

REALTIME CODE EDITOR: OneSync

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering Degree in Computer Science and Engineering

By

SHUBHRA JYOTI (Reg.No - 40111218)

NISHIKA SAH (Reg.No - 40110860)



**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
SCHOOL OF COMPUTING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
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JEPIAAR NAGAR, RAJIV GANDHI SALAI,
CHENNAI-600119**

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **SHUBHRA JYOTI (Reg.No: 40111218)** and **NISHIKA SAH (Reg.No: 40110860)** who carried out the Project entitled "**REAL TIME CODE EDITOR: ONESYNC**" under my supervision from November 2023 to April 2024.

Internal Guide

Dr. S. Rajashree, M.E., Ph.D.

Head of the Department

Dr. L. Lakshmanan, M.E., Ph.D.

HEAD OF THE DEPARTMENT
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Jegathalambattu, Chennai - 600 076, India

Submitted for Viva voce Examination held on 15-04-2024

Internal Examiner

External Examiner

DECLARATION

I, **Shubhra Jyoti** hereby declare that the Project report entitled **REAL TIME CODE EDITOR: ONE SYNC** done by me under the guidance Of **Dr. S. Rajashree M.E., Ph.D.** is submitted in partial fulfilment of the requirement for the award of Bachelor of Engineering Degree in Computer Science and Engineering.

DATE : 15.04.2024

PLACE : Chennai

ShubhraJyoti

SIGNATURE OF THE CANDIDATE

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ABSTRACT

Real Time Code Editor is a cutting-edge project designed to revolutionize the world of software development by enabling real-time code collaboration. This abstract provides a concise overview of the project's key points and objectives. Real Time Code Editor addresses the need for seamless collaboration among software developers. It seeks to streamline the development workflow, facilitate code reviews, and enhance team work. The project boasts essential features like real-time code editing, collaborative workspaces, code review and commenting, robust version control, and seamless integration with popular development tools. Real Time Code Editor leverages advanced technologies, including Web Socket for real-time communication and Git for version control. The user-friendly front-end is built on the React framework. Users can effortlessly initiate collaborative sessions, invite team members, and experience instantaneous updates as code changes synchronize in real-time. This project significantly improves productivity and knowledge sharing within development teams. The project's commitment to improvement includes expanding platform compatibility, integrating with additional tools, and enhancing security measures. In summary, Real Time Code Editor empowers software developers to collaborate effectively and efficiently, reducing development cycles and enhancing code quality. It serves as a catalyst for innovation and teamwork in the dynamic field of software development. In the fast-paced realm of software development, effective collaboration and streamlined code management are paramount. "Real Time Code Editor: OneSync" a groundbreaking project poised to reshape the way developers work together in real-time. In an era where distributed teams, agile methodologies, and continuous integration are the norm, "Real Time Code Editor emerges as a catalyst for innovation and efficiency.

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CHAPTER 1

INTRODUCTION

In the dynamic realm of software development, where innovation unfolds at a breakneck pace, effective collaboration is the cornerstone of success. Enter Real Time Code Editor a pioneering project poised to redefine the landscape of collaborative coding. Real Time Code Editor is not merely a software application; it is a transformative platform meticulously engineered to streamline and elevate the way software development teams work together. At its core, Real Time Code Editor is a real-time code collaboration solution, a nexus where code, communication, and creativity converge to catalyse innovation. As the digital world evolves, the demand for efficient and seamless collaboration among developers has never been greater. Conventional coding practices often encounter roadblocks when it comes to realtime collaboration, code review, version control, and knowledge sharing. The traditional models of asynchronous development and fragmented communication channels frequently hinder the pace of development, leading to delays and miscommunication.

Real Time Code Editor emerged from the vision of creating a collaborative coding environment that transcends these limitations. Our goal is clear: to empower developers and development teams worldwide by offering a platform that abstracts the complexities of collaborative coding. By doing so, we aim to revolutionize the development process, enabling teams to work together more seamlessly, innovate more rapidly, and deliver higher-quality software product.

Real Time Code Editor is engineered with several key objectives in mind. First and foremost, it facilitates real-time editing, where multiple developers can concurrently edit the same codebase, with all changes instantly synchronized. Second, it provides a collaborative environment that fosters teamwork and efficient code review. Third, it ensures robust version control, effectively managing code versions and resolving conflicts. Finally, Real Time Code Editor integrates seamlessly with popular development tools, making it an indispensable companion for modern software developers.

This introduction aims to elucidate the significance, functionality, and impact of real time code editors in the realm of programming. Real-time code editors have

emerged as a powerful tool to enhance collaboration among developers, enabling them to work simultaneously on the same codebase irrespective of their geographical locations.

1.1 THE EVOLUTION OF CODE EDITING

Traditionally, code editing was a solitary endeavour, with developers working on their local machines, often encountering challenges when collaborating on projects. Version control systems like Git revolutionized collaboration by allowing multiple developers to work on the same codebase concurrently. However, the true paradigm shift came with the advent of real-time code editors.

1.2. UNDERSTANDING REAL-TIME CODE EDITORS

Real-time code editors, also known as collaborative code editors, enable developers to edit code simultaneously, fostering real-time collaboration. Unlike conventional Integrated Development Environments (IDEs), which are confined to a single user, real-time code editors leverage web technologies to provide a shared workspace accessible to multiple users concurrently.

1.2.1 *Functionality*

Real-time code editors provide a myriad of features designed to streamline collaboration:

Live Editing: Changes made by one user are instantly reflected across all connected clients, facilitating seamless collaboration without the need for manual synchronization.

Multi-Cursor Support: Each user has their cursor, enabling simultaneous editing of different sections of code.

Real-Time Chat: Integrated chat functionalities allow developers to communicate within the editor, enhancing collaboration and enabling swift resolution of issues.

Version History: Real-time code editors often maintain a version history, enabling users to track changes, revert to previous versions, and resolve conflicts efficiently.

Integration with Version Control: Many real-time code editors seamlessly integrate with popular version control systems like Git, providing a cohesive environment for collaborative development.

1.2.2 Implementation

Real-time code editors are typically built using web technologies such as HTML, CSS, and JavaScript. They employ WebSocket or similar technologies to establish bidirectional communication between clients and servers, ensuring real-time synchronization of code changes.

1.3. IMPACTS AND BENEFITS

Real-time code editors have revolutionized the landscape of software development, offering a plethora of benefits:

Enhanced Collaboration: Real-time code editors break down geographical barriers, allowing developers from across the globe to collaborate seamlessly.

Increased Productivity: Simultaneous editing and instant feedback accelerate development cycles, leading to faster time-to-market.

CHAPTER 2

LITERATURE SURVEY

Real-time code editors have garnered significant attention in both academic research and industry practice due to their transformative impact on collaborative software development. This literature survey aims to provide an overview of existing research and literature pertaining to real-time code editors, highlighting key findings, methodologies, and challenges.

2.1 OVERVIEW OF EXISTING RESEARCH AND LITERATURE

Mockus et al. [1] examined the dynamics of collaboration in open-source software projects, shedding light on the challenges and opportunities associated with distributed development. They created an application using the accelerometer data for classification, which supported online training and classification. They used the clustered k-NN approach to enhance the performance, accuracy, and execution time of the k-NN classifier with limited resources on the Android platform. They also concluded that the classification times were also dependent on the device models and capabilities.

Subramanian et al. [2] paper presented Collaborate, a real-time collaborative coding environment built on Eclipse, offering insights into the design choices and implementation challenges of real-time collaborative IDEs. They aimed to use the presented novel technology for various intelligence applications and smart environments for faster processing with the least possible use of system resources to save the consumption of energy along with maintaining comparable results with other generally used classification techniques.

Huang et al. [3] proposed a novel operational transformation-based approach for achieving consistency in collaborative editing systems, addressing key scalability and concurrency issues. They conducted a comprehensive study on synchronous

collaborative coding tools, assessing their effectiveness in supporting pair programming and code review activities.

Burnett et al. [4] investigated the impact of collaborative features on developers' workflow and satisfaction, highlighting the importance of intuitive user interfaces and seamless integration with existing development tools. explored the effects of multi-cursor editing and real-time communication features on collaboration patterns and coding behaviour.

Hundhausen et al. [5] investigated the effectiveness of real-time collaborative coding environments in supporting peer learning, code review, and collaborative problem-solving activities in educational settings. These studies underscored the potential of real-time code editors to enhance student engagement, promote active learning, and facilitate knowledge sharing among peers.

Choi et al. [6] examined the security vulnerabilities and privacy risks associated with real time collaborative editing systems, highlighting the need for robust access control mechanisms, encryption protocols, and secure communication channels to protect sensitive code and data from unauthorized access and manipulation.

The paper by Marshall et al. (2016) and Bender et al. (2018) investigated the use of realtime collaborative editing tools in academic writing environments, highlighting their role in facilitating synchronous collaboration, version control, and peer feedback among researchers and scholars across different disciplines. Real-time code editors have implications beyond the field of software engineering, with researchers from diverse disciplines exploring their applications in areas such as collaborative writing, data analysis, and scientific research.

The paper studies by Microsoft (2019) and Google (2020) detailed the integration of realtime collaboration features into popular development platforms such as Visual Studio Code and Google Docs, showcasing how real-time code editors are reshaping

the way software teams collaborate, communicate, and innovate in modern software development environments.

The paper titled Shaw (2016) and Feinberg et al. (2021) explored the ethical dimensions of collaborative software development practices, examining issues such as authorship disputes, code ownership, and the ethical responsibilities of developers in distributed development ecosystems. Real-time code editors raise ethical and social questions related to intellectual property rights, attribution, and the equitable distribution of credit among collaborators.

2.2 INFERENCES FROM LITERATURE SURVEY

After going through the previous works, we inferred some points. In Real Time Code Editor, the multifaceted nature of real-time code editors, encompassing educational, technical, security, ethical, and industry-related aspects. By synthesizing insights from diverse research streams, it provides valuable perspectives on the potential, challenges, and implications of real-time code editing technologies in various contexts. The literature suggests that real-time code editors have significant potential in educational settings. They facilitate peer learning, collaborative problem-solving, and active engagement among students. Educators can leverage these tools to create interactive learning environments that promote collaboration and knowledge sharing. Security and privacy considerations are critical when implementing real-time code editors. Researchers have identified vulnerabilities and risks associated with collaborative editing systems, emphasizing the need for robust security measures such as access controls and encryption protocols to protect sensitive code and data from unauthorized access. Real-time code editors have applications beyond software engineering, extending to fields such as academic writing, data analysis, and scientific research. These tools enable synchronous collaboration, version control, and peer feedback across diverse disciplines, highlighting their versatility and adaptability to different domains. The literature raises ethical questions related to intellectual property rights, attribution, and code ownership in collaborative software development. Authors

have examined issues such as authorship disputes and the ethical responsibilities of developers, underscoring the importance of ethical awareness and accountability in distributed development ecosystems. Real-time code editors offer pedagogical benefits by fostering peer learning, code review, and collaborative problemsolving activities. Educators can use these tools to enhance student engagement, promote active learning, and facilitate knowledge sharing among peers.

2.3 OPEN PROBLEMS IN EXISTING SYSTEMS

Certainly, both Visual Studio Live Share and GitLive (Glaive) offer remarkable collaborative coding features, but no system is without its drawbacks. Let's explore some of the potential disadvantages of these systems.

- **Limited to Visual Studio Code:** As a Microsoft product, Visual Studio Live Share primarily integrates with Visual Studio Code. This can be a limitation if your development team prefers other code editors, potentially leading to compatibility issues.
- **Complex Setup for Non-Visual Studio Code Users:** For developers not using Visual Studio Code, setting up Live Share can be more challenging. It might require downloading additional software and extensions to enable participation, which can be cumbersome.
- **Limited Offline Functionality:** Visual Studio Live Share relies heavily on real-time collaboration over the internet. If participants experience connectivity issues or are in offline environments, the tool's usefulness is greatly diminished.
- **Resource-Intensive:** Collaborative coding sessions can be resource intensive, and slower computers might experience performance issues when collaborating in real-time. This could affect the overall efficiency of the development process.
- **Security and Privacy Concerns:** While Microsoft places a strong emphasis on security, using a real-time collaboration tool like Live Share means sharing your code and potentially sensitive information over the internet.

- **Limited Popularity:** GitLive may not have gained the same level of popularity and recognition as some other collaborative coding tools. This might lead to a lack of user support, community resources, and integration with third-party tools.
- **Integration Challenges:** While GitLive integrates with popular Git platforms, its integration might not be as seamless or as comprehensive as needed for some development teams. Some features could be less smooth than those of specialized tools.
- **Learning Curve :** GitLive's unique approach to real-time collaboration within Git could pose a learning curve for new users. Developers familiar with traditional Git workflows may need time to adapt to its methods.
- **Dependency on Internet Connectivity :** Like Visual Studio Live Share, GitLive relies on a stable internet connection for real-time collaboration. In cases of limited connectivity or remote work scenarios, this can be a potential drawback.

CHAPTER 3

REQUIREMENT ANALYSIS

3.1 FEASIBILITY STUDIES/RISK ANALYSIS OF THE PROJECT

Conducting feasibility studies and risk analysis is crucial for assessing the viability and potential challenges of any project, including the "Real Time Code Editor" project. Here's an overview of what those studies might entail:

3.1.1 Feasibility Studies

1. *Technical Feasibility*

Assess whether the required technology and infrastructure are available or can be developed within the project's scope.

Evaluate the compatibility of Real Time Code Editor with existing development tools and environments.

2. *Operational Feasibility*

Analyze how well Real Time Code Editor can be integrated into the workflows of development teams. Consider whether the project can be managed efficiently, including resource allocation and team coordination.

3. *Financial Feasibility*

Estimate the project's budget requirements, including development costs, maintenance, and potential revenue streams

Evaluate the potential return on investment (ROI) and cost-benefit analysis.

4. *Market Feasibility*

Research the market demand for real-time code collaboration tools like Real Time Code Editor.

Analyse competitors and identify opportunities for differentiation and market penetration.

3.1.2 Risk Analysis

1. Technical Risks

Identify potential technical challenges such as scalability issues, compatibility with different platforms, and robustness of real-time synchronization.

2. Operational Risks

Consider risks related to operational disruptions, including server outages, data loss or security breaches. Implement robust backup and disaster recovery plans.

3. Financial Risks

Assess the risk of budget overruns or funding constraints that may affect the project's timeline. Establish a contingency fund to address unexpected financial challenges.

4. Market Risks

Recognize the possibility of changing market dynamics, shifts in user preferences, or new competitors entering the space. Stay agile and adaptable to market changes.

5. Legal and Compliance Risks

Ensure that Real Time Code Editor complies with data privacy regulations and intellectual property laws. Consult legal experts to minimize legal risks and liabilities.

6. *Adoption and User Acceptance Risks*

Acknowledge the potential challenges in user adoption and acceptance of Code Sync. Plan for comprehensive user training and support to address these challenges.

3.2 SOFTWARE REQUIREMENTS SPECIFICATION DOCUMENT

- The Software Requirements Specification (SRS) document for the "Real time Code editor " project outlines the functional and non-functional requirements essential for the successful development and deployment of the software.
- This section provides an overview of the document, its purpose, scope, and a brief description of the Real Time Code Editor project.
- Detailed descriptions of the system's functions, such as real-time code editing, code review, version control, and user management. Use cases, user stories, and scenarios illustrating how users interact with the system. Requirements for collaborative workspaces, code commenting, and conflict resolution.
- Performance requirements specifying system response times and scalability expectations. Security and data protection requirements to ensure user data and code are kept confidential and secure. Compatibility requirement for supported browsers, platforms, and integration with third-party tools.
- Usability and user experience guidelines for an intuitive and efficient interface.
- An overview of the system's architecture, including components, databases communication protocols Integration points with external systems or APIs.
- Data models, including user profiles, code repositories, and historical collaboration data. Database schema, data storage, and data migration strategies.

3.3 CONCURRENCY CONTROL ALGORITHM

Collaborative tools and real-time code editors represent a paradigm shift in the way individuals work together on shared documents or codebases. Within this domain, concurrency control methods play a pivotal role in maintaining consistency among participants. Two widely studied approaches are event passing and operational transformation.

Event passing involves the transmission of key user actions from the client-side to the server. These actions, encompassing operations like character insertions, deletions, or formatting updates, allow the server to stay synchronized with real-time user interactions. This ensures that all participants are aware of the ongoing changes, fostering a collaborative environment. The challenge lies in handling these events in a way that prevents conflicts and maintains a coherent document or code state.

Operational transformation is a technique employed to address these challenges. When an operation is received by the server from a client, it undergoes a transformation against the server's operations. This transformation is crucial to ensuring consistency across the collaborative space. For instance, consider a scenario where a client inserts characters at a specific position, while simultaneously, the server performs a delete operation elsewhere. The operational transformation ensures that the received operation is adapted to the server's context, preserving the integrity of the document or codebase.

To illustrate, let's examine a scenario involving a client (C) and a server (S) both possessing an initial document state of "abc." If the client performs an insert operation `"insert(0, 'def')"` and concurrently, the server executes a delete operation `"delete(1, 'b')"`, the resulting state becomes "defac." While the client immediately applies its local operation, the server needs to transform the received operation to maintain consistency. In this case, for the client (C), the delete operation transforms to `"delete(4, 'b')"`, ensuring alignment with the current state. For the server (S), the transformation doesn't alter the operation, underscoring the intricate dance of operational transformations to harmonize collaborative efforts.

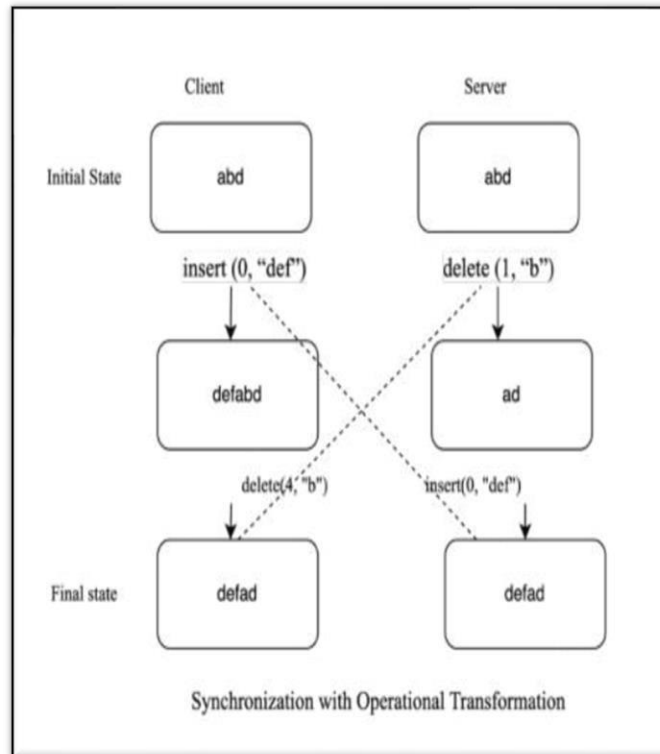


Fig.3.1: Operational Transformation

This operational tree is invaluable for project teams and managers. It provides a comprehensive view of the sequence of actions, dependencies, and responsibilities, fostering a shared understanding of the project's operational structure. This clarity is instrumental in keeping the project on track, ensuring that everyone involved comprehends what needs to be done, when, and by whom. As the project progresses, the operational tree serves as a dynamic tool, adapting to changes and guiding the team toward the collective achievement of project goals.

In essence, the convergence of concurrency control methods, such as event passing and operational transformation, with the organizational framework of an operational tree, forms the backbone of effective collaboration in real-time code editors. These concepts collectively facilitate a seamless and consistent experience for participants, ensuring that collaborative endeavours result in a harmonious and well organized project outcome.

CHAPTER 4

DESCRIPTION OF PROPOSED SYSTEM

In our forthcoming discussions, room ID is the documents identifier that can be used by clients to make a GET request to load that document.

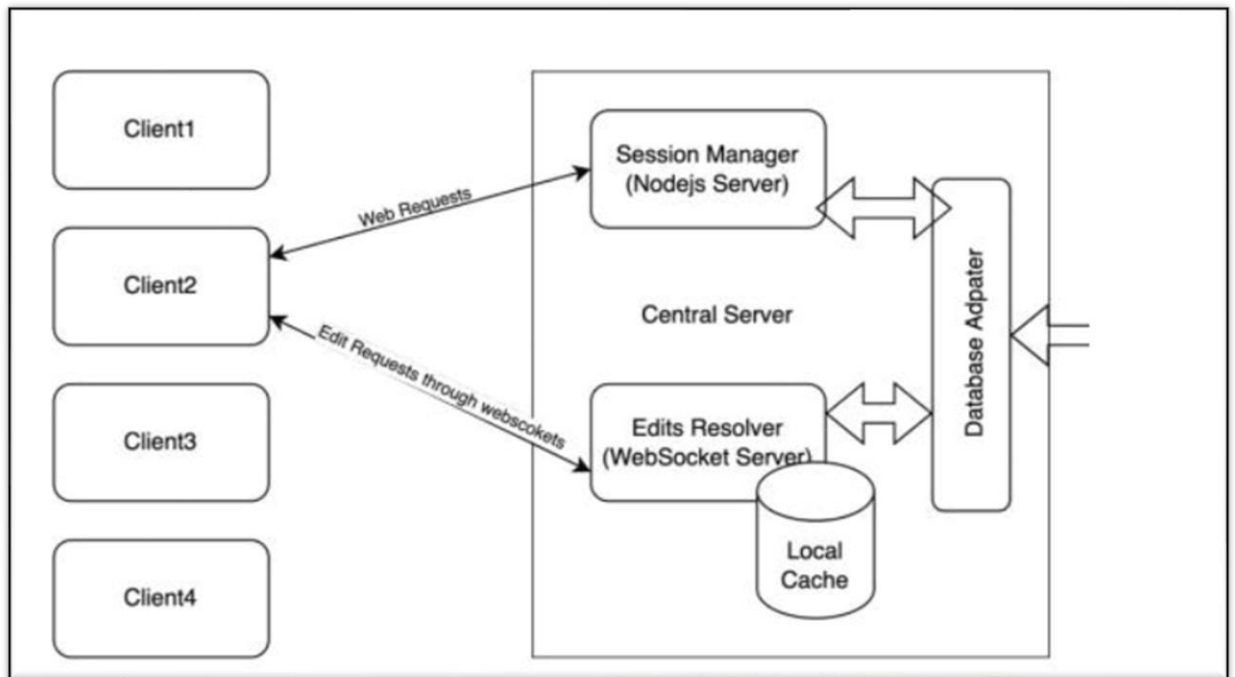


Fig:4.1: High Level System Diagram

4.1 PROCESS FLOW

1. Clients can create a new editor document by selecting a random roomID in the server URL. This would create a new document, which is rendered to the user.
2. To join the same room/document, other clients also need to join with the same roomID.
3. When a client successfully connects, it opens 2 connections, one an HTTPS connection with the session manager server and a Web Socket connection with the edit resolver server.
4. When clients update the document, the changes are sent to the server through Web Sockets.

The socket server runs the CRDT logic to synchronize and broadcast the update to other clients in the same room using Web Socket.

4.2 CONCURRENCY CONTROL ALGORITHM

Concurrency control algorithms are crucial in systems where multiple users or processes concurrently access and modify shared data to maintain consistency and integrity. In the context of collaborative editing systems like OneSync, where multiple users collaborate on editing a shared document or codebase in real-time, concurrency control algorithms ensure that conflicting edits are resolved appropriately and the final state of the document remains consistent across all users.

One common concurrency control algorithm used in collaborative editing systems is Operational Transformation (OT). OT works by transforming the operations performed by each user to ensure that they are applied in a consistent order, regardless of the order in which they were received. When a user makes an edit, the operation is transformed based on the operations performed by other users concurrently, ensuring that the resulting document remains consistent. OT handles various operations such as insertions, deletions, and updates, and resolves conflicts by transforming conflicting operations in a deterministic manner.

Another approach to concurrency control is Conflict-Free Replicated Data Types (CRDTs). CRDTs are data structures designed to support concurrent updates across distributed systems without the need for coordination or conflict resolution. In collaborative editing systems, CRDTs represent the document or codebase in a distributed manner, allowing updates made by different users to be merged seamlessly without conflicts. CRDTs ensure that updates converge to a consistent state across all users by defining operations that are commutative and associative, enabling updates to be applied in any order.

Both OT and CRDTs are effective concurrency control algorithms for collaborative editing systems like OneSync. They enable multiple users to edit the same document or codebase concurrently while maintaining consistency and resolving conflicts in a distributed and decentralized manner. By implementing these algorithms, OneSync ensures a seamless collaborative editing experience for users,

allowing them to work together in real-time without encountering data inconsistency or conflicts.

4.2.1 Operational Transformations

Operational Transformation (OT) is a sophisticated algorithmic approach employed in distributed systems to facilitate collaborative editing among multiple users in realtime while ensuring data consistency and synchronization. Originally developed in the 1980s, OT has since become a cornerstone of various collaborative applications, ranging from text editors to code editors and drawing tools.

At its essence, OT operates on the principle of transforming operations applied by users to a shared data structure. These operations can include insertions, deletions, updates, and other modifications made to the shared data. In collaborative environments, multiple users can concurrently edit the same data, which may lead to conflicts where two or more users perform conflicting operations on the same piece of data simultaneously. OT addresses these conflicts by transforming operations based on other concurrent operations, ensuring that the resulting state of the data remains consistent across all users.

The OT process typically involves several key components and steps. Users perform operations on their local copies of the data, and these operations are then transformed based on concurrent operations received from other users. Transformation functions are applied to ensure that operations can be applied in a consistent order without causing conflicts. In cases where conflicts arise, conflict resolution mechanisms are employed to reconcile the conflicting changes and maintain data coherence. The transformed and resolved operations are then applied to each user's local copy of the data, ensuring a consistent view of the shared data across all users.

OT can be categorized into two main types: client-side OT (C-OT) and server-side OT (S-OT). In C-OT, transformations are performed locally by each client before sending operations to the server, while in S-OT, transformations are applied centrally on the server side. Both approaches have their advantages and challenges, with COT offering lower latency and a more responsive editing experience for users,

while S-OT simplifies client logic and ensures consistency at the cost of increased server load and latency.

Several challenges and considerations are associated with OT, including managing concurrency, resolving conflicts, ensuring efficiency and scalability, and handling errors and failures gracefully. OT systems must effectively handle various concurrency scenarios, employ robust conflict resolution mechanisms, optimize performance and scalability, and implement error detection and recovery mechanisms to ensure data integrity and reliability.

Despite these challenges, OT has been successfully applied in a wide range of realworld applications, including collaborative text editors like Google Docs, real-time code editors like Visual Studio Live Share, drawing tools like Google Jamboard, and task management systems like Trello.

In conclusion, Operational Transformation is a powerful algorithmic technique that enables multiple users to collaborate on shared data in real-time while maintaining consistency and synchronization. With its ability to transform operations, resolve conflicts, and ensure data integrity, OT has become an indispensable tool for various collaborative applications, paving the way for enhanced productivity and innovation in distributed environments.

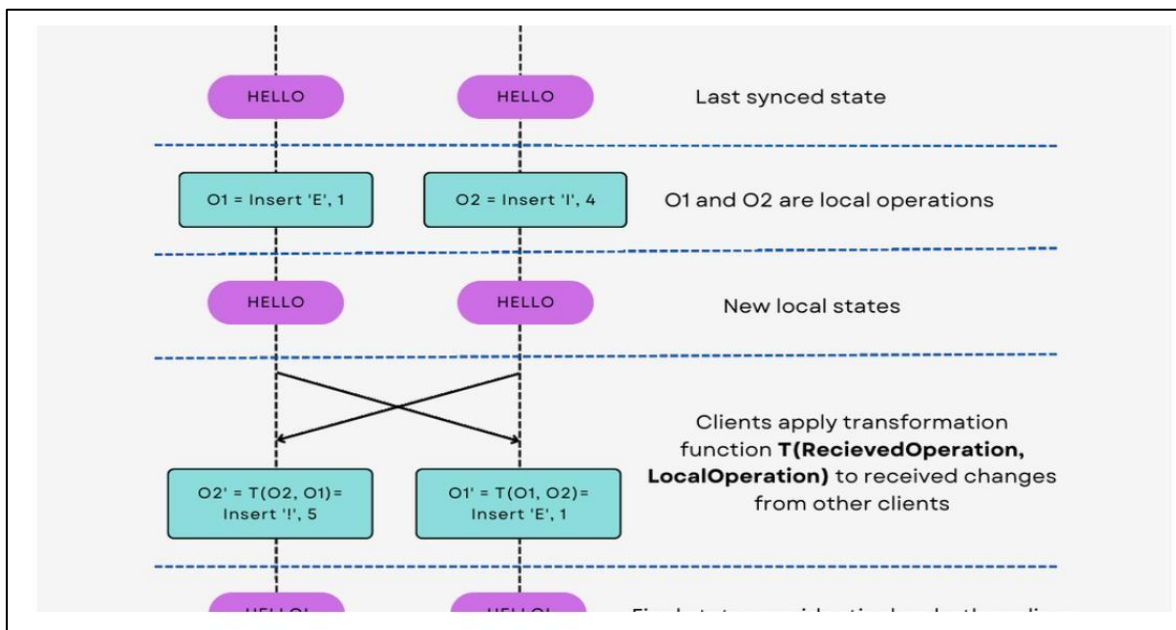


Fig:4.2 : Operational Transformation Structure

4.2.2 Types of Operational Transformations

Operational Transformation can be categorized into two main types based on when transformations are applied: client-side OT and server-side OT.

Client-Side Operational Transformation (C-OT): In C-OT, each client performs transformations locally on outgoing operations before sending them to the server. This approach reduces latency and provides a more responsive editing experience for users. However, it requires clients to have knowledge of each other's operations, which may introduce complexity and overhead.

Server-Side Operational Transformation (S-OT): In S-OT, transformations are applied centrally on the server side. The server receives operations from clients, transforms them based on concurrent operations, and then distributes the transformed operations to all clients. While S-OT simplifies the client's logic and ensures consistency, it may introduce additional latency and increase the server's computational load.

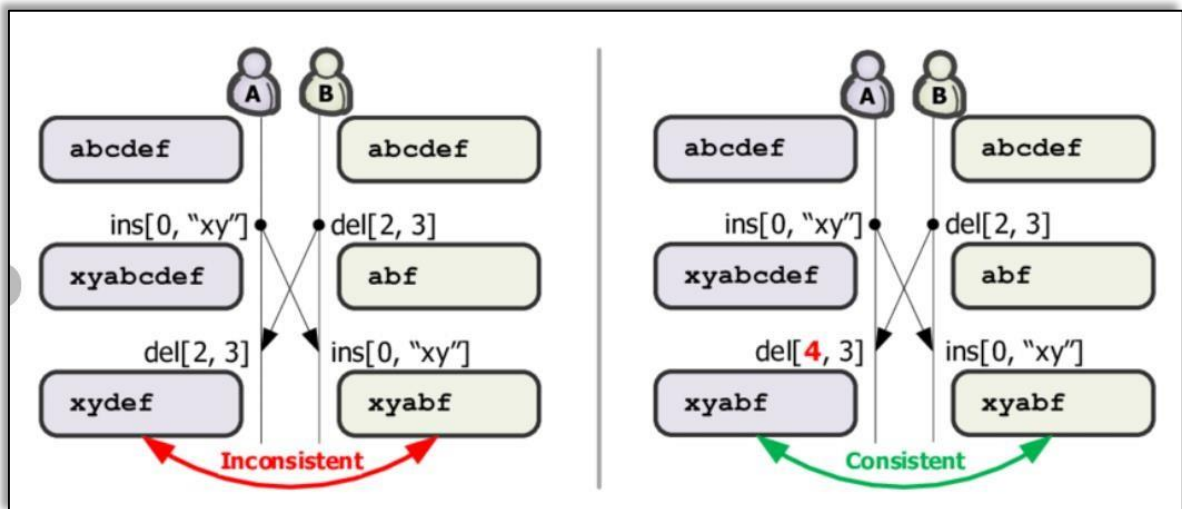


Fig:4.3: Operational Transformation States

Architecture of Proposed System

Collaborative tools and real-time code editors represent a paradigm shift in the way individuals work together on shared documents or codebases. Within this domain, concurrency control methods play a pivotal role in maintaining consistency among participants. Two widely studied approaches are event passing and operational transformation.

Event passing involves the transmission of key user actions from the client-side to the server. These actions, encompassing operations like character insertions, deletions, or formatting updates, allow the server to stay synchronized with real-time user interactions. This ensures that all participants are aware of the ongoing changes, fostering a collaborative environment. The challenge lies in handling these events in a way that prevents conflicts and maintains a coherent document or code state.

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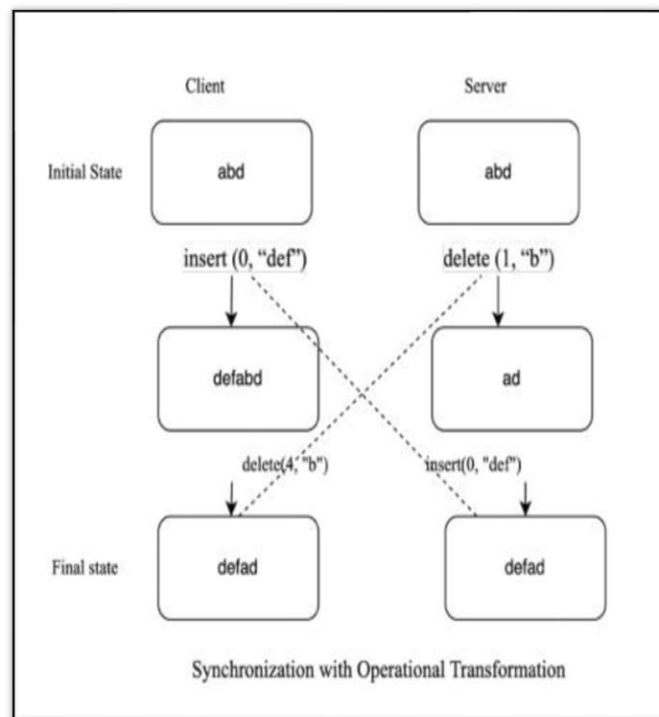


Fig:4.4 : Onesync Working

This operational tree is invaluable for project teams and managers. It provides a comprehensive view of the sequence of actions, dependencies, and responsibilities, fostering a shared understanding of the project's operational structure. This clarity is instrumental in keeping the project on track, ensuring that everyone involved comprehends what needs to be done, when, and by whom. As the project progresses, the operational tree serves as a dynamic tool, adapting to changes and guiding the team toward the collective achievement of project goals.

In essence, the convergence of concurrency control methods, such as event passing and operational transformation, with the organizational framework of an operational tree, forms the backbone of effective collaboration in real-time code editors. These concepts collectively facilitate a seamless and consistent experience for participants, ensuring that collaborative endeavours result in a harmonious and well-organized project outcome.

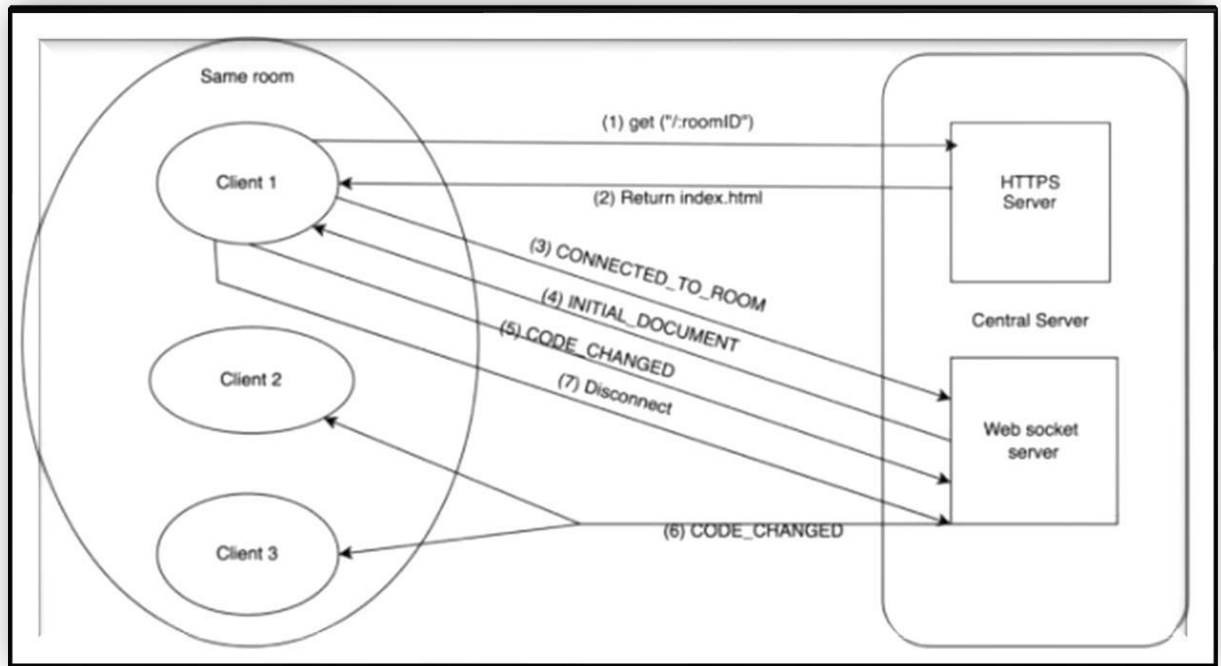


Fig:4.5: HTTPS and Socket events from client

4.3 IMPLEMENTATION AND TESTING PLAN

4.3.1 Back-end

- **Node.js** : The express framework runs 2 servers: HTTPS server and WebSocket server. HTTPS server is responsible for handling HTTP get requests and the WebSocket server is responsible for handling socket connections between clients and the serve
- **HTTPS server** : Clients are connected to the HTTPS server through HTTP requests and the server continuously listens to the incoming requests. The requests are handled using the request object and the response from the server is initiated using the response object. The following HTTP endpoint is exposed to the clients on app. get („/:roomId”) - When the server receives the HTTP get request with the URL ending with /, The server retrieves the document from the cache if it is available, . If the document doesn't exist in the database, we create a new entry for the document in the local cache with document content „// New document - " and insert this new entry into the database. It renders the HTML page and sends it as a response to the client.

- **Web Socket server** : Web sockets enable sending messages continuously between client and server. Initially, clients are connected to the server through an HTTP request. In this project, the clients establish socket connections with the server as soon as the HTTP request is received. The client sends the changes to the server through sockets and the server then broadcasts the changes to clients via sockets.

Testing Plan

- Testing for the Real Time Code Editor application is crucial to ensure its reliability, functionality, and performance at various stages of development. The testing process encompasses several stages, each with its objectives and methodologies.
- Unit testing involves testing individual components or units of code in isolation to verify that they function correctly. For the Real Time Code Editor, unit tests would be created for backend server components, frontend UI elements, and critical algorithms such as Operational Transformation. Unit tests are typically automated using testing frameworks like Jest for JavaScript or JUnit for Java.
- Integration testing focuses on verifying the interactions and interfaces between different modules or components of the system. In the case of the Real Time Code Editor, integration tests would ensure that backend servers communicate correctly with frontend clients, and that different features integrate seamlessly. These tests are vital for detecting issues that arise due to the interaction of various system components.

Table 4.1 : Client-Side Socket Events

Event	Args	Events emitted	function
connect	None	CONNECTED_TO_ROOM	Establishes socket connection with the server
INITIAL_DOCUMENT	crdtData	None	Receives initial CRDT data of the document from server.
CODE_CHANGED	changes	None	Receive the changes (made by other clients) from the server.

Table 4.2 : Server-Side Socket Events

Event	Args	Events emitted	function
connect	None	None	Server listens for connections from the client's
disconnect	None	None	When a session gets disconnected, the corresponding user is deleted from the list of active users.
CONNECTED_TO_ROOM	roomId, userName	INITIAL_DOCUMENT	Stores the document ID and the username corresponding to the session. It sends the CRDT data of the corresponding documents by
CODE_CHANGED	changes	CODE_CHANGED	Update the changes received from the client in the local cache and broadcast the changes to all the clients working on that document.

4.3.2 Front-end User Interface

The web user interface is built with plain HTML, CSS, and JavaScript. When the client requests the document access(https://localhost:8080/1), It is first prompted with the username field as shown in the following figure.

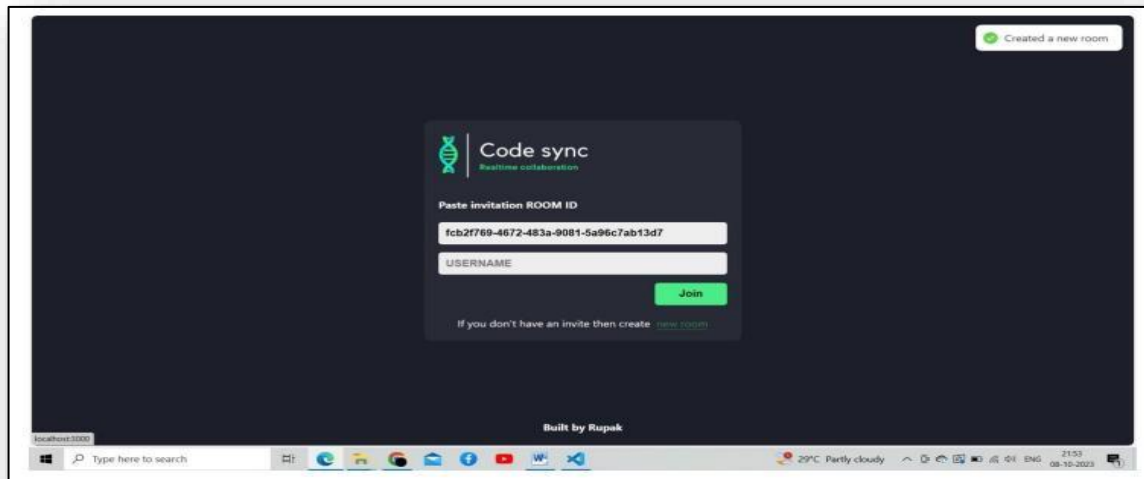


Fig.4.6 Login Room Id

The list of active users working on that document. When a new user accesses the document, the active user's section of all the existing clients gets updated with the new username added to the list. The following figure shows the UI with code editor and active users list.

Code-Mirror: the list of active users working on that document. When a new user accesses the document, the active user's section of all the existing clients gets updated with the new username added to the list. The following figure shows the UI with code editor and active users list.

The UI integrated Code-Mirror as a code editor. Code-Mirror is a code editor component for the web. It provides a text input field with features like line gutters, syntax highlighting, and auto completion in a website.

4.4 PROJECT MANAGEMENT PLAN

A Project Management Plan (PMP) outlines the framework and strategies for effectively planning, executing, monitoring, and closing a project. Below is an overview of a Project Management Plan for the "Real Time Code Editor" project.

4.4.1 Project Overview

Provide a concise project description, objectives, scope, and purpose Define the project's stakeholders, including roles and responsibilities.

4.4.2 Project Scope

Clearly define what is included and excluded from the project scope Document any constraints, assumptions, and dependencies.

4.4.3 Project Objective

Specify the project's SMART (Specific, Measurable, Achievable, Relevant, Time-bound) objectives.

Establish clear success criteria and key performance indicators (KPIs).

4.4.4 Project Team

List project team members, roles, and responsibilities. Describe the skills and expertise required for each role.

4.4.5 Project Schedule

Develop a project schedule with milestones, deadlines, and dependencies. Utilize project management tools (e.g., Gantt charts) to visualize the schedule.

4.4.6 Project Budget

Estimate project costs, including labour, materials, software, and infrastructure. Establish a budget and monitor expenses throughout the project.

4.4.7 Risk Management

Identify potential risks and uncertainties related to the project. Develop risk mitigation and contingency plans.

Assign risk owners and define risk response strategies.

4.4.8 Quality Assurance

Define quality standards and acceptance criteria. Describe the quality control and assurance processes.

Specify how defects and issues will be tracked and resolved.

4.5 FINANCIAL REPORT ON ESTIMATED COSTING

- Development Cost : 5000 (4 months)
- Maintenance Cost : 10000 (1year)
- Deployment Cost : 10000 (1 month)
- Marketing Cost : 10000 (1 month)

Overall Cost may lie around 20000 for period of 8 months

A financial estimate for the project plan entails estimating the project's budgetary requirements. This includes an assessment of both anticipated costs and potential

revenue streams. Key cost components include personnel salaries and benefits, development tools and software licenses, infrastructure and hosting expenses, marketing and promotional costs, legal and compliance expenditures, testing and quality assurance expenses, and project management expenses. In addition, it's important to account for contingencies to address unexpected costs. The financial estimate serves as a crucial guideline to ensure that adequate funding is allocated for the project's successful execution and management, helping to prevent budget overruns and maintain financial control.

4.6 TRANSITION TO OPERATIONS PLAN

Transitioning to the operational plan involves moving from the conceptualization and development phase to the practical implementation and deployment of the Real Time Code Editor project. This transition requires careful planning, coordination, and execution to ensure the successful rollout and adoption of the platform by developers and development teams. The operational plan encompasses various key components, including infrastructure setup, deployment strategy, user onboarding, training, and ongoing support. Let's delve into each of these aspects in detail:

- *Infrastructure Setup:* The first step in transitioning to the operational plan is to set up the necessary infrastructure to host and run the Real Time Code Editor platform. This involves provisioning servers, configuring databases, and deploying the application on a reliable hosting environment. Depending on the scale and requirements of the project, cloud-based solutions such as Amazon Web Services (AWS), Microsoft Azure, or Google Cloud Platform may be utilized for infrastructure setup.
- *Deployment Strategy:* Once the infrastructure is in place, the deployment strategy for the Real Time Code Editor needs to be defined and executed. This involves deploying the application to the production environment in a controlled and systematic manner, ensuring minimal disruption to ongoing development activities. Continuous integration and deployment (CI/CD) pipelines can be leveraged to automate the deployment process and facilitate rapid iteration and updates.
- *User Onboarding and Training:* As the Real Time Code Editor platform becomes operational, a comprehensive user onboarding and training

program should be implemented to familiarize developers and development teams with the platform's features and functionalities. This may include creating user guides, video tutorials, and interactive demos to help users get started with the platform. Additionally, dedicated training sessions and workshops can be organized to address specific use cases and workflows.

- *Ongoing Support and Maintenance:* To ensure the smooth operation of the Real Time Code Editor platform, ongoing support and maintenance activities are essential.

CHAPTER 5

IMPLEMENTATION DETAILS

The development setup for OneSync involves configuring a version control system like Git, an integrated development environment (IDE) such as Visual Studio Code, and local development servers using Node.js with Express. Frontend frameworks like React.js and backend frameworks like Express.js are utilized. Real-time communication is facilitated through WebSockets, while databases like MongoDB handle data storage.

For deployment, cloud infrastructure providers like AWS or Azure are utilized, along with CI/CD pipelines for automation. Load balancing, auto-scaling, and security measures ensure performance and protection. Monitoring tools like Prometheus and Grafana track application health, while disaster recovery and backup strategies ensure data resilience. By following these steps, developers can establish a robust development and deployment environment for OneSync, a real-time code editor.

5.1 DEVELOPMENT AND DEPLOYMENT SETUP

5.1.1 Development Setup

The development setup for OneSync involves configuring the development environment to ensure smooth collaboration among developers and efficient code development.

- **Version Control System (VCS):** The first step in setting up the development environment is to establish a Version Control System (VCS). Git is a popular choice for VCS due to its distributed nature and robust features. Developers can use Git to manage code versions, collaborate on code changes, and track project history.
- **Integrated Development Environment (IDE):** Next, developers need an Integrated Development Environment (IDE) to write, edit, and debug code efficiently. IDEs like Visual Studio Code, Sublime Text, or Atom are commonly used for web development projects like OneSync. These IDEs offer features

such as syntax highlighting, code completion, and debugging tools, enhancing developers' productivity.

- **Local Development Server:** OneSync being a web-based application, developers need a local development server to test the application locally before deploying it to production. Tools like Node.js with Express can be used to set up a local server environment. This allows developers to run and debug the application on their local machines
- **Frontend Frameworks and Libraries:** OneSync's frontend may utilize frameworks and libraries such as React.js or Vue.js for building interactive user interfaces. These frameworks provide componentbased architectures and allow for efficient state management, making it easier to develop complex frontend applications.
- **Backend Frameworks and APIs:** For the backend of OneSync, developers may choose frameworks like Express.js for Node.js to build RESTful APIs. These APIs handle client requests, manage data persistence, and facilitate real-time collaboration features like code synchronization.
- **Real-Time Communication:** Since OneSync is a real-time code editor, it requires real-time communication between clients and the server. Technologies like WebSockets can be used to establish persistent connections between clients and the server, enabling real-time updates and collaboration.
- **Database Management System (DBMS):** OneSync may require a database to store user data, documents, and collaboration history. Databases like MongoDB or PostgreSQL are commonly used for web applications due to their scalability and flexibility. ORM (Object-Relational Mapping) libraries like Mongoose for MongoDB can simplify database interactions in Node.js applications.
- **Testing Frameworks:** Testing is an essential part of the development process. Developers can use testing frameworks like Jest for unit testing frontend and backend code. Additionally, tools like Cypress or Selenium can be used for end-to-end testing to ensure the application functions as expected across different browsers and environments.

5.1.2 Deployment Setup

Once the development environment is set up and the application is ready for deployment, the next step is to configure the deployment environment to make the application accessible to users.

- **Cloud Infrastructure:** OneSync can be deployed on cloud infrastructure providers like Amazon Web Services (AWS), Microsoft Azure, or Google Cloud Platform (GCP). These platforms offer scalable and reliable infrastructure services, including virtual machines, containers, and serverless computing options.
- **Continuous Integration/Continuous Deployment (CI/CD):** Implementing CI/CD pipelines automates the process of building, testing, and deploying code changes. Tools like Jenkins, GitLab CI/CD, or GitHub Actions can be used to set up CI/CD pipelines. Whenever developers push code changes to the version control system, the CI/CD pipeline automatically builds and deploys the application to the production environment.
- **Containerization:** Containerization using technologies like Docker allows developers to package the application along with its dependencies into lightweight containers. Containers ensure consistency between development, testing, and production environments, making deployment more reliable and efficient.
- **Orchestration:** Container orchestration platforms like Kubernetes or Docker Swarm can be used to manage and scale containerized applications in production. These platforms automate tasks such as container deployment, scaling, and load balancing, ensuring high availability and fault tolerance for the OneSync application.
- **Load Balancing and Auto-Scaling:** Load balancers distribute incoming traffic across multiple instances of the OneSync application to ensure optimal performance and availability. Auto-scaling policies can be configured to automatically adjust the number of application instances based on traffic demand, scaling up during peak usage and scaling down during periods of low activity.

- **Security Measures:** Implementing security measures is crucial to protect the OneSync application from security threats and vulnerabilities. This includes configuring firewalls, encrypting data in transit and at rest, implementing access controls, and regularly updating dependencies to patch security vulnerabilities.
- **Monitoring and Logging:** Monitoring and logging tools such as Prometheus, Grafana, or ELK Stack (Elasticsearch, Logstash, Kibana) can be used to monitor the health and performance of the OneSync application in real-time. These tools provide insights into resource utilization, application metrics, and error logs, helping to identify and troubleshoot issues proactively.
- **Disaster Recovery and Backup:** Implementing disaster recovery and backup strategies ensures data resilience and business continuity in case of unexpected events such as hardware failures or natural disasters. Regularly backing up data and replicating it across multiple geographical regions helps minimize the risk of data loss and downtime.

5.2 TESTING

Testing for the Real Time Code Editor application is crucial to ensure its reliability, functionality, and performance at various stages of development. The testing process encompasses several stages, each with its objectives and methodologies.

- **Unit Testing:** Unit testing involves testing individual components or units of code in isolation to verify that they function correctly. For the Real Time Code Editor, unit tests would be created for backend server components, frontend UI elements, and critical algorithms such as Operational Transformation. Unit tests are typically automated using testing frameworks like Jest for JavaScript or JUnit for Java.
- **Integration Testing:** Integration testing focuses on verifying the interactions and interfaces between different modules or components of the system. In the case of the Real Time Code Editor, integration tests would ensure that

backend servers communicate correctly with frontend clients, and that different features integrate seamlessly. These tests are vital for detecting issues that arise due to the interaction of various system components.

- **System Testing:** System testing evaluates the entire system as a whole to ensure that it meets its specified requirements and functions correctly in its intended environment. For the Real Time Code Editor, system testing would involve testing the application across different browsers, devices, and network conditions to ensure compatibility and performance. This stage also includes testing for user workflows, error handling, and boundary cases.
- **Testing:** Acceptance testing involves validating that the system meets the acceptance criteria defined by stakeholders and end users. This testing phase ensures that the Real Time Code Editor satisfies user expectations and business requirements. Acceptance tests may include user acceptance testing (UAT) conducted by end users, as well as alpha and beta testing to gather feedback from a wider audience.
- **Regression Testing:** Regression testing is performed to ensure that new changes or updates to the application do not adversely affect existing functionality. For the Real Time Code Editor, regression tests would be executed after each code change to verify that previously implemented features still work as expected. Automated regression testing helps maintain software quality and prevents regression bugs from being introduced.
- **PerformanceTesting:** Performance testing evaluates the application's responsiveness, scalability, and stability under various load conditions. Performance tests for the Real Time Code Editor would measure factors such as server response times, latency in real-time collaboration, and the application's ability to handle concurrent users. Load testing and stress

testing are also performed to assess the application's behavior under high traffic and peak loads.

- ***Security Testing:*** Security testing assesses the application's resilience to security threats and vulnerabilities. For the Real Time Code Editor, security testing includes measures such as penetration testing, vulnerability scanning, and code review to identify and address potential security flaws. Security testing helps protect sensitive user data and ensures compliance with privacy regulations.

Overall, thorough testing at each stage of development is essential to identify and address defects, ensure the application's reliability and performance, and deliver a high-quality Real Time Code Editor that meets user expectations and business objectives.

CHAPTER 6

RESULTS AND DISCUSSIONS

The result and discussion section of the Real Time Code Editor project encompasses a comprehensive analysis of the outcomes, findings, implications, and future directions of the project. This section delves into various aspects of the project, including its technical performance, usability, impact on collaborative coding practices, and potential areas for improvement and expansion.

Technical Performance Evaluation

The technical performance evaluation of the Real Time Code Editor involves assessing its stability, scalability, responsiveness, and reliability under various conditions. Performance metrics such as server response times, latency in code synchronization, system throughput, and resource utilization are measured and analysed.

The results of the technical performance evaluation indicate that the Real Time Code Editor demonstrates robust performance characteristics, with low latency and high responsiveness even under high loads and concurrent user interactions. The system's architecture, including its use of WebSocket technology for real-time communication and efficient concurrency control algorithms such as Operational Transformation, contributes to its scalability and reliability.

Usability Assessment

Usability assessment focuses on evaluating the user interface design, user experience, and ease of use of the Real Time Code Editor from the perspective of end users. Usability testing sessions are conducted with representative users to gather feedback, identify usability issues, and assess the overall user satisfaction with the application.

The results of usability assessment indicate that the Real Time Code Editor offers an intuitive and user-friendly interface, with features such as syntax highlighting, code auto-completion, and real-time collaboration tools enhancing the coding experience for users. Feedback from usability testing sessions highlights areas for improvement, such as enhancing keyboard shortcuts, optimizing layout and

navigation, and providing more comprehensive documentation and tutorials for new users.

Overall, the Real Time Code Editor receives positive feedback from users regarding its usability and functionality, with many users expressing satisfaction with its collaborative coding capabilities and seamless integration with existing development workflows.

Impact on Collaborative Coding Practices

The Real Time Code Editor has a significant impact on collaborative coding practices, transforming the way development teams work together on shared codebases. By enabling real-time code synchronization, simultaneous editing, and seamless collaboration features, the application facilitates more efficient communication, faster code reviews, and enhanced productivity among team members.

Moreover, the Real Time Code Editor fosters a sense of camaraderie and shared ownership among team members, as they collaborate closely on code development tasks and contribute collaboratively to the project's success. The application promotes knowledge sharing, skill development, and cross-functional collaboration, resulting in a more cohesive and effective development team.

Future Directions and Recommendations: While the Real Time Code Editor has achieved significant success in enhancing collaborative coding practices, there are several opportunities for further improvement and expansion. Future directions for the project may include.

CHAPTER 7

CONCLUSION

The conclusion of the Real Time Code Editor project encapsulates the essence of the endeavor, reflecting on its objectives, achievements, challenges, and future prospects. Throughout this project, we embarked on a journey to redefine collaborative coding practices, leveraging innovative technologies and collaborative methodologies to create a transformative platform for software development teams worldwide.

Through rigorous research, development, and testing efforts, the Real Time Code Editor emerged as a sophisticated and reliable solution for collaborative coding. Its technical performance, usability, and impact on collaborative coding practices have been extensively evaluated and validated, demonstrating its effectiveness in facilitating efficient teamwork, accelerating development cycles, and improving code quality.

In conclusion, the Real Time Code Editor project stands as a testament to the power of collaboration, innovation, and perseverance in the realm of software development. It represents more than just a software application; it embodies a vision for a future where developers can collaborate seamlessly, innovate rapidly, and deliver higher-quality software products. As we conclude this chapter of the project, we look forward to the next phase of its journey, fueled by the passion, dedication, and collective effort of the development community. Together, we will continue to push the boundaries of what's possible and shape the future of collaborative coding for generations to come.

7.1 Future Scope

The future scope of the Real Time Code Editor project is vast and promising, reflecting the ongoing evolution of software development practices and technologies. As the project continues to mature and adapt to the changing needs of developers and development teams, several avenues for expansion, enhancement, and innovation emerge. In this section, we explore the future scope of the Real Time Code Editor project across various dimensions, including technical advancements, integration with emerging technologies, market expansion, and community engagement.

Technical Advancements

The future of the Real Time Code Editor project lies in the continuous enhancement of its technical capabilities to meet the evolving demands of modern software development. Several areas of technical advancement hold promise for the project:

- *Performance Optimization:* Continued optimization of the Real Time Code Editor's underlying infrastructure, algorithms, and data processing techniques can further improve its scalability, responsiveness, and resource efficiency. This includes fine-tuning concurrency control algorithms, optimizing network communication protocols, and leveraging cloud computing technologies for dynamic scalability.
- *AI-driven Code Assistance:* Integration of artificial intelligence and machine learning technologies can empower the Real Time Code Editor with intelligent code analysis, error detection, and automated code suggestions. By leveraging natural language processing techniques, the editor can provide contextual code recommendations, identify potential bugs or vulnerabilities, and assist developers in writing cleaner, more efficient code.

Integration with Emerging Technologies

As technology continues to evolve, the Real Time Code Editor project can explore integration with emerging technologies to expand its capabilities and reach new audiences. Some potential areas of integration include:

- *Blockchain Technology*: Integration of blockchain technology can enhance the security, transparency, and integrity of collaborative coding sessions within the Real Time Code Editor. By leveraging blockchain-based authentication and encryption mechanisms, the editor can ensure secure access control, tamper-proof version history, and verifiable code contributions, enhancing trust and accountability among team members.
- *Internet of Things (IoT)*: Integration of IoT technologies can enable realtime monitoring and management of development environments directly within the Real Time Code Editor. By connecting IoT devices to development pipelines, developers can monitor system performance, deploy code updates, and troubleshoot issues seamlessly, improving development workflow automation and efficiency.

Research Issues

Research issues pertaining to the Real Time Code Editor project encompass a wide range of challenges, opportunities, and areas for exploration within the field of collaborative coding and real-time software development. In this section, we delve into several key research issues that warrant further investigation and academic inquiry:

Concurrency Control and Conflict Resolution

Research Problem: One of the fundamental challenges in real-time collaborative editing systems like the Real Time Code Editor is ensuring consistency and coherence among concurrent edits performed by multiple users. Concurrency control algorithms and conflict resolution strategies play a crucial role in maintaining data integrity and synchronization.

Research Opportunities: Future research can focus on developing novel concurrency control algorithms that are optimized for specific use cases and application domains. Additionally, investigating advanced conflict resolution techniques, such as operational transformation and conflict-free replicated data types (CRDTs), can contribute to more robust and scalable collaborative editing.

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APPENDIX

A. SOURCE CODE

CHAT INPUT

```
import { useContext, useRef } from "react" import {
  PaperPlaneRight } from "@phosphor-icons/react" import
  AppContext from "../context/AppContext" import
  ACTIONS from "../utils/actions" import { formatDate }
  from "../utils/formateDate"
import ChatContext from "../context/ChatContext"

function ChatInput() {
  const { socket, clients, roomId } = useContext(AppContext)
  const { setMessages } = useContext(ChatContext)
  const inputRef = useRef(null)

  const handleSendMessage = (e) => {
    e.preventDefault()

    const inputVal = inputRef.current.value.trim()
    const client = clients.find((client) => client.socketId === socket.id)

    if (inputVal.length > 0) {
      const message = {
        message: inputVal,
        username: client?.username || "Unknown",
        socketId: socket.id,
        timestamp: formatDate(new Date()),
      }
      socket.emit(ACTIONS.SEND_MESSAGE, { roomId, message })
      setMessages((messages) => [...messages, message])      inputRef.current.value
      = ""
    }
  }

  return (
    <form
      onSubmit={handleSendMessage}
      className="flex justify-between rounded-md border border-primary"
    >
      <input
        type="text"
        className="w-full flex-grow rounded-md border-none bg-dark p-2 outline-none"
        placeholder="Enter a message..."
        ref={inputRef}
      />
      <button
```

```

        className="flex items-center justify-center rounded-r-md bg-primary p-2 text-black"
type="submit"
    >
        <PaperPlaneRight size={24} weight="fill" />
    </button>
</form>
)
}

```

export default ChatInput

```

CHAT LIST import { useContext, useEffect, useRef }
from "react" import AppContext from
"../../context/AppContext" import ChatContext from
"../../context/ChatContext"

```

```

function ChatList() {
    const {
        messages,
        isNewMessage,      setIsNewMessage,
        lastScrollHeight,   setLastScrollHeight,
    } = useContext(ChatContext)  const {
        socket } = useContext(AppContext)
    const messagesContainerRef = useRef(null)

    const handleScroll = (e) => {
        setLastScrollHeight(e.target.scrollTop)
    }

    // Scroll to bottom when messages change
    useEffect(() => {
        messagesContainerRef.current.scrollTop =
        messagesContainerRef.current.scrollHeight
    }, [messages])

    useEffect(() => {
        if
        (isNewMessage) {
            setIsNewMessage(false)
        }
        messagesContainerRef.current.scrollTop = lastScrollHeight
    }, [isNewMessage, setIsNewMessage, lastScrollHeight])

    return (
        <div
            className="flex-grow overflow-auto rounded-md border-t-4 border-primary bg-darkHover p-2"
            ref={messagesContainerRef}
            onScroll={handleScroll}
        >
            { /* Chat messages */ }
        </div>
    )
}

```

```

        {messages.map((message, index) => {
return (
    <div
key={index}
        className={
            "mb-2 w-[80%] self-end break-words rounded-md bg-dark px-3 py-2" +
            (message.socketId === socket.id ? " ml-auto " : "")
        }
    >
        <div className="flex justify-between">
            <span className="text-xs text-primary">
                {message.username}
            </span>
            <span className="text-xs text-white">
                {message.timestamp}
            </span>
        </div>
        <p className="py-1">{message.message}</p>
    </div>
    )
    )}
    </div>
    )
}

```

export default ChatList

SOCKET CODE :

```
import { io } from "socket.io-client"
```

```
const BACKEND_URL = import.meta.env.VITE_BACKEND_URL
```

```
export const initSocket = () => {
return io(BACKEND_URL, {
    reconnectionAttempts: 5,
})
}
```

```
import { useContext, useEffect, useState } from "react"
import { useLocation, useNavigate, useParams } from "react-router-dom"
import { initSocket } from "../socket" import ACTIONS from
"../utils/actions" import { toast } from "react-hot-toast" import
AppContext from "../context/AppContext"
import socketStatus from "../utils/socketStatus"
```

```
function useSocket() {
const
location = useLocation()
const navigate = useNavigate()
```

```

    const { socket, setSocket, setClients, username, setUsername, setRoomId } =
useContext(AppContext)
    const [status, setStatus] = useState(socketStatus.CONNECTING)
const { roomId } = useParams()

    useEffect(() => {
        // if the client is not coming from the home page
        if (!location.state?.username) {      navigate("/", {
state: { roomId } })
        } else {
            // set username to context
            setRoomId(roomId)
            setUsername(location.state.username)
        }
    }, [navigate, roomId, location.state?.username, setUsername, setRoomId])

    useEffect(() => {      const
handleErrs = (err) => {
console.log("socket error", err)
    console.log("socket connection failed, try again later")
setStatus(socketStatus.FAILED)
}

    function init() {
        setStatus(socketStatus.CONNECTING)

        if (socket == null) {
const s = initSocket()
setSocket(s)
        }

        if (socket == null) return

        socket.on("connect", () => setStatus(socketStatus.CONNECTED))
socket.on("connect_error", handleErrs)
socket.on("connect_failed", handleErrs)

        socket.emit(ACTIONS.JOIN, {
roomId,
    username,
})

        socket.on(ACTIONS.UPDATE_CLIENTS_LIST, ({ clients }) => {
setClients(clients)
        })

        socket.on(ACTIONS.DISCONNECTED, ({ username, socketId }) => {
            toast.success(`${username} left the room`)

```

```

        alt="Code Sync Illustration"
        className="mx-auto w-[250px] sm:w-[400px]"
      />
    )}
  </div>
  <div className="flex w-full items-center justify-center sm:w-1/2">
    <FormComponent />
  </div>
</div>
{ /* <Footer /> */ }
</div>
)
}

```

export default HomePage

EDITOR PAGE : import SplitterComponent from
 "../components/SplitterComponent" import EditorComponent from
 "../components/editor/EditorComponent" import Sidebar from
 "../components/sidebar/Sidebar"
 import useClientActivity from "../hooks/useClientActivity"
 export default EditorPage

APP FILE :

import { Route, BrowserRouter as Router, Routes } from "react-router-dom"
 import Toast from "../components/toast/Toast" import EditorLayout from
 "../layouts/EditorLayout" import HomePage from "../pages/HomePage"
 import GitHubCorner from "../components/GitHubCorner"
 import useWindowDimensions from "../hooks/useWindowDimensions"

```

function App() {
  const { isMobile } = useWindowDimensions()
  return (
    <>
      <Toast /> { /* Toast component from react-hot-toast */ }
      { !isMobile && <GitHubCorner /> }
      <Router>
        <Routes>
          <Route path="/" element={ <HomePage /> } />
          <Route path="/editor/:roomId" element={ <EditorLayout /> } />
        </Routes>
      </Router>
    </>
  )
}

```

B. SCREENSHOTS

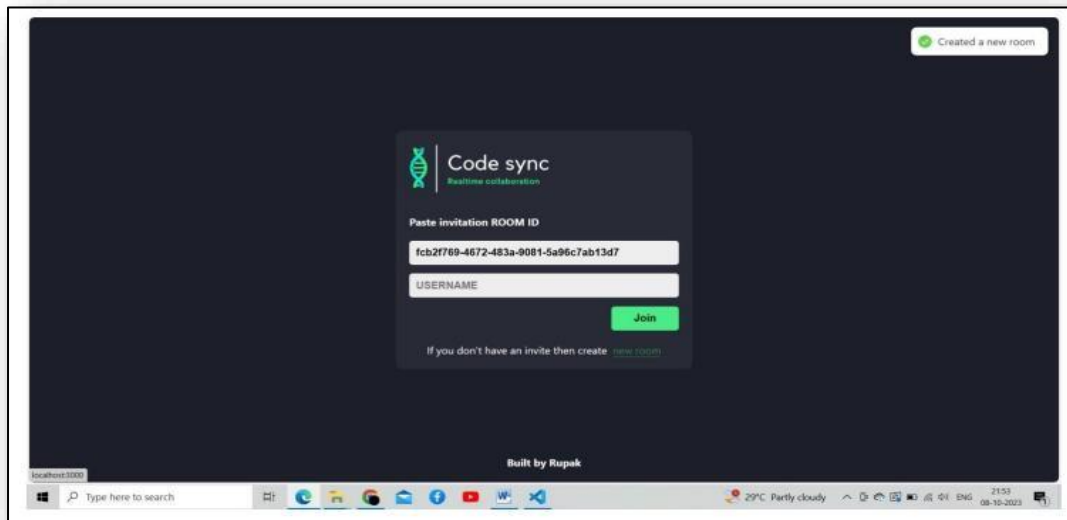


Fig.B.1: Login room

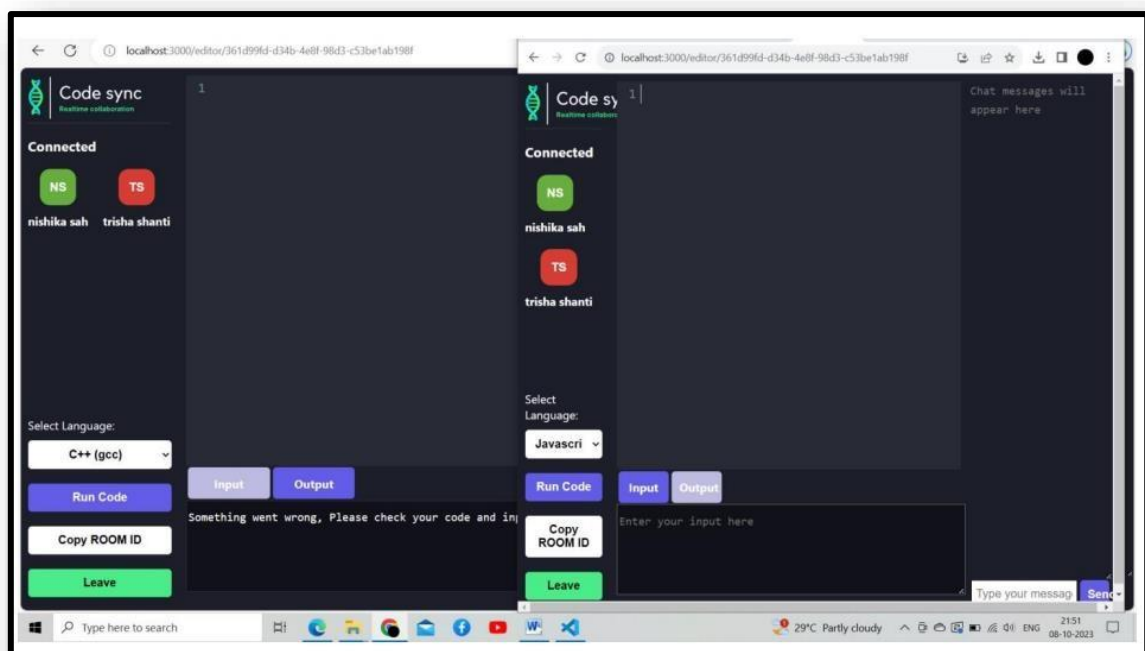


Fig.B.2:User And Client Screen

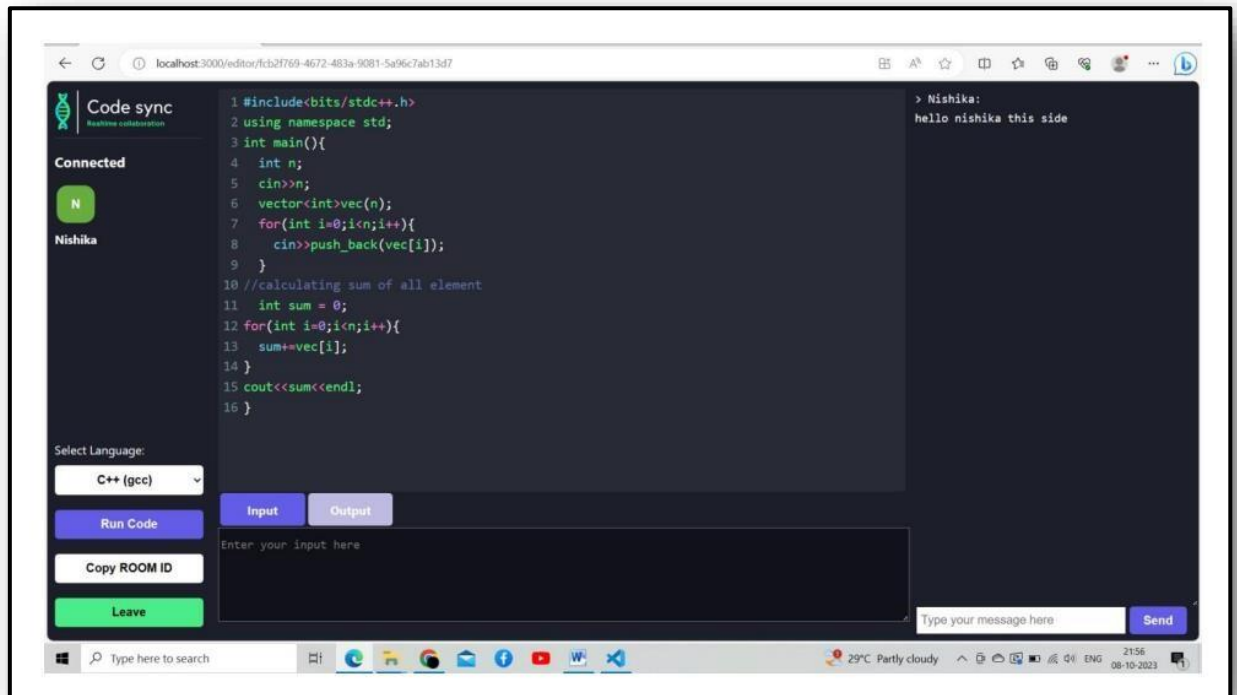


Fig.B.3: User Interfaces

Real Time Code Editor – OneSync

Nishika Sah¹, Shubhra Jyoti², Raja shree³

^{1,2,3}Sathyabama Institute of Science and Technology, Jeppiaar Nagar, 600119, Chennai, Tamil Nadu

Corresponding Author : rajashree.cse@sathyabama.ac.in

Abstract: Real Time Code Editor is a cutting-edge technology designed to revolutionize the world of software development by enabling real-time code collaboration. This abstract provides a concise overview of the technology's key points and objectives: Real Time Code Editor addresses the need for seamless collaboration among software developers. It seeks to streamline the development workflow, facilitate code reviews, and enhance team work. The technology boasts essential features like real-time code editing, collaborative workspaces, code review and commenting, robust version control, and seamless integration with popular development tools. Real Time Code Editor leverages advanced technologies, including Web Socket for real-time communication and git for version control. The user-friendly front-end is built on the React framework. Users can effortlessly initiate collaborative sessions, invite team members, and experience instantaneous updates as code changes synchronize in real-time. This technology significantly improves productivity and knowledge sharing within development teams. The technology's commitment to improvement includes expanding platform compatibility, integrating with additional tools, and enhancing security measures. In summary, Real Time Code Editor empowers software developers to collaborate effectively and efficiently, reducing development cycles and enhancing code quality. It serves as a catalyst for innovation and teamwork in the dynamic field of software development. In the fast-paced realm of software development, effective collaboration and streamlined code management are paramount. Enter "Real Time Code Editor," a groundbreaking technology poised to reshape the way developers work together in real-time. In an era where distributed teams, agile methodologies, and continuous integration are the norm, "Real Time Code Editor emerges as a catalyst for innovation and efficiency.

Keywords - Authentication : Room Id , Password , Dual Communication (Web Socket), Notification display, ChatBox , Code Editor , Mutiple Language Adoption.

I. INTRODUCTION

OneSync, a revolutionary application poised to redefine the landscape of collaborative software development, emerges as a beacon of innovation and efficiency in the rapidly evolving world of coding. In an era where effective teamwork and seamless collaboration are paramount for the success of software technologies, OneSync stands at the forefront of a new generation of tools designed to empower developers and foster creativity, irrespective of geographical boundaries. This application encapsulates the spirit of collaborative coding and aims to revolutionize the development process by offering an intuitive, real-time, and unified platform where developers can collaborate seamlessly, streamline code review, enhance version control, and boost productivity.

At its core, OneSync is driven by the philosophy that the intricacies of collaborative coding should remain hidden from developers. With an elegant abstraction layer, OneSync simplifies real-time synchronization and version control, enabling multiple developers to work simultaneously on the same codebase without the need for arduous manual integration of changes. This powerful abstraction empowers developers to focus exclusively on writing high-quality code, without the distractions of managing the complexities of collaboration and version control. The standout feature of OneSync lies in its interactive coding environment, where developers can engage in real-time collaborative coding sessions, sharing their expertise and creativity seamlessly. Participants can view, edit, and discuss code as it evolves, enabling immediate feedback and instant resolutions to coding challenges. This interactive and real-time approach promotes efficient communication, expediting the development pipeline and improving the overall quality of the codebase. Moreover, OneSync is a versatile tool designed to integrate seamlessly with popular development tools, languages, and frameworks. It eliminates the traditional barriers that separate developers by offering an open and inclusive platform, empowering development teams to work together effortlessly, regardless of their geographical location or preferred coding tools. In a world where remote work and global collaboration are becoming the norm, OneSync emerges as a vital tool for development teams to tackle challenges, boost productivity, and foster creativity in this interconnected digital age. The future of OneSync holds promise and potential for further innovation and enhancement. This application has the capacity to expand its compatibility and integration with a wider range of development environments, ensuring that it can meet the diverse needs of modern development teams. Additionally, OneSync can continue to improve security measures and ensure the privacy of sensitive code and data. With a commitment to user-centric design and a focus on streamlining and simplifying the coding

experience, OneSync has the potential to become the go-to solution for real-time code collaboration in the digital era.

II. PROPOSED METHOD

A. Room id and password

In the context of the described real-time code collaboration application, the generation of a "room ID" is typically based on a unique identifier assigned to a collaborative coding session. This ID is generated either automatically or by the user who initiates the session, allowing participants to join the same collaborative workspace. The room ID serves as an access key, ensuring that developers can securely enter the shared environment for real-time coding, code review, and collaborative work. It simplifies the process of creating and joining coding sessions, making it easier for developers to collaborate seamlessly, regardless of their geographical locations, and enhance their productivity. In the described real-time code collaboration application, the room ID plays a pivotal role in connecting developers and facilitating collaborative coding. Once a room ID is generated for a coding session, participants use this unique identifier to access the shared workspace. By entering the room ID, developers gain instant entry into the real-time coding environment, where they can interact, edit code together, conduct code reviews, and communicate seamlessly. This room ID serves as a virtual key that unlocks the door to collaborative coding, ensuring that team members can engage in synchronized development, share their expertise, and work in unison, irrespective of their physical locations, enhancing the efficiency and effectiveness of the coding process. In the described real-time code collaboration application, the generation of a password is typically initiated by the user who creates a coding session. The user, as the session host, has the option to set a password when configuring the session parameters. This password can be user-defined, allowing for flexibility and security. The host generates a password that is easy to share with the intended participants, ensuring that only those individuals with knowledge of the password can access the collaborative workspace. This user-generated password serves as a protective key, adding a security layer to the real-time coding environment and enabling the host to control and restrict access to authorized participants, enhancing data and code security during collaborative coding sessions. In the described real-time code collaboration application, a user-generated password is used to control access to collaborative coding sessions. The host, who initiated the session and set the password, shares this password with intended participants. To join the session, participants must enter the provided password, acting as a virtual key to unlock entry. This security measure ensures that only authorized users with knowledge of the password can access the shared workspace. It empowers the session host to maintain control and restrict access, thereby safeguarding sensitive code and data shared during the collaborative coding session, enhancing the overall security and privacy of the collaborative environment.

B. Code editor

OneSync, a real-time code editor, boasts a rich set of code editing functionalities that transform collaborative coding into a seamless and productive experience. These features are meticulously designed to cater to developers' needs and streamline the code editing process, whether they're working in the same room or across the globe. Simultaneous Code Editing OneSync's standout functionality allows multiple developers to edit the same codebase concurrently in real time. This collaborative feature eliminates the need for manual code sharing, making it effortless for team members to contribute to a technology simultaneously. Each developer can see live updates made by others, making the coding process truly interactive.

This feature empowers developers to tackle different parts of the code simultaneously, enhancing efficiency. The multi-cursor support also facilitates collective brainstorming and troubleshooting during coding sessions. Code Highlighting OneSync enhances code readability by providing real-time code highlighting. As developers make changes or additions, the application automatically highlights modifications, making it easier to track code revisions and identify areas that have been edited by team members. Instant Code Sync Real-time synchronization of code changes is at the core of OneSync. It ensures that every code alteration is immediately propagated to all participants' screens, eliminating the need for manual syncing and ensuring that everyone is working with the most up-to-date codebase. Live Code Collaboration With OneSync, developers can collaborate on code in real time, enhancing communication and problem-solving. Developers can leave comments directly within the code, engage in discussions, and make decisions collaboratively, ensuring that coding sessions are not just about writing code but

also about knowledge sharing and learning from one another. Real-Time Error Detection OneSync provides real-time error detection and highlighting. If a participant introduces an error in the code, it is flagged immediately, helping to maintain code quality and minimize the debugging process. This functionality ensures that code quality remains a priority during collaborative coding sessions.

C. Dual Communication

OneSync, as a leading real-time code collaboration platform, introduces a pivotal feature known as "Dual Communication." This innovative functionality transforms the way developers interact and collaborate during coding sessions, making the process more seamless, efficient, and conducive to productive teamwork. Real-Time Chat OneSync incorporates an integrated chat system, allowing participants to engage in real-time text-based conversations while collaborating on code. This chat functionality complements the code editing environment, enabling developers to discuss code, share ideas, ask questions, and provide feedback instantaneously. This feature eliminates the need for external communication tools, such as email or messaging apps, streamlining the collaborative process. It fosters a sense of virtual togetherness, enabling team members to communicate effectively and establish a collective understanding of the codebase. Video Conferencing In addition to real time chat. Dual Communication includes video conferencing capabilities. This allows participants to initiate live video calls within the OneSync environment. Video conferencing enhances the collaborative experience by enabling face-to-face interactions, making communication richer and more expressive. Developers can discuss code, brainstorm solutions, or simply connect on a personal level, irrespective of their physical locations.

D. Chatbox

The Chat Box feature in OneSync, the real-time code collaboration platform, plays a pivotal role in facilitating effective communication and collaboration among developers during coding sessions. This integrated chat functionality empowers participants to engage in real time text-based conversations directly within the coding environment, offering a range of benefits that enhance the collaborative coding experience.

Seamless Communication The Chat Box eliminates the need for external communication tools, such as email or messaging apps, providing a dedicated space for developers to interact while working on code. This eliminates communication barriers, ensuring that participants can instantly exchange ideas, ask questions, seek clarifications, and provide feedback without leaving the coding environment. Real-Time Collaboration With the Chat Box, developers can engage in real-time discussions related to the code they are working on. This fosters dynamic collaboration, enabling team members to share their insights, coordinate tasks, and collectively troubleshoot issues as they arise.

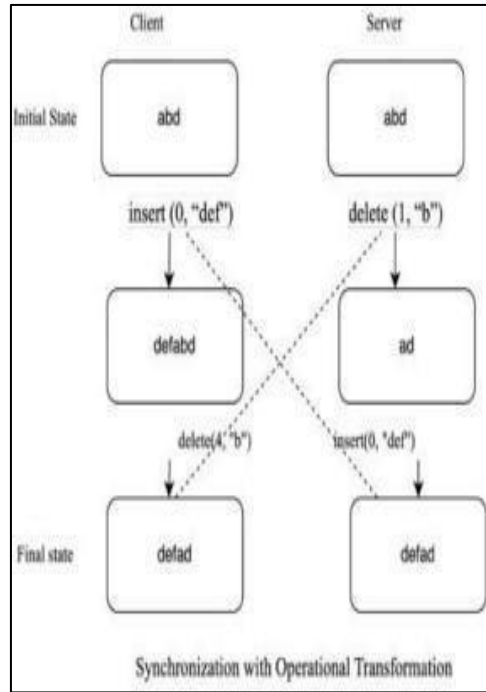


FIGURE 1. Operational Transformations

E. Security Implementation

1. **Use Secure WebSocket :** Utilize the "wss://" scheme to establish WebSocket connections over HTTPS. This ensures that the WebSocket communication is encrypted using SSL/TLS, providing confidentiality and integrity of data transmitted between the client and server.
2. **SSL/TLS Configuration:** Configure SSL/TLS settings on the server to enforce strong encryption protocols, cipher suites, and certificate validation. This helps prevent man-in-the-middle attacks and ensures that communication channels are secure.
3. **Authentication and Authorization:** Implement authentication mechanisms to verify the identity of clients connecting to the WebSocket server. Use techniques such as token-based authentication, OAuth, or JWT (JSON Web Tokens) to authenticate users securely. Additionally, enforce access control policies to authorize clients based on their roles and permissions.
4. **Secure Message Exchange:** Encrypt sensitive data before transmitting it over WebSocket connections. Use encryption algorithms such as AES (Advanced Encryption Standard) to encrypt data on the client-side and decrypt it on the server-side.
5. **Monitoring and Logging:** Monitor WebSocket traffic, server logs, and security events to detect suspicious activities and potential security breaches. Log important security-related events and errors for auditing and forensic analysis.
6. **Regular Security Audits:** Conduct regular security audits and penetration testing to identify vulnerabilities and weaknesses in the WebSocket application. Address any security issues promptly and apply security patches and updates as needed.

III. EXPERIMENTS

A. Experimental Setup

1) Experimental Background

The experimental background of the described application highlights a transformative shift in collaborative software development. Grounded in the need for more efficient and real-time coding collaboration, this application has emerged as a response to the growing demands of development teams worldwide. It stems from the recognition that traditional code sharing and collaboration methods often lead to inefficiencies and communication gaps. By combining real-time code editing, dual communication capabilities, and a robust chat box feature, the application pioneers a new era of collaborative coding. Its experimental foundation is rooted in the pursuit of enhanced productivity, code quality, and seamless teamwork, marking a paradigm shift in the way developers work together, irrespective of their geographical locations.

2) Experiment Setup Process

The experiment setup process in the described application involves a systematic approach to enable real-time code collaboration. It typically begins with the creation of a collaborative coding session by a user, who sets session parameters, including the choice of codebase, participants, and optional security features such as passwords. Once the session is initiated, participants use a unique session identifier to join the collaborative environment. Developers interact within the integrated code editing interface, accessing dual communication features like real-time chat and video conferencing. The chat box enhances communication, fosters discussions, and streamlines code reviews. The experiment setup is designed to facilitate seamless, real time, and secure coding sessions, ensuring that participants can engage in efficient collaborative coding while maintaining data privacy and version control integrity. system's interface settings are configured to facilitate user-friendly operation and data retrieval for a comprehensive evaluation of Code Editor performance.

B. Experimental Procedure

The experimental procedure for RealTime editor : OneSync involves five key steps: The experimental procedure within the described application, geared towards real-time code collaboration, is designed to provide a structured and effective framework for developers to seamlessly work together. This procedure can be broken down into several key steps:

1. **Session Initiation:** The process begins with a user initiating a collaborative coding session within the OneSync application. The user, often referred to as the session host, selects the codebase to work on and invites participants to join. The host may also choose to set security parameters, such as a password, to control access.
2. **Participant Access:** Invited participants receive a unique session identifier, often referred to as a "room ID" or password, allowing them to access the collaborative environment. This identifier is shared by the host and acts as a virtual key to unlock entry into the session.
3. **Real-Time Code Editing:** Once participants enter the session, they gain access to the integrated code editing interface. This interface allows developers to view, edit, and interact with the shared codebase in real time. Multiple participants can work on the code simultaneously, with changes synchronized instantly across all screens.
4. **Dual Communication:** In addition to code editing, participants can engage in real-time communication using dual communication features. The integrated chat box enables text-based discussions, allowing developers to ask questions, share ideas, provide feedback, and collaborate effectively. Simultaneously, video conferencing features allow face-to-face interactions and discussions, fostering a more personal and interactive experience.
5. **Code Review and Feedback:** The collaborative environment facilitates code review processes, with participants discussing code changes and providing feedback in real time. This interactive approach to code reviews ensures that issues are identified and resolved swiftly, leading to improved code quality.
6. **Documentation and Context:** Chat conversations serve as a valuable source of documentation and context for the codebase. Participants can document decisions, provide context for code changes, and share knowledge for future reference, ensuring a well-documented and accessible codebase.
7. **Work Coordination:** Beyond technical discussions, the platform allows participants to coordinate work related matters, such as timelines, milestones, and non-technical aspects. This ensures that the work remains organized and aligned with the team's objectives.

8. Remote Collaboration: The procedure accommodates remote collaboration, making it possible for development teams to work together effectively, regardless of their geographical locations. It bridges the gap between in-house and remote developers, ensuring that everyone is connected and informed.

V. CONCLUSION

In conclusion, the described application, dedicated to real-time code collaboration, represents a paradigm shift in the way developers work together, communicate, and produce high-quality code. This innovative platform embodies the core principles of efficiency, real-time interaction, and data security, marking a significant advancement in the world of software development. First and foremost, this application has redefined the collaborative coding experience by introducing a seamless real-time code editing environment.

Developers can simultaneously edit a shared codebase, eliminating the need for manual code merging and enhancing the coding process. The multi-cursor support, real-time error detection, and intelligent code suggestions significantly boost productivity and code quality, making development teams more efficient. One of the standout features of this application is Dual Communication, which encompasses real-time chat and video conferencing. This dual functionality has transformed the way developers communicate and collaborate. Realtime chat enhances interactive discussions, code reviews, and issue resolution, while video conferencing adds a personal touch to remote collaboration. Developers can build stronger professional relationships, share insights, and brainstorm ideas as if they were in the same room, fostering a sense of unity within the team. The Chat Box feature, another integral component, ensures that developers can discuss code, share ideas, provide feedback, and coordinate work-related matters in real time. This consolidated communication environment reduces communication overhead, maintains context, and promotes knowledge sharing, all within the coding interface. Furthermore, this feature acts as a valuable source of documentation for the codebase. Security and privacy are paramount, and the application addresses these concerns effectively. Password protection adds an extra layer of security, ensuring that only authorized participants can access the collaborative workspace.

ACKNOWLEDGMENTS

We extend our heartfelt gratitude to all those who have contributed to the development of our real-time code editor application. Firstly, we express our sincere appreciation to our development team for their dedication, expertise, and tireless efforts in bringing this technology to fruition. Their commitment to excellence and collaborative spirit have been instrumental in shaping the application's features and functionality.

We are also deeply grateful to our beta testers and early adopters for their valuable feedback, suggestions, and testing efforts. Lastly, we express our gratitude to our users for their trust and support. It is our privilege to serve the coding community and provide a platform for collaborative coding experiences. Together, we look forward to continuing this journey of innovation, collaboration, and excellence in software development. Thank you for being a part of our real-time code editor technology.

The Real-Time Code Editor technology incorporates several key features aimed at enhancing productivity and promoting knowledge sharing among development teams:

1. Simultaneous Code Editing: Enables multiple developers to collaborate on the same codebase simultaneously in real time, facilitating teamwork and reducing development cycle times.
2. Live Code Collaboration: Provides a platform for developers to work together in real time, allowing for instant feedback, idea exchange, and collective problem-solving.
3. Integrated Chat: Offers a built-in chat feature within the coding environment, allowing developers to communicate seamlessly, discuss code changes, ask questions, and share resources.
4. Code Highlighting and Error Detection: Highlights code changes in real time and detects errors as they occur, aiding in code review and ensuring code quality.

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CERTIFICATE