Department of Artificial Intelligence and Machine Learning
B.Tech. Sem: V Subject: Full Stack Development Laboratory (DJS22AML504)

Experiment 9

Name: Shubham Mourya **SAP ID: 60017230110**

Name:- Shubham Mourya
A065
60017230110

Experiment No - 9

Aim :- Create an application to demonstrate various Node.js events

Theory :-

Event-Driven Architecture (EDA) is a design paradigm that focuses on production, detection & reaction to events, allowing for more scalable & responsive applications.

EDA in Node JS revolves around core concepts of events, emitters, and listeners, which allow dynamic communication between various parts of an application.

1) Event Emitter Module

This module allows developer to create objects that can emit & handle events. The Event Emitter serves as a central building block for implementing event-driven patterns & enables creation of custom events, making it highly flexible for application development.

- Event Registration :- Objects inheriting from EventEmitter can register listeners for specific events. These listeners are functions that respond to emitted events, enabling components to react to different states or actions

- Event Emission :- The emit() method in EventEmitter allows instances to broadcast or signal that an event has occurred, which triggers execution of all listener bound to that event.

2) Event in NodeJS

Events are integral to functioning of any event-driven system. In NodeJS, they represent actions or changes in system's state. Each event type is identified by name, and it may carry additional data (known as event payload) which listeners use to perform tasks.

Event Types:
- User actions (clicking button, submitting form)
- System-level occurrences (HTTP requests, database changes)
- Errors or failures in system.

3) Listeners

- Listeners are function that are executed when specific events are emitted. They allow different parts of an application to respond to events dynamically.

- Listeners are bound to events using on() or addListener() methods of EventEmitter

- When an event occurs, all listeners associated with that event are executed in order they were registered.

- Listeners can also receive data, known as any event payload, from emitted event.

Conclusion:- EDA in NodeJS is robust & flexible design pattern that significantly enhances apps performance, scalability.

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Date:	**08/10/2024 and 10/10/2024**
Aim	**Create an application to demonstrate various Node.js Events**
Software	
Pre-requisite	Active internet connection

Theory	Event-Driven Architecture (EDA) has emerged as a powerful paradigm for building scalable, responsive, and loosely coupled systems. In Node.js, EDA plays a pivotal role, leveraging its asynchronous nature and event-driven capabilities to create efficient and robust applications. Let's delve into the intricacies of Event-Driven Architecture in Node.js exploring its core concepts, benefits, and practical examples.
	
	Key Components in Node.js Event-Driven Architecture:
	
	1. EventEmitter Module:
	At the heart of Node.js event-driven architecture lies the EventEmitter module, which enables the creation of objects that can emit events and handle them. It serves as a foundational building block for implementing event-driven patterns within applications. Key aspects of the EventEmitter include:
	
	• ***Event Registration:***
	Objects that inherit from EventEmitter can register event listeners for specific events they are interested in. This registration involves associating a function (listener) with a particular event name.
	• ***Event Emission:***
	The emit() method within the EventEmitter allows instances to emit events, signalling that a specific action or state change has occurred. This triggers the invocation of all registered listeners for that particular event.
	• ***Custom Events:***
	Developers can create custom events in their applications, defining unique event names to represent various actions or occurrences within the system.
	
	`const EventEmitter = require('events');`
	`class MyEmitter extends EventEmitter {}`
	`const myEmitter = new MyEmitter();`
	`// Event listener for 'customEvent'`
	`myEmitter.on('customEvent', (arg1, arg2) => {`
	`  console.log('Event received with arguments:', arg1, arg2);`
	`});`
	`// Emitting the 'customEvent'`
	`myEmitter.emit('customEvent', 'Hello', 'World');`

n this example, a custom MyEmitter class is created, inheriting from EventEmitter. An event listener is added for the event "customEvent", which logs the received arguments when the event is emitted using emit().

2. Events:
In Node.js, events are fundamental occurrences that are recognized and handled within an application. They encapsulate specific actions or changes in the system's state. Key aspects of events include:

- ***Event Types:***
  Events can encompass a wide range of actions or changes, such as data updates, user interactions, system errors, or lifecycle events.
- ***Event Naming:***
  Events are typically identified by strings that represent their nature or purpose. Well-defined and descriptive event names facilitate better understanding and maintainability within the codebase.
- ***Event Payload:***
  Events can carry additional data or information, known as the event payload. This data can be passed along when emitting events and can be utilized by listeners to perform specific actions based on the event context.

```
const http = require('http');
const server = http.createServer((req, res) => {
 if (req.url === '/home') {
 res.writeHead(200, { 'Content-Type': 'text/plain' });
 res.end('Welcome to the home page!');
 } else if (req.url === '/about') {
 res.writeHead(200, { 'Content-Type': 'text/plain' });
 res.end('About us page.\n');
 } else {
 res.writeHead(404, { 'Content-Type': 'text/plain' });
 res.end('Page not found!');
 }
});
// Listening for the 'request' event
server.on('request', (req, res) => {
 console.log(`Request received for URL: ${req.url}`);
});
server.listen(3000, () => {
 console.log('Server running on port 3000');
});
```

In this example, the HTTP server emits a "request" event each time it receives a request. The on() method is used to listen to this event, enabling logging of the requested URL.

3. Listeners:
Listeners are functions associated with specific events that are triggered when the corresponding event is emitted. Key aspects of listeners include:

- ***Event Binding:***
  Listeners are bound to events using the on() or addListener() method provided by EventEmitter. They are registered to respond to particular events emitted by an emitter.
- ***Execution of Listeners:***
  When an event is emitted, all registered listeners for that event are executed sequentially, allowing multiple functions to respond to the same event.
- ***Listener Parameters:***
  Listeners can receive parameters or the event payload when they are invoked, enabling them to access relevant information associated with the emitted event.

```
const EventEmitter = require('events');
const myEmitter = new EventEmitter();
// Listener 1 for 'eventA'
myEmitter.on('eventA', () => {
 console.log('Listener 1 for eventA executed');
});
// Listener 2 for 'eventA'
myEmitter.on('eventA', () => {
 console.log('Listener 2 for eventA executed');
});
// Emitting 'eventA'
myEmitter.emit('eventA');
```

In this example, two listeners are registered for the "eventA". When the event is emitted using emit(), both listeners are executed sequentially in the order they were registered.

Benefits of Event-Driven Architecture in Node.js

1. Asynchronous Processing and Non-Blocking IO:
Node.js known for its asynchronous nature complements EDA seamlessly. EDA leverages this by enabling non-blocking event handling. As events occur, Node.js efficiently manages these events concurrently without waiting for each operation to complete. This approach significantly

enhances application performance, as the system can handle multiple tasks simultaneously without getting blocked by I/O operations or other tasks.

2. Loose Coupling and Modularity:
EDA promotes loose coupling between different components of an application. Components communicate through events, reducing direct dependencies among them. This loose coupling allows for greater modularity, as components can operate independently, making the system more maintainable and easier to extend or modify. Changes to one component generally have minimal impact on others, fostering a more adaptable and scalable architecture.

3. Scalability and Responsiveness:
Node.js event-driven model contributes significantly to the scalability of applications. The ability to distribute events across multiple listeners or subscribers allows for better load distribution and resource utilization. This scalability ensures that the application remains responsive, even under heavy loads, by efficiently handling concurrent events and requests.

4. Enhanced Error Handling and Resilience:
EDA facilitates robust error handling within Node.js applications. By emitting specific error events, components can communicate failures or exceptional conditions, allowing other parts of the system to respond accordingly. This enhances the application's resilience by providing a structured way to handle errors and recover from unexpected situations.

5. Real-time Communication and Event-Driven Data Flow:
In scenarios requiring real-time communication or data flow, such as chat applications or IoT systems, EDA in Node.js excels. The event-driven approach allows for seamless communication between different parts of the system in real-time. Events can propagate updates or changes across the system, ensuring that all relevant components are notified and can react promptly.

6. Flexibility and Extensibility:
EDA fosters a flexible architecture that accommodates future changes and extensions. New functionalities or features can be added by introducing new events or listeners without disrupting the existing components. This extensibility ensures that the system can evolve over time to meet changing requirements without significant architectural overhauls.

Examples

1: Real-Time Chat Application
Imagine building a real-time chat application using Node.js and Socket, where multiple users can exchange messages instantly. Here's a simplified demonstration.

```
const http = require('http');
const express = require('express');
const socketIO = require('socket.io');
const app = express();
const server = http.createServer(app);
const io = socketIo(server);
// Event handler for WebSocket connections
io.on('connection', (socket) => {
  // Event handler for incoming messages
  socket.on('message', (message) => {
    // Broadcasting the received message to all connected clients except the
sender
    socket.broadcast.emit('message', message);
  });
});
server.listen(8080, () => {
  console.log('Server running on port 8080');
});
```

In this example, the SocketIO server (an instance of SocketIO Server) listens for connections. When a client connects, an event is emitted. Subsequently, the server listens for incoming messages from clients, emitting the 'message' event. The server broadcasts received messages to all connected clients, ensuring real-time communication between multiple users.

2: Event-Driven File System Monitoring

Consider a scenario where you need to monitor a directory for file changes using Node.js.

```
const fs = require('fs');
const EventEmitter = require('events');
class FileWatcher extends EventEmitter {
  watchDir(directory) {
    fs.watch(directory, (eventType, filename) => {
      if (eventType === 'change') {
        this.emit('fileChanged', filename);
      }
    });
  }
}
```

In this example, an instance of FileWatcher, which extends EventEmitter, is created. It watches a specified directory for file changes using Node.js' fs.watch() method. When a 'change' event occurs in the directory, the

watcher emits a 'fileChanged' event. An event listener is set up to handle this event by logging the filename that has been changed.

3: HTTP Request Handling with Express.js
Let's expand on the HTTP server example using Express.js to handle incoming requests.

```
const express = require('express');
const app = express();
// Event handler for GET request to the home route
app.get('/', (req, res) => {
  res.send('Welcome to the home page!');
});
// Event handler for GET request to other routes
app.get('*', (req, res) => {
  res.status(404).send('Page not found!');
});
// Start the server
const server = app.listen(3000, () => {
  console.log('Server running on port 3000');
});
// Event listener for server start event
server.on('listening', () => {
  console.log('Server started!');
});const wss = new WebSocket.Server({ port: 8080 });
```

In this example, Express.js which itself utilizes event-driven patterns is used to define routes and handle incoming HTTP requests. When a GET request is made to the home route ('/') express emits a 'request' event. Similarly for other routes, a 'request' event is emitted. Additionally, the server emits a 'listening' event when it starts, allowing for event-driven handling of server startup.

Code

App.jsx

```
import React, { useState, useEffect, useMemo } from 'react';
import { io } from 'socket.io-client';

const App = () => {
  const [message, setMessage] = useState('');
  const [receivedMessages, setReceivedMessages] = useState([]);
  const [room, setRoom] = useState('');
  const [socketID, setSocketID] = useState('');
  const [targetSocketID, setTargetSocketID] = useState('');
  const [joinedRoom, setJoinedRoom] = useState('');
  const socket = useMemo(() => io('http://localhost:3000'), []);
```

```
useEffect(() => {
  socket.on('connect', () => {
    console.log('Connected to server', socket.id);
    setSocketID(socket.id);
  });

  socket.on('receive-message', (data) => {
    console.log('Received message:', data);
    setReceivedMessages((prevMessages) => [...prevMessages, data]);
  });

  socket.on('room-joined', (roomName) => {
    console.log(`Successfully joined room: ${roomName}`);
    setJoinedRoom(roomName);
  });

  return () => {
    socket.disconnect();
  };
}, [socket]);

const handleChange = (e) => {
  setMessage(e.target.value);
};

const handleRoomChange = (e) => {
  setRoom(e.target.value);
};

const handleTargetSocketChange = (e) => {
  setTargetSocketID(e.target.value);
};

const handleJoinRoom = (e) => {
  e.preventDefault();
  socket.emit('join-room', room);
  console.log(`Requested to join room: ${room}`);
  setRoom('');
};

const handleSubmit = (e) => {
  e.preventDefault();
  if (targetSocketID) {
    socket.emit('message-to-socket', { message, targetSocketID });
    console.log(`Sent message to socket: ${targetSocketID}`);
```

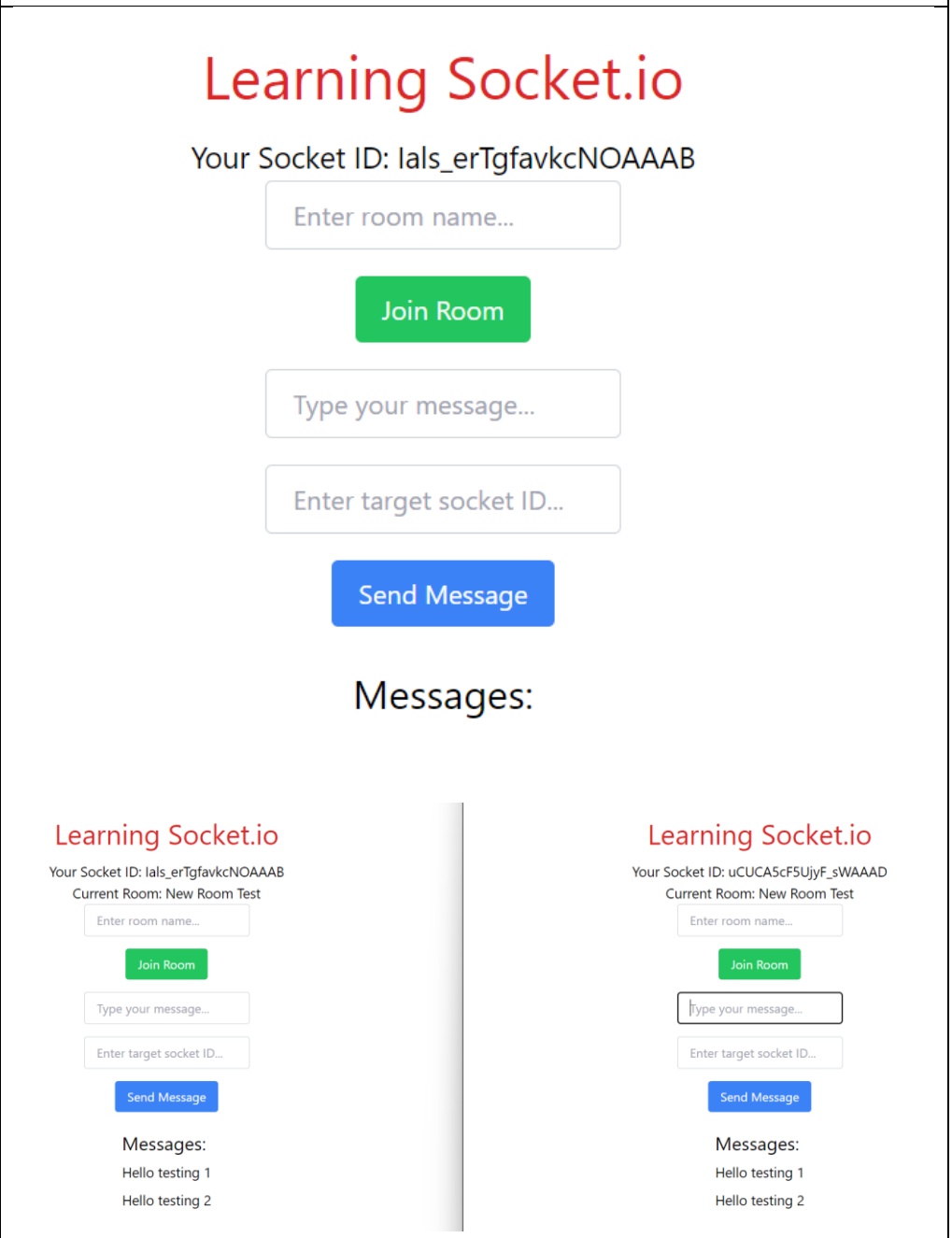
```
    } else if (joinedRoom) {
      socket.emit('message-to-room', { message, room: joinedRoom });
      console.log(`Sent message to room: ${joinedRoom}`);
    } else {
      socket.emit('broadcast-message', { message });
      console.log('Sent broadcast message');
    }
    setMessage('');
  };

  return (
    <div className="flex flex-col items-center justify-center min-h-screen">
      <h1 className="text-red-600 text-4xl text-center m-4">Learning
Socket.io</h1>
      <h2 className="text-lg">Your Socket ID: {socketID}</h2>
      {joinedRoom && <h3 className="text-lg">Current Room:
{joinedRoom}</h3>}

      <form onSubmit={handleJoinRoom} className="flex flex-col items-
center space-y-4">
        <input
          type="text"
          placeholder="Enter room name..."
          value={room}
          onChange={handleRoomChange}
          className="border border-gray-300 rounded px-4 py-2"
        />
        <button type="submit" className="bg-green-500 text-white px-4 py-2
rounded">
          Join Room
        </button>
      </form>

      <form onSubmit={handleSubmit} className="flex flex-col items-
center space-y-4 mt-4">
        <input
          type="text"
          placeholder="Type your message..."
          value={message}
          onChange={handleChange}
          className="border border-gray-300 rounded px-4 py-2"
        />
        <input
          type="text"
          placeholder="Enter target socket ID..."
```

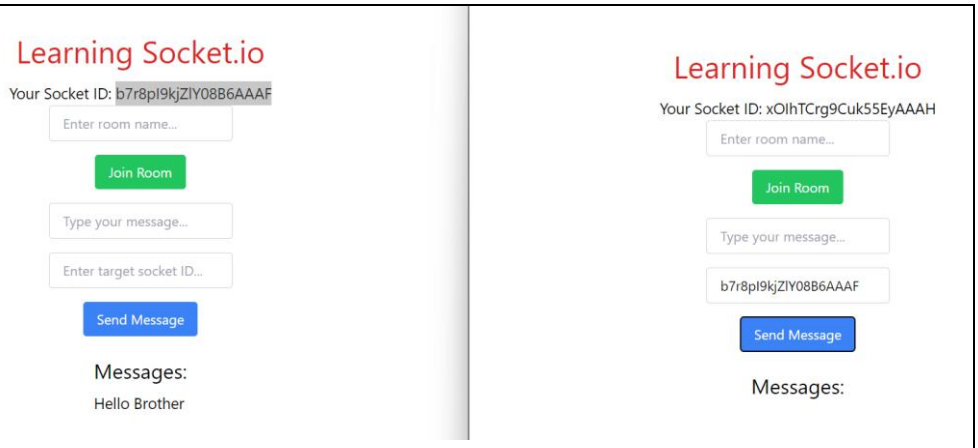
```
          value={targetSocketID}
          onChange={handleTargetSocketChange}
          className="border border-gray-300 rounded px-4 py-2"
        />
        <button type="submit" className="bg-blue-500 text-white px-4 py-2
rounded">
          Send Message
        </button>
      </form>

      <div className="mt-6">
        <h2 className="text-2xl">Messages:</h2>
        <ul>
          {receivedMessages.map((msg, index) => (
            <li key={index} className="mt-2 text-lg">
              {msg}
            </li>
          ))}
        </ul>
      </div>
    </div>
  );
};

export default App;
```

index.js

```
import express from 'express';
import { Server } from 'socket.io';
import { createServer } from 'http';
import cors from 'cors';

const port = 3000;
const app = express();
const server = createServer(app);

app.use(cors({
    origin: 'http://localhost:5173',
    methods: ['GET', 'POST'],
    credentials: true,
}));

const io = new Server(server, {
```

```
    cors: {
        origin: 'http://localhost:5173',
        methods: ['GET', 'POST'],
    }
});

io.on('connection', (socket) => {
    console.log('User connected');
    console.log('ID:', socket.id);
    socket.emit('user-id', socket.id);

    socket.on('join-room', (room) => {
        socket.join(room);
        console.log(`User ${socket.id} joined room: ${room}`);
        socket.emit('room-joined', room);
    });

    socket.on('message-to-room', ({ message, room }) => {
        console.log(`Message from ${socket.id} to room: ${room}`);
        io.to(room).emit('receive-message', message);
    });

    socket.on('message-to-socket', ({ message, targetSocketID }) => {
        console.log(`Message from ${socket.id} to ${targetSocketID}:
${message}`);
        io.to(targetSocketID).emit('receive-message', message);
    });

    socket.on('broadcast-message', ({ message }) => {
        console.log(`Broadcast message from ${socket.id}: ${message}`);
        socket.broadcast.emit('receive-message', message);
    });

    socket.on('disconnect', () => {
        console.log('User disconnected');
    });
});

app.get('/', (req, res) => {
    res.send('Hello World');
});

server.listen(port, () => {
    console.log(`Server is running on port ${port}`);
});
```

Result	 Learning Socket.io Your Socket ID: Ials_erTgfavkcNOAAAB Enter room name... Join Room Type your message... Enter target socket ID... Send Message Messages: Learning Socket.io Your Socket ID: Ials_erTgfavkcNOAAAB Current Room: New Room Test Enter room name... Join Room Type your message... Enter target socket ID... Send Message Messages: Hello testing 1 Hello testing 2 Learning Socket.io Your Socket ID: uCUCA5cF5UjyF_sWAAAD Current Room: New Room Test Enter room name... Join Room Type your message... Enter target socket ID... Send Message Messages: Hello testing 1 Hello testing 2

	
Conclusion	Event-Driven Architecture in Node.js provides a multitude of benefits that empower developers to create high-performing, scalable and responsive applications. By leveraging asynchronous processing, loose coupling, scalability, and real-time communication, EDA enhances the overall architecture's robustness, flexibility, and ability to handle complex tasks efficiently.