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# JavaScript's Journey: Tracing the Evolution of Modern Web Development

***Vaishali Kumari[1], Dr. Vishal Shrivastava[2], Dr. Akhil Pandey[3]***

[1]B.TECH. Scholar, [2,3]Professor
Computer Science & Engineering, Arya College of Engineering & I.T. India, Jaipur
[1]kumarivaishali562@gmail.com , [2]vishalshrivastava.cs@aryacollege.in, [3]akhil@aryacollege.in

**ABSTRACT**

In the dynamic realm of web development, we've traversed a considerable journey since the '90s. Presently, the foundational trio of HTML, CSS, and JavaScript orchestrates the functionality of web applications, accompanied by a keen emphasis on crafting seamless UI/UX experiences. Delving into architectural considerations, we scrutinize the distinctions between monolithic and microservices approaches. The assurance of quality is fortified by robust testing tools like Jest. In the engine room, MongoDB, Mongoose, Node.js, and React.js participation to push the web development engine, delivering a blend of speed, scalability, and interactivity. This landscape is not static but rather dynamic and constantly evolving, with these tools positioned at the vanguard of novelty and progress.

## 1. Introduction

In the lively '90s, the digital realm experienced a groundbreaking metamorphosis, orchestrated by the brilliance of Tim Berners-Lee, a visionary British scientist. His unveiling of the World Wide Web (WWW) wasn't merely about connecting global scientists; it laid the cornerstone for the contemporary web. Tim introduced three pivotal technologies: Hypertext Markup Language (HTML), Uniform Resource Identifier (URI), and Hypertext Transfer Protocol (HTTP).

As the sands of time drifted forward, web development experienced a whirlwind of evolution. Emerging programming languages such as Cascading Style Sheets (CSS), JavaScript, Python, Hypertext Preprocessor (PHP), Structured Query Language (SQL), Angular, and more joined the digital soiree. These languages not only ushered in robust security measures but also eased the lives of programmers.

Fast forward to today, and three coding juggernauts stand tall as indispensable for any web application: HTML, CSS, and JavaScript. They are the bedrock of web development. Yet, amidst these stalwarts, a rising star commands attention—User Interface/User Experience (UI/UX) design. It's the art of not only ensuring functionality but also crafting visually captivating experiences, heavily reliant on the dynamic duo of HTML and CSS. In a world where aesthetics reign, UI/UX design takes centre stage.

For web developers, the terms "monolithic" and "microservices architecture" are likely familiar territory. In simple terms, monolithic is akin to placing all your eggs in one basket, bundling everything from authentication to posts, profiles, databases, and servers under one roof. However, it comes with a caveat: a glitch in one section can potentially bring down the entire structure.

Now, enter the cool kid on the block—microservices. It's akin to having a team of superheroes, each endowed with unique powers. If one superhero falters, the others seamlessly pick up the slack. In a microservices setup, if the authentication service hits a rough patch, the other routes stay operational. These services inhabit their own server spaces, interconnected through an event bus, resembling a bustling data highway.

A user logs in, the authentication service updates the event bus, and other applications receive the memo, opening up protected routes. Why go micro? It's all about scalability and incremental improvements, avoiding the need for a complete overhaul. But here's the twist—it takes Kubernetes to work the microservices magic.

Monolithic architecture, conversely, can be likened to speed dating—quick and straightforward, suited for the early days when a small team manages databases.

Enough theory—let's shift our gaze to Jest.

When crafting an application, diving into the code blindly is akin to commencing a painting without envisioning the final masterpiece. Enter Adobe Xd, a virtual canvas for web developers to sketch the blueprint of their application's UI, ensuring it dazzles. There's no point in coding the CSS and React part without a plan!

To breathe life into your UI dreams, draft the UI design in SCSS and metamorphose it into CSS using the enchantment of SCSS npm packages—like turning a sketch into a digital painting. And for a developer-friendly environment, Firefox stands as a steadfast ally. Naturally, React takes the stage, transforming your front-end aspirations into reality.

During the development phase, a monolithic approach proves advantageous, especially for startups. However, as business expands, contemplation of a switch to microservices becomes pertinent. Testing, akin to a quality control team, becomes imperative. Jest assumes the role of a trusty sidekick, rigorously testing everything to ensure seamless functionality. To harmonize the components, the Postman API checks the backend server and REST APIs. When it's showtime, Git, Github, and Heroku step up to deploy your website. NPM packages such as bcrypt and validator ensure the security and integrity of your users' passwords.

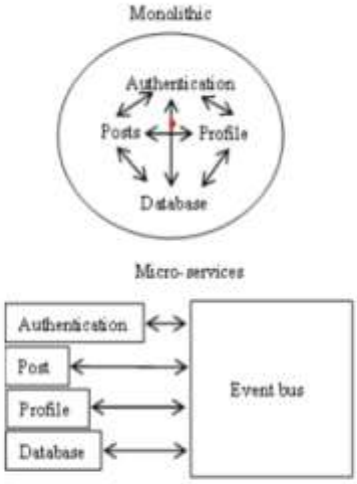


Figure 1. Monolithic and micro-services architecture comparison

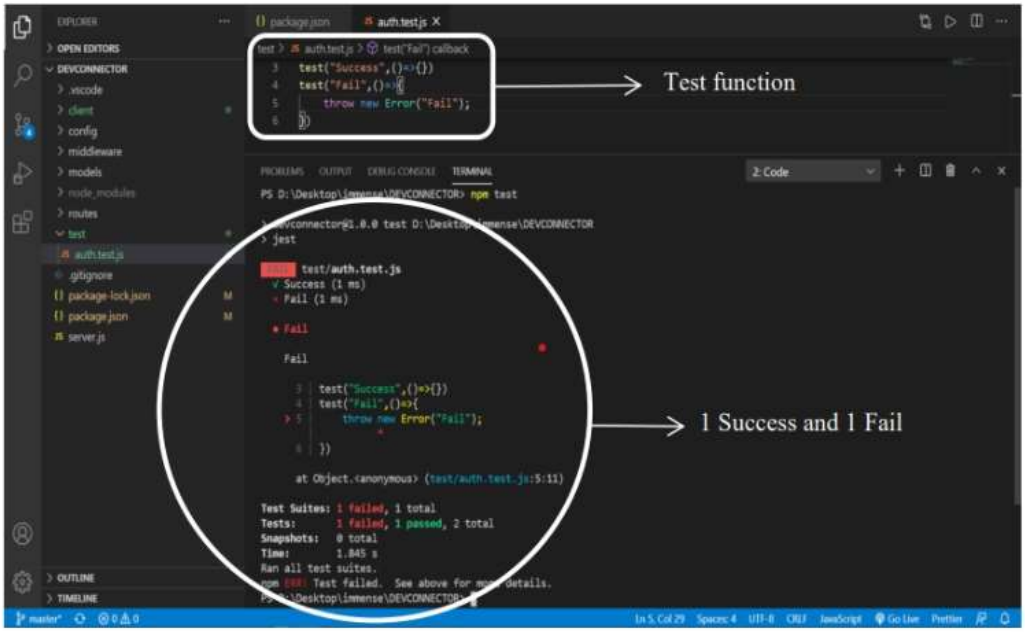


Figure 2. Testing an application using Jest

## 2. Approaches to Research Methods

In this segment, let's explore the current waves in web development and unveil the instruments that can elevate you to a proficient web developer. We're delving into tools that seamlessly align with the demands of contemporary web technology, enhancing a developer's experience for smoother workflows.

### *2.1. MongoDB and NoSQL: Harnessing the Power of JSON for Database Management*

In the swiftly evolving digital landscape of today, the speed at which an application operates stands as the ultimate game-changer. The responsiveness of your app can singlehandedly shape or break the overall user experience. From a business perspective, expanding your reach necessitates scaling up, and this, in turn, calls for a database capable of meeting the demands of such growth.

Conventional relational databases, governed by structured query language (SQL), encounter limitations, particularly when grappling with extensive datasets. As the user base expands, SQL may struggle to sustain optimal performance.

Let's journey back to 1998 when Carlo Strozzi introduced a revolutionary concept known as "NoSQL." This type of data management system diverges from the established norms of rigid schemas seen in traditional relational databases (RDBMS). Instead, it embraces adaptability by storing data in a versatile JavaScript Object Notation (JSON) format, liberating itself from the constraints of fixed tables. It is this very adaptability that sets NoSQL apart.

Among the diverse array of NoSQL databases, MongoDB emerges as a prominent player. It harnesses the power of JSON for data storage, earning its stripes in the realm of non-SQL databases.

In a captivating comparative analysis, MySQL, a renowned RDBMS system, was pitted against MongoDB. The tests covered a spectrum of standard database operations: insertion, updating, and deletion of data. In the initial test, where 500 users, 500 individual orders, and 500 items were created, MongoDB exhibited a commendable response time, clocking in at a swift 0.0474 seconds. The second test, featuring 1000 users and 1000 user requests for data modification, showcased MongoDB's impressive performance, with a response time of 2.3201 seconds at its slowest.

The third and final test raised the stakes with the creation of 7,000 users and handling 10,000 user updates. Even in this demanding scenario, MongoDB demonstrated resilience, with the slowest response time recorded at 23.3427 seconds. The key takeaway? As your data volume expands, the traditional RDBMS system significantly extends the time required for performing create, read, update, and delete (CRUD) operations.

### *2.2. Mongoose: Navigating the MongoDB Data Modeling Landscape*

Now, let's venture into the realm of MongoDB accompanied by its reliable ally, Mongoose. MongoDB isn't just your typical database; it stands as a flexible NoSQL database. To effectively communicate with it, you require something special—an Object Data Mapper (ODM).

Visualize an ODM as a mediator, facilitating communication between your app and MongoDB's non-SQL environment. It serves as a language translator for your data, as MongoDB assigns a unique ID to each piece of data, allowing you to later locate specific information.

Developers commonly turn to a library known as Mongoose to bridge the gap between their app and MongoDB. Mongoose goes beyond mere data retrieval; it actively manages relationships between data, ensures data adheres to a structure (schema validation), and acts as an intermediary between your code and the database.

When creating a model in Mongoose, certain guidelines come into play. You must name your model and define a schema that outlines the type of data you'll be handling. The schema serves as a checkpoint, ensuring everything stays in order. For instance, if you're crafting a user model, the schema might dictate that it must include a name, email, and password—all in text format. And that "required" keyword you come across? It functions as a vigilant guardian for your data, ensuring nothing slips through the cracks.

### *2.3. Node.js: Unleashing the Power of Server-Side JavaScript*

Now, let's research into the world of Node.js. It support as the standout performer in the realm of server-side JavaScript, utilizing Google's V8 engine—the same powerhouse behind the Chrome browser—for executing JavaScript code. The enchantment of Node.js resides in its outstanding speed and memory effectiveness.

Node.js marches to its unique beat, adhering to an asynchronous I/O event model that enables it to manage multiple requests concurrently. Picture it like having a chef adept at juggling numerous orders in a bustling restaurant. All orders are taken, and the chef strategically starts cooking the lengthier ones last, while the other dishes are already en route to your table. This asynchronous prowess is the secret sauce allowing Node.js to gracefully handle multiple requests simultaneously, courtesy of the async and await keywords.

This dynamic capability is a game-changer, particularly when compared to traditional synchronous systems where one order is processed and served before the next one begins. It's no surprise that the combination of Node.js and MongoDB results in lightning-fast performance. Traditional databases operate synchronously, and as user numbers swell, they often experience a slowdown. Waiting isn't ideal in today's fast-paced world.

To keep pace, synchronous systems typically demand additional hardware to accommodate more users, incurring additional costs. However, Node.js, with its asynchronous architecture, sidesteps this challenge. It adeptly manages an increased influx of requests without necessitating a surplus of extra hardware. It's a dual triumph, catering to both speed and cost-effectiveness.

### *2.4. React.js: Crafting Dynamic and Responsive User Interfaces*

Finally, let's delve into React.js, a trailblazer in the realm of front-end development. It serves as the canvas for artists to craft visually stunning user interfaces and is often compared to its counterpart, Angular.

Angular, championed by Google, and React, crafted by Facebook, stand as open-source frameworks empowering developers to construct single-page applications. These frameworks underpin some of the most prominent names in the tech industry.

React's distinctive strength lies in its utilization of a Virtual DOM, resembling a turbocharged, lightweight rendition of the actual Document Object Model (DOM) employed by Angular. When a change occurs in the DOM, Angular refreshes the entire structure, but React operates with greater intelligence. It updates only the portion that has undergone a change. Picture it as making a small edit on a large whiteboard with numerous drawings; while Angular would erase and redraw the entire board, React would deftly rectify that specific spot, resulting in a much swifter process.

Moreover, React employs a one-way data-binding system. Unlike Angular's two-way data binding, React's data flow is more methodical and easier to comprehend.

## 3. Findings and Analysis

Now, let's explore the step-by-step journey of constructing this project. To tackle our coding tasks, we opted for Visual Studio Code – an approachable yet potent code editor. It's akin to the Swiss Army knife of code editors, equipped with numerous practical extensions such as Emmet, Prettier, Bracket Pair Colorizer, Auto Rename Tag, and Live Server. These extensions are more than mere embellishments; they function as tools that aid us in identifying bracket pairs, detecting errors, and facilitating the setup of a local server for testing and deployment. In essence, they are our reliable companions in this coding expedition.

### *3.1. Crafting Mongoose Schemas: A Guide to Structuring Data Models*

The user schema diligently gathered crucial details such as name, email, password, and the date of joining. Expanding on this foundation, the profile schema allowed users to share additional information about their company, website, location, skills, experience, and education. This became the canvas for users to narrate their professional journey.

Enter the post schema, orchestrating attributes like text, name, likes, comments, and date. The metrics of likes and comments played a pivotal role in monitoring user interactions with posts. In our MongoDB cloud database, we meticulously organized three folders – one dedicated to users, another for profiles, and the last for posts. Witness this organizational feat in action in Figure 3, where these collection folders find their place in the MongoDB cloud.

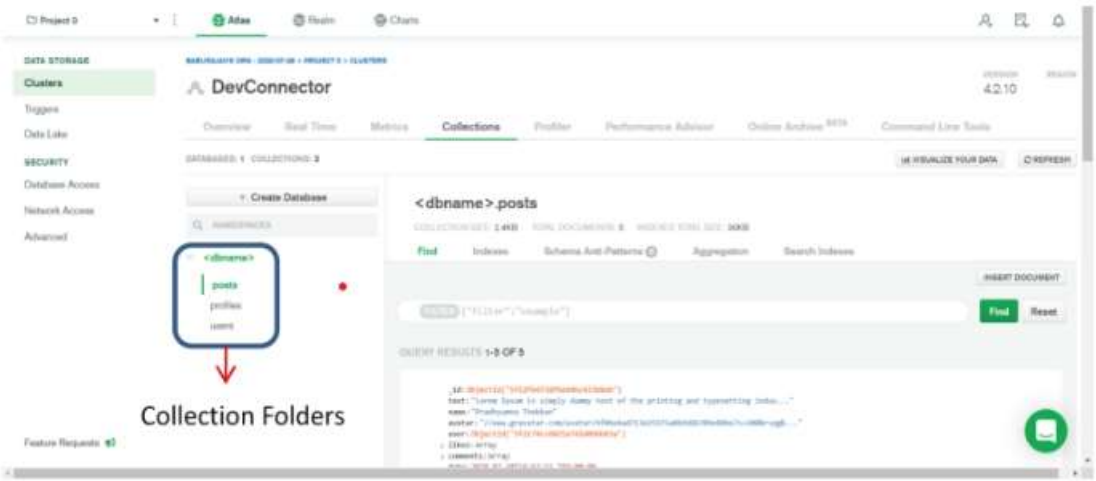


Figure 3. MongoDB collection

### *3.2. Navigating the Web: Building and Securing API Routes*

Now, let's explore the domain of REST APIs, where we constructed three distinct routes catering to users, profiles, and posts. These routes served as gateways for user authentication and interaction. Users had the capability to log in using their email and password, leveraging post requests to create or delete posts and profiles.

But the intricacy doesn't end there – the profile and post routes featured a specialized get request, facilitating the retrieval of data from other users' posts and profiles. Prioritizing security, we implemented JSON web tokens (JWT) for user authentication during login. Access to these routes was restricted to users with valid tokens, introducing an additional layer of protection.

To ensure seamless operation, we relied on the Postman API to meticulously assess the performance of our REST API. Following a user's login, a JWT was generated, granting them access to all protected routes. However, akin to Cinderella's enchantment, this token bore an expiration time set at 3600 seconds (or one hour). Once the clock struck, the JWT relinquished its powers, prompting users to log in anew for the issuance of a fresh, valid JWT, ensuring continued access to the routes. Refer to Figure 4 for a visual representation of this process.

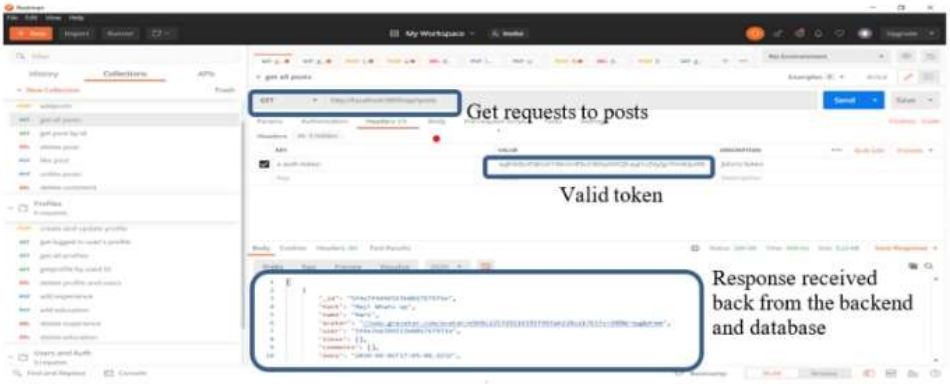


Figure 4. Valid JWT and response from the backend and database

### *3.3. Crafting the User Experience: The Artistry of Front-End Development*

Now, let's enter the imaginative realm of front-end development. Picture the front-end as the canvas where artists paint the user interface, breathing life into web content. This canvas encompasses two pivotal elements: CSS for styling and React.js for content rendering. The overarching objective? A seamless transfer of data from the backend server (nodemon) to the client server (node), enabling users to experience real-time posts, comments, and profiles.

To actualize this vision, we required both servers to collaborate seamlessly. Our task was made simpler with the assistance of an NPM package named "concurrently." With this enchanting tool, there was no need to juggle nodemon and the client server separately. A single command initiated both, streamlining the entire process.

#### *3.3.1. Designing for Ease: Creating a User-Friendly Experience*

In the realm of web applications, design transcends mere aesthetics; it's about forging an intuitive, user-friendly experience. The user interface holds sway over customer satisfaction, subsequently influencing business growth. Satisfied customers often become advocates, drawing in more clientele. Recognizing the potential pitfalls of delving into UI design without a clear roadmap, we turn to User Experience (UX) design to steer our course.

Our preferred tool for UX/UI design is Adobe XD, a versatile software available on both macOS and Windows. Adobe XD empowers developers to craft a prototype of the application's UI, providing a functional and visual representation. Designers can sketch the entire application, incorporating design and functionality elements such as pop-up windows (CSS modals), page links, animation effects, color schemes, and more. An added advantage is Adobe XD's use of feature names aligned with CSS properties, facilitating a seamless transition from design to code.

Within the design section of Adobe XD, we refine web designs. The "repeat grid" feature allows us to replicate a grid cell across the webpage. Components in the design section symbolize recurring elements like sidebars and navbars, streamlining their use across multiple pages. Once declared as a component, it's designed once and deployed across various pages. In the prototype section, we establish page links and imbue modals (pop-up windows) with functionality.

Furthermore, in Syntactically Awesome Style Sheets (SASS), we efficiently employ block element and identifier notations, a contemporary approach to organizing block item elements. For example, Figure 5 illustrates block element notation, where "gallery" is a block, and "item" is a block element. The figure also showcases the compilation of SCSS to CSS. SCSS incorporates SASS features but with curly braces, offering ease of use compared to SASS, which demands indentation.

Post UX design and UI prototype completion, the next step is coding the CSS. However, traditional CSS can be inflexible. Hence,

#### *3.3.2. Redux*

Now, let's explore Redux, an ingenious open-source JavaScript library playing a pivotal role in overseeing your app's status, or in simpler terms, its state. Imagine Redux as the conductor directing an orchestra, ensuring seamless harmony among all your front-end components.

In the realm of Redux, the term "state" might sound imposing, but envision it as the master switchboard governing your app's status. It resides within the realm of the Redux store and is accessible through the getState() function. This state encapsulates everything unfolding in your Redux-powered app, so any modification in one part sends ripples across the entire interface.

Middleware in Redux intercepts actions before they reach the reducer, akin to an action handler. Actions act as messengers, transporting data from your app's back-end to the store, ensuring the state stays informed. For example, when a user logs in, information streams from the back-end to the front-end, connecting the app to a database and making the data available on the front-end. Actions act as the envoys facilitating this seamless connection.

Your Redux store serves as the command center where rules, initial conditions, and middleware are established. If you're curious about your app's status, consider yourself fortunate—there's a convenient Chrome extension for Redux providing you with a glimpse under the hood.

Actions consist of two primary components: the "type" and the "payload." The "type" serves as a label instructing Redux on which action to execute. For instance, when fetching a user's profile, the action type becomes "GET_PROFILE." The "payload" is the compartment where data fetched from the back-end is stored. Therefore, if you're retrieving a user's profile, the fetched data becomes the payload.

This payload then travels to the Redux store, disseminating through your app's front-end, effecting changes along its path. For example, if a user's login effort fails, the action type transitions to "LOGIN_FAIL," and the "authenticated" position becomes "false," indicating that the user's credentials did not authenticate.

Upon this existence, the back-end communications a message to the front-end through the "LOGIN_FAIL" action, prompting a brief notification on the login page. To maintain orderliness, this notification fades away after 5 seconds, thanks to a clever technique using JavaScript's setTimeout function. This action quietly tucks the notification away by setting its display to "none."

## 4. Conclusion

In the rapidly evolving realm of web technologies, we're witnessing a seamless interplay between retailers and customers worldwide. Taking center stage in the web tech arena are MongoDB, Node.js, and React.js, and here's why they've emerged as the stars of the show.

MongoDB commands the spotlight as a non-relational database system, surpassing traditional counterparts like MySQL. Its prowess in handling extensive data volumes stems from the flexibility of its JSON data format. In contrast to MySQL's structured tables, JSON's key-value approach simplifies data management. Mongoose, our trusted companion, steps in to craft data schemas, establishing a crucial bridge between the application's back-end and the MongoDB database.

Node.js, our unsung hero backstage, fuels the server-side with JavaScript. Its asynchronous nature ensures swift handling of all user requests, eliminating any instances of waiting. The synergy between Node.js and MongoDB outshines lumbering RDBMS systems.

Now, let's introduce React.js, the shining star on the front-end. It works its enchantment by rendering content on the client-side. With its virtual DOM, React.js selectively re-renders only the updated segments, positioning itself as a premier choice for efficient and visually captivating user experiences.

In this ever-evolving tech landscape, MongoDB, Mongoose, Node.js, and React.js stand tall, simplifying global connections and delivering exceptional web experiences. This tech revolution displays no signs of deceleration.

**5. References**


- Alaoui, K. S., Foshi, J., & Zouine, Y. (2019). "Radio over fiber system based on a hybrid link for the next generation of optical fiber communication." International Journal of Electrical and Computer Engineering, 9(4), 2571-2577. DOI: 10.11591/ijece.v9i4.pp2571-2577.
- Stuart, G. (2017). "HTML5 and the Canvas Element." In Introducing JavaScript Game Development (pp. 3-16). DOI: 10.1007/978-1-4842-3252-1.
- Attardi, J. (2020). "Introduction to CSS." In Modern CSS (pp. 1-15). DOI: 10.1007/978-1-4842-6294-8.
- Guha, A., Saftoiu, C., & Krishnamurthi, S. (2010). "The Essence of JavaScript." In European Conference on Object-Oriented Programming–Object-Oriented Programming (pp. 126-150). DOI: 10.1007/978-3-642-14107-2_7.
- Song, K. T., & Park, S. H. (2017). "Design of Master-Slave-Slave Replication Model to Balance Master Overhead for Key-value Database." The Journal of Korean Institute of Information Technology, 15(2), 7-14. DOI: 10.14801/JKIIT.2017.15.2.7.
- Waseem, M., Liang, P., Shahin, M., Salle, A. D., & Márquez, G. (2021). "Design, monitoring, and testing of microservices systems: The practitioners' perspective." Journal of Systems and Software, 182. DOI: 10.1016/j.jss.2021.111061.