**Non-Blocking I/O in Node.js**

**1. What is Non-Blocking I/O?**

* **Non-blocking I/O** means that operations (like reading a file, making a network request, or querying a database) **do not block** the execution of other code.
* Instead of waiting for an operation to complete, Node.js **delegates** the task and moves to the next operation.
* When the operation is done, Node.js uses **callbacks, promises, or async/await** to handle the result.

**2. How Node.js Handles Non-Blocking I/O?**

Node.js is **single-threaded** and uses an **event loop** to handle I/O operations asynchronously.

**Event Loop & Asynchronous Callbacks**

1. **I/O operation starts** (e.g., reading a file).
2. Instead of waiting, Node.js **delegates** the task to the OS.
3. The **event loop** continues executing other tasks.
4. When the I/O operation completes, **callback functions** are executed.

**3. Example: Blocking vs. Non-Blocking Code**

**Blocking (Synchronous) Code**

const fs = require('fs');

console.log('Start');

const data = fs.readFileSync('file.txt', 'utf8');  // Blocks execution

console.log(data);

console.log('End');

//  Output (Execution Order):

// Start

// (file contents)

// End

The program **waits** for the file to be read before moving on.

**Non-Blocking (Asynchronous) Code**

const fs = require('fs');

console.log('Start');

fs.readFile('file.txt', 'utf8', (err, data) => {

    if (err) throw err;

    console.log(data);

});

console.log('End');

// ✅ Output (Execution Order):

// Start

// End

// (file contents)

The file is read **asynchronously**, and execution continues without waiting.

**4. How Non-Blocking I/O Works with APIs**

Node.js **delegates** tasks like:

* **File System Operations** (fs.readFile, fs.writeFile)
* **Database Queries** (MongoDB, MySQL)
* **Network Requests** (http, axios, fetch)
* **Timers** (setTimeout, setInterval)

Example: **Asynchronous HTTP request**

const https = require('https');

console.log('Start');

https.get('https://jsonplaceholder.typicode.com/todos/1', (res) => {

    let data = '';

    res.on('data', chunk => data += chunk);

    res.on('end', () => console.log(JSON.parse(data)));

});

console.log('End');

// ✅ Execution Order:

// Start

// End

// { JSON response from API }

The HTTP request is **asynchronous**, so console.log('End') executes before the response arrives.

**5. Handling Non-Blocking I/O with Promises & Async/Await**

Using **callbacks** can lead to "callback hell." Instead, use **Promises** or async/await for cleaner code.

**Using Promises**

const fs = require('fs').promises;

console.log('Start');

fs.readFile('file.txt', 'utf8')

    .then(data => console.log(data))

    .catch(err => console.error(err));

console.log('End');

// 🔹 Using Async/Await

const fs = require('fs').promises;

async function readFileAsync() {

    console.log('Start');

    try {

        const data = await fs.readFile('file.txt', 'utf8');

        console.log(data);

    } catch (err) {

        console.error(err);

    }

    console.log('End');

}

readFileAsync();

// ✅ Output Order (Both Promises & Async/Await):

// Start

// End

// (file contents)

**Clean and readable!**

**6. Key Takeaways**

✔ Node.js uses **non-blocking I/O** to handle multiple operations efficiently.  
✔ The **event loop** ensures that Node.js remains responsive.  
✔ **Callbacks, Promises, and Async/Await** are used to manage asynchronous tasks.  
✔ Always prefer **async/await** for better code readability.

**Want to Learn More?**

Would you like a deeper dive into:

* Event Loop & Call Stack
* Asynchronous Patterns (Callbacks vs. Promises vs. Async/Await)
* Performance Optimization with Non-Blocking I/O

Let me know what interests you!