

COMP 322: Fundamentals of Parallel Programming

Lecture 10: Event-Based Programming

Mack Joyner
mjoyner@rice.edu

<http://comp322.rice.edu>



What is an Event-Based Programming?

- Event-based programming is a paradigm where actions are performed (event handlers) in response to events.
- Events are often triggered by a user (GUI, web programming)
- Events include:
 - Mouse events (clicks, mouse over)
 - Timeouts, Intervals
 - Keyboard events (key press down/up)

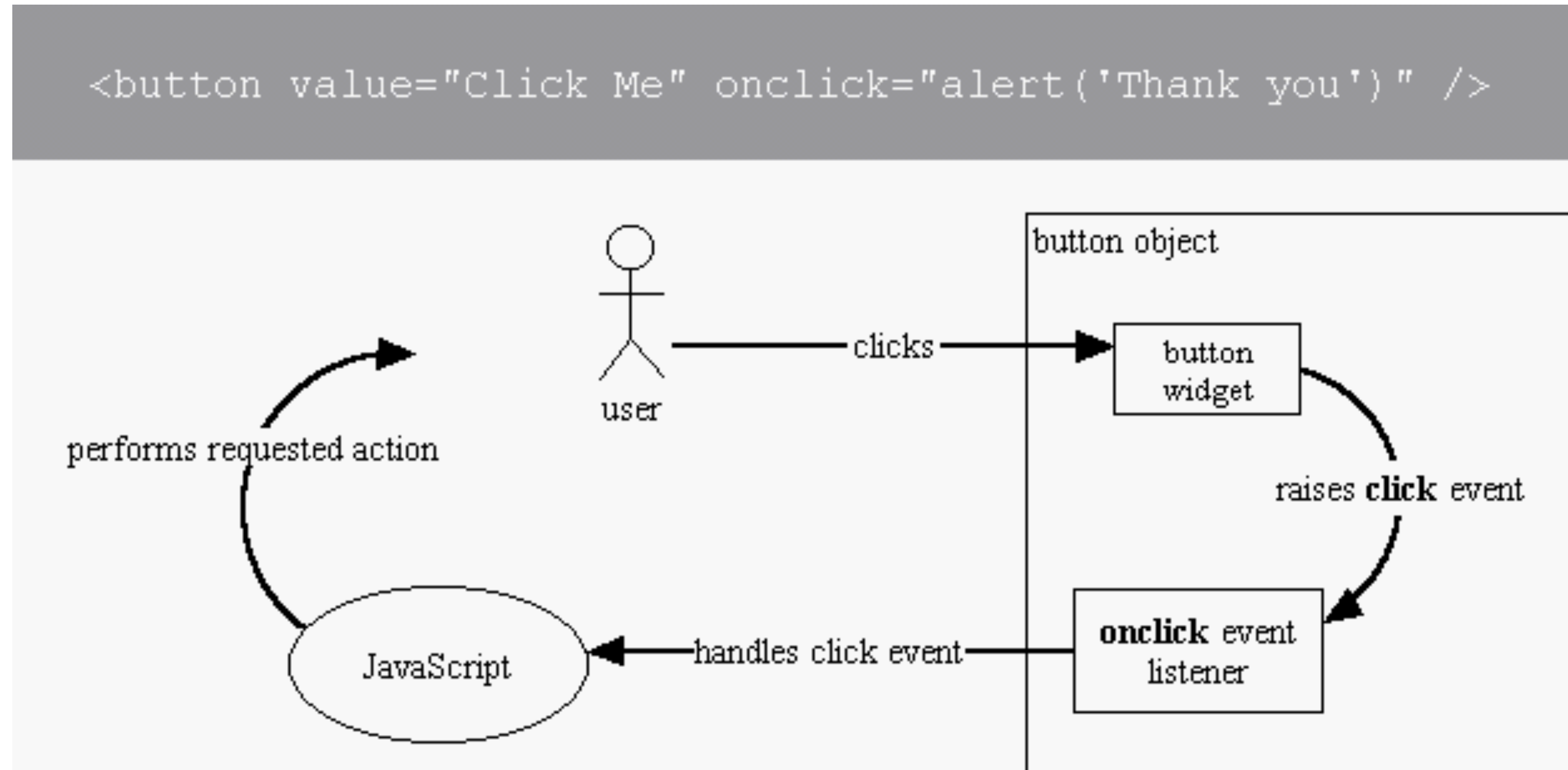
See: https://en.wikipedia.org/wiki/Event-driven_programming



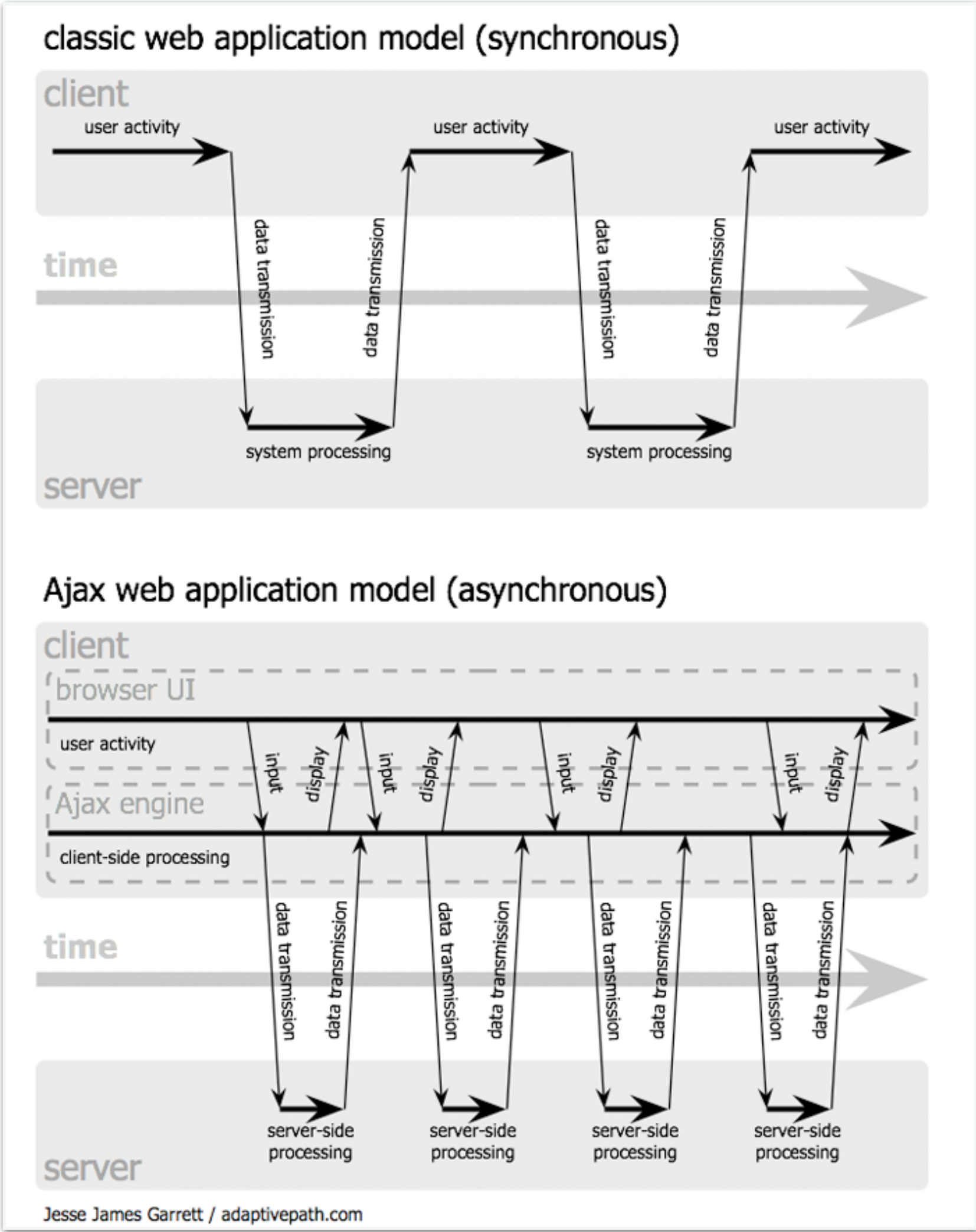
Event Handling

```
<button value="Click Me" onclick="alert('Thank you')" />
```

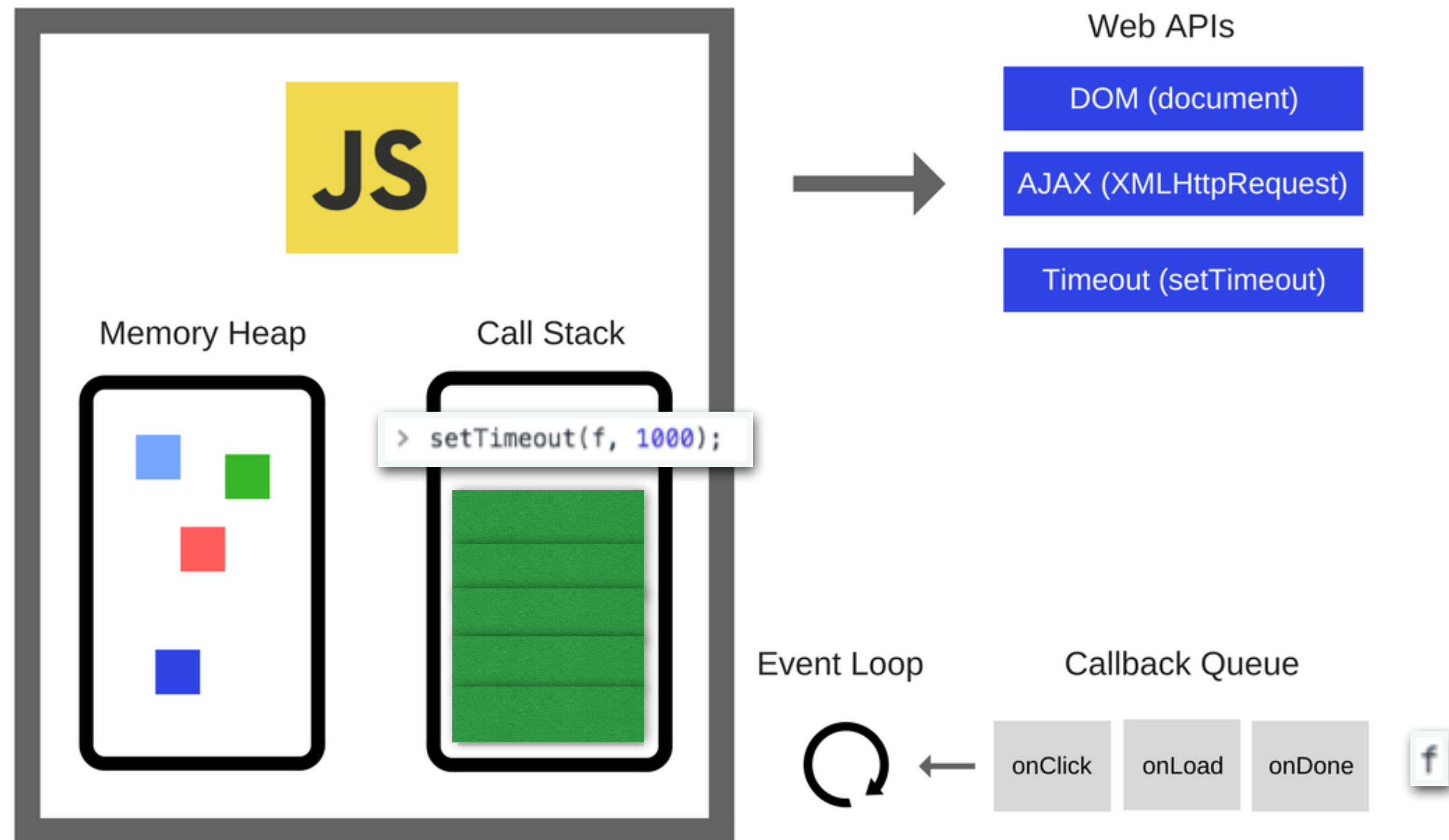
JavaScript



Asynchronous Event Handling



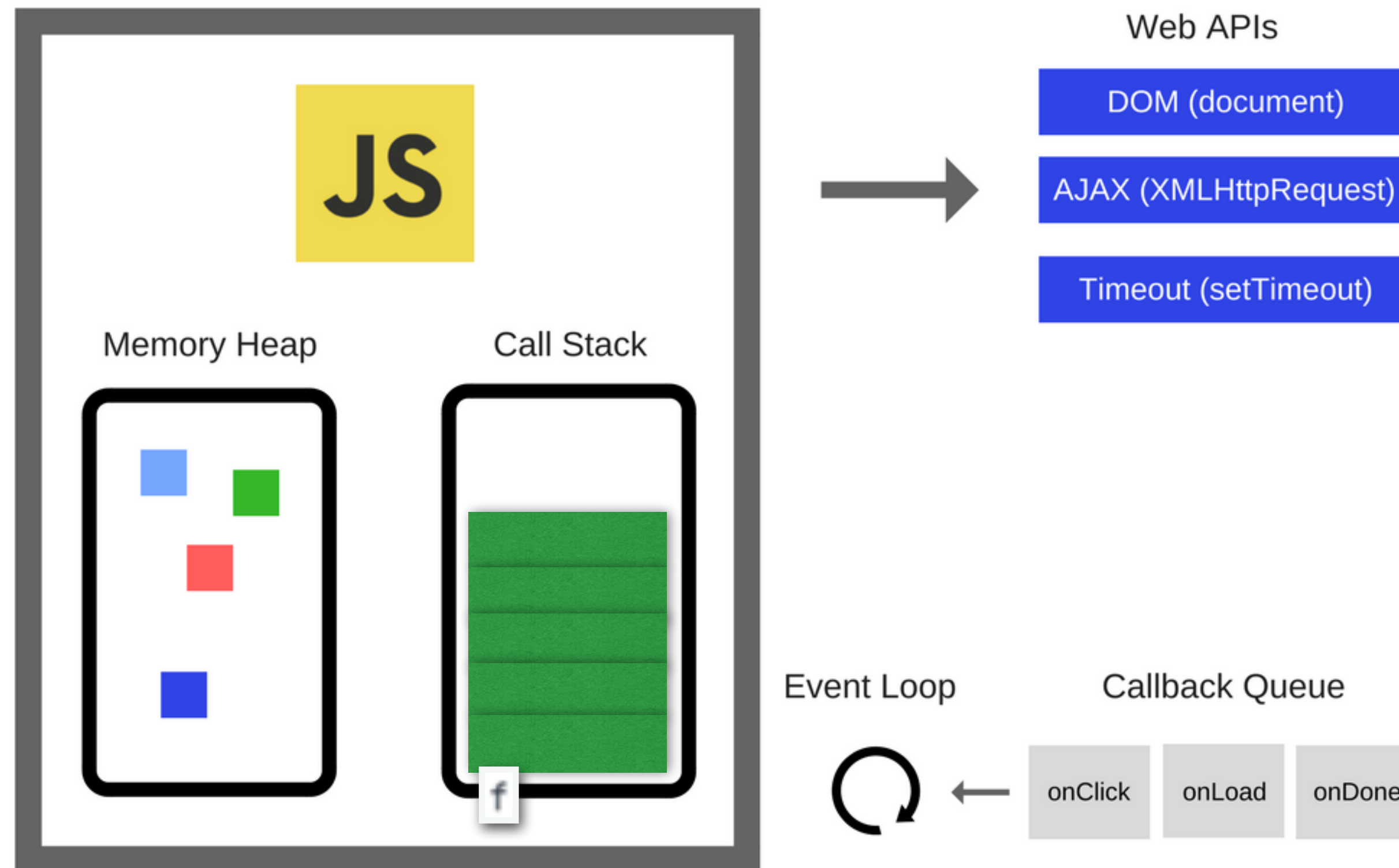
System Control over Event Response



Source: <https://blog.sessionstack.com/how-does-javascript-actually-work-part-1-b0bacc073cf>



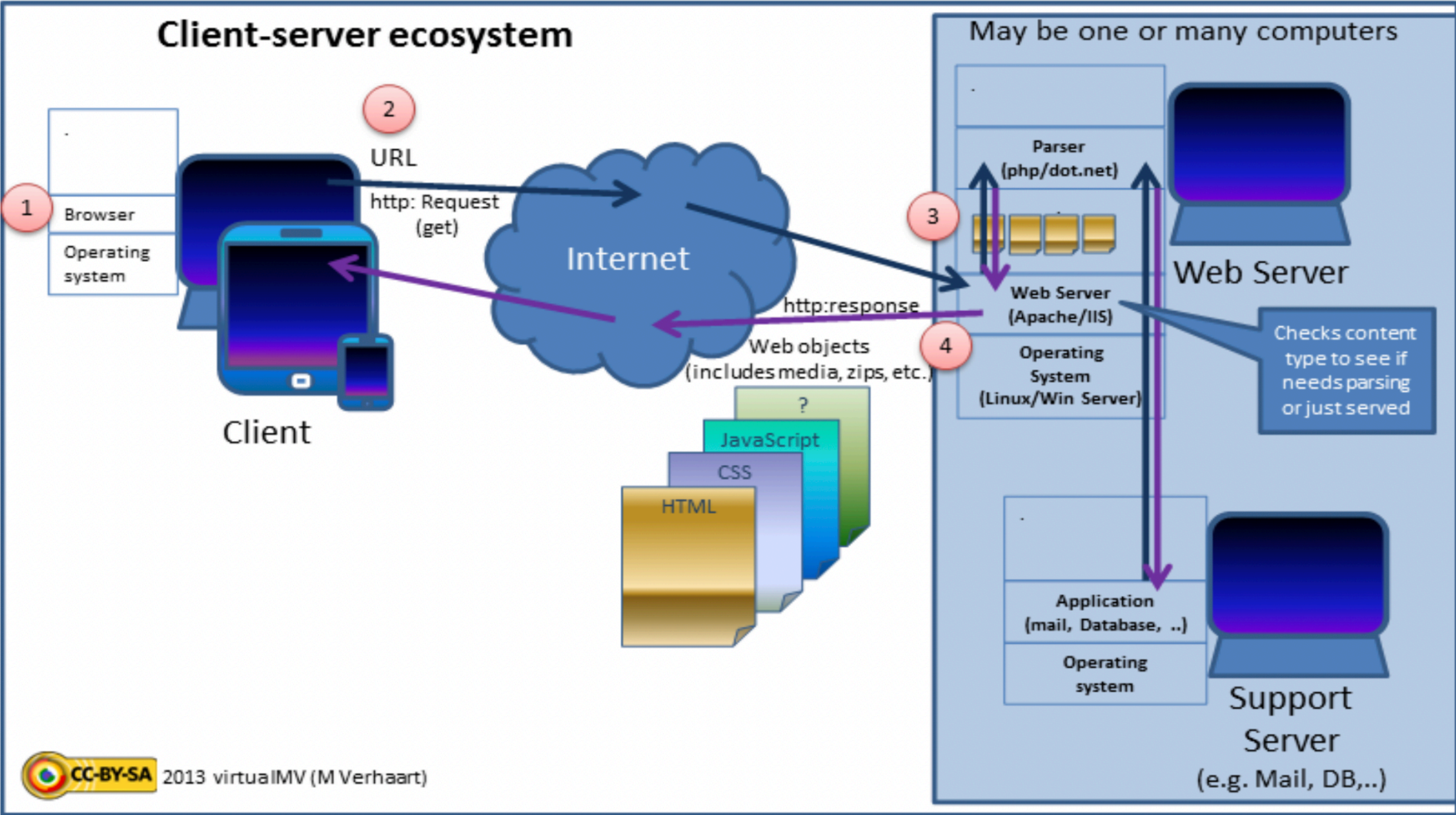
System Control over Event Response



Would the execution order change if `setTimeout` used 0 instead of 1000?



World Wide Web



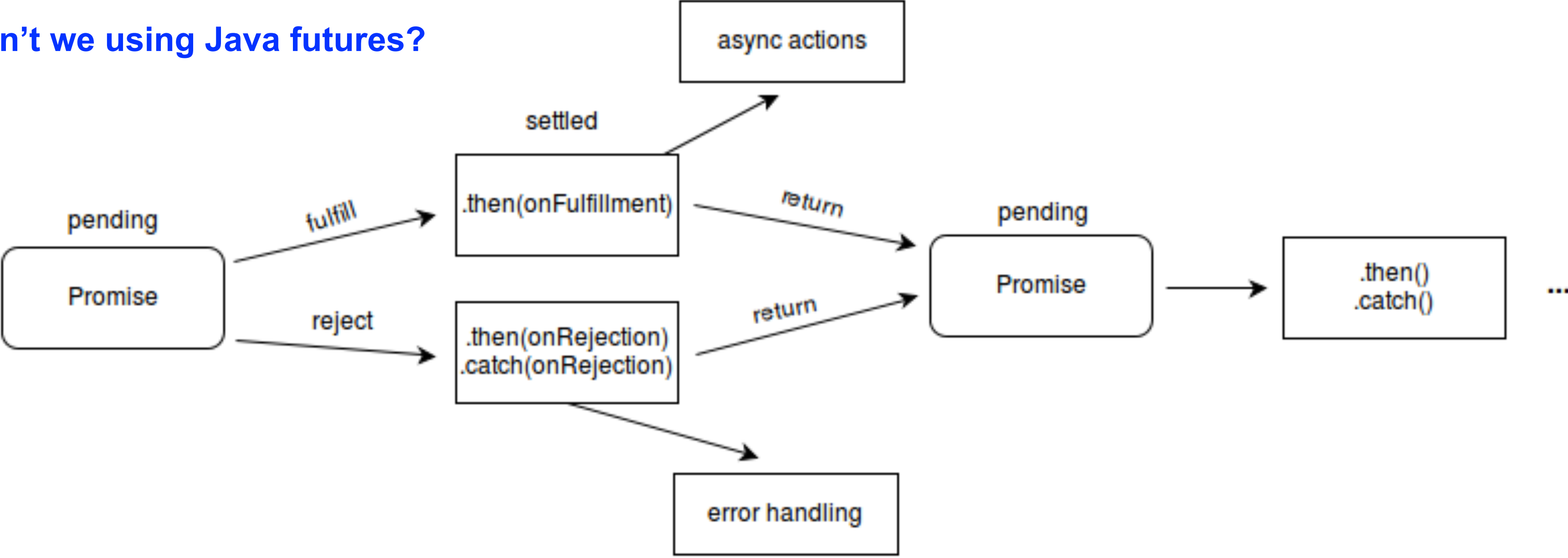
CC-BY-SA 2013 virtualMV (M Verhaart)



JavaScript Promises

Java has both Futures (since JDK 1.5) and Promises (CompletableFuture since JDK 8)

Wait...then why aren't we using Java futures?



https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global_Objects/Promise
See also <http://www.html5rocks.com/en/tutorials/es6/promises/>



Promise: Fetching Web Data

Inline function callbacks
with arrow notation

```
> fetch
< f fetch() { [native code] }
> fetch('https://jsonplaceholder.typicode.com/posts').then(r => r.json())
< ▼ Promise {<pending>} ⓘ
  ▶ __proto__: Promise
    [[PromiseStatus]]: "resolved"
    ▼ [[PromiseValue]]: Array(100)
      ▶ 0: {userId: 1, id: 1, title: "sunt aut facere repellat provident occaecati
      ▶ 1: {userId: 1, id: 2, title: "qui est esse", body: "est rerum tempore vitae
      ▶ 2: {userId: 1, id: 3, title: "ea molestias quasi exercitationem repellat qu
      ▶ 3: {userId: 1, id: 4, title: "eum et est occaecati", body: "ullam et saepe
      ▶ 4: {userId: 1, id: 5, title: "nesciunt quas odio", body: "repudiandae venia
      ▶ 5: {userId: 1, id: 6, title: "dolorem eum magni eos aperiam quia", body: "u
      ▶ 6: {userId: 1, id: 7, title: "magnam facilis autem", body: "dolore placeat
      ▶ 7: {userId: 1, id: 8, title: "dolorem dolore est ipsam", body: "dignissimos
      ▶ 8: {userId: 1, id: 9, title: "nesciunt iure omnis dolorem tempora et accusa
      ▶ 9: {userId: 1, id: 10, title: "optio molestias id quia eum", body: "quo et
      ▶ 10: {userId: 2, id: 11, title: "et ea vero quia laudantium autem", body: "d
      ▶ 11: {userId: 2, id: 12, title: "in quibusdam tempore odit est dolorem", bod
      ▶ 12: {userId: 2, id: 13, title: "dolorum ut in voluptas mollitia et saepe qu
      ▶ 13: {userId: 2, id: 14, title: "voluptatem eligendi optio", body: "fuga et
      ▶ 14: {userId: 2, id: 15, title: "eveniet quod temporibus", body: "reprehende
      ▶ 15: {userId: 2, id: 16, title: "sint suscipit perspiciatis velit dolorum re
      ▶ 16: {userId: 2, id: 17, title: "fugit voluptas sed molestias voluptatem pro
      ▶ 17: {userId: 2, id: 18, title: "voluptate et itaque vero tempora molestiae"
      ▶ 18: {userId: 2, id: 19, title: "adipisci placeat illum aut reiciendis qui",
      ▶ 19: {userId: 2, id: 20, title: "doloribus ad provident suscipit at", body:
      ▶ 20: {userId: 3, id: 21, title: "asperiores ea ipsam voluptatibus modi minim
```

Same as:
.then(function(r) {
 return r.json()
})
r.json() returns a Promise, the next
then() is called when json() resolves.



JavaScript Async/Await (like HJ Futures/Data Driven Tasks)

- **Async** functions always return Promise
- **Await** can only be inside async
- Expression after **await** is like using Promise **then**

```
(async () => {  
  const connector = mongoose.connect(connectionString)  
  const username = process.argv[2].split('=')[1]  
  
  let user = await connector.then(async () => {  
    return findUser(username)  
  })  
  
  if (!user) {  
    user = await createUser(username)  
  }  
})
```

```
console.log(user)  
process.exit(0)  
})();
```

Need response before sending result



Login/Logout registered users with Futures

```
var username = ...
var password = ...
...
var regUser = future(() -> registerNewUser(username, password)); // { username: user, result: "success" or "failure"}
...
var logUser = future(() -> loginUser(username, password)); // {userId: id, result: "success" or "failure" }
...
var loggedIn = future(() -> isLoggedIn(id)); // { userId: id, result: "success" or "failure" }
...
var logOut = future(() -> logoutUser(id)); // { result: "success" or "failure" }
...
```

What future dependencies are missing?



Login/Logout registered users with Futures

```
var username = ...
var password = ...
...
var regUser = future(() -> registerNewUser(username, password)); // { username: user, result: "success" or "failure"}
...
var logUser = future(() -> { if (regUser.get().result.equals("success"))
    return loginUser(username, password); // {userId: id, result: "success" or "failure"}
    return {result: "failure" };
});
...
var loggedIn = future(() -> { if (logUser.get().result.equals("success"))
    return isLoggedIn(logUser.get().userId); // {userId: id, result: "success" or "failure" }
    return {result: "failure" };
});
...
var logOut = future(() -> { if (loggedIn.get().result.equals("success"))
    return logoutUser(loggedIn.get().userId); // { result: "success" or "failure" }
    return {result: "failure" };
});
...
```

What are the problems here? Should we use DDF/DDTs?



Login/Logout registered users with DDTs

```
var username = ...
var password = ...
...
var regUser = newDataDrivenFuture();
var logUser = newDataDrivenFuture();
var loggedIn = newDataDrivenFuture();
var logOut = newDataDrivenFuture();
...
async(() -> regUser.put(registerNewUser(username, password))); // { username: user, result: "success" or "failure"}
...
asyncAwait(regUser, () -> { if (regUser.safeGet().result.equals("success"))
    logUser.put(loginUser(username, password)); // {userId: id, result: "success" or "failure"}
    else
    logUser.put({result: "failure" }); });
...
asyncAwait(logUser, () -> { if (logUser.safeGet().result.equals("success"))
    loggedIn.put(isLoggedIn(logUser.safeGet().userId)); // {userId: id, result: "success" or "failure" }
    else
    loggedIn.put({result: "failure" }); });
...
asyncAwait(loggedIn, () -> { if (loggedIn.safeGet().result.equals("success"))
    logOut.put(logoutUser(loggedIn.safeGet().userId)); // { result: "success" or "failure" }
    else
    logOut.put({result: "failure" }); });
...
...

```

