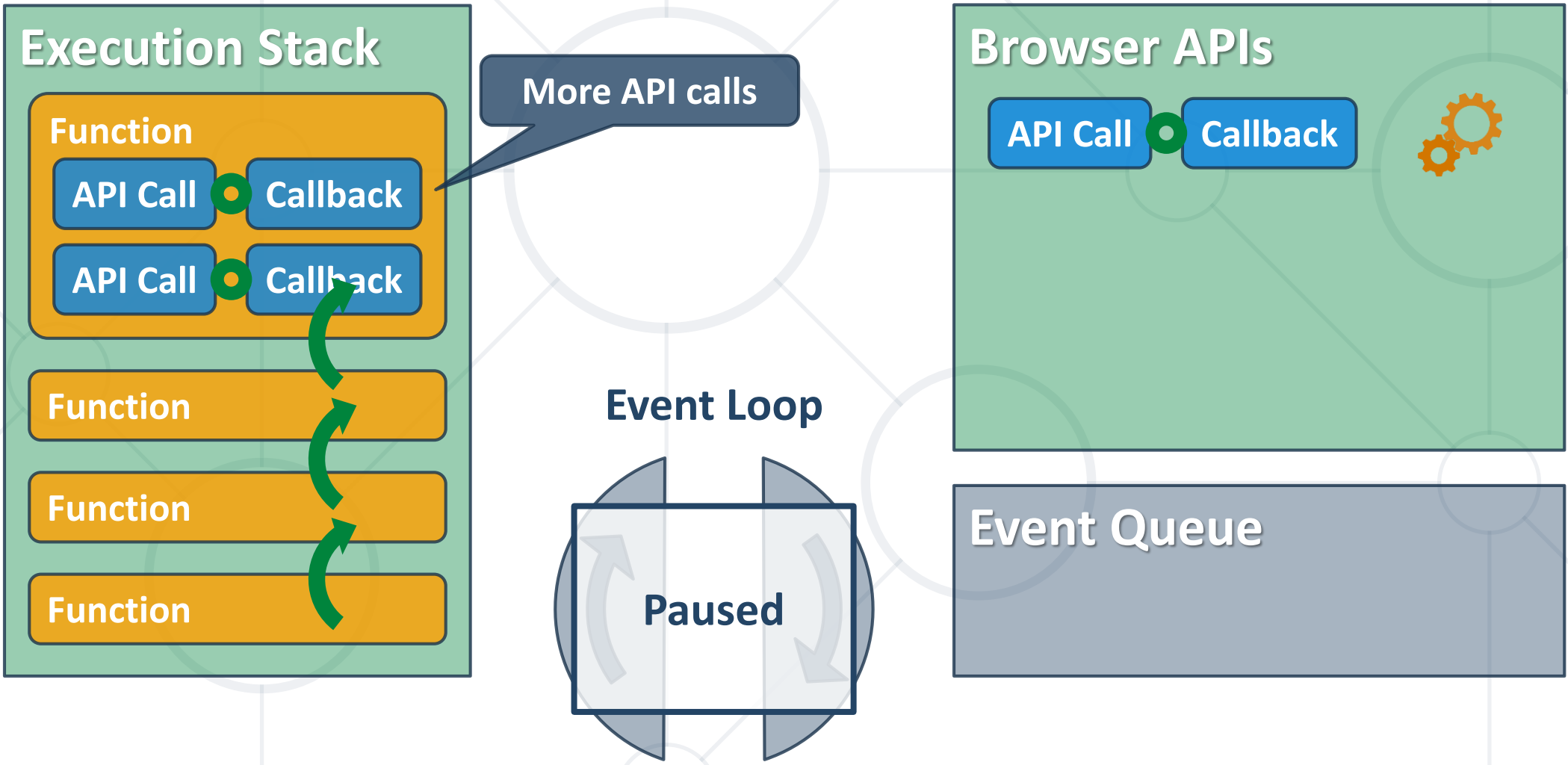
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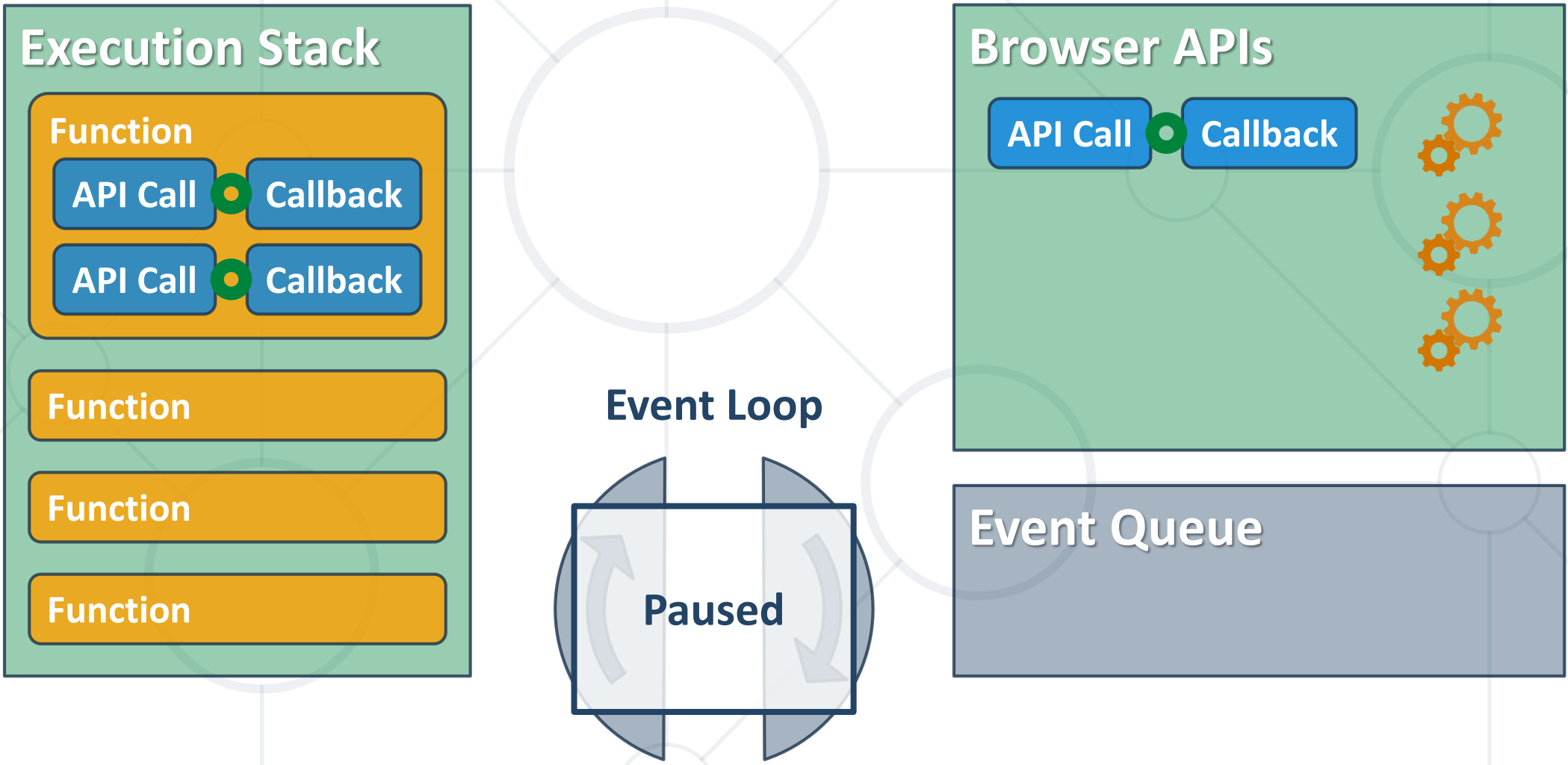
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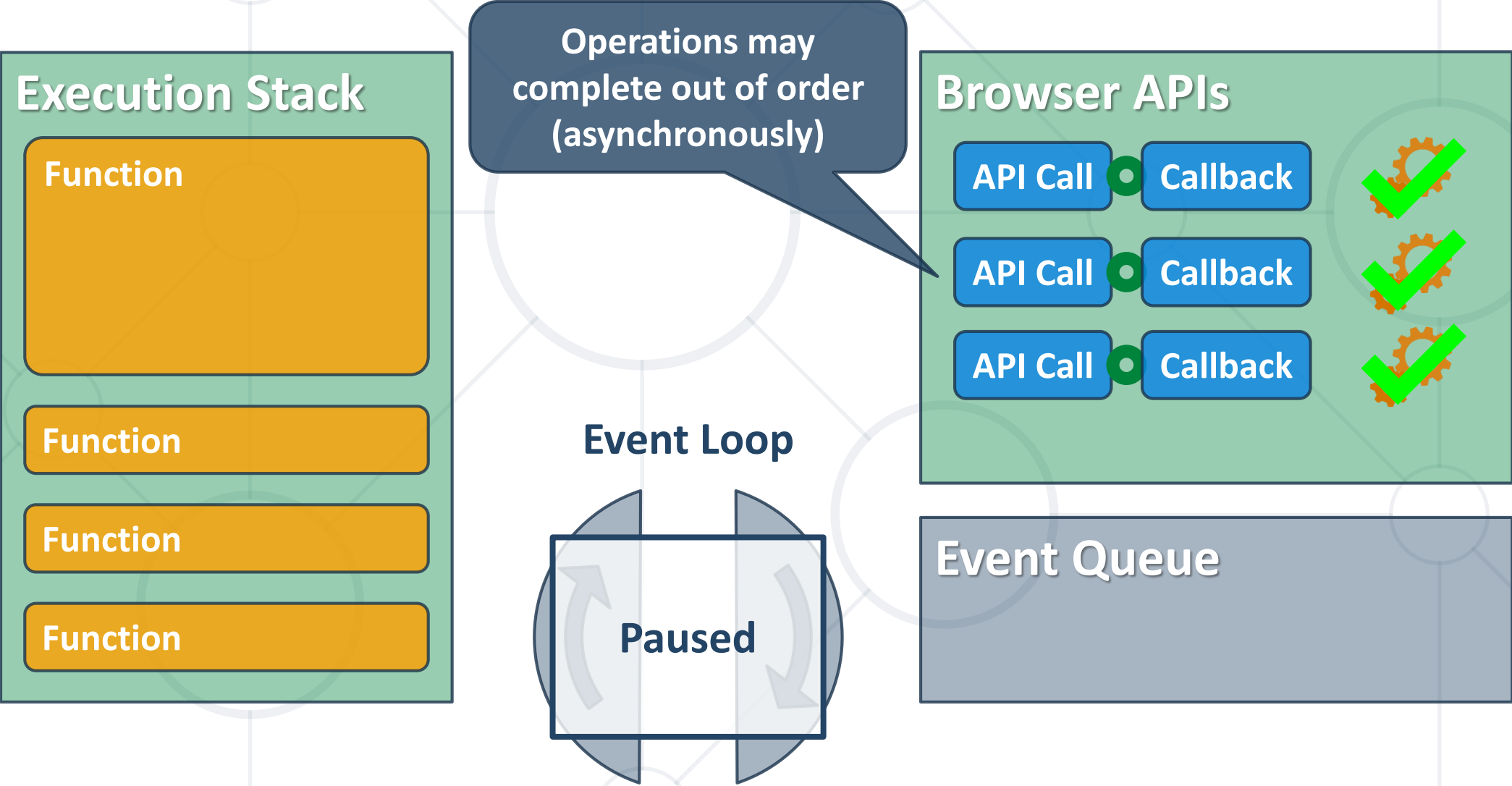
Event Loop Synchronization



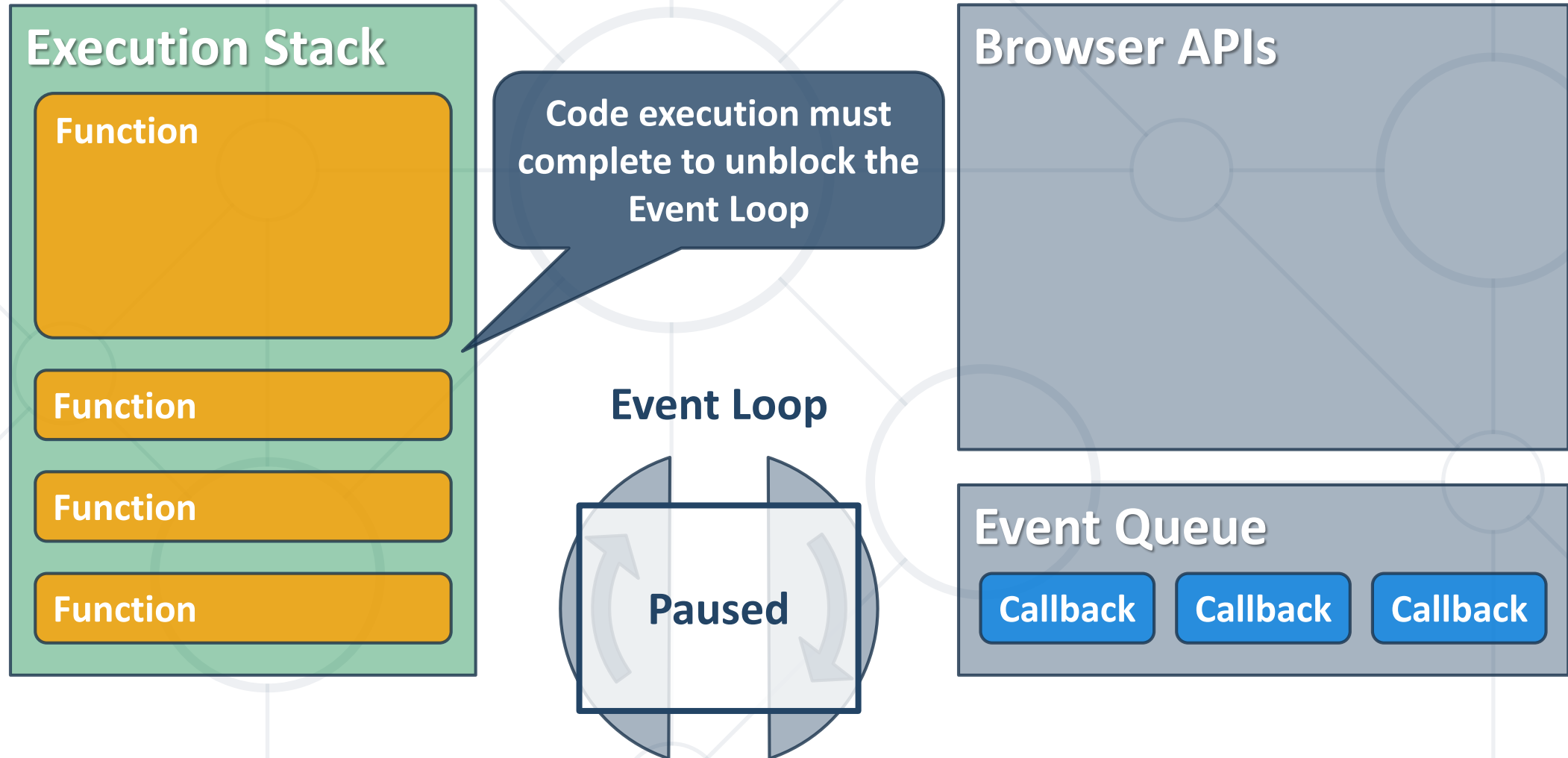
Event Loop Synchronization



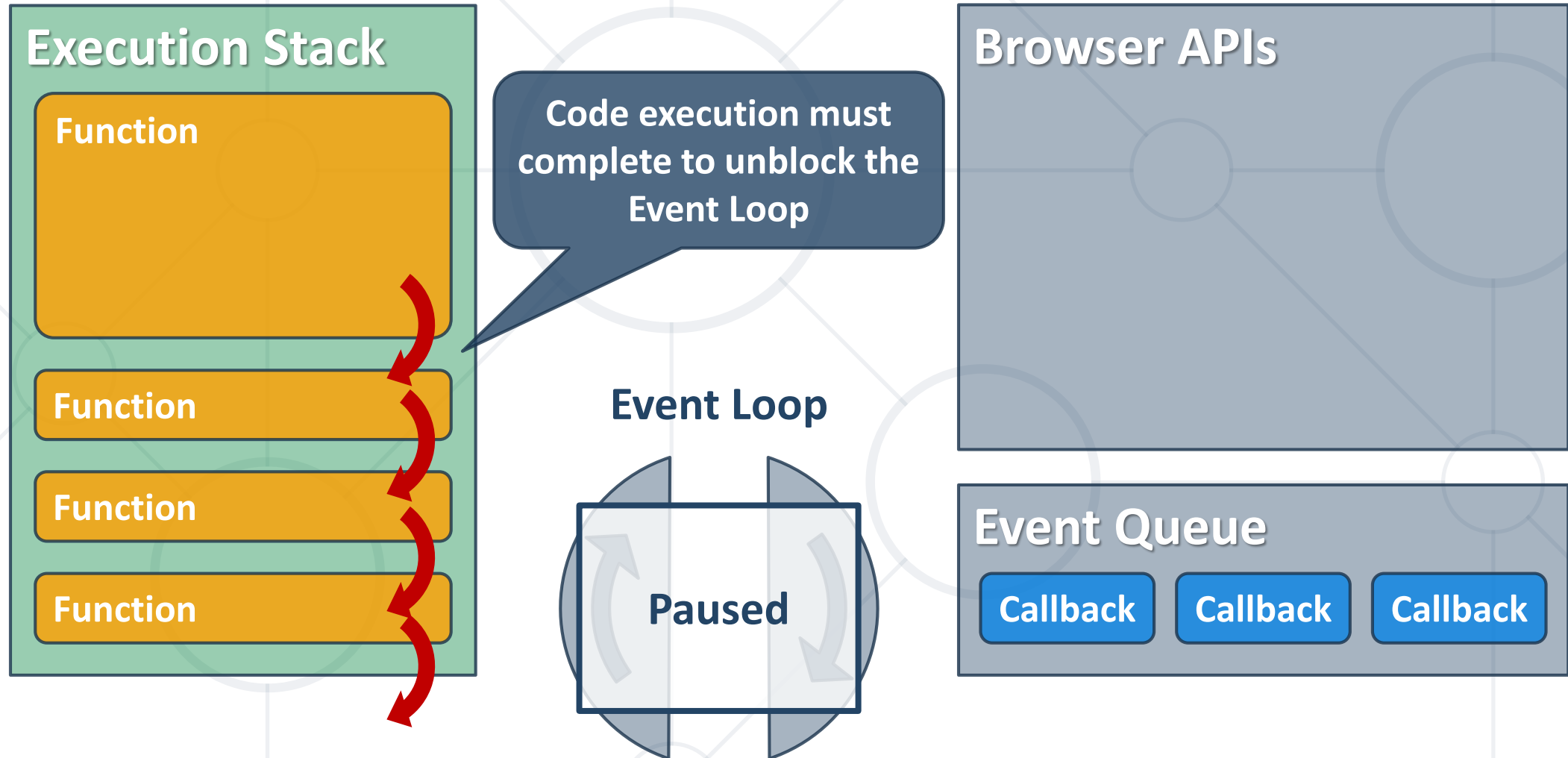
Event Loop Synchronization



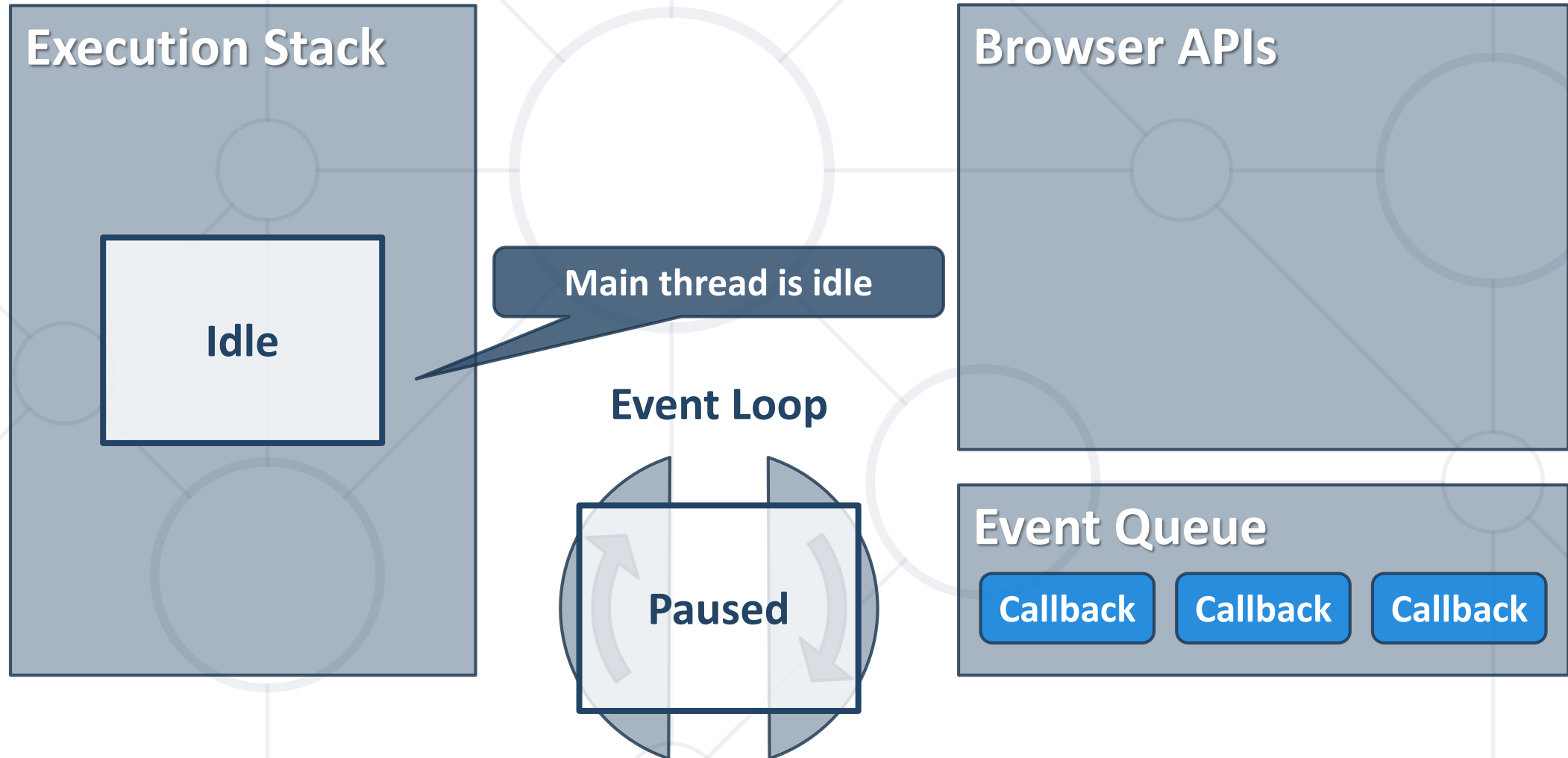
Event Loop Synchronization



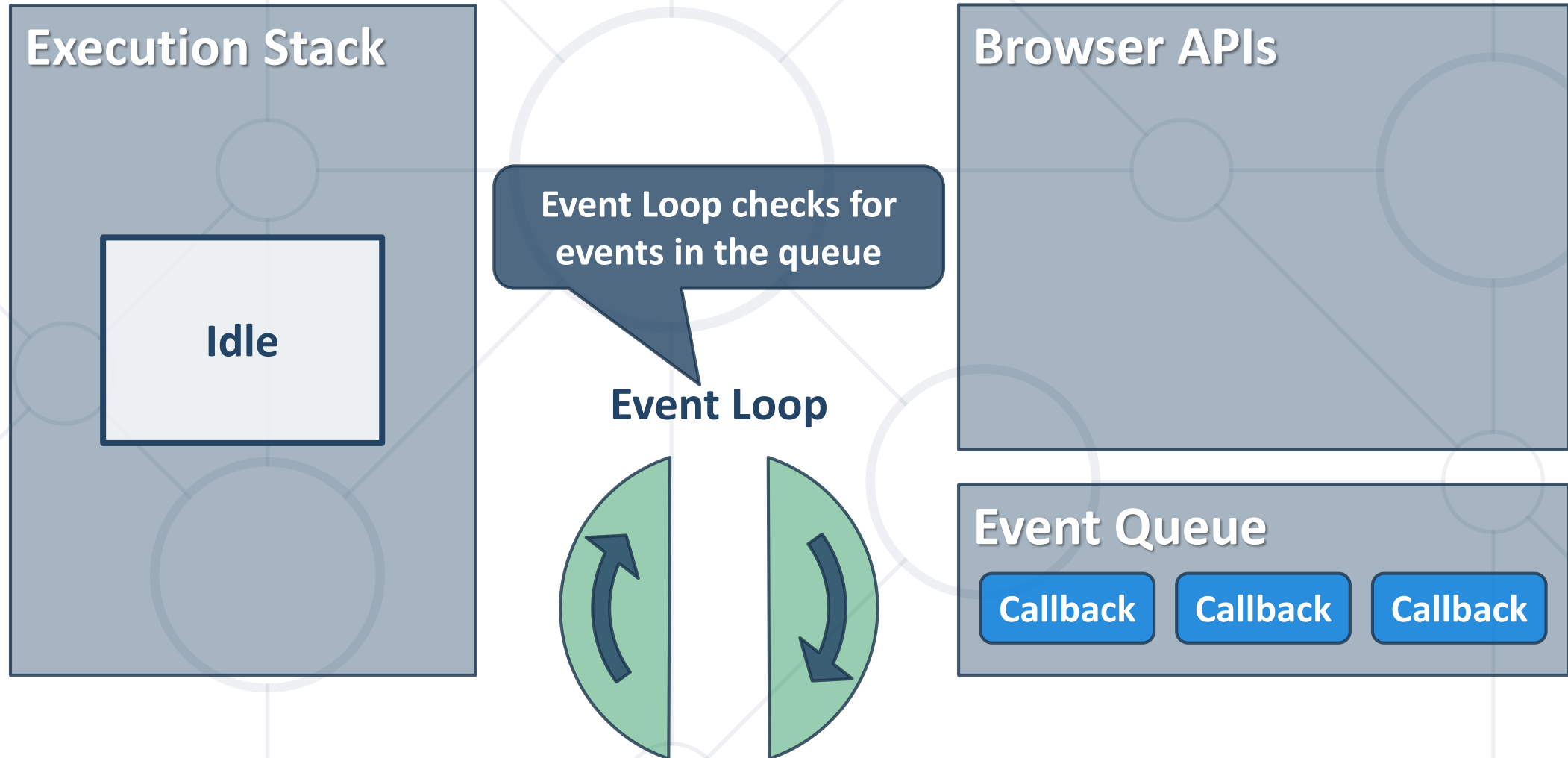
Event Loop Synchronization



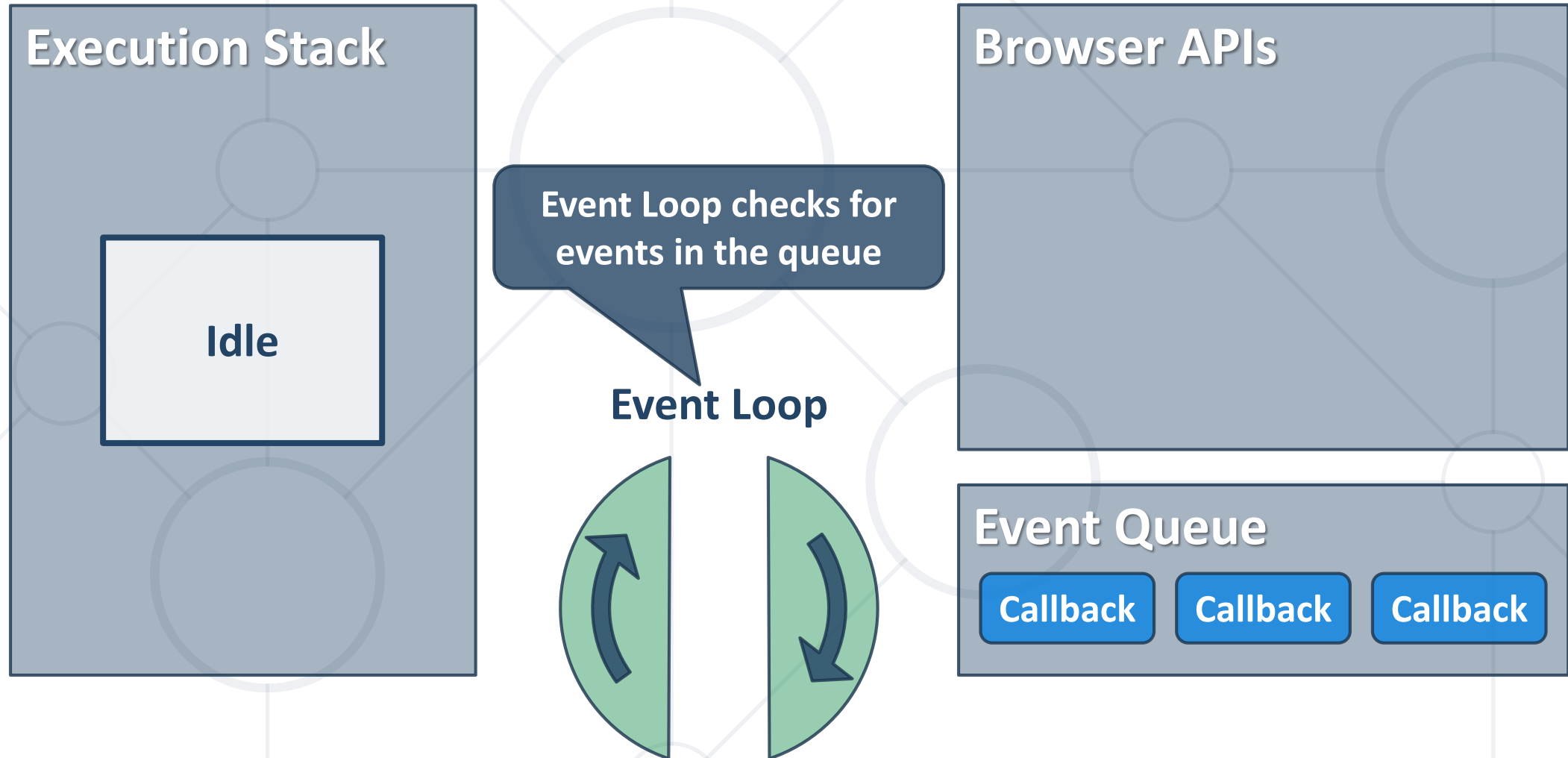
Event Loop Synchronization



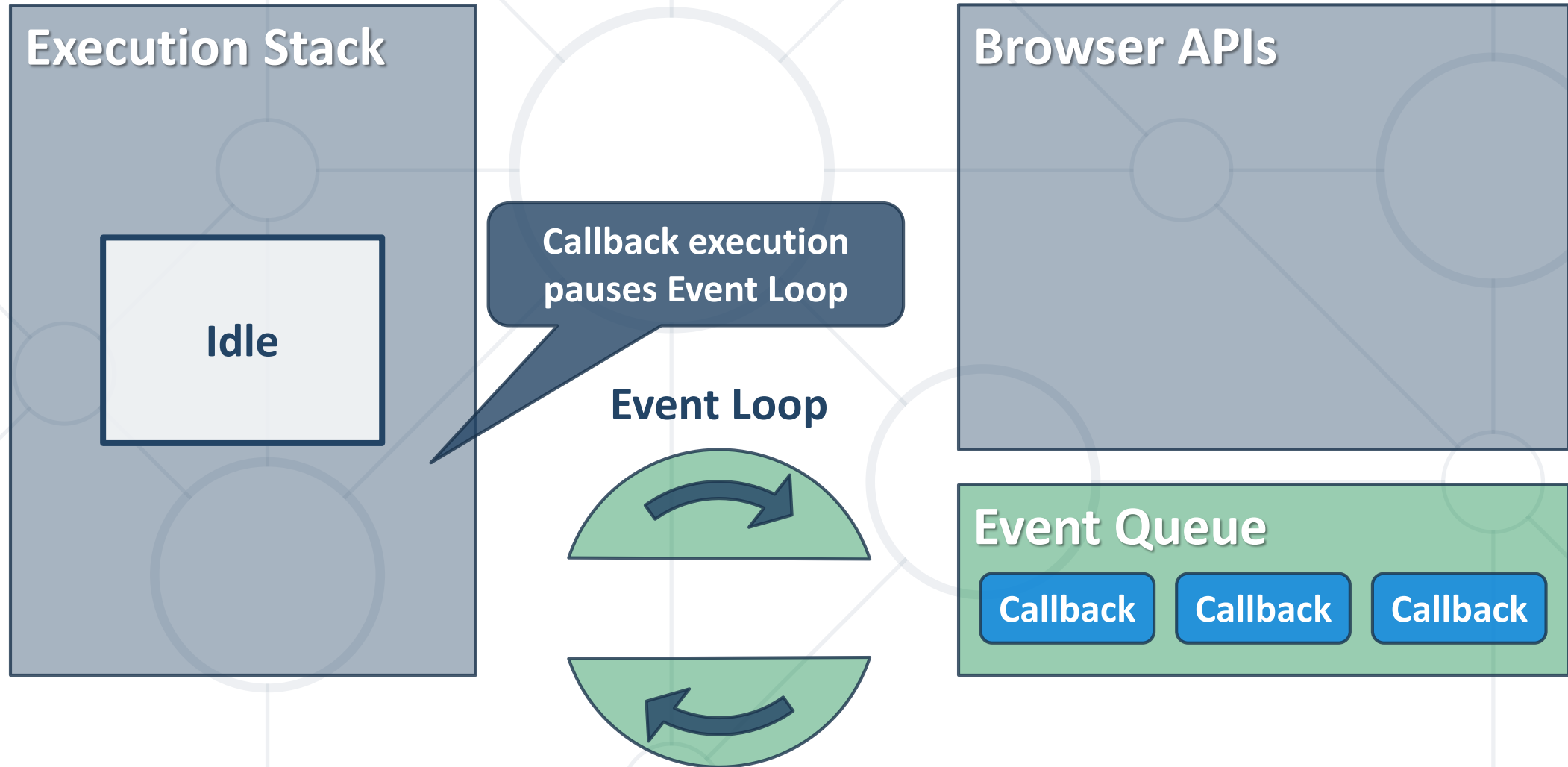
Event Loop Synchronization



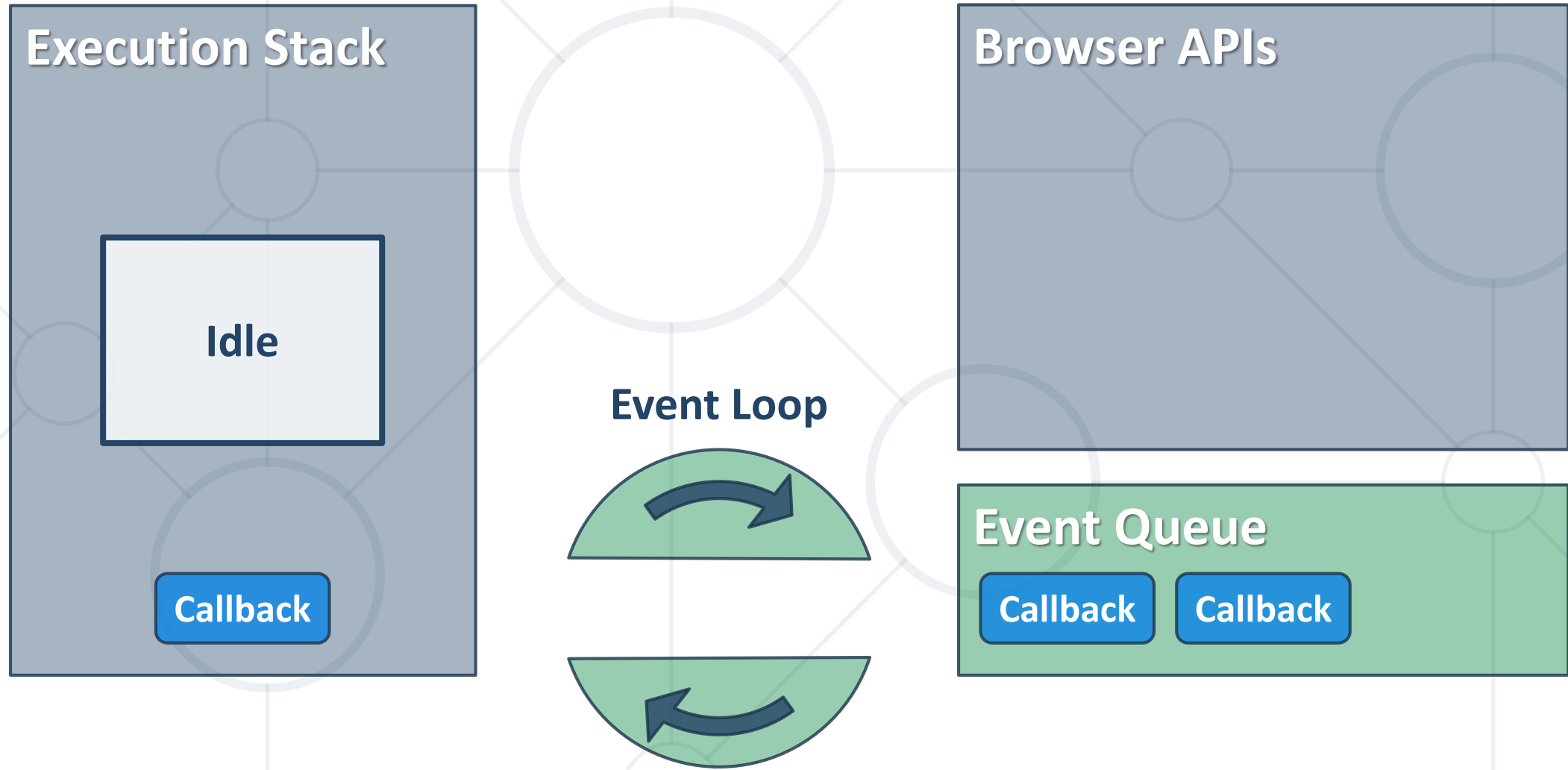
Event Loop Synchronization



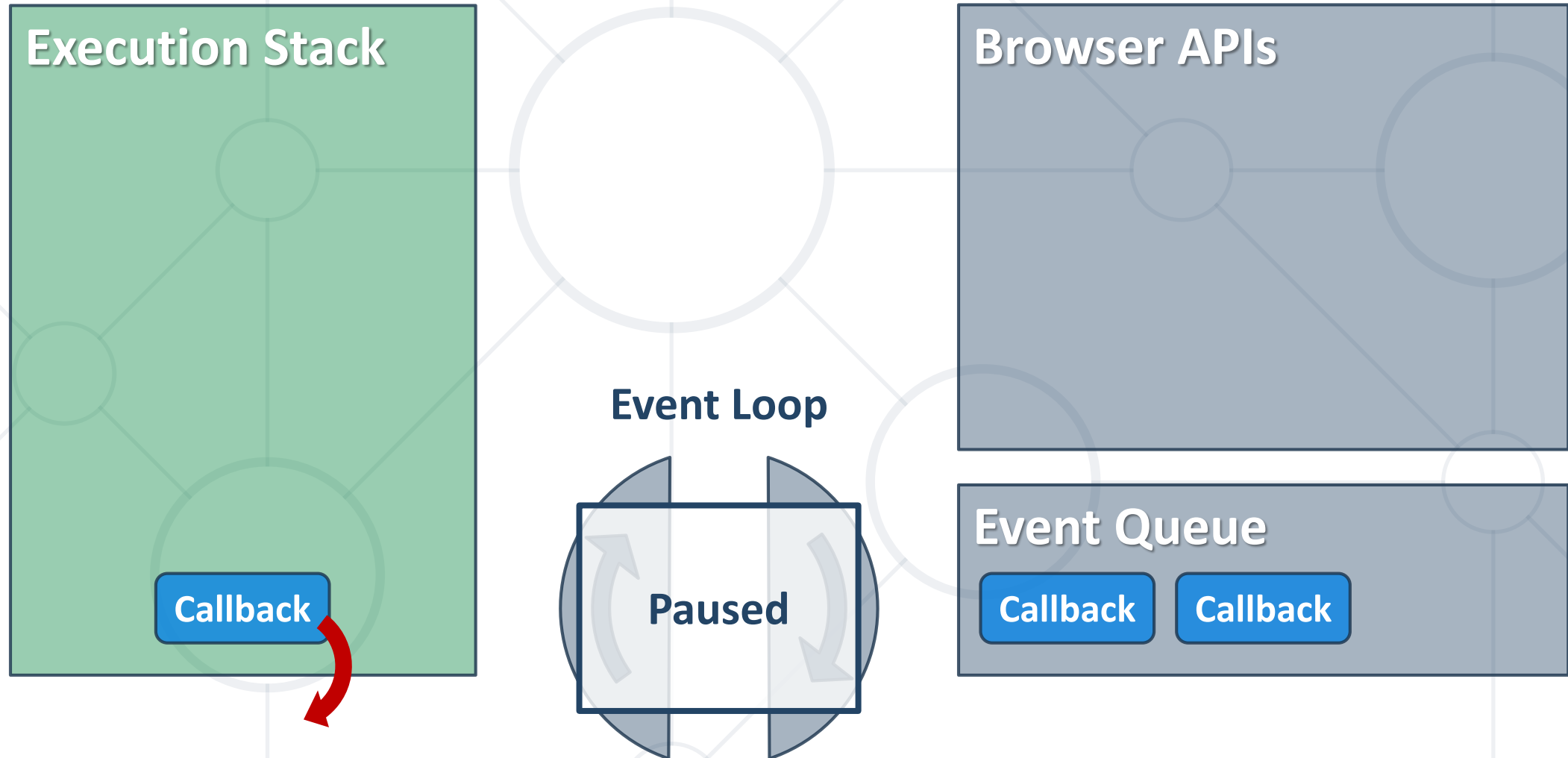
Event Loop Synchronization



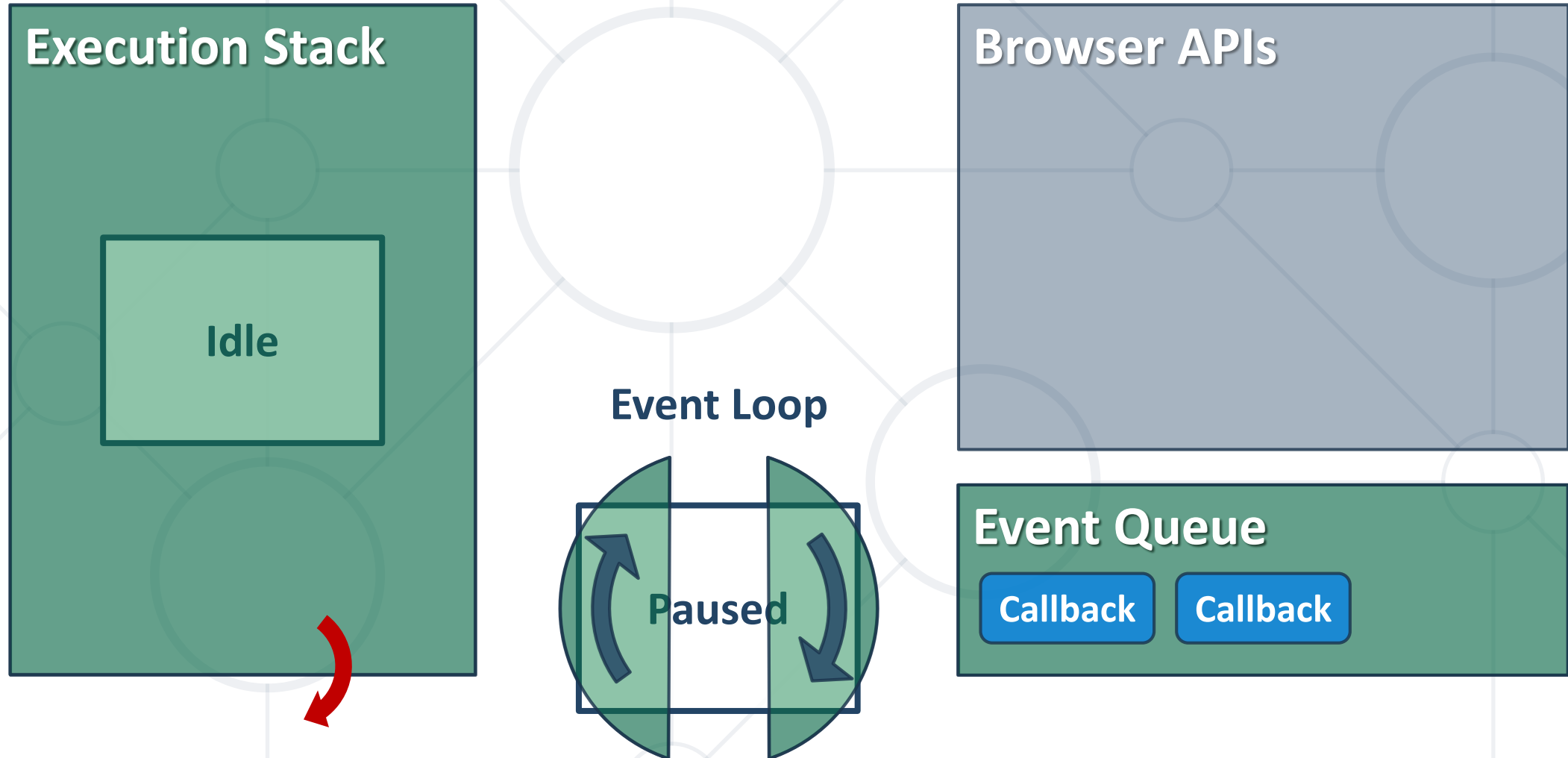
Event Loop Synchronization



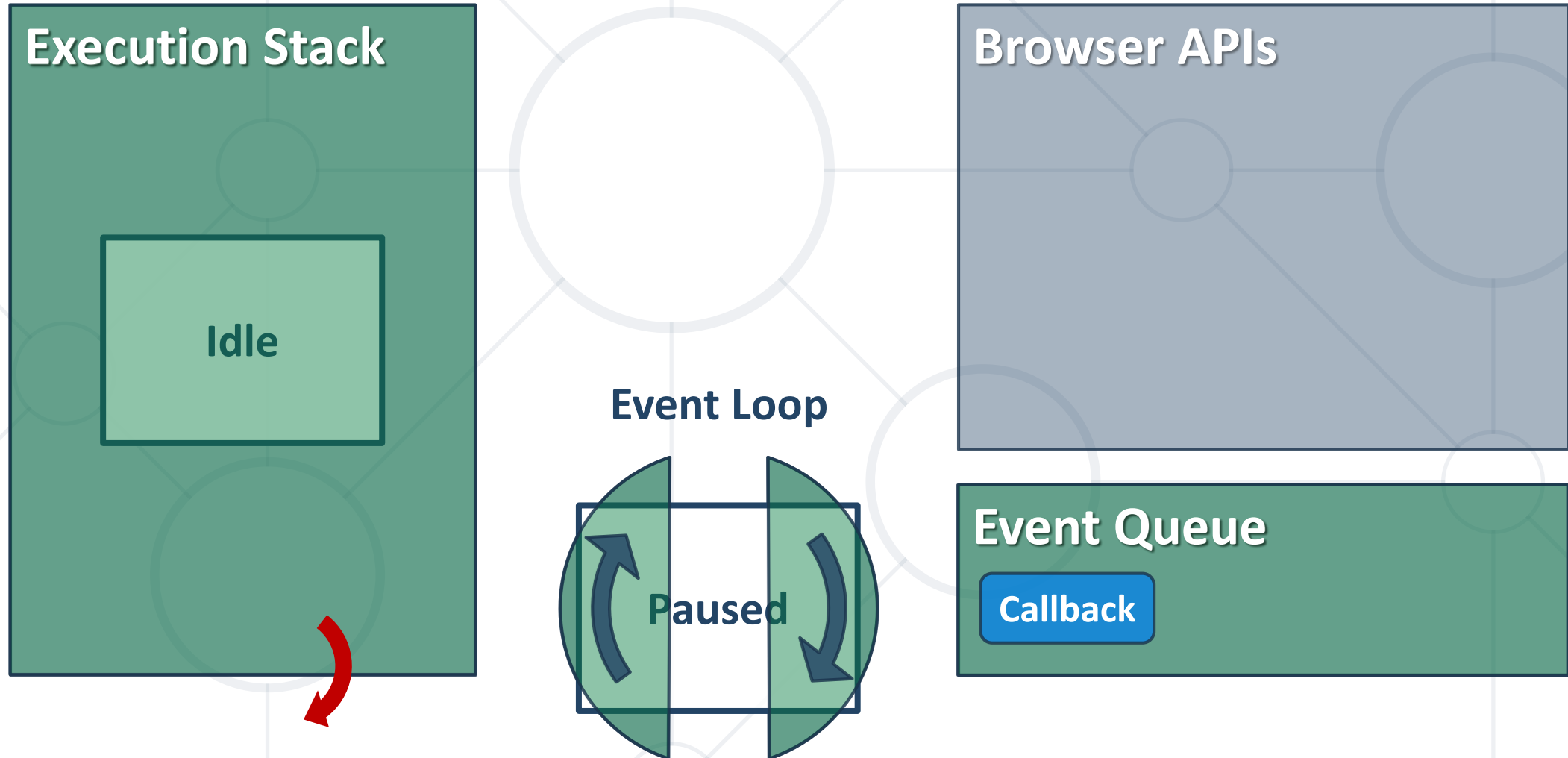
Event Loop Synchronization



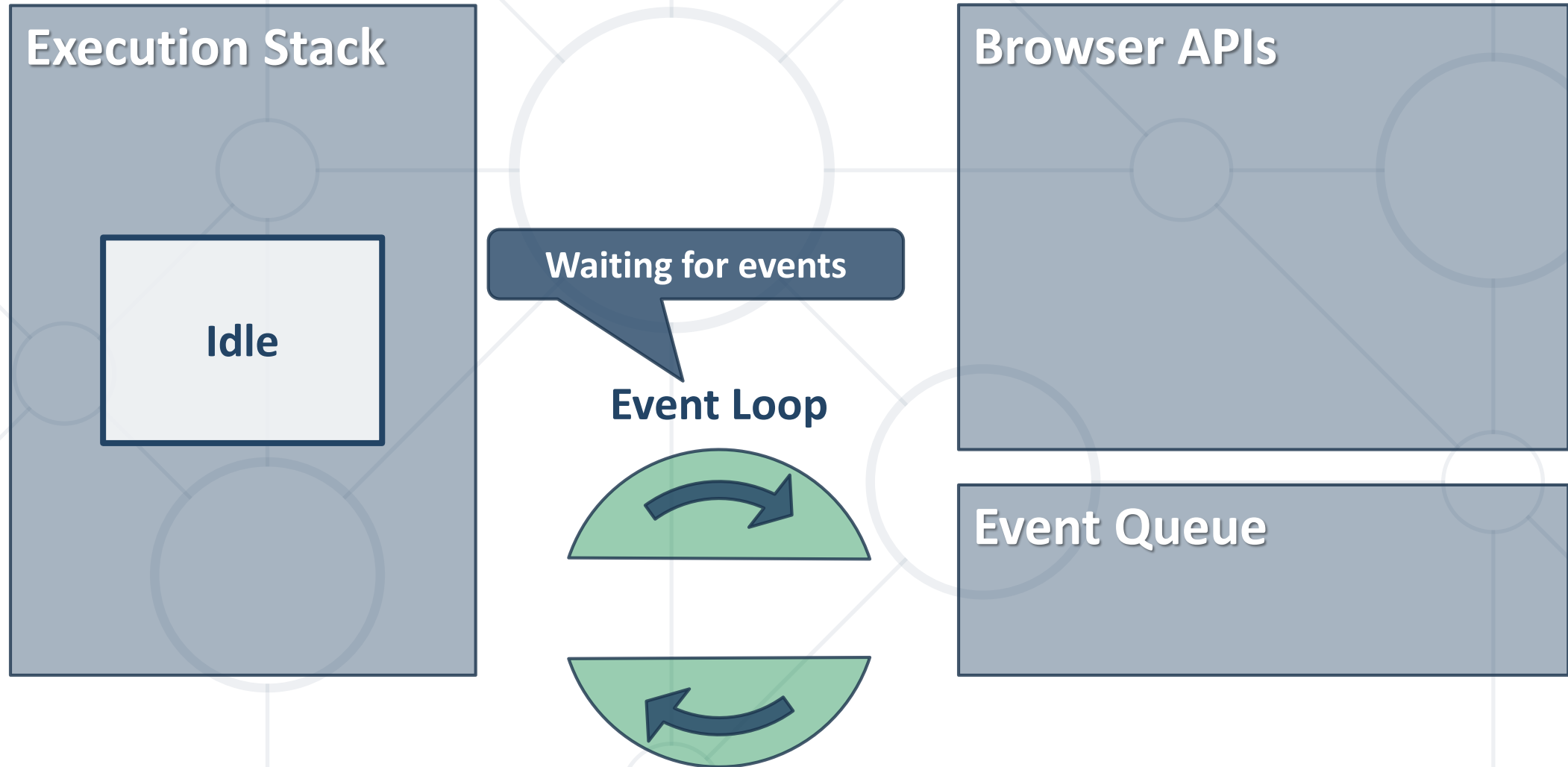
Event Loop Synchronization



Event Loop Synchronization



Event Loop Synchronization





Promises

Objects Holding Asynchronous Operations

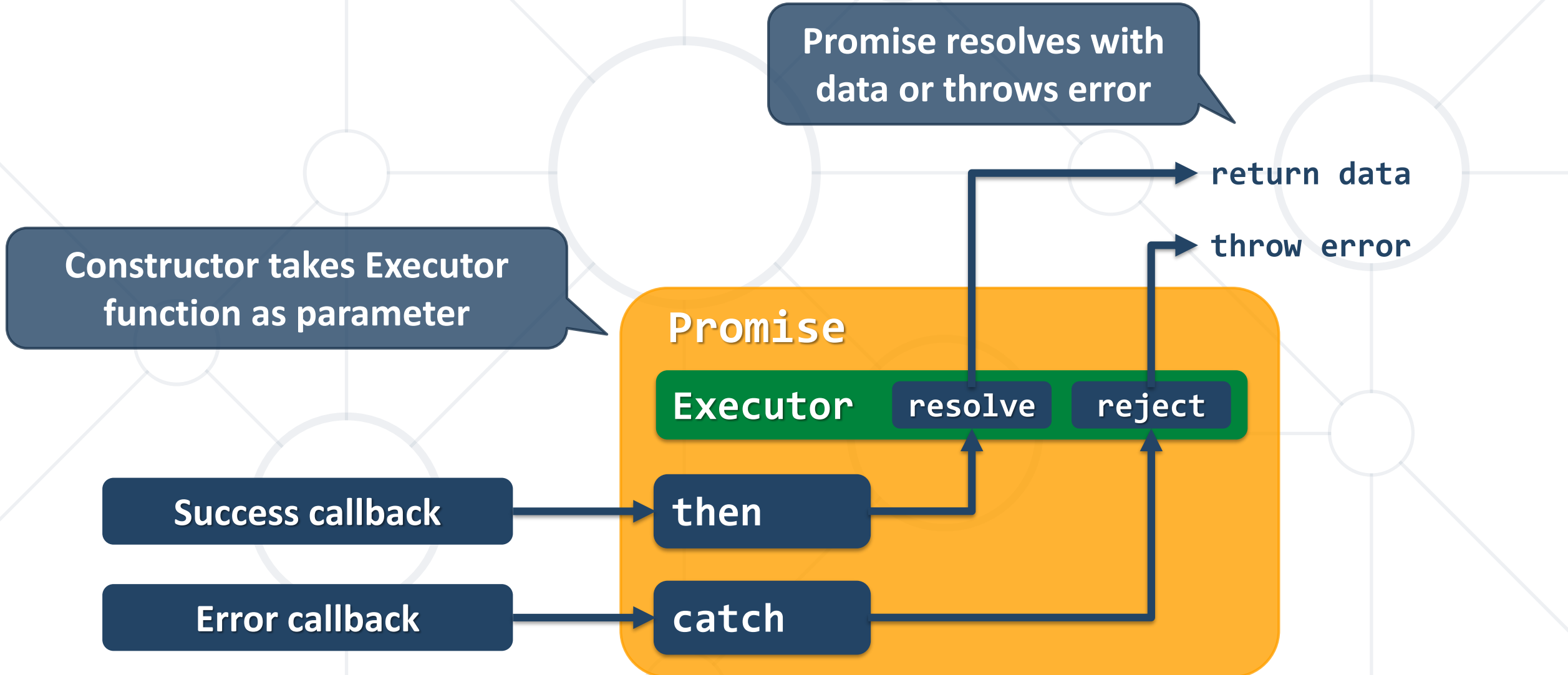
What is a Promise?

- 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.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.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) {...})
```

- 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),  
})
```



- **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

- **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
```

```
}
```

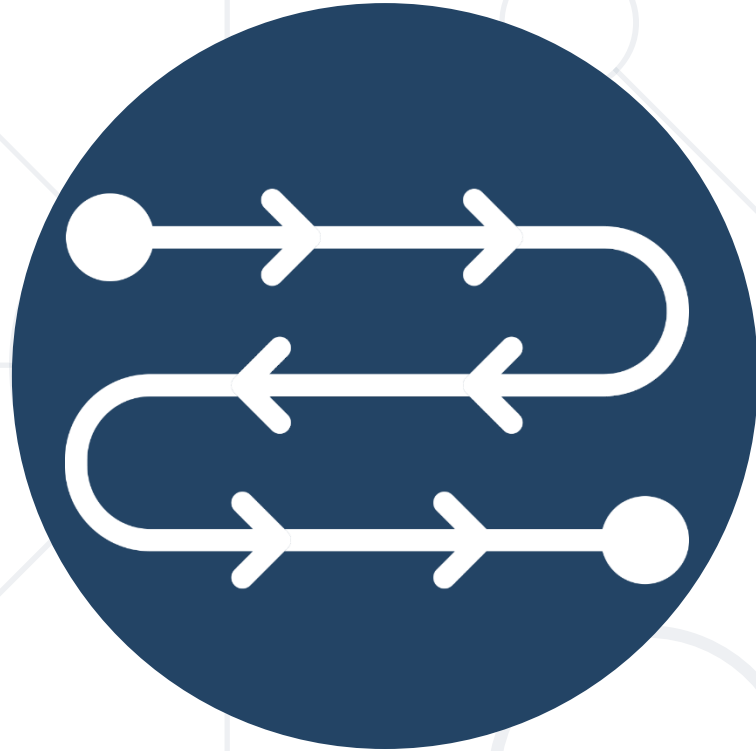
```
</script>
```

GitHub username:

Repo:

Load Commits

- Svetlin Nakov: Delete Console.Cin.v11.suo
- Svetlin Nakov: Create LICENSE
- Svetlin Nakov: Update README.md
- Svetlin Nakov: Added better documentation



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);  
}
```

- 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**

■ 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 and response.json  
    alert(err);  
  }}  

```

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

```

- 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



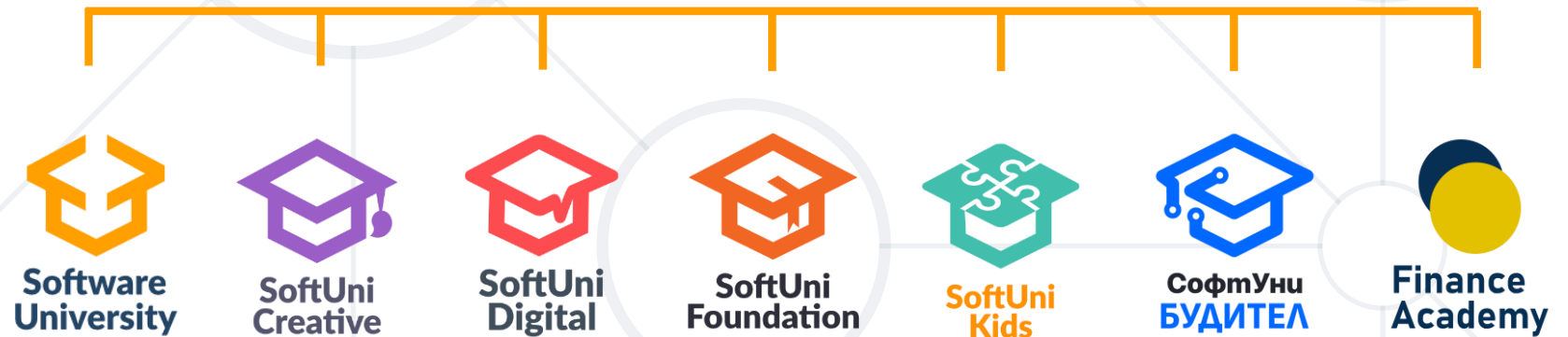
```
async function parallelFlow() {  
  let result1 = execute(1,1);  
  let result2 = execute(2,2);  
  let result3 = execute(3,3);  
  let finalResult = await result1 +  
                    await result2 +  
                    await result3;  
  console.log(finalResult);  
}
```

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


- 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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