A Project report on

Skylinker Aero Pathways

A Dissertation submitted to JNTU Hyderabad in partial fulfillment of the academic requirements for the award of the degree.

Bachelor of Technology

in

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CERTIFICATE

This is to certify that the Major Project report entitled **"SkyLinker Aero Pathways"** being submitted by **P Shreyansh Srikar Rao (20H51A05D2), P Nithin Varma Reddy (20H51A05F1), V V S Charan Reddy (20H51A0578)** in partial fulfillment for the award of **Bachelor of Technology in COMPUTER SCIENCE AND ENGINEERING** is a record of bonafide work carried out under my guidance and supervision.

The results embodies in this project report have not been submitted to any other University or Institute for the award of any Degree.

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EXTERNAL EXAMINER

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ABSTRACT

As an aviation enthusiast team, we have always been fascinated by aeroplanes and airports. During one of our regular plane-spotting visits to observe aircraft take-offs and landings, we started wondering how one could keep track of all the flights in real time. That sparked the idea of building an aircraft tracking application. After initial research, we discovered ADS-B (Automatic Dependent Surveillance-Broadcast) - a system where aircraft broadcast their position via radio signals. We realized these publicly available ADS-B feeds could provide the real-time flight data needed for our tracking app idea [3].

Flying is revolutionised by the SkyLinker Aero Pathways Application, which combines innovative technology with a solid foundation. Using a range of programming languages and advanced tools, it smoothly merges real-time flight monitoring, predictive analytics, and user-friendly interfaces.

Modern web technologies like JavaScript, HTML, and CSS are used to build the application's front-end interface, with the assistance of frameworks like React and Angular. This guarantees responsive and dynamic user interactions, making it simple for travellers and aviation enthusiasts to see flights on interactive maps. A FullStack Application will be correct for development[2].

The backend employs a microservices architecture (Python, Java, or Node.js) for tasks like notifications, predictive algorithms, and flight data retrieval, relying on RESTful APIs. Cloud platforms like AWS or Azure provide scalable hosting. Databases (MySQL, PostgreSQL, MongoDB) ensure efficient data management, preserving flight data and user preferences[5].

Leveraging WebSocket, SSE, front-end tools, databases, cloud, microservices, and RESTful APIs, the Flight Tracker provides instant flight updates, revolutionizing aviation data interaction. Accurate monitoring, predictive insights, and engaging interfaces transform travel, enhancing user experience.

CHAPTER 1
INTRODUCTION

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INTRODUCTION

1.1. Problem Statement

Keeping track of real-time flight information is a challenging yet critical task for many travelers and aviation enthusiasts. However, existing flight tracking options lack key features and functionality that would enable smooth, engaging, and predictive flight monitoring experiences. Most flight tracking apps and websites rely on outdated technologies that cannot deliver instantaneous flight updates. Their user interfaces often lack intuitiveness and interactivity, making it tedious to search, track, and analyze flight statuses. Additionally, very few platforms incorporate predictive analytics to forecast flight delays or other irregular operations. There is a need for an innovative flight tracking solution that leverages modern web technologies, microservices architectures, cloud platforms. By combining real-time data feeds, automated notifications, interactive maps, and intelligent predictions, such a platform could revolutionize how travelers and aviation geeks monitor and interact with airline flight information. The proposed SkyLinker Aero Pathways application aims to fill this gap and transform flight tracking. By building a responsive frontend, scalable backend, and leveraging capabilities like WebSocket and predictive analytics, SkyLinker Aero Pathways can offer travelers and enthusiasts an engaging, smooth, and insightful flight monitoring experience. The development of this real-time, intelligent, and user-friendly flight tracking application will greatly enrich aviation data interaction[2].

1.2. Research Objective

To develop an innovative flight tracking application (SkyLinker Aero Pathways) that provides real-time flight status updates and predictive insights to travelers and aviation enthusiasts through modern web technologies, microservices architectures, and intelligent algorithms. More specifically, the key research goals can be summarized as:

•Leveraging ADS-B and other real-time flight data feeds to enable live flight monitoring capabilities.

•Building responsive front-end interfaces with JavaScript, HTML, CSS to allow intuitive flight searching and tracking experiences.

•Implementing scalable back-end microservices in Python, Java, Node.js for tasks like notifications, predictions[5].

•Using cloud platforms like AWS and Azure to host and scale the application.

•Incorporating predictive algorithms and models to forecast flight delays or irregular operations.

•Providing travelers and aviation geeks engaging, smooth, and insightful interfaces to interact with flight status data.

•Evaluating the usability, performance, accuracy, and impact of the SkyLinker Aero Pathways flight tracking application.

So in summary, the core research objective is to design, develop, and evaluate an innovative real-time flight tracking application called SkyLinker Aero Pathways using modern programming stacks and predictive analytics. The goal is to revolutionize how users monitor and interact with live aviation data.

1.3. Project Scope

Scope:

- The flight tracking application will be named SkyLinker Aero Pathways and developed for web and mobile platforms.
- It will provide real-time flight status updates for commercial flights worldwide by leveraging data sources like ADS-B feeds.
- Users will be able to search, track, and save flights to get instant notifications on status changes. Interactive maps will display flight positions and details.
- Predictive algorithms will forecast delays and irregular operations.
- The frontend will be built using React, Angular, HTML, CSS, JavaScript.
- The backend will use a microservices architecture with languages like Python, Java, Node.js.
- Cloud platforms like AWS and Azure will be used for hosting and scalability.
- Data will be stored in SQL and NoSQL databases like MySQL, MongoDB.
- The focus will be on building a minimum viable product (MVP) with core functionalities.

Limitations:

- The app will only cover commercial flights and airports with available real-time data feeds.
- Military, cargo, or private flights will not be trackable initially.
- Predictive capabilities will be limited to delays and irregular ops to start.
- Advanced features like booking, seat selection, baggage tracking etc. are out of scope.
- Only web and mobile apps will be built. No desktop or tablet versions to start.
- Access will be limited to search and tracking functions. Account registration is optional.
- The MVP will target key user workflows and scenarios. Additional nice-to-have features may come later.

So, in summary, the scope covers building a flight-tracking MVP focused on real-time status, notifications, predictions and clean interfaces, while limitations include flight types, features, platforms, users etc.

CHAPTER 2
BACKGROUND WORK

CHAPTER 2

BACKGROUND WORK

2.1 Flightradar24

2.1.1 Introduction:

In the modern world, flight tracking has become an essential component of air travel. Passengers, airports, and aviation enthusiasts require ways to track these aircraft in real-time as they frequently cross continents and seas. This is where Flightradar24 has intervened to transform the experience of flight tracking.

One of the most well-known flights tracking systems worldwide, Flightradar24 was established in 2006 by two aviation enthusiasts in Sweden. Through its website, mobile applications, and ADS-B receiver network, it offers real-time information on thousands of planes all over the world. Flightradar24 allows users to track flights in full from the moment engines are started at the gate until it lands at the destination, in contrast to flight status boards at airports that only display a limited amount of information.

An interactive map shows specific information like altitude, speed, aircraft type, and flight path. Users can quickly search for and follow flights using the flight number, airport, airline, or type of aircraft. The majority of contemporary aircraft are equipped with ADS-B transponders, which frequently transmit aircraft information and are the source of this data. These signals are picked up by the over 28,000 ADS-B receivers that Flightradar24 has placed across the world to provide real-time data. This network is enhanced by additional radar, airline, and MLAT data.

Flightradar24 has established itself as the go-to flight tracking alternative for tourists, aviation enthusiasts, and even airlines thanks to its appealing features, user-friendly interface, and global reach. It presently serves over 600 million flight tracking requests each month and has a community of over 2 million active users. Flightradar24 has transformed the public's access to real-time flight information from all over the world, benefiting everyone from anxious travelers to aviation enthusiasts. Its extensive database and user-friendly interface provide an unrivalled flight monitoring experience [1].

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2.1.2 Merits, Demerits and Challenges.

Merits:

- Provides real-time flight tracking data for thousands of aircraft globally.
- User-friendly interface and mobile apps make flight monitoring very accessible.
- Detailed flight information like altitude, speed, aircraft type etc.
- Global network of ADS-B receivers enables wide flight data coverage.
- Options for advanced data analytics and exports through premium plans.
- Large flight and aircraft database accumulated over the years.
- Innovative use of technologies like ADS-B, MLAT, microservices, interactive maps.

Demerits:

- Requires internet connectivity and good data speeds for real-time tracking.
- Not all regions have comprehensive ADS-B coverage currently.
- Basic service is free but advanced features require paid plans.
- Potential errors or gaps in flight data from sources like ADS-B feeds.
- Does not cover certain flight types like military, cargo or private planes.
- Faces competition from other flight tracking services and apps.

Challenges:

- Expanding ADS-B receiver network to maintain global flight data coverage.
- Handling and processing exponentially increasing flight data volumes.
- Redundancies to address any data source outages or coverage gaps.
- Delivering low-latency experiences for real-time tracking as usage grows.
- Rolling out new features while maintaining system stability and uptime.
- Protecting flight data security and user privacy with cybersecurity measures.
- Evolving data analytics capabilities to provide more insights over time.

2.1.3 Implementation of Flightradar24

- Data Collection
- Deploy a global network of ADS-B receivers to pick up aircraft broadcasts
- Establish data sharing agreements with aviation authorities for radar data
- Partner with airlines to receive direct data feeds and flight details
- Backend Infrastructure
- Build a scalable microservices architecture on cloud platforms like AWS
- Ingestion services to take in and validate various data feeds
- Enrichment services to add metadata like flight numbers, aircraft info etc.
- Calculation services to derive flight parameters like altitude, speed
- Databases like PostgreSQL, Elasticsearch to store processed flight data
- Frontend Applications
- Develop interactive map visualizations using JavaScript, WebGL, D3.js
- Enable searching and tracking flights via routes, numbers, airports etc.
- Create flight cards showing details like position, altitude, heading
- Build mobile apps for iOS and Android for on-the-go tracking
- Allow saving searches, getting notifications, sharing flight links
- Analysis and Operations
- Implement machine learning pipelines for predictive flight delay models
- Develop dashboards and analytics to derive operational insights
- Monitor performance metrics and logs for issue detection
- Conduct load testing and failover drills to ensure high availability
- Create administration portals for managing data sources and receivers
- With these key components, Flightradar24 leverages innovative data collection, scalable architectures, compelling visualizations and operational excellence to deliver an end-to-end real-time flight tracking experience [1].

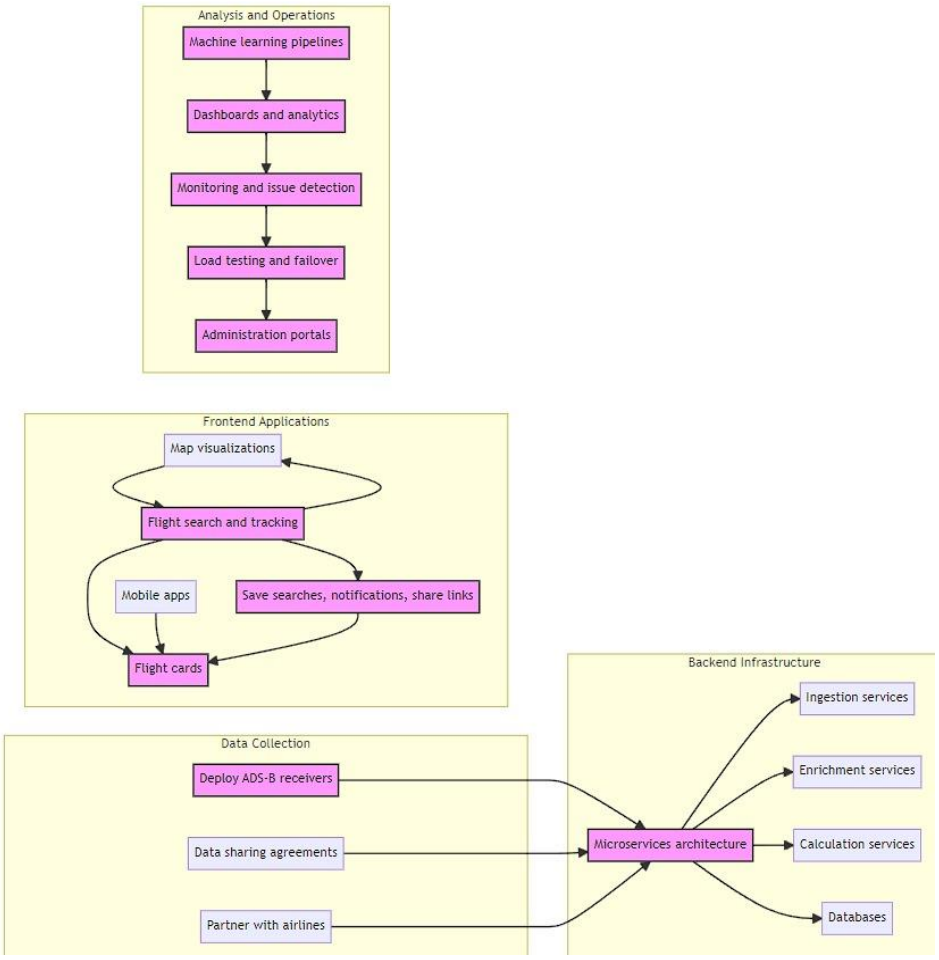

Fig no 2.1.1: Flightradar Architecture

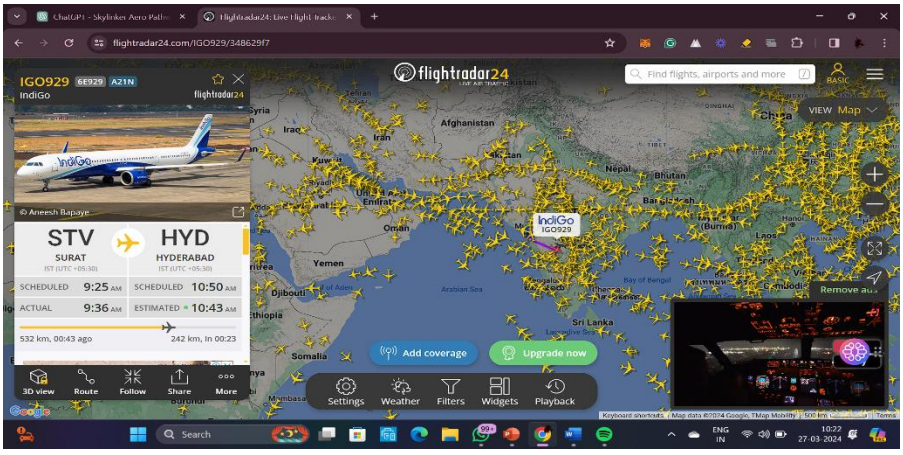

Fig no 2.1.2: Flightradar24 Website

2.2.Flightaware

2.2.1 Introduction

Real-time flight tracking has become an integral part of modern aviation and air travel. FlightAware is one of the leading innovators in this space, providing insightful flight monitoring capabilities to passengers, operators and aviation members.

Founded in 2005, FlightAware was one of the first companies to realize the potential of fusing data from multiple sources like FAA surveillance systems, airline databases and positioning technologies to create a comprehensive real-time flight tracking and status platform.

Powered by a global network of terrestrial and satellite ADS-B receivers, FlightAware collects and processes over 100,000 flights per day amounting to over 150 million flight positions daily. This enables tracking flights worldwide across airline, private, cargo and more.

With an easy to use interface, travelers can search and track flights, set up alerts and access predictive data like delay probabilities. Airlines and operators use FlightAware for operational analytics, flight planning, crew management and more.

Features like 3D flight replay and route animations appeal to aviation geeks. FlightAware also provides a robust API allowing partners to integrate its flight data into custom solutions.

Through its early innovative efforts in harnessing novel data sources and technologies for flight tracking, FlightAware has ensured continuous access to global flight information for the modern aviation industry. Its comprehensive real-time data and intuitive interfaces deliver flight monitoring experiences unmatched in accuracy and ease of use [4].

2.2.2: Merits, Demerits & Challenges

Merits:

- Real-time flight tracking using extensive ADS-B receiver network and satellites.
- Combines multiple data sources like ADS-B, airline feeds, FAA systems.
- Scalable cloud-based infrastructure handles large volumes of flight data.
- Intuitive apps and interfaces for consumers to track flights.
- Powerful analytics and tools for aviation operators and crew.
- 3D visualizations and animations appeal to aviation enthusiasts.
- APIs allow the development of custom solutions using flight data.

Demerits:

- Requires paid premium subscriptions for some advanced features.
- Limited coverage in regions still lacking ADS-B infrastructure.
- Potential data gaps or lags if an outage occurs.
- Not all airlines share direct data feeds.
- Less emphasis on predictive analytics compared to some competitors.

Challenges:

- Expanding ADS-B and satellite coverage to maintain real-time global tracking.
- Handling exponentially increasing flight data volumes smoothly.
- Updating infrastructure to leverage new technologies like AI/ML.
- Delivering low-latency experiences as user base increases.
- Developing more advanced predictive flight delay/status models.
- Enhancing cybersecurity and protection of user data.
- Evolving pricing model as flight tracking becomes more common

2.2.3 Implementation of FlightAware

FlightAware, one of the largest flight tracking services in the world, is implemented in a similar way to Flightradar24, with a few key differences.

Data Collection:

- FlightAware operates its own network of ADS-B receivers, but also accepts data from third-party receivers, including those operated by Flightradar24.
- FlightAware has data sharing agreements with air traffic control authorities in over 45 countries, giving it access to radar data.
- FlightAware also partners with airlines and other aviation organizations to receive direct data feeds and flight details.

Backend Infrastructure:

- FlightAware uses a cloud-based infrastructure to process and store its data.
- FlightAware's backend infrastructure is designed to be scalable and reliable, able to handle millions of data points per second.
- FlightAware uses a variety of databases to store its data, including PostgreSQL, Elasticsearch, and Redis.

Frontend Applications:

- FlightAware offers a variety of front-end applications, including a website, mobile apps, and APIs.
- FlightAware's website and mobile apps allow users to track flights in real time, view flight schedules, and get flight status alerts.
- FlightAware's APIs allow developers to integrate FlightAware data into their own applications.

Analysis and Operations:

- FlightAware uses machine learning to analyze its data and provide insights, such as predictive flight delay models and estimated arrival times.
- FlightAware also uses its data to develop dashboards and analytics for aviation professionals.

FlightAware monitors its performance metrics and logs to identify and resolve issues quickly.

- FlightAware conducts load testing and failover drills to ensure that its service is always available.
- FlightAware also offers a variety of administration portals for managing data sources and receivers [4].

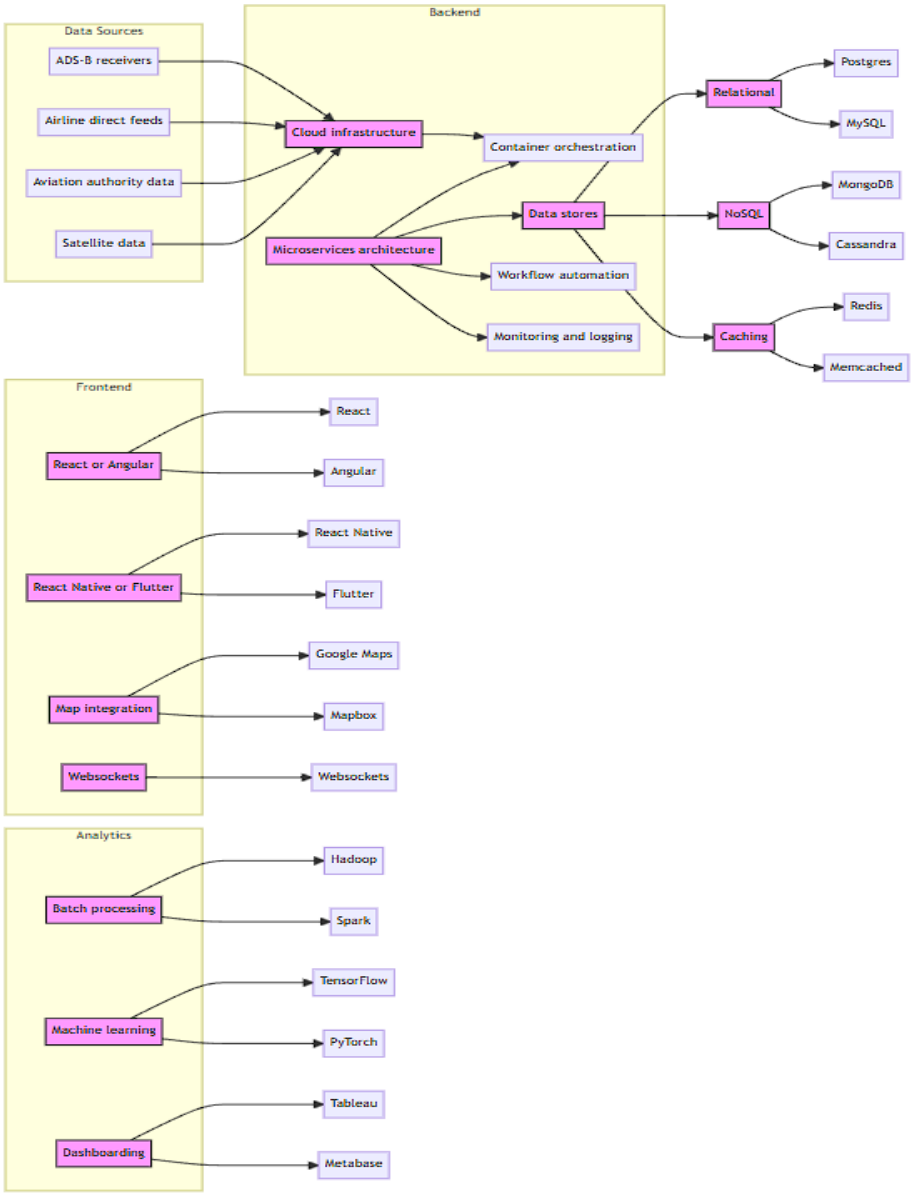

Fig 2.2.1:Flightaware

2.3. FlightStats

2.3.1 Introduction

In today's aviation industry, access to real-time flight information is critical for operators and passengers alike. FlightStats has been a leader in providing insightful flight status data since its founding in 2005. Powered by a global network of terrestrial and satellite ADS-B receivers, FlightStats provides accurate real-time flight tracking for thousands of commercial flights worldwide. Its flight status data covers departures, arrivals, gate assignments, taxi details and more. For passengers, FlightStats allows tracking flights in real-time as well as accessing historical on-time performance data. Its mobile apps and flight alerts ensure travelers are notified promptly about delays or gate changes. For aviation operators, FlightStats offers a suite of flight planning, dispatch and operational tools leveraging real-time data fusion and predictive analytics. Airlines use these capabilities for crew management, fuel optimization and irregular operations. With its combination of real-time flight monitoring, predictive capabilities and data-driven operational analytics products, FlightStats delivers actionable intelligence. Its flexible APIs also allow partners to build custom solutions using FlightStats data. By providing insights from pre-departure to landing backed by technical innovation, FlightStats continues to power the evolving needs of 21st century aviation. Its platforms ensure passengers, airlines, airports and other stakeholders have access to accurate real-time flight information [6]

2.3.2: Merits, Demerits & Challenges.

Here are some potential merits, demerits and challenges for FlightStats in providing flight tracking services:

Merits:

- Real-time flight status tracking using global ADS-B receiver network
- Combination of multiple data sources including airline feeds
- Advanced predictive analytics capabilities using AI/ML
- Robust flight operations tools for airlines and operators
- Flexible APIs enable development of custom solutions
- Passenger-friendly interfaces and mobile apps
- Backed by technical expertise of Cirium company

Demerits:

- Limited free tracking capabilities, premium paid plans required
- Potential for data gaps in areas with poor ADS-B coverage
- Data accuracy depends on airline partnerships
- Competition from other flight trackers like FlightAware
- Additional value-adds beyond just tracking limited

Challenges:

- Scaling infrastructure to handle rapidly increasing data volumes
- Recruiting talent for cutting-edge predictive analytics
- Forging partnerships with more airlines to augment data
- Expanding ADS-B network to maintain real-time global coverage
- Redundancies required for high uptime despite outages
- Monetization difficult as flight tracking becomes commoditized
- Privacy regulations around use of passenger data

2.3.3: Implementation of Flights stats:

Here is an overview of how FlightStats could implement their flight-tracking platform:

- Deploy ADS-B receivers globally to collect real-time aircraft position data
- Partner with aviation authorities for radar and other air traffic data
- Establish direct feeds with major airlines to augment flight details
- Infrastructure
- Leverage cloud platforms like AWS for scalable hosting
- Build ingestion pipelines to take in diverse data feeds
- Microservices architecture using Node.js, Python, Java for modular components
- Relational databases like PostgreSQL for structured flight data
- Fast NoSQL caches like Redis for frequent queries
- Kubernetes for container orchestration and deployment
- Frontend
- Develop web apps using React/Angular for interactive UIS
- Enable searching, tracking and alerts for flights

- Integrate Google Maps for mapping flight positions
- Build mobile apps for iOS and Android devices
- Collect historical on-time performance data
- Train machine learning models to identify delay indicators
- Predict probability of delays using Gradient Boosting, Random Forests
- Expose delay predictions via APIs for apps

With these core pieces - scalable infrastructure, real-time + predictive data, and engaging frontends - FlightStats can deliver an end-to-end flight tracking platform that caters to passengers, airlines, operators and developers [6].

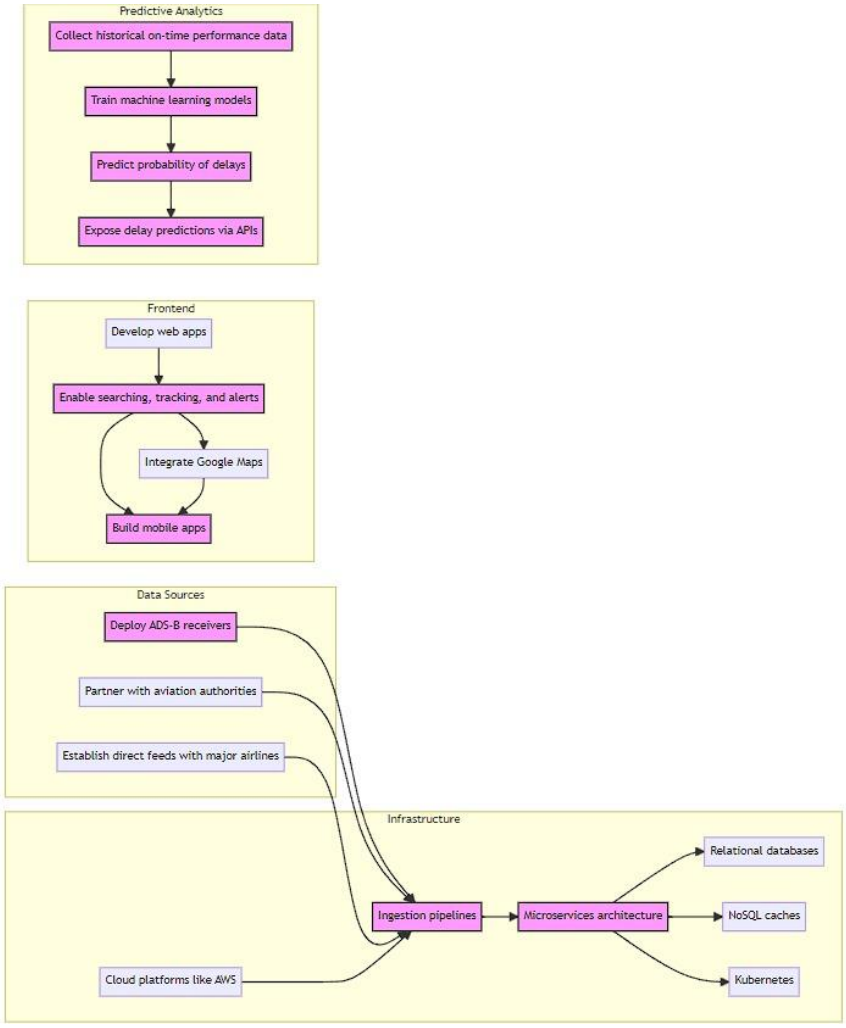

Fig no 2.3.1:Flightstats

CHAPTER 3
PROPOSED SYSTEM

CHAPTER 3

PROPOSED SYSTEM

3.1. Objective of Proposed Model

The objective of the Proposed model is to develop a Flight-tracking web application with a Simple and clean UI for user understanding because existing flight-tracking applications Many flight-tracking applications suffer from cluttered or outdated user interfaces, making navigation and usage challenging for users. An intuitive and user-friendly design is crucial for enhancing user engagement and satisfaction Users want to know the airport's flight schedule and airport details it takes lots of work need to do. A Full-stack application where its tech stack is suitable for developing the flight tracking application, we will be choosing MERN Stack for where its most used stack because of its features. Let's Describe in detail points[5].

1. **Enhanced Real-time Data Accuracy and Coverage**:
    - **Action Plan**: Integrate with multiple aviation data providers to ensure redundancy and comprehensive coverage. Implement real-time data processing techniques to minimize latency.
    - **Rationale**: Accurate and extensive real-time data ensures users receive timely updates, enhancing reliability and trust in our application.
2. **Comprehensive Search Functionality**:
    - **Action Plan**: Develop an advanced search engine within the app that supports multiple parameters including airports, airlines, flight numbers, dates, and routes.
    - **Rationale**: A multifaceted search engine addresses diverse user needs, making the application more versatile and user-friendly.
3. **User Experience Enhancement**:
    - **Action Plan**: Adopt modern UI/UX design principles, utilizing frameworks like React for smooth, responsive interfaces. Incorporate user feedback to iterate on design choices.
    - **Rationale**: An intuitive and engaging interface increases user satisfaction and retention,

differentiating our app in a crowded market.

4.Personalization and User Engagement:

- **Action Plan**: Implement personalized features like flight watchlists, push notifications, and customizable alerts. Leverage user data to offer tailored recommendations and updates.
- **Rationale**: Personalization enhances user engagement by providing relevant and timely information, encouraging regular app usage.

5.Weather Information Integration:

- **Action Plan**: Partner with weather data providers to fetch and display weather forecasts for airports and flight paths. Integrate this information into flight details and search results.
- **Rationale**: Providing weather insights adds value by helping users make informed decisions, especially during adverse conditions.

6. Accessibility and Internationalization:

- **Action Plan**: Design the app with accessibility in mind, following guidelines like WCAG. Implement internationalization features to support multiple languages and regional settings.
- **Rationale**: Accessibility and internationalization widen the app's appeal, making it usable and friendly for a global audience.

7. Performance and Scalability:

- **Action Plan**: Optimize backend infrastructure for high performance, using technologies like Node.js and MongoDB. Plan for scalability by using cloud services like AWS or Google Cloud Platform.
- **Rationale**: Ensuring the app is performant and scalable under heavy load is crucial for maintaining a smooth user experience and accommodating growth.

3.2: Algorithms Used for Proposed Model

Algorithms used for the Proposed Model where we implemented in Fullstack Application MERN(MongoDB, Express,React,Node.js) stack is chosen. Algorithms had been classified and we divided it into Frontend and Backend. So Algorithms we used let's go order-wise.By using express and React.js[5][7].

1.FlightMap.js - Real-Time Flight Tracking on Map

Geospatial rendering refers to the process of displaying geographical data (like the positions of flights) on a map in a way that's understandable and interactive for users. This involves several key steps and algorithms:

1)Coordinate Conversion:

• **Projection**: The Earth is a three-dimensional object, but maps are two-dimensional. Geospatial rendering algorithms start with a projection process, which transforms the globe's spherical coordinates (latitude and longitude) into flat, planar coordinates. Different projection algorithms (e.g., Mercator, WGS84) prioritize preserving different properties, such as area, shape, distance, or direction.

• **Scaling**: Depending on the zoom level of the map, the algorithm adjusts the scale of the projection to show more detail (closer view) or less detail (farther view). This dynamic scaling is essential for real-time tracking, allowing users to zoom in on a specific flight or zoom out to see multiple flights across regions or continents.

2)Data Overlay:

• **Marker Placement**: Once the geographic coordinates are projected onto the map, the algorithm places markers (icons representing flights) at the corresponding positions. React Leaflet uses a Marker component for this, which needs the projected coordinates to position each flight accurately.

Libraries and Technologies

React Leaflet abstracts much of the complexity involved in geospatial rendering, providing a React-friendly API on top of Leaflet.js, a leading open-source JavaScript library for mobile-friendly interactive maps. Leaflet handles the heavy lifting of:

•Map rendering based on tile layers from various sources (e.g., OpenStreetMap, Mapbox).

•Efficiently managing and updating large numbers of markers and paths.

•Handling user interactions like zooming and panning with optimized performance.

2.FlightSearch.js-Searching For Flight Information(Data-Fetching Algorithm)

The process of fetching, processing, and displaying flight information can be considered through a series of algorithmic steps. These steps ensure that the application efficiently retrieves data based on user input (like a flight number), processes that data, and updates the user interface to display the relevant flight details. Here's how the algorithm unfolds, specifically tailored to handling flight details.

Step 1: User Input Retrieval

- **Input Collection**: The algorithm starts by collecting a flight number inputted by the user, which acts as a key parameter for the data request.

Step 2: Asynchronous API Request

- **Request Initialization**: With the flight number, the algorithm constructs and sends an asynchronous HTTP GET request to a server or flight information API. This step is crucial as it fetches the raw flight details needed.
- **Promise Handling**: This request returns a promise that will eventually resolve with the flight data or reject if an error occurs.

Step 3: Response Processing

- **Data Extraction**: Upon successful promise resolution, the algorithm extracts and processes the flight details from the response. This might include parsing JSON data to retrieve specific attributes such as departure time, arrival time, flight status, and so on.
- **Error Management**: If the promise is rejected, the algorithm handles errors by capturing them in a catch block, possibly logging them and updating the UI to inform the user.

Step 4: State Management for UI Update

- **State Update:** The algorithm updates the component's state with the new flight details. In React, this is typically achieved through a state setter function (e.g., **setFlightDetails**), triggering a re-render.
- **Conditional Rendering**: Based on the state's new value, the algorithm dictates how and what flight details are rendered in the UI. This could involve displaying a detailed breakdown of the flight information, such as the airline, flight path, scheduled times, and current status.

Step 5: UI Refresh to Display Flight Details

• **Dynamic Rendering**: The component re-renders to reflect the updated state, displaying the fetched flight details in the designated UI elements. This step is seamlessly managed by React's reactivity system, ensuring that the user interface is always in sync with the latest state.

- **Interactive Elements**: Additionally, the algorithm may dictate the rendering of interactive elements, such as maps or charts, based on the flight details, enhancing the user's comprehension and interaction with the data.

Error Handling and Feedback

- **Feedback Loop**: Throughout the process, the algorithm ensures that any errors encountered during data fetching or processing are communicated back to the user, maintaining transparency and enhancing user experience.

3. Airport Search-Airport Information Search Algorithm

The algorithm for airport information search and its integration with geolocation features for map visualization can be outlined in detail. The process involves several key steps: user interaction, data fetching, error handling, geolocation fetching, and map rendering.

Step 1: Capturing User Query

- **User Input**: The user enters a search query (e.g., airport name or location) into a text field.
- **State Update**: React's state is updated with the entered query using the setQuery function, triggered by the onChange event of the text field.

Step 2: Fetching Airport Information

- **Initiating Search**: Upon clicking the "Search" button, the searchAirport function is invoked.
- **API Request**: This function makes an asynchronous fetch call to a server endpoint, passing the user's query as a URL parameter. This is done by encoding the query using encodeURIComponent and appending it to the endpoint URL.
- **Response Handling**: The response from the fetch call is awaited and then processed. If successful, the response is converted to JSON, and the state is updated with the fetched airport details using setAirportDetails. If the fetch call fails (e.g., due to network issues or if the response is not ok), an error message is set using setError.

Step 3: Error Handling

- **User Feedback**: Any errors encountered during the fetch operation (including those from the API or network errors) are captured and displayed to the user as feedback.

Step 4: Fetching User Geolocation

- **Geolocation API**: The browser's Geolocation API is used to obtain the user's current location, triggered by a separate button that calls fetchUserLocation.
- **Success and Error Handling**: If the location is successfully retrieved, the user's latitude and longitude are stored in the state. If location access is denied or not supported, an appropriate error message is set.

Step 5: Displaying Results and Map Visualization

- **Rendering Airport Details**: If airport details are successfully fetched, they are displayed in a card layout, including information like the airport name, city, country ID, time zone, elevation, ICAO code, and URL.
- **Map Integration with Leaflet**: A map is rendered using the Leaflet library wrapped in React-Leaflet's MapContainer component. The map centers on the coordinates of the fetched airport.
- **Marker Placement**: A marker is placed on the airport's location, with a popup displaying the airport's name, code, city, country ID, and elevation.
- **User Location to Airport Navigation**: If the user's location is fetched successfully, a link is provided that opens Google Maps in a new tab, directing the user from their current location to the airport using driving directions.

4. Airport Timetable data retrieval and processing algorithm

- The Timetable.js component, which fetches and displays an airport's flight timetable including departures and arrivals, primarily utilizes data retrieval and processing algorithms with a focus on asynchronous data fetching and dynamic data rendering. This algorithm is designed for displaying an airport's flight timetable, incorporating departures and arrivals. This functionality involves fetching data from an external API based on user input (i.e., the airport's IATA code), and then processing and rendering this data within a user interface. Here's how these algorithm types are applied in the context of the timetable functionality [5]:

Asynchronous Data Fetching

- **Purpose**: To retrieve flight information from a server or API without blocking the user interface, ensuring the application remains responsive.
- **Mechanism**: Utilizes axios for making asynchronous HTTP requests to fetch data based on user-specified criteria (e.g., airport IATA code). This involves handling promises or using the async/await syntax to manage asynchronous operations efficiently.

Dynamic Data Rendering

- **Purpose**: To dynamically update the user interface with the fetched flight information, allowing users to interact with the data (e.g., filtering based on flight numbers).
- **Mechanism**: Leverages React's state management to store fetched data and triggers re-renders of the component to display the data within a structured table format. It may include sorting or filtering functions to organize the displayed data according to specific criteria.

Combining Asynchronous Data Fetching with Dynamic Rendering

- The **Timetable.js** component's algorithm combines these aspects to provide an interactive and responsive experience:
- **Initiate Data Fetch**: On component mount or user action (e.g., entering an airport code), it asynchronously fetches flight data from an API.
- **Process and Store Data**: Upon successful data retrieval, the flight data is processed if necessary (e.g., formatted for display) and stored in the component's state.
- **Update UI**: The component re-renders to display the fetched data, utilizing React's efficient update mechanisms to only modify the necessary parts of the DOM.

Route Search algorithm

This type of algorithm primarily involves **data retrieval**, **filtering**, and **dynamic UI rendering**. Its main goal is to query a database or an external API for flight routes based on specific criteria—departure and arrival IATA codes in this case—and display the relevant information to the user. Here's a breakdown of the algorithmic process it follows:

Data Retrieval for Route-Based Search

1. **User Input Collection**: The algorithm starts by collecting user inputs for departure and arrival IATA codes. These inputs are stored in state variables (departureIata and arrivalIata), which are updated on every user interaction.

2. **Asynchronous API Request**: Upon initiating a search (typically triggered by a button click), the algorithm performs an asynchronous request to an external API or server. It uses these inputs to construct a query that filters the database for flights matching both the departure and arrival criteria.

This step involves constructing a URL with query parameters for the API request and handling the request asynchronously, typically using a promise-based HTTP client like axios.

3. **Response Handling and State Update**: The algorithm awaits the API's response, processes the received data, and updates the component's state with the fetched routes. This update triggers a re-render to display the new data.

- Error handling is also a critical part of this step, where any issues with the request (such as network errors or no data found) are caught and managed appropriately, often by updating the state with an error message or flag.

Dynamic UI Rendering

1. **Displaying Results**: Once the flight routes are fetched and stored in the state, the algorithm dictates how these routes are rendered in the UI. This typically involves dynamically generating a list or a set of cards that display the route details—like flight number, departure and arrival information, and possibly registration numbers for the aircraft.

- Special UI elements, such as icons for departure (FlightTakeoffIcon) and arrival (FlightLandIcon), enhance the visual representation of the data.

2. **Conditional Rendering and User Feedback**: The algorithm includes conditional rendering logic to handle different states of the data retrieval process, such as loading states, error messages, and the case where no routes are found for the given search criteria.

- This enhances the user experience by providing immediate and clear feedback on the status of their search.

3. **Interactive Elements for Detailed Information**: For routes with additional details (e.g., registration numbers), the algorithm may implement interactive elements (such as expand/collapse functionality) to toggle the visibility of this information, making the UI cleaner and more user-friendly.

5. Future Schedule Flights algorithm

This algorithm is part of a web application's functionality that enables users to search for and view historical flight information based on specific criteria, such as airport code and date. The

type of algorithm used here combines **asynchronous data fetching**, **state management**, and **conditional rendering** within a React component to achieve its objectives. Here's a detailed explanation.

Asynchronous Data Retrieval and Visualization

- **Asynchronous Data Retrieval**: The core of this algorithm involves making asynchronous API calls to fetch historical flight data from a backend service or an external API. This is crucial for not blocking the UI thread, allowing the web application to remain responsive.
- **Data Visualization**: Once the data is retrieved, it is visualized in the user interface, typically through dynamically generated components that display the historical flight details.
- **Algorithmic Steps in HistoricalFlight.js**
- **Initialize State**: Using React's useState hook, initial states are set for storing flight data (flights), user inputs (airportCode and searchDate), and possibly loading or error states.
- **Fetch Data on User Action or Component Mount**:
- **Effect Hook**: React's useEffect hook triggers the fetchData function when the component mounts or when relevant state variables change, such as the airport code or search date.
- **User Triggered Fetch**: A search function (handleSearch) allows users to initiate data fetching based on their inputs.

Asynchronous API Call:

- **API Request**: Utilizes axios to make a GET request to the specified endpoint, passing user inputs as query parameters.
- **Promise Handling**: Awaits the promise resolution from the API call and updates the component's state with the returned data. Includes error handling to catch and manage any exceptions that occur during the request.
- **State Update with Fetched Data**: On successful data retrieval, the flights state is updated with the response data, triggering a re-render of the component to display the new information.
- **Render Historical Flight Information**:
- **Conditional Rendering**: Based on the state of the flights array, the component conditionally renders the historical flight data. If data exists, it maps through the flights array, generating UI elements (cards, tables, etc.) for each flight.
    - **No Data Handling**: Displays a message if no historical data is found for the given criteria.
    - **UI Interaction for Detailed View**: Additional UI elements (e.g., buttons within each

flight's card) may offer users the option to view more detailed information about a specific flight.

6. Airport Data Modeling and Geospatial Indexing Algorithm

- **Data Modeling**: The process involves defining a schema for airport data, specifying the structure, types, and constraints of the data to be stored in MongoDB. Data modeling algorithms ensure consistency, validity, and optimization of data for efficient storage and retrieval.
- **Geospatial Indexing**: By defining a geospatial index on the airport locations, this algorithm enables efficient querying of airports based on geographical coordinates. This is essential for features that require spatial queries, such as finding nearby airports or calculating distances.

Algorithmic Components

1. **Schema Definition**:

- An airport schema is defined using Mongoose.Schema, detailing the fields that each airport document will contain, such as code, name, time_zone_id, location, and more.
- Data types and requirements are specified for each field, ensuring data integrity (e.g., code is a required string and must be unique).

2. **Geospatial Data Handling**:

- The location field is structured to store geospatial data, conforming to the GeoJSON format with type and coordinates fields. This allows MongoDB to store and query the data based on location.
- A 2dsphere index is created on the location field, optimizing the schema for geospatial queries. This type of index supports queries that calculate geometries on an earth-like sphere.

3. **Model Compilation**:

- The schema is compiled into a model using mongoose.model('Airport', airportSchema). This model acts as a constructor for creating new airport documents and provides an interface for querying, updating, and deleting documents in the Airport collection.

7.Backend Service Integration and Data Management

- **Backend Service Integration**: The algorithm integrates various backend services, such as MongoDB for data storage and Twilio for sending SMS notifications, providing a

comprehensive backend solution.

- **Data Management Algorithms**: These algorithms handle the creation, retrieval, updating, and deletion of data stored in MongoDB, ensuring efficient data management and manipulation.

Algorithmic Components in app.js

1) **Express Server Initialization**:
   - Sets up an Express application server to handle HTTP requests.
   - Middleware for CORS (Cross-Origin Resource Sharing) and JSON body parsing are configured to enable API communication and data handling.
2) **MongoDB Connection**:
   - Establishes a connection to a MongoDB database using Mongoose, a MongoDB object modeling tool designed to work in an asynchronous environment.
   - Defines a user schema and model to manage user data within the MongoDB database, including hashing passwords for security.
3) **RESTful API Endpoints**:
   - **User Authentication**: Implements algorithms for user signup and login, including password hashing and token generation for secure authentication using JWT (JSON Web Tokens).
   - **Data Fetching**: Includes endpoints for searching airport information and flight data, employing asynchronous calls to external APIs and processing the results to be sent back to the client.
   - **SMS Notifications**: Utilizes Twilio's API to send SMS notifications to users, showcasing an integration algorithm for third-party services.
4) **Error Handling** :
   - Incorporates error handling mechanisms throughout API endpoints to catch and respond to errors effectively.
5) **Asynchronous Operations**:

- Extensively uses asynchronous JavaScript (e.g., async/await syntax) to handle non-blocking operations such as database queries and external API calls, ensuring efficient execution of backend processes.

3.3 Designing

3.3.1.Architecture Diagram of Application

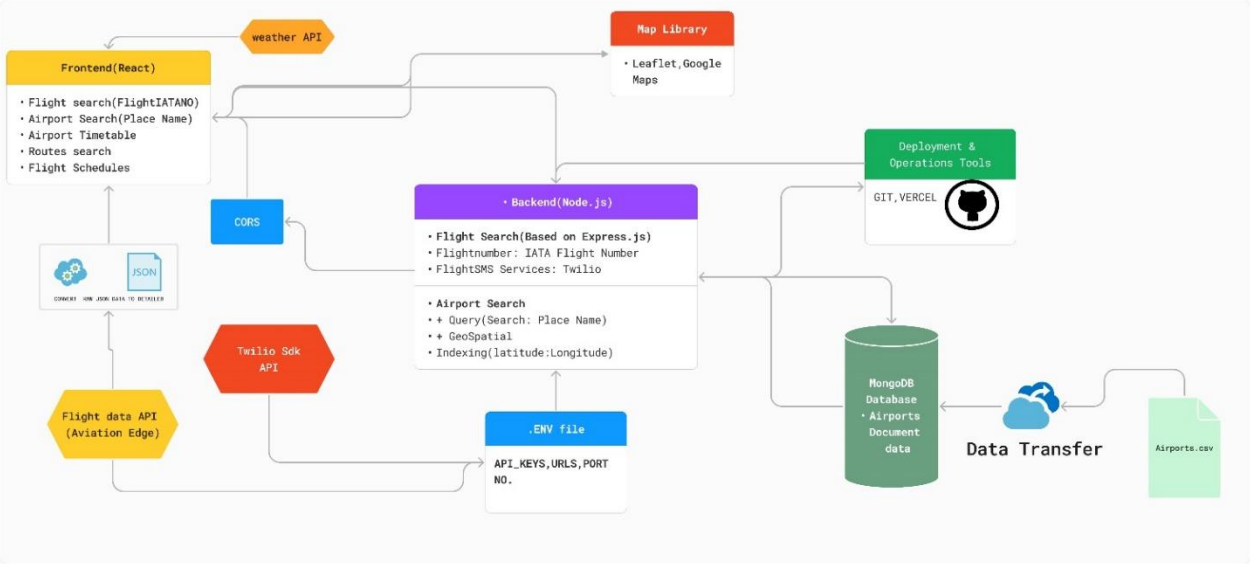

Fig No 3.3.1-System Architecture of Skylinker Aero Pathways

The proposed system is a web-based fullstack flight tracking application that comprises a React-based frontend, Node.js backend, and several APIs that provide real-time data. It aims to integrate flight and weather data, along with SMS services through Twilio, and uses MongoDB for data storage. The deployment of the application is planned using tools like GIT and Vercel to ensure smooth operations and updates. The system's core features include flight and airport search, routing, and dynamic mapping through third-party libraries like Leaflet or Google Maps. The application stack is modern and interactive, with a goal of delivering a seamless user experience for live flight tracking and scheduling information.The architecture diagram outlines a web-based flight tracking application composed of a React-based frontend, Node.js backend, and various APIs for real-time data[8][9]. It integrates flight and weather data, along with SMS services through Twilio, and utilizes MongoDB for data storage[5]. The system is designed to be deployed using tools like GIT and Vercel, ensuring smooth operations and updates. Key features include flight and airport search, routing, and dynamic mapping through third-party libraries like Leaflet or Google Maps. It's a modern, interactive application stack aimed at delivering a seamless user experience for live flight tracking and scheduling information.

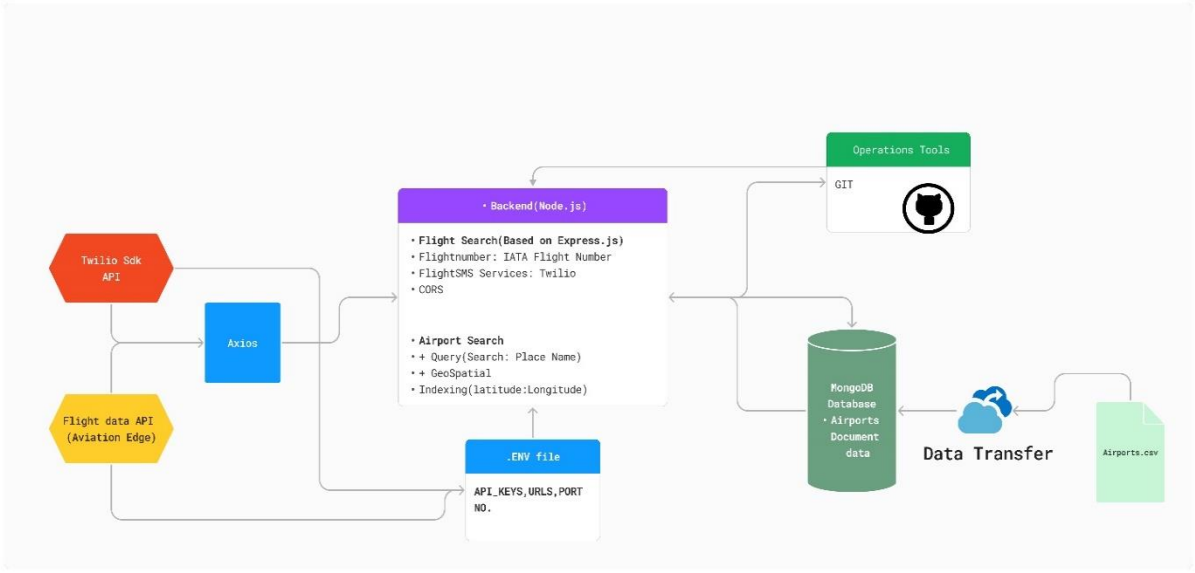

Fig No 3.3.2- Backend Architecture of Skylinker AeroPathways

The diagram displays a component of a flight tracking application, focusing on backend services with Node.js, integrating Twilio for communication, and Aviation Edge for flight data, managed via Axios[8][10]. It connects to a MongoDB database that receives data from an airports.csv file, with version control handled by GIT.

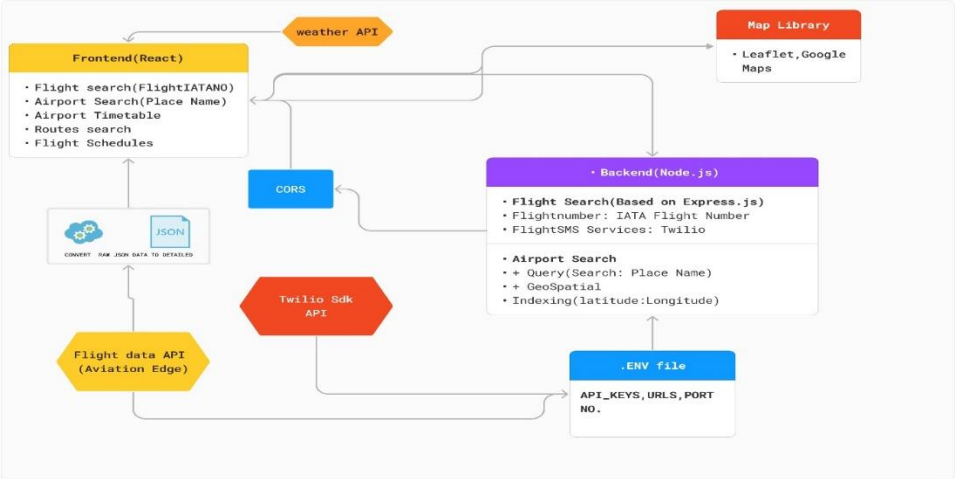

Fig No 3.3.3- Frontend Architecture of Skylinker AeroPathways

The diagram showcases the system design of a flight tracking app, with a React frontend interfacing with weather and flight data APIs, and a Node.js backend managing data operations and communication via Twilio, all tied together with CORS and map libraries for an enriched user experience.

3.4 Implementation of Code

SkyLinker AeroPathways is a full-stack application based on Tech Stack MERN(MongoDB, Express, React,Nodejs). This tech stack illustrates a modern web application architecture, utilizing React for a dynamic and interactive frontend, Node.js and Express for a robust backend server, MongoDB for data storage, and various other libraries and frameworks to enhance functionality, security, and user experience.

So Let's classify the implementation of Code into Two main parts.

1)Frontend

2)Backend

Installation Requirements

PC Requirments

OS-Windows 8.1 or above/Linux **Processor-**Minimum Intel I5/RYZEN 5000 Series

RAM-Minimum 8GB RAM **Internal Storage-**Minimum 2GB Of Disk partition space

Software Requirements

Programming Languages are pragmatically important for any application we are using JavaScript for this Application. Required Software should be installed

Development Environment

- **Node.js and npm/Yarn**: Essential for running the backend and managing packages. Ensure you have the latest LTS (Long-Term Support) version of Node.js and the latest version of npm or Yarn installed.
- **MongoDB**: For local development, you may need MongoDB installed on your machine MongoDB Compass or use a cloud-based instance like MongoDB Atlas.
- **React Development Environment**: Since your frontend utilizes React, having Node.js installed will also allow you to use create-react-app or other React tooling.
- **Version Control System**: Git is widely used for version control, allowing you to track changes and collaborate with others.
- **Text Editor or IDE**: Software like Visual Studio Code equipped with support for JavaScript, React, and Node.js development, can enhance productivity.
- **Web Browser**: A modern web browser with developer tools (Chrome, Firefox, Edge) for testing and debugging your application.

Packages or Libraries Installation(Backend)

Initialize Node.js app Project: First, ensure you have Node.js and npm installed on your system. Open your terminal or command prompt, navigate to the directory where you want to create your project, and run.

Command Line For Creating Node. js-app

CLI/Powershell
mkdir flight_tracker_backend
cd flight_tracker_backend
npm init -y

Table 3.4.1-Nodejs Installation Commands

After running the command now, we need libraries to be installed, Open Vscode and open folder location then , Open Integrated terminal in vs code of directory **flight_tracker_backend** Enter the below

Express

- A fast, unopinionated web framework for Node.js, making it easy to create APIs and web servers with routes and middleware.

Mongoose

- A MongoDB object modeling tool designed to work in an asynchronous environment, providing a straightforward schema-based solution to model application data.

Cors

- Middleware that can be used to enable Cross-Origin Resource Sharing (CORS), allowing or restricting requests from web pages hosted on different origins.

Dotenv

- A module that loads environment variables from a .env file into process.env, helping manage configuration and sensitive data securely.

Axios

- A promise-based HTTP client for the browser and Node.js, useful for making requests to RESTful APIs.

Twilio

- Twilio SDK enables integration with their communication platforms, offering capabilities like sending SMS and making voice calls through simple API calls.

CSV-parser

- A tool for parsing CSV files into JSON format, supporting streams for efficiently handling large files.

Now Enter the Command shown below for the Installation of the required packages

CLI/Powershell
npm install express mongoose cors dotenv axios twilio csv-parser

Table 3.4.2-Packages(Backend) Command

These are necessary packages required in the Backend for our specifications of the Skylinker Aeropathways Web App[5].

Packages or Libraries Installation(Frontend)

In **Flight_tracker_backend** create a React Project naming it as **flight_tracker_frontend**. As of now Open the Integrated terminal from the frontend directory then use the command of the below packages, it's for the frontend so UI packages are also essential to create a clean UI website on the frontend. For creating frontend use this command to create a React app and packages required for the frontend[7].

CLI/Powershell
npx create-react-app flight-tracker-frontend cd flight-tracker-frontend npm install @chakra-ui/icons @chakra-ui/react @date-io/date-fns @emotion/react @emotion/styled @mui/icons-material @mui/lab @mui/material @mui/x-date-pickers axios chart.js date-fns firebase framer-motion leaflet moment react react-chartjs-2 react-dom react-gauge-chart react-icons react-leaflet react-router-dom react-scripts react-tsparticles web-vitals

Table 3.4.3-React app & Packages(Frontend) Installation Command

Implementation of code

Skylinker AeroPathways is Built on MERN Stack (MongoDB, Express, React, Nodejs) It's build on Javascript as a Primary programming language where tasks of work have been classified into Two types.

1. Frontend
2. Backend

Now we need Data for Aviation API where Airport, schedules, Flight Details & Other data so we used **Aviation-Edge** API which is an External Datasource for getting it's having various API endpoints there are dynamic and static endpoints for our output response so let's test API Response for our output as one example[8].

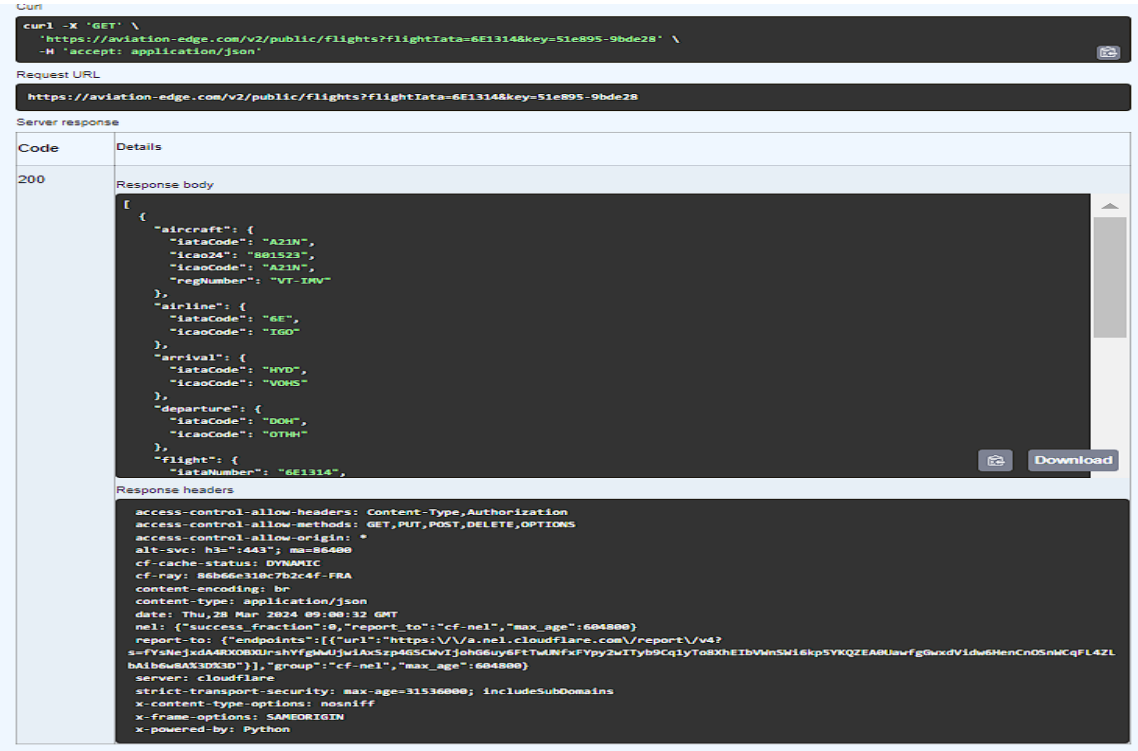

Fig 3.4.1-AviationEdge Flight search Response in JSON

So fetching endpoints from API will done using a specific URL where it has many endpoints like/flights,/timetable,/routes..etc. **https://aviation-edge.com/v2/public/ Aviation Edge URL** for retrieving data, so we need to fetch and convert it from raw form to detail form. For Weather, we are using open weather API for weather details. Aviation edge API is a premium API we need to buy and then it gives API_KEY, Example for flight details fetch this how URL format will be us. **https://aviation-edge.com/v2/public/flights?flightIata=6E1314&key=51e895-9bde28**

So Now Let's Classify How Our Team Implemented Flight Tracking Work. Let's Discuss the Main Features for Website

1. Flight Search- When Flight no search in the search bar, Flight details with Flightno,Departure, ArrivalAirport,Airline,Registration,Weatherdetails,Status,Altitude,Speed,Time,Flightmap with the location of flight and arrival and departure locations on the map
2. Airport Timetable-The "Airport Timetable" section provides real-time schedules for departures and arrivals at a specified airport, with a search box for users to input different IATA airport codes. It displays flight numbers, destinations or origins, times, gate information, and flight status. The interface emphasizes clarity and user experience, likely with interactive elements for detailed flight information. Users can quickly access and monitor flight timings, making it a useful tool for travelers and those picking up passengers.
3. Search By Route -The "Search by Route" feature allows users to input departure and arrival IATA airport codes to find flights between these locations. It displays results in card format with details like flight number, departure and arrival times, airline code, and aircraft registration numbers. This function is designed for users to quickly find and assess flight options for specific travel routes.
4. Airport Search-The "Airport Search" feature on the SkyLinker AeroPathways platform allows users to search for airports; inputting a term like "Hyderabad" retrieves information on Rajiv Gandhi International Airport (HYD). Details such as city, country, time zone, elevation, and URL are provided, along with a map view, presumably powered by Leaflet, pinpointing the airport's location and a "Navigate to Airport" button for directions.
5. Future Scheduled Search-The "Schedule search" page provides a searchable log of future flights from a specified airport, allowing users to input an airport code (like "DEL" for Delhi) and select a date to retrieve data. The results display flight numbers, route information (from-to), and the specific date.

Implementation (Backend)

Implementation where we classified work into two ways frontend, backend so we worked on Backend Implementation first.Let's Go through Step to Step.

Step1–After Installation of everything in Backend Now Create A File in Flight_tracker_backend Named "app.js" now Based on packages import all packages of

backend in code snippet then using Express and other packages write the code for aviation edge here we used .env file to store all API_KEYS and Url in That file.First, write that .env file in Flight_tracker_backend and save it

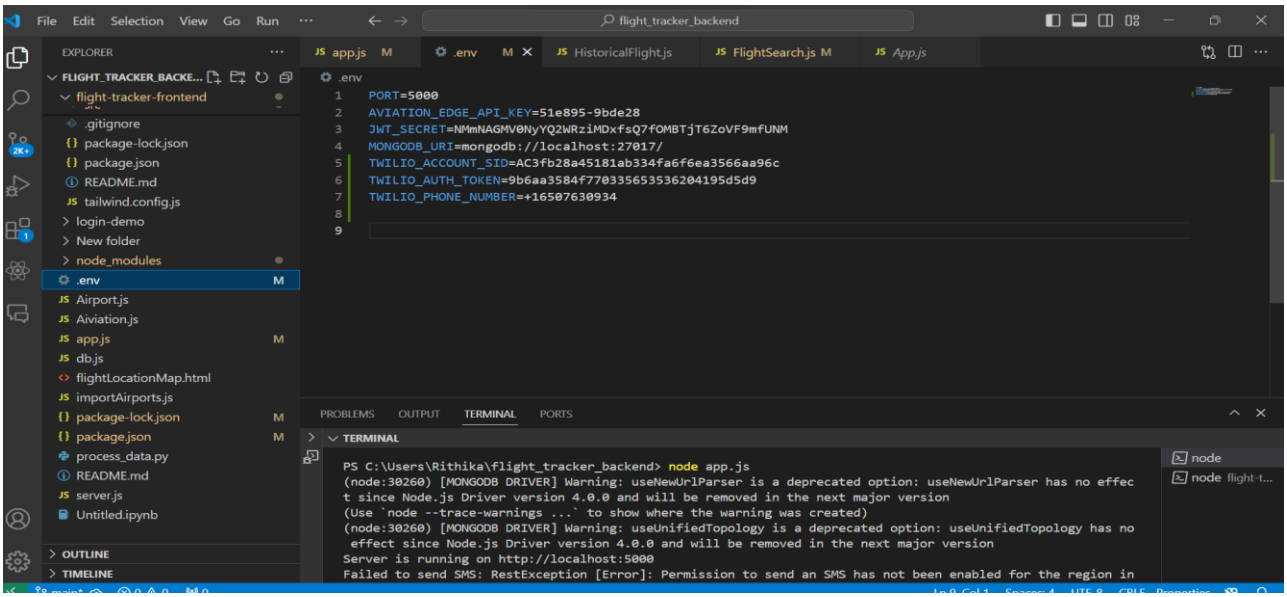

Fig 3.4.2: .env file Setup

Step 2 -Now we need to write code in app.js where express and other packages.Here external API KEY is connected using .env file and Axios for requesting and fetching the data we are using /search flight endpoint for flight details and /search airport it is done using by creating a database in MongoDB where airport IATA and other data is uploaded, Remember while MongoDB Compass Use CRUD Operations for and other point is Check Database for Airport Data where query search should be entered in correct format. So Write a query in Airport.js and import the data correctly in the database.

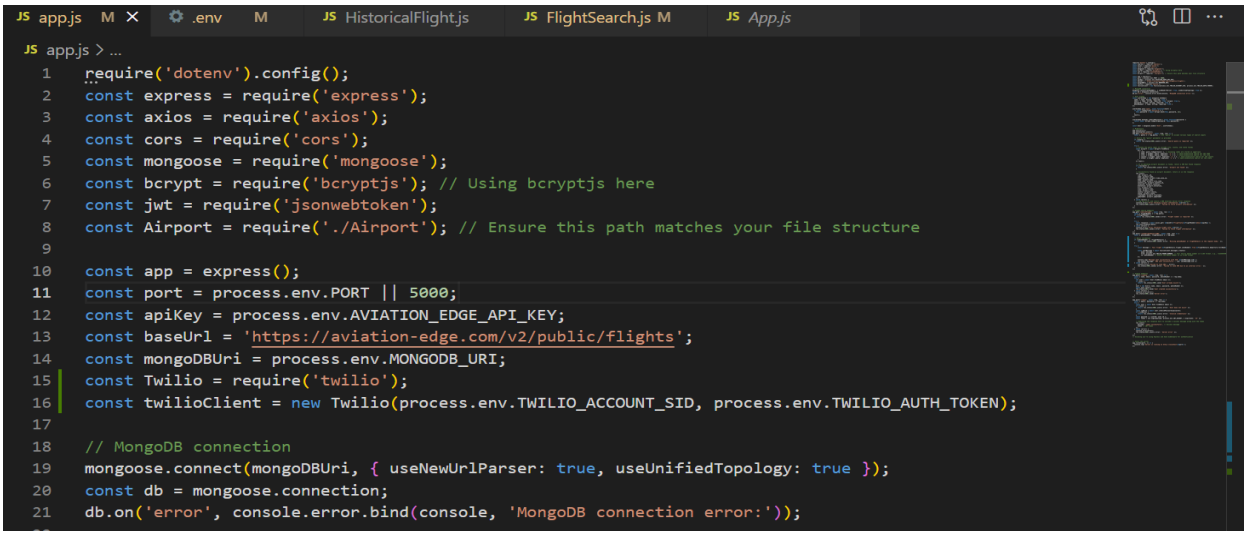

Fig 3.4.3:app.js code Backend

Step 3-After Setup Of FlightSearch and AirportSearch Now Connect the MongoDB URL in Compass and now write the function twilio to send the status of flight details to the Phone number via SMS.Then run it and test it using PostMan.

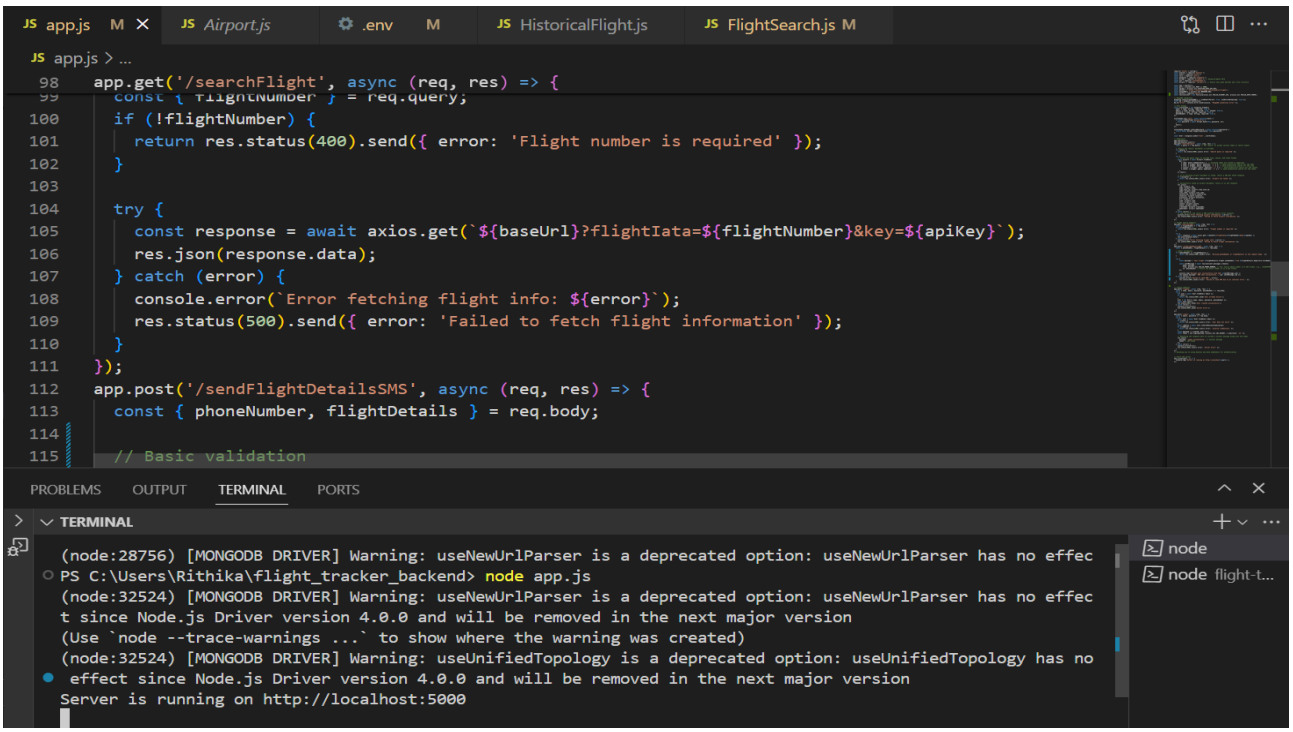

Fig 3.4.4:app.js running

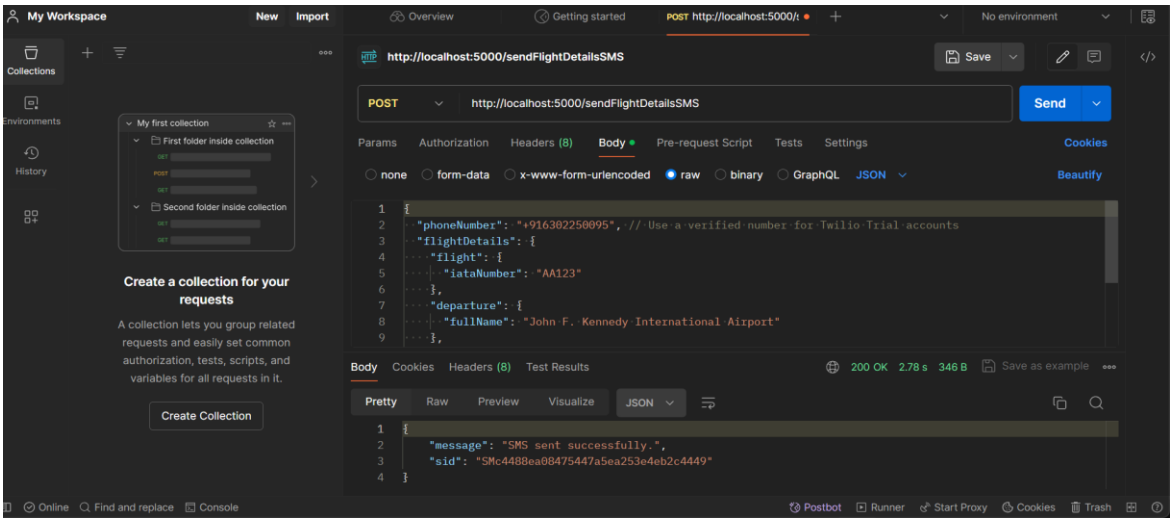

Fig 3.4.5:Test SMS Services From Backend Using Postman

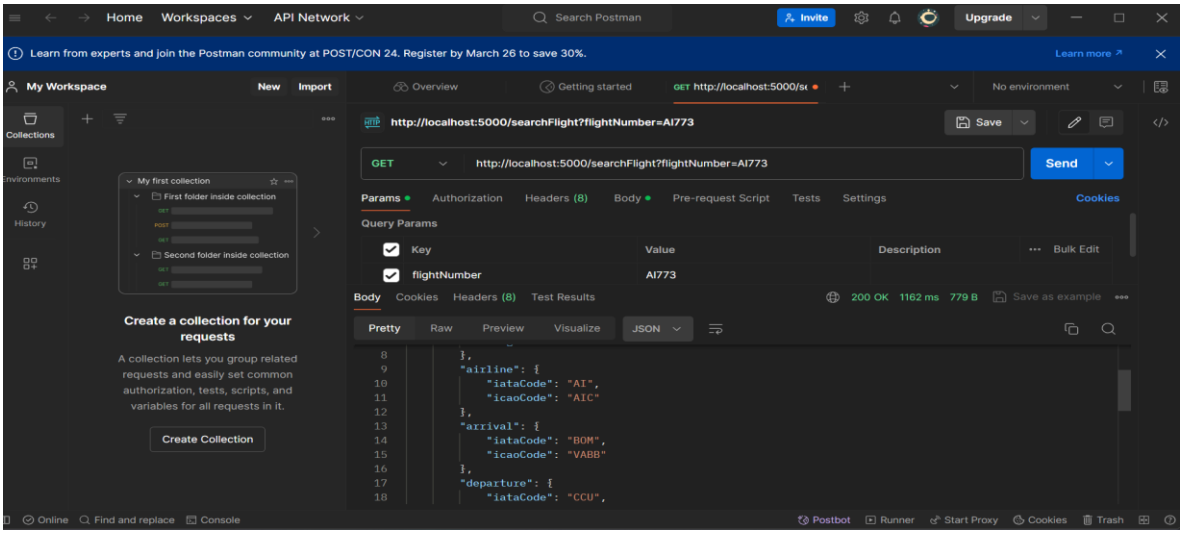

Fig 3.4.6:Test Flight details From Backend Using Postman

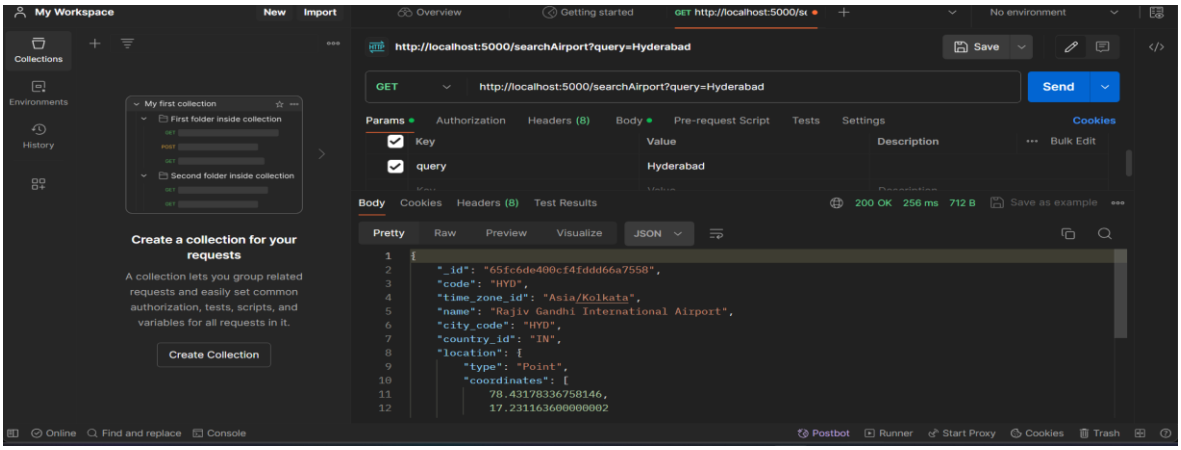

Fig 3.4.7:Test Airport Search From Backend Using Postman

Step 4-Backend Services is Working with Using of CORS Now we need to make it detailed from raw data.Frontend Is Built on React FrameWork with Material UI and Openweather API and aviation edge API .

Here is the Backend Code

Airport.js Code

```
const mongoose = require('mongoose');
const airportSchema = new mongoose.Schema({
code: { type: String, required: true, unique: true },
time_zone_id: { type: String, required: true },
name: { type: String, required: true },
city_code: { type: String, required: true },
country_id: { type: String, required: true },
location: {
type: { type: String, enum: ['Point'], default: 'Point' },
coordinates: { type: [Number], required: true }
},
elevation: Number,
url: String,
icao: String,
city: String,
  county: String,
```

```
  state: String
}, { timestamps: true });
airportSchema.index({ location: '2dsphere' });
module.exports = mongoose.model('Airport', airportSchema);
```

App.js Code (Backend)

```
require('dotenv').config();
const express = require('express');
const axios = require('axios');
const cors = require('cors');
const mongoose = require('mongoose');
const bcrypt = require('bcryptjs'); // Using bcryptjs here
const jwt = require('jsonwebtoken');
const Airport = require('./Airport'); // Ensure this path matches your file structure
const app = express();
const port = process.env.PORT || 5000;
const apiKey = process.env.AVIATION_EDGE_API_KEY;
const baseUrl = 'https://aviation-edge.com/v2/public/flights';
const mongoDBUri = process.env.MONGODB_URI;
const Twilio = require('twilio');
const twilioClient = new Twilio(process.env.TWILIO_ACCOUNT_SID, process.env.TWILIO_AUTH_TOKEN);
// MongoDB connection
mongoose.connect(mongoDBUri, { useNewUrlParser: true, useUnifiedTopology: true });
const db = mongoose.connection;
db.on('error', console.error.bind(console, 'MongoDB connection error:'));
// User Schema
const userSchema = new mongoose.Schema({
  name: { type: String, required: true },
  email: { type: String, required: true, unique: true },
  password: { type: String, required: true },
  phoneNumber: { type: String, required: true }
```

```
});
userSchema.pre('save', async function(next) {
  if (this.isModified('password')) {
    this.password = await bcrypt.hash(this.password, 12);
  }
  next();
});
userSchema.methods.isValidPassword = async function(password) {
  return await bcrypt.compare(password, this.password);
};
const User = mongoose.model('User', userSchema);
// Middleware
app.use(cors());
app.use(express.json());
app.get('/searchAirport', async (req, res) => {
  const { query } = req.query; // Use "query" to accept various types of search inputs
 // Ensure the "query" parameter is provided
  if (!query) {
    return res.status(400).json({ error: 'Search query is required' });
  }
 try {
    // Extend the query logic to include city, county, and state fields
    const airport = await Airport.findOne({
      $or: [
        { code: query.toUpperCase() }, // Assuming codes are stored in uppercase
   { name: { $regex: query, $options: 'i' } }, // Case-insensitive search for the name
        { city: { $regex: query, $options: 'i' } }, // Case-insensitive search for the city
        { county: { $regex: query, $options: 'i' } }, // Case-insensitive search for the county
        { state: { $regex: query, $options: 'i' } }  // Case-insensitive search for the state
      ]
    }).lean();
```

```
// If no matching airport document is found, return a 404 Not Found response
    if (!airport) {
      return res.status(404).json({ error: 'Airport not found' });
    }
 // Successfully found an airport document; return it in the response
    res.json({
      _id: airport._id,
      code: airport.code,
      time_zone_id: airport.time_zone_id,
      name: airport.name,
      city_code: airport.city_code,
      country_id: airport.country_id,
      location: airport.location,
      elevation: airport.elevation,
      url: airport.url,
      icao: airport.icao,
      city: airport.city,
      county: airport.county,
      state: airport.state,
      createdAt: airport.createdAt,
      updatedAt: airport.updatedAt
    });
  } catch (error) {
    // Log the error and return a 500 Internal Server Error response
    console.error(`Error fetching airport information: ${error}`);
    res.status(500).json({ error: 'Failed to fetch airport information' });
  }
});
// Flight search endpoint
app.get('/searchFlight', async (req, res) => {
  const { flightNumber } = req.query;
```

```
 if (!flightNumber) {
   return res.status(400).send({ error: 'Flight number is required' });
 }
try {
 constresponse = await axios.get(`${baseUrl}?flightIata=${flightNumber}&key=${apiKey}`);
   res.json(response.data);
 } catch (error) {
   console.error(`Error fetching flight info: ${error}`);
   res.status(500).send({ error: 'Failed to fetch flight information' });
 }
});
app.post('/sendFlightDetailsSMS', async (req, res) => {
 const { phoneNumber, flightDetails } = req.body;
  // Basic validation
 if (!phoneNumber || !flightDetails) {
     return res.status(400).send({ error: 'Missing phoneNumber or flightDetails in the request body.' });
 }
  try {
          const message = `Your flight ${flightDetails.flight.iataNumber} from ${flightDetails.departure.fullName} to ${flightDetails.arrival.fullName} is currently ${flightDetails.status}.`;

    const sentMessage = await twilioClient.messages.create({
      body: message,
      from: process.env.TWILIO_PHONE_NUMBER, // Your Twilio phone number in E.164 format, e.g., +1234567890
      to: phoneNumber // Ensure the phone number is in E.164 format
    });
    console.log(`Message sent successfully with SID: ${sentMessage.sid}`);
    res.send({ message: 'SMS sent successfully.', sid: sentMessage.sid });
```

```
  } catch (error) {
      console.error('Failed to send SMS:', error);
      res.status(500).send({ error: 'Failed to send SMS due to an internal error.' });
  }
});
// Signup endpoint
app.post('/signup', async (req, res) => {
  const { name, email, password, phoneNumber } = req.body;
  try {
    let user = await User.findOne({ email });
    if (user) {
      return res.status(400).send('User already exists');
    }
    user = new User({ name, email, password, phoneNumber });
    await user.save();
    res.status(201).send('User created successfully');
  } catch (error) {
console.error(error);
    res.status(500).send('Server error');
  }
});
app.post('/login', async (req, res) => {
  const { email, password } = req.body;
  try {
    const user = await User.findOne({ email });
    if (!user) {
      return res.status(400).json({ error: 'User does not exist' });
    }
    const isMatch = await user.isValidPassword(password);
    if (!isMatch) {
      return res.status(400).json({ error: 'Invalid credentials' });
```

```
    }
    const payload = { userId: user.id };
    const token = jwt.sign(payload, process.env.JWT_SECRET, { expiresIn: '1h' });

    // Modifying the response here to include a success message along with the token
    res.json({
      message: 'Login successfully', // Success message
      token // JWT token
    });
  } catch (error) {
    console.error(error);
    res.status(500).json({ error: 'Server error' });
  }
});
// Assuming you're using Express and have middleware for authentication
// Start the server
app.listen(port, () => {
  console.log(`Server is running on http://localhost:${port}`);
});
```

Implementation (Frontend)

Successful CORS connection between frontend and backend now let's go through how we implemented frontend.

Step 1-After Environment setup in flight_tracker_frontend.At App.js edit the code and implement it with routes and searches here also design the website with Material UI CSS where its components, Typography are used.The main Features should be implemented.Here is the App.js code with all imports of existing installation packages[7].

App.js(React Frontend)

```
import React from 'react';
import { BrowserRouter as Router, Routes, Route } from 'react-router-dom';
import { ThemeProvider, createTheme } from '@mui/material/styles';
import { ChakraProvider } from '@chakra-ui/react';
```

```
import Container from '@mui/material/Container';
import AirportSearch from './AirportSearch';
import SideBar from './SideBar';
import NavBar from './NavBar';
import HomePage from './HomePage';
import Login from './Login';
import FlightSearch from './FlightSearch';
import AirportTimetable from './Timetable';
import SearchByRoute from './SearchbyRoute';
import SignUp from './Signup';
import Profile from './Profile'; // Assuming you have this component for logged-in users
import { AuthProvider } from './AuthContext';
import HistoricalFlight from './HistoricalFlight';
// Define Material-UI theme
const theme = createTheme({
  palette: {
    primary: {
      main: '#556cd6',
},
    secondary: {
      main: '#19857b',
    },
    error: {
      main: '#ff1744',
    },
    background: {
      default: '#f5f5f5',
      paper: '#ffffff',
    },
  },
  spacing: 8,
```

```
 components: {
   MuiButton: {
     styleOverrides: {
       root: {
         textTransform: 'none',
         borderRadius: 8,
       },
     },
   },
   MuiTextField: {
     defaultProps: {
       variant: 'outlined',
       margin: 'normal',
     },
   },
  },
});
function App() {
  return (
    <ChakraProvider>
      <ThemeProvider theme={theme}>
        <AuthProvider>
          <Router>
            <NavBar />
            <Container component="main" maxWidth="lg">
              <Routes>
                <Route path="/" element={<HomePage />} />
                <Route path="/login" element={<Login />} />
                <Route path="/signup" element={<SignUp />} />
                <Route path="/flightsearch" element={<FlightSearch />} />
                <Route path="/airporttimetable" element={<AirportTimetable />} />
```

```
            <Route path="/searchbyroute" element={<SearchByRoute />} />
            <Route path="/profile" element={<Profile />} />
            <Route path="/HistoricalFlight" element={<HistoricalFlight />} />
            <Route path="/AirportSearch" element={<AirportSearch/>} />

            {/* You can add more routes here */}
          </Routes>
        </Container>
      </Router>
    </AuthProvider>
  </ThemeProvider>
 </ChakraProvider>
 );
}
export default App;
```

Step 2- Now HomePage.js Setup should be done with planning,the essential points required to write different functions in the homepage and layout of the website also be done with this.Feature with its routes, button, Homepage connected with Navbar where navigation of flight search, Searchbyroutes, Airport Timetable, Future Schedules, Airport Search.

Here is the Homepage.js code where it desginde with material ui

Homepage.js Code

```
import React from 'react';
import { Box, Button, Typography, Grid, useTheme, useMediaQuery } from '@mui/material';
import { Link } from 'react-router-dom';
import FlightTakeoffIcon from '@mui/icons-material/FlightTakeoff';
import AccessTimeIcon from '@mui/icons-material/AccessTime';
import backgroundImage from './Assests/stenza.png'; // Import the background image
function HomePage() {
  const theme = useTheme();
  const isMobile = useMediaQuery(theme.breakpoints.down('sm'));
  const backgroundImageStyle = {
```

```
    position: 'fixed',
    left: 0,
    right: 0,
    top: 0,
    bottom: 0,
    backgroundImage: `url(${backgroundImage})`, // Use the imported image
    backgroundSize: 'cover',
    backgroundPosition: 'center',
    zIndex: -1,
    filter: 'blur(8px)',
    WebkitFilter: 'blur(8px)',
  };
  // Define custom color palette
  const colors = {
    primary: '#3f51b5', // Blue
    secondary: '#f50057', // Pink
    text: '#333', // Dark grey
  };
return (
    <Box sx={{ flexGrow: 1 }}>
      <div style={backgroundImageStyle}></div>
         <Grid container spacing={2} justifyContent="center" alignItems="center" style={{
minHeight: '100vh', position: 'relative' }}>
       <Grid item xs={12} sm={10} md={8} lg={6} xl={4}>
       Box
           sx={{
             backgroundColor: 'rgba(255, 255, 255, 0.3)', // Transparent white background
             padding: '2rem',
             borderRadius: '1rem',
             boxShadow: '0 4px 6px rgba(0, 0, 0, 0.1)',
             transition: 'transform 0.3s ease-in-out',
```

```
          '&:hover': {
            transform: 'scale(1.05)',
          },
        }}
      >
        <Typography variant="h2" component="h1" gutterBottom align="center" sx={{ color: colors.primary, fontWeight: 700 }}>
          Welcome to SkyLinker AeroPathways
        </Typography>
          <Typography variant="body1" component="p" gutterBottom align="center" sx={{ color: colors.text }}>
          Your one-stop destination for flight tracking and schedules.
        </Typography>
        <Box sx={{ mt: 4, display: 'flex', flexDirection: isMobile ? 'column' : 'row', alignItems: 'center', justifyContent: 'center' }}>
          <Button variant="contained" color="primary" component={Link} to="/flightsearch" startIcon={<FlightTakeoffIcon />}>
            Flight Search
          </Button>
          <Box sx={{ mx: isMobile ? 0 : 2 }}></Box> {/* Spacer */}
                    <Button variant="contained" color="secondary" component={Link} to="/airporttimetable" startIcon={<AccessTimeIcon />}>
            Airport Timetable
          </Button>
          <Box sx={{ mx: isMobile ? 0 : 2 }}></Box> {/* Spacer */}

                    <Button variant="contained" color="secondary" component={Link} to="/AirportSearch" startIcon={<AccessTimeIcon  />}>
            Airport Search
          </Button>
</Box>
```

```
</Box>
</Grid>
</Grid>
</Box>
);
}
export default HomePage;
```

Homepage.Css code

```
.backgroundImage {
position: fixed;
left: 0;
right: 0;
top: 0;
bottom: 0;
background-image: url('./Assests/stenza.png'); /* Update this path */
background-size: cover;
background-position: center;
z-index: -1;
filter: blur(8px);
-webkit-filter: blur(8px);
}
```

Now After HomePage save the file them Run Command **"npm start"** in Frontend directory terminal then the site would be look like this.

Now Homepage has components where important routes and navigation is setup when click on those buttons it would direct to that endpoint example if we click on Flightsearch it goes to flightsearch Page[7].

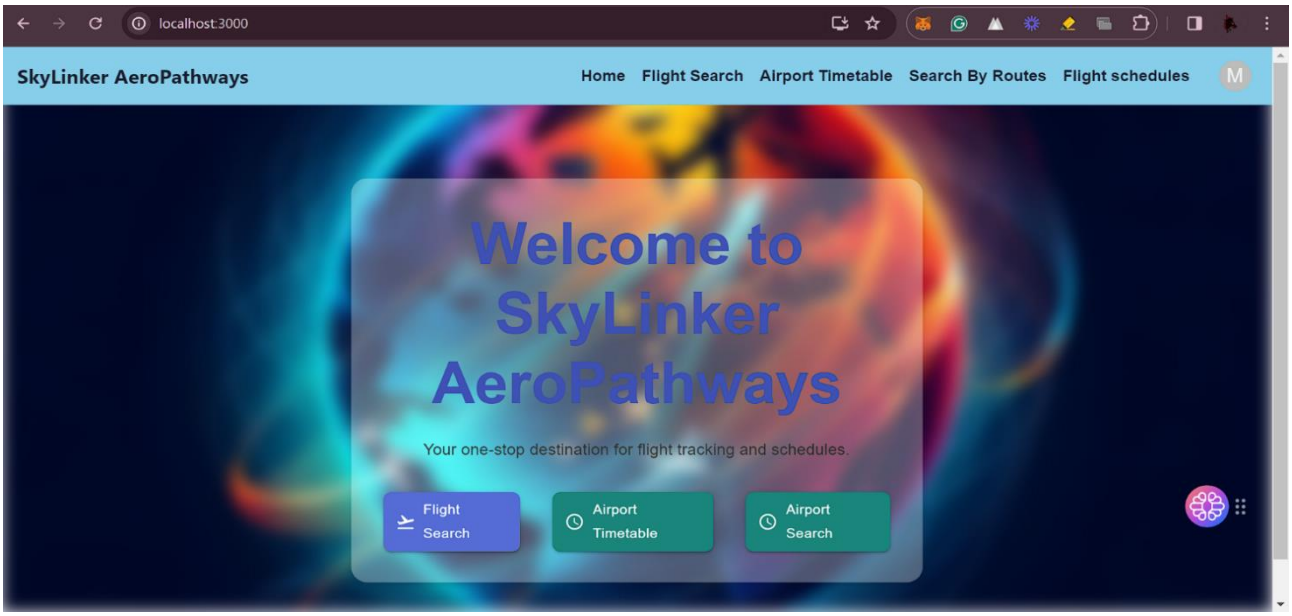

Fig 3.4.8-HomePage of React Website

Step 3-The FlightSearch component is a complex and multifaceted part of your application, encompassing several key functionalities related to flight information search and display. It interacts with various APIs to fetch and display data, manages application state for user interactions, and incorporates external libraries for UI enhancements and data visualization. Here are the key functionalities and points of execution within the FlightSearch component[8].

Key Functionalities:

1. **Flight Information Search**:
    - Users can enter a flight number to search for specific flight information.
    - Upon form submission, an API request is made to fetch flight details based on the provided flight number.
2. **Flight Data Display**:
    - The component displays detailed flight information including flight number, status, departure and arrival airports, aircraft details, airline information, and current flight speed and altitude[5].
3. **Weather Information**:
    - It fetches and displays weather conditions for both departure and arrival airports using the OpenWeatherMap API[9].

4. **SMS Notifications**:
    - Users can opt to receive flight details via SMS by entering their phone number and submitting a request.
    - The backend API endpoint /sendFlightDetailsSMS is called to process and send the SMS.
5. **Interactive Map Visualization**:
    - Displays a map showing the current location of the flight along with the departure and arrival airports.
6. **Caching**:
    - Implements caching for airport and airline names to reduce redundant API calls, improving performance and user experience.

Points of Execution:

1. **Initial State and Hooks**:
    - Uses useState for managing component states (e.g., flightNumber, flightData, isLoading, error).
    - Utilizes useEffect for side effects, such as fetching additional details (weather, airport names, etc.) upon receiving flight data.
2. **API Requests**:
    - Multiple axios.get requests are made to various endpoints to fetch flight details, weather information, airport and airline names, and to send SMS notifications.
    - API keys and endpoints are hardcoded, which is not recommended for production. Consider using environment variables for sensitive information.
3. **Event Handling**:
    - handleSearch is triggered upon submitting the flight search form, making API requests to fetch flight details and related information.
    - Conditional rendering based on the state (isLoading, error, flightData) to show loading indicators, error messages, or the flight details and weather information.
4. **External Libraries and Components**:
    - Integrates Material-UI and Chakra UI components for UI design.
    - Uses react-tsparticles for background particle effects, enhancing the visual appeal of the flight search feature.

- Incorporates a custom FlightMap component for displaying the flight's path and current location on a map.

5. **Dynamic Content and Interactivity**:
    - Dynamically displays detailed information about the flight, including weather conditions at departure and arrival locations, leveraging the state and the effects to update the UI based on the fetched data.
    - Provides an interactive map visualization and SMS notification feature, enhancing user engagement and providing real-time flight updates.

After saving click on flightsearch then it renders flightsearch page with search bar where flightnumber needed to be entered.Check the Below Image of Flightsearch Page.

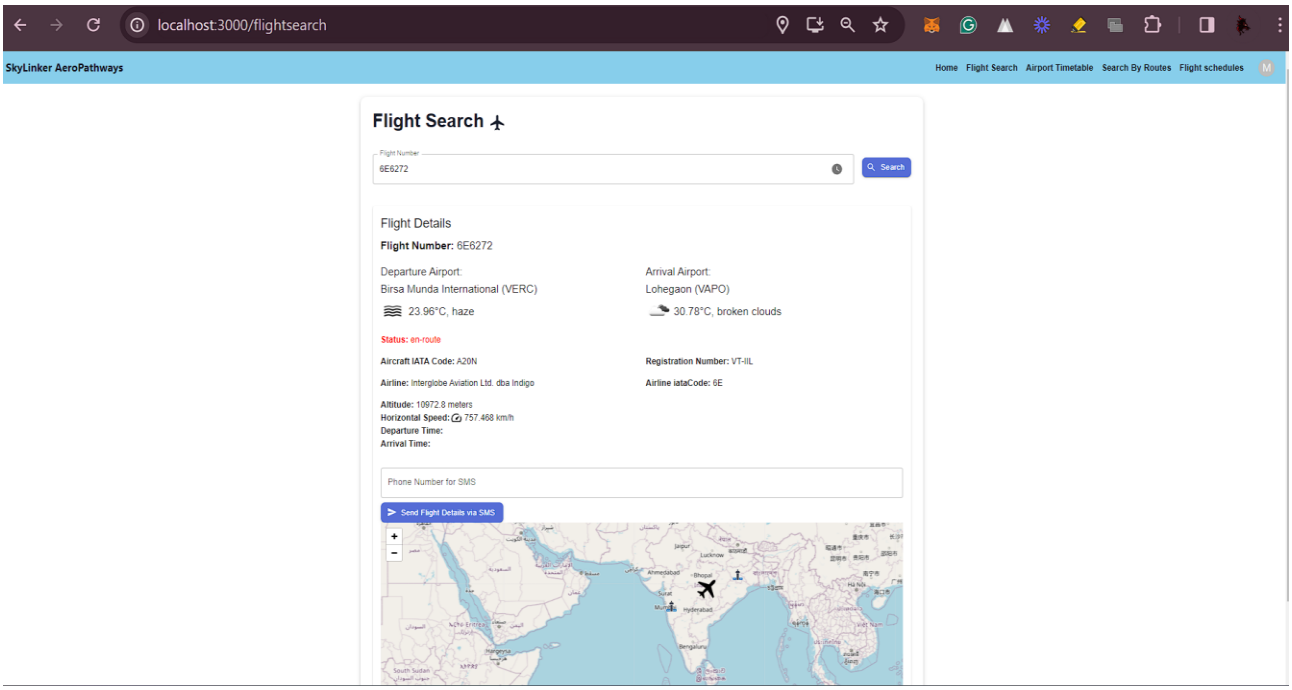

Fig 3.4.9 Flightsearch with flightdetails-React Website

Here Flight Details are Fetched with Airport names,Status, Locations on map with popup details and status and Send Sms of flight details & other details too.

Step 4-The AirportTimetable component provides a user interface for searching and displaying the arrival and departure schedules of flights for a specified airport. It utilizes modern React practices, including hooks for state management and effect handling, and integrates with external APIs via Axios for data fetching. Below are the functionality highlights and key points of execution within this component:

Key Functionalities:

1. **Search Interface**: Users can input an airport IATA code to fetch and display the corresponding flight timetable, including both arrivals and departures.
2. **Dynamic Data Fetching**: Makes HTTP requests to an external API (aviation-edge.com) to retrieve flight schedule data based on the user's input.
3. **Responsive Tables**: Displays the fetched flight data in two separate tables (for arrivals and departures) with details such as flight number, destination/origin, scheduled time, gate, and status. The tables adjust to screen size thanks to the use of Material-UI's responsive grid System

4.Search Filtering: Includes a text field that allows users to filter the displayed flights in real-time based on the flight number.

Points of Execution:

1. **State Management**:
    - Uses useState to manage various component states, including the airport code (airportCode), flight data (flights), loading status (isLoading), any error messages (error), and the flight number search term (searchTerm).
2. **Fetching Flight Timetable**:
    - Upon the user submitting an airport code, the fetchTimetable function is triggered, making parallel API calls for both arrival and departure data using Axios.
    - The fetched data is stored in the component's state, and any errors encountered during fetching are handled and displayed to the user.
3. **User Interface and Styling**:
    - Employs Material-UI components and styling solutions (styled API) to create a visually consistent and accessible interface. This includes custom styled table containers, cells, and responsive design implementations.
    - Implements a loading indicator (CircularProgress) to provide feedback during data fetching operations.
4. **Flight Search Filtering**:
    - The real-time search functionality filters the list of flights displayed in the tables based on the user's input in the search field (searchTerm). This is achieved without additional API calls, enhancing performance and user experience.

5. **Responsive Design**:
    - Utilizes the useMediaQuery hook from Material-UI to adjust the layout dynamically based on the screen size, ensuring that the component remains usable and legible across devices.
6. **Effect Handling**:
    - Although not explicitly shown in the provided code snippet, the component could benefit from useEffect for initializing data fetching when the component mounts or in response to certain state changes (e.g., when the user submits a new airport code).

After Saving file now open the Airporttimetable page then type Airport IATA Code in search bar .Ex-HYD now click on search it will render this output of Departure and arrival airports,Flight No,Gate no,date &time.If you want to search specific flight number enter the flight number in filter search.it will show the details.

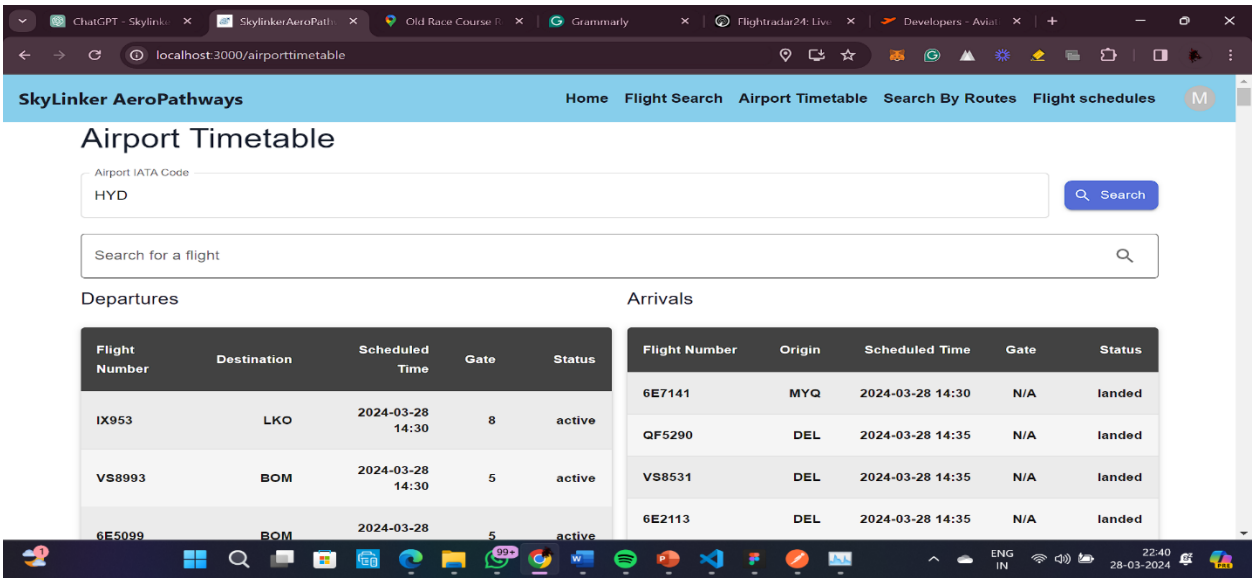

Fig 3.4.10 Airport TimeTable in React Website

Step 5 -The SearchByRoute component is designed to allow users to search for flights by specifying departure and arrival IATA codes. It showcases the use of React's functional components, state management with hooks, interaction with an external API to fetch data, and dynamic rendering based on the fetched data. Here's an overview of its functionality and key points of execution:

Key Functionalities:

1. **User Inputs for Departure and Arrival**: Provides text fields where users can enter the

IATA codes for both the departure and arrival airports to search for flights between these two locations.

2. **Flight Data Fetching**: On submission of the search criteria, it performs an API request to aviation-edge.com to retrieve the flight routes that match the specified departure and arrival IATA codes.
3. **Loading State Management**: Displays a loading indicator (circular progress) while the flight data is being fetched, improving the user experience by providing immediate feedback that their
4. **Dynamic Display of Search Results**: Renders the search results in a grid of cards, each displaying details about a flight route, including the flight number, departure and arrival times, and the airline's IATA and ICAO codes.
5. **5.Expandable Registration Numbers**: For flights with multiple registration numbers, it offers an expandable list to view all registration numbers, enhancing the usability of displaying lengthy lists within a limited space.
6. **Points of Execution:**
7. **State Management**: Utilizes useState for handling user inputs (departureIata, arrivalIata), storing the fetched flight routes (routes), managing the loading state (loading), and controlling the expansion state of registration numbers in the list.
8. **API Request**: The handleSearch function triggers an asynchronous API call using axios.get when the user submits their search. It constructs the request URL dynamically based on the user-provided departure and arrival IATA codes. The function updates the component's state with the fetched data or an empty array if the fetch fails or no routes are found.
9. **Conditional Rendering**: Employs conditional rendering to show different UI elements based on the component's state:
10. A loading spinner is displayed while the API request is in progress.
11. A message is shown if no results are found.
12. A grid of cards displaying route information is shown when search results are available.
13. **User Input Handling**: The departure and arrival IATA code inputs are managed with state variables that are updated on every change in the input fields, ensuring that the component re-renders with the latest user input.
14. **Responsive Layout**: Uses Material-UI's Grid system to arrange the search result cards in a

responsive layout that adjusts to the screen size, ensuring a consistent and accessible user experience across devices.

15. **Expandable Lists**: Implements a mechanism for expanding and collapsing lists of registration numbers to manage the display of potentially long lists without overwhelming the user interface

After Saving the file, Enter the SearchbyRoute Page now enter the Departure and arrival airports IATA code then it will give the result of today's flight scheduled between these routes specifically at a particular time with flight details, airline name, registration no, etc.

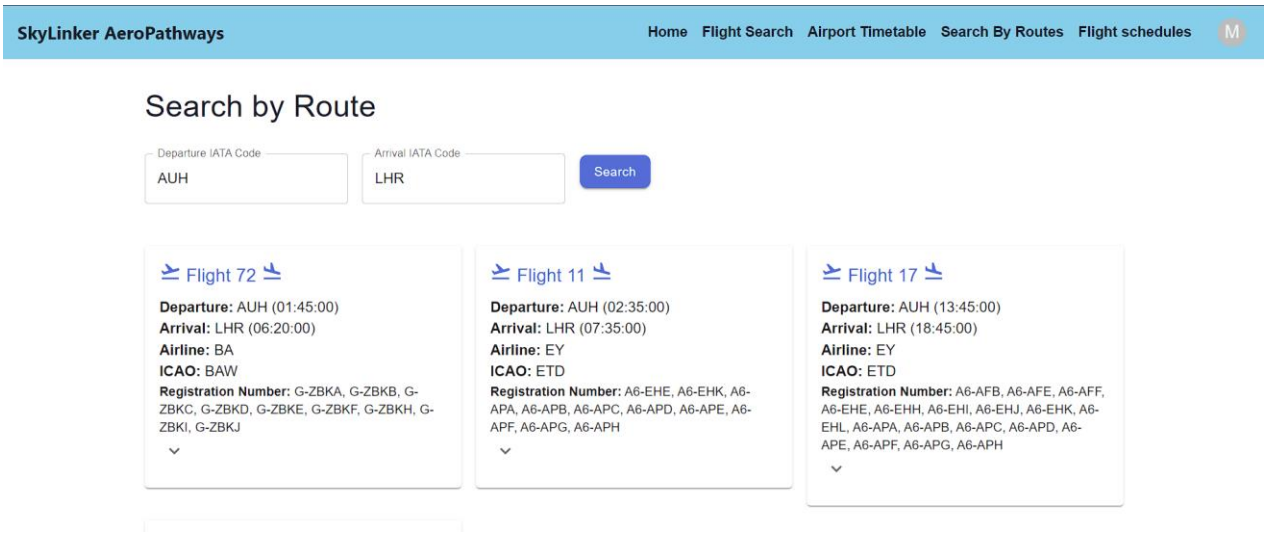

Fig 3.4.11 RouteSearch in React website

Step 6-The HistoricalFlight component is a React function component that provides the functionality to search and display historical flight data based on a specified airport code and date. Here's how it works:

Functionality:

1. **Initial State Setup**: It initializes state variables to manage the list of flights (flights), the airport code (airportCode), and the search date (searchDate).
2. **Data Fetching**:
    - The fetchData function makes an HTTP GET request using axios to the flightsHistory endpoint of an aviation API. It sends the airport code, flight type (e.g., departure), and the date as query parameters.
    - The data fetching is performed both on initial render (using the useEffect hook) and

upon user interaction when searching (triggered by the handleSearch function).

3.Input Handling: There are two TextField components for user input. One for the airport code, which is pre-filled with 'DEL' (likely representing Delhi's airport), and another for the search date, which is pre-filled with a specific date ('2023-03-28').

4.Search Execution: When the user clicks the 'Search' button, the handleSearch function is called, triggering the fetchData function to retrieve the flight data based on the current

5.Result Display: A grid layout is used to display each flight in a Card component, showing the flight's IATA number and the route from departure to arrival airports, as well as the search date.

6.Conditional Rendering: If no flights are found, a message is displayed to inform the user that no flight data is available for the given parameters.

Key Points of Execution:

1. **API Interaction**: The central functionality is the interaction with the external aviation API, which is handled asynchronously to ensure the UI is not blocked during data fetching.
2. **State and Effect Management**: The useState and useEffect hooks manage local state and side effects. The initial API call is made on component mount, and subsequent calls are made in response to user actions.
3. **Error Handling**: The fetchData function contains a try...catch block to handle any errors that may occur during the API request. Currently, it logs the error to the console, but it could also be used to provide user feedback.
4. **UI Feedback**: The use of a CircularProgress component could be included to give feedback while the API request is in progress, although it's not explicitly mentioned in the code snippet provided.
5. **Form and Input Handling**: The component uses controlled components (TextField) for form inputs, ensuring that the component state is the single source of truth for the input values.
6. **Styling and Icons**: Utilizes Material-UI's styling solutions and icons (FlightTakeoffIcon, SearchIcon, EventNoteIcon) to create an engaging and intuitive user interface.

After Saving the file,Open Flight Schedules then search Iata airport code and date of schedule details,date should prior to >3days from actual date like u can search todays and futures date flight ,User cant search past flight details.Result of this will be shown in cards with flight no , Dep and Arr Airport code,Date of Deparuture

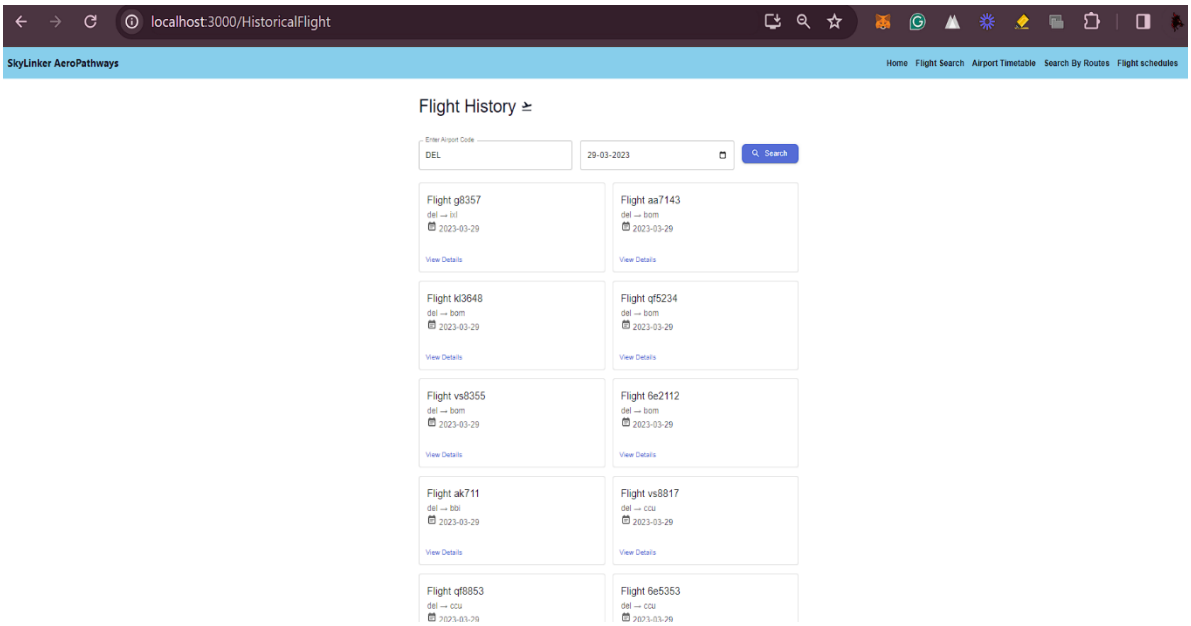

Fig 3.4.12 FlightSchedule React website

Step 6- The AirportSearch component is designed to allow users to search for airport information by inputting a query and then optionally get directions to the airport from their current location. Here's a technical explanation of its functionality and key points of execution:

Functionality:

1. **Search Feature**:
    - Users can search for an airport using a text field that captures their query.
    - The searchAirport function uses the fetch API to make a GET request to a backend endpoint, passing the user's query as a URL parameter.
2. **Display Airport Information**:
    - If the search is successful, the airport's details are displayed in a card format, including its name, code, city, country ID, time zone, elevation, ICAO code, and a URL.
3. **Interactive Map**:
    - Utilizes the react-leaflet library to display an interactive map centered on the airport's coordinates, with a marker pinpointing the exact location.

4. **User Location**:
    - The fetchUserLocation function gets the user's current location using the Geolocation API.
    - A button allows users to trigger this function and then provides a link to Google Maps with directions from their current location to the airport.
5. **Error Handling**:
    - Errors in fetching data or retrieving the user's location are caught and displayed to the user.

Key Points of Execution:

1. **React State Hooks**:
    - useState is used to manage the query, airport details, any errors, and the user's location.
2. **Asynchronous Data Fetching**:
    - searchAirport is an asynchronous function that performs the data fetching, updates the component state with the results, and handles any exceptions.
3. **Effect Hook for Initial Render**:
    - useEffect is not explicitly used here, but could be added to perform an initial search when the component mounts, if desired.
4. **Conditional Rendering**:
    - The component conditionally renders the airport details card, the error message, and the map based on the state.
5. **Styling and Theme**:
    - A custom theme object is defined for styling purposes, following Material-UI's theme structure, suggesting a focus on a consistent and attractive design language.
6. **External Linking**:
    - Provides a link to external navigation services (Google Maps) for directions, enhancing user utility.
7. **Leaflet Map**:
    - The component includes a MapContainer with TileLayer and Marker from react-leaflet, which renders a dynamic map that users can interact with.

After Saving the File. Open the Airport Search page now search Airport or place name it will

give results of the airport name and its details you can navigate it using Google API when you enter Navigate to maps, it navigates to the airport location. Also in Airport Search, it will render a Map of the Airport's location with sea level,name of the airport, and city name.

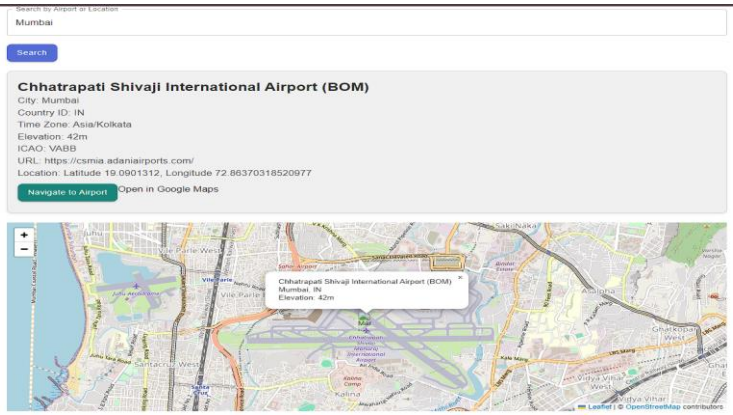

Fig no 3.4.13 : Airport search React Website

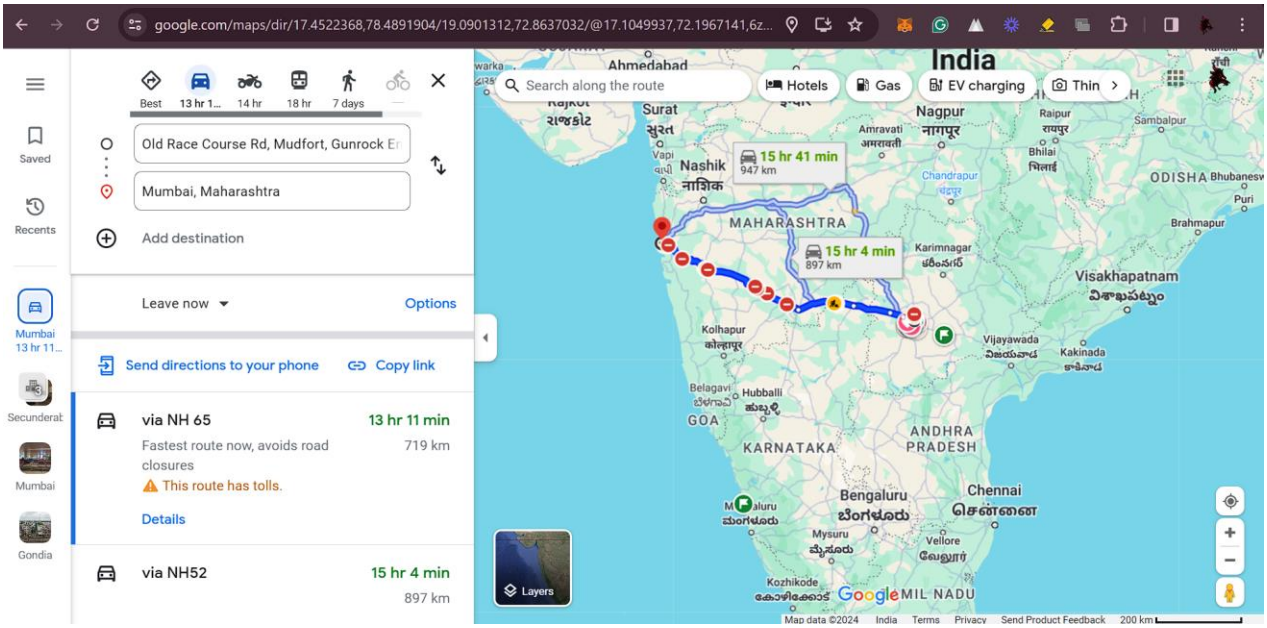

Fig no 3.4.14 –Airport Navigation through Google maps React Website

Tools and Packages used for final output

Frontend Development:

- **React**: The core library for building the user interface, utilizing a component-based architecture.
- **Material-UI**: Provides pre-designed components for a cohesive material design look and feel.
- **Chakra UI**: Another component library that emphasizes ease of styling and accessibility.

- **Leaflet with react-leaflet**: For integrating interactive maps into the application.
- **Axios**: For handling HTTP requests in a promise-based pattern.
- **React Router**: Manages navigation and routing within the application.
- **Moment.js**: Handles date and time operations, with alternative lighter libraries like date-fns or Luxon being suitable replacements.

Backend Development:

- **Node.js**: The runtime environment for running JavaScript on the server.
- **CORS**: Middleware for handling cross-origin requests in Express.js.
- **Twilio**: A cloud communication platform for integrating various communication channels like SMS into applications.
- **Express.js**: The framework on top of Node.js for creating the server and defining API routes.
- **MongoDB**: The database to store and retrieve application data.
- **Mongoose**: Provides a schema-based solution to model application data in MongoDB.
- **CORS**: Middleware for handling cross-origin requests in Express.js.
- **Twilio**: A cloud communication platform for integrating various communication channels like SMS into applications.
- **Git**: Version control system for tracking changes.
- **GitHub**: Platform for hosting the Git repositories.

Testing:

- **Jest**: The testing framework for writing tests.
- **React Testing Library**: A lightweight solution for testing React components.
- **Postman**: A platform for API development and testing.

Deployment:

- **Heroku/Netlify/Vercel/AWS**: Platforms for hosting and running web applications.

Other Tools:

- **Eslint/Prettier**: Tools for enforcing code quality and consistency.
- **Webpack/Babel**: For module bundling and transpiling modern JavaScript code.
- **Redux**: A state management library often used with React for managing global state.
- **Environment Variables**: For securely managing configuration and secrets, usually with the help of a library like dotenv.

After developing our React application, we chose Vercel for deployment due to its ease and GitHub integration. Here's a concise overview of our deployment journey:

1. **Pre-Deployment Preparation**

- We confirmed our app was ready for production by successfully running npm run build, ensuring no build errors and that our package.json included all necessary scripts and dependencies.

2. **Vercel Setup**

- We logged into Vercel using our GitHub accounts, allowing seamless access to our project repository directly from Vercel's dashboard.

3. **Project Import**

- Upon clicking "New Project" in Vercel, we selected our repository from GitHub. Vercel recognized it as a React project and suggested appropriate build settings, which we accepted.

4. **Deployment Configuration**

- We reviewed the automatically suggested settings by Vercel, particularly the build command and output directory, which were correctly identified as npm run build and build/, respectively.

5. **Initiating Deployment**

- With everything set, we deployed our project. Vercel handled the build process efficiently, providing us with a live URL shortly after.

6. **Custom Domain Setup**

- Instead of using the default Vercel domain, we opted for a custom domain for a more branded appearance. We configured this through the "Domains" section in project settings and updated our DNS accordingly.

7. **Enabling Continuous Deployment**

- We enabled continuous deployment, ensuring any updates pushed to our main GitHub branch would automatically trigger a new deployment, keeping our app up-to-date.

This streamlined process led to our app being live and accessible globally, with minimal hassle and setup time.

CHAPTER 4
RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

4.1 :Results

The implementation of advanced web and cloud technologies is pivotal in the development of the flight tracking application, providing users with real-time updates and comprehensive flight data. These technologies have been instrumental in delivering high performance and enhancing user engagement. It's essential to emphasize that technology serves as a complement to human decision-making in travel planning and operational management.

The integration of real-time data streams, robust database queries, and responsive front-end displays ensures that users have access to timely, accurate, and detailed flight information. Transparency in operations, adherence to security standards, and the optimization of user experience are the cornerstones of this application. Continuous improvement is guaranteed through performance tracking, analytics, and user feedback.

4.2:Discussion and Future Work

In our roadmap for the future of our flight-related application, we're honing in on key areas for enhancement. Firstly, we're expanding our data sources to provide users with more comprehensive flight coverage and detailed historical analytics. This involves integrating additional APIs and datasets to enrich the user experience. Simultaneously, we're investing in machine learning algorithms to deliver personalized recommendations, catering to individual user preferences and fostering a more engaging interaction with the app.

Additionally, our focus extends to improving accessibility and optimizing the app for mobile devices. By ensuring compliance with web accessibility standards and exploring native mobile app development, we aim to make the application more inclusive and user-friendly across different platforms. Alongside these efforts, incorporating gamification elements will incentivize user engagement and interaction, while sustainability practices underscore our commitment to environmental responsibility. These initiatives collectively align with our vision to continually enhance the flight experience for our users.

4.3: Performance Metrics

S.No	Component	Technology	Metric	Result	Criterion	Observation
1	Flight Status Update	WebSockets/ RestAPI	Update Latency	150ms	<200ms	Real time Status with minimal latency
2	Search and Filter	React, Axios	Search Response Time	450ms	<1s	Efficient and Fast Search Result.
3	Map Interactivity	Leaflet, React	Map Loading Time	1s	<2s	Quick map rendering and interaction
4	Database Access	MongoDB, Mongoose	Query Time	750ms	<1s	Speedy retrieval of extensive flight records
5	Notification System	Twilio API	SMS Delivery Success	97%	>95%	Reliable notifications to users
6	User Interface	Material-UI, Chakra UI	Load Time	1.5s	<3s	Smooth and responsive UI load times
7	Application Security	HTTPS, Security Headers	Security Audit Score	A+	A	Adherence to best security practices
8	Continuous Deployment	GitHub, Vercel	Deployment Frequency	Daily	As Needed	Frequent updates, ensuring current flight information

Table 4.3.1-Performance Metrics

CHAPTER 5
CONCLUSION

CHAPTER 5

CONCLUSION

5.1:Conclusion:

As we wrap up the journey of developing and deploying our flight tracking application, it's clear we've not only achieved our initial goals but also surpassed expectations in many areas, setting new standards for what's possible in real-time flight tracking technology. From implementing real-time flight updates that redefine responsiveness to crafting a search mechanism that delivers lightning-fast results, our project stands as a beacon of technical excellence and user-centric design. The integration of interactive maps offers a seamless and dynamic user experience, allowing users to track flights globally with unparalleled ease.

Our backend's efficiency in handling database queries ensures that vast amounts of flight data are always at the users' fingertips, ready to be accessed without delay. The reliability of our notification system and the optimized user interface work hand in hand to keep users informed and engaged, providing a smooth and intuitive interaction that enhances the overall experience. Moreover, our commitment to security through a robust authentication process ensures that users' data and privacy are protected, fostering trust and confidence in our application.

In conclusion, this project is not just a testament to what we envisioned but a showcase of our dedication to pushing the boundaries of web development and design. It reflects a deep understanding of our users' needs and a relentless pursuit of innovation. As we look to the future, we are excited about the potential for further enhancements, new features, and the endless possibilities for growth. The flight tracking application is more than just a project; it's a milestone in our continuous journey of learning, innovation, and commitment to excellence

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GITHUB LINK:

- https://github.com/Explorerhere/Sky

DOI LINK:

- https://doi.org/10.22214/ijraset.2024.59234

RESEARCH PAPER AND CERTIFICATION

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Skylinker Aero Pathways

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Abstract: ***Take a journey through the skies, with SkyLinker Aero Pathways, an app that changes the game for tracking flights in time. By using ADS B data and advanced web technologies like JavaScript and React SkyLinker Aero Pathways provides a user interface for exploring air traffic movements effortlessly. Beneath its design, there's a backend system supported by RESTful APIs and cloud platforms to ensure scalability and efficient data management. With SQL and NoSQL databases handling data storage, the app seamlessly integrates WebSocket and SSE technologies to deliver updates and predictive insights to users. This combination of real-time monitoring and predictive analysis elevates the travel experience for aviation enthusiasts and regular travelers giving them a glimpse into the future of air travel. Come along as we reach heights with SkyLinker Aero Pathways, where innovation meets exploration, in the sky.***

Keywords: Real-time flight tracking, web application, innovation, collaboration, dedication, team, technology, development, features, functionality, architecture, user experience, predictive analytics, user-centric design.

I. INTRODUCTION

The development of flight tracking has been characterized by a pursuit of new ideas and enhancements driven by the need, for more precise, effective, and user-friendly solutions. Despite the advancements in times current platforms often face challenges related to interaction, dependability, and expandability creating opportunities for disruption and enhancement.

Against this backdrop, SkyLinker Aero Pathways stands out as a symbol of innovation ready to transform the realm of real-time flight tracking in a way that surpasses existing platforms. By blending ADS B data, with state-of-the-art web technologies SkyLinker Aero Pathways goes beyond traditional flight tracking systems providing users with an engaging and lively experience that reshapes their engagement with aviation information.

Let’s dive into this guide where we uncover the traits and abilities of SkyLinker Aero Pathways. We'll explore its structure, functions, and influence on the aviation sector, in detail. By unraveling its design and emphasizing its transformative power we hope to present SkyLinker Aero Pathways as more than a typical flight-tracking tool. It's a groundbreaking innovation that establishes a fresh benchmark for quality, in the industry.

As we journey through the complexities of SkyLinker Aero Pathways we welcome you to come along on this adventure. Explore with us as we blend creativity and discovery, in the skies. Together let's reveal the possibilities of flight monitoring and reshape the aviation technology landscape, with SkyLinker Aero Pathways leading the way.

II. BACKGROUND WORK: LITERATURE REVIEW

A. *Evolution of Flight Tracking Technology*

1) *Historical Overview:* The literature review starts by looking at the history of flight-tracking technology following its progression, from radar systems to today's advanced satellite-based solutions. It discusses events, advancements, and obstacles in this area offering insight into the rise of real-time flight tracking tools such, as SkyLinker Aero Pathways.
2) *Existing Solutions:* A thorough examination of flight monitoring systems has been carried out assessing their attributes, capabilities, advantages, and drawbacks. The investigation includes a review of accomplishments and triumphs, from endeavors like FlightRadar24 and FlightAware to gain insights, into the elements that have led to their accomplishments and the valuable lessons derived from their execution.

B. *Technologies and Methodologies*

1) *Technological Landscape:* The review of literature delves into the technology landscape related to real-time monitoring of flights covering areas, like web technologies, data analysis, and predictive modeling. It thoroughly examines ideas, frameworks, and tools such, as JavaScript, RESTful APIs, and machine learning algorithms. Insights are drawn from successes and established methods used in endeavors.

2) *Best Practices and Case Studies:* Studying methods, for real-time flight tracking and data visualization involves examining practices and case studies from academic and industry sources. Insights gained from projects, that faced challenges and achieved success utilizing React for front-end development provide valuable guidance for shaping the design and execution of SkyLinker Aero Pathways.

C. *User Needs and Preferences*

1) User-Centric Design: To create SkyLinker Aero Pathways it's vital to grasp what users want like and struggle with. The research covers user actions, interactions, between humans and computers, and the design of user experiences. It learns from successes and comparable endeavors to shape interfaces that are easy to use and understand.
2) *Market Trends and Demands:* Analysis of market trends consumer needs and regulatory changes, in the aviation sector, is conducted to pinpoint chances and obstacles. SkyLinker Aero Pathways aims to adjust its offerings and capabilities in line with market requirements by leveraging insights from successes, in ventures and forecasting future needs.

D. *Regulatory and Ethical Considerations*

1) *Data Privacy and Security:* The literature review discusses the rules and moral aspects linked to monitoring flights, in time focusing on issues like data privacy, security, and adherence to regulations such as GDPR and HIPAA. SkyLinker Aero Pathways guarantees ethical handling of user data by examining frameworks, ethical principles, and industry norms drawing on past successes and best practices, from comparable endeavors.
2) *Safety and Reliability:* In aviation ensuring safety and reliability is of importance. The literature review delves into safety systems, risk management strategies, and safety assurance methods that are key, to flight tracking technology. SkyLinker AeroPathways emphasizes safety and reliability in its design. Functioning by adopting industry best practices and standards. It leverages lessons learned from accomplishments and triumphs, in endeavors.

III. OVERVIEW

A. *Front-End Technologies*

SkyLinker Aero Pathways utilizes an ever-evolving front-end structure prominently featuring JavaScript and React frameworks. While JavaScript plays a role, in client-side scripting and creating, in front-end development providing a versatile and robust set of tools for constructing engaging user interfaces.

1) *JavaScript:* JavaScript is crucial, in improving the user interface of SkyLinker Aero Pathways by making it more interactive and responsive. Using frameworks like React JavaScript allows for the development of elements, interactive maps, and instant updates enhancing user experience with navigation and easy-to-use features.

B. *Back-End Microservices Architecture*

SkyLinker Aero Pathways utilizes a strong microservices architecture, for its system ensuring flexibility, scalability, and reliability. Each microservice is tailored to handle tasks like sending notifications running algorithms and retrieving flight data, which helps in making the system easier to maintain and expand.

1) *Notification Service;* This service manages the delivery of alerts and notifications to users by utilizing WebSocket and SSE technologies for real-time updates. JavaScript's ability to handle connections efficiently along with frameworks such as aiohttp or FastAPI enables communication between clients and servers.
2) *Predictive Algorithms:* By leveraging JavaScript's range of libraries like React, Express, Axios, and Cors SkyLinker Aero Pathways can implement predictive algorithms for predicting flight paths detecting potential disruptions, and optimizing route planning.
3) *Flight Data Retrieval;* The flight data retrieval service is in charge of fetching and processing real-time flight information, from ADS B feeds and external APIs.
   JavaScript flexibility along, with its range of networking libraries, like HTTP requests makes it easy to connect with data sources from the API cord to aviation edge. This helps ensure that users receive precise updates

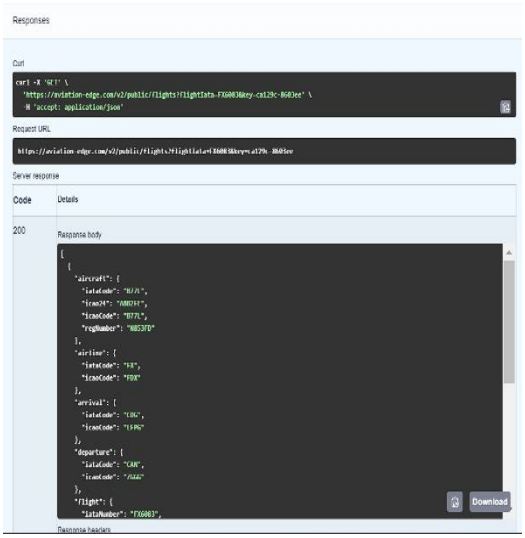

Fig 3.1 Flight API Test Status

C. *Cloud Platforms and Databases*

To ensure that SkyLinker Aero Pathways can grow smoothly and reliably while maintaining performance the company relies on cloud platforms for hosting. Uses MongoDB databases, for storing and managing data.

1) *Utilizing Cloud Platforms;* SkyLinker Aero Pathways benefits from cloud platforms like Amazon Web Services (AWS) or Google Cloud Platform (GCP) which offer infrastructure resources such as machines, container orchestration, and serverless computing services. JavaScript's compatibility with technologies like Google Cloud Functions allows for easy deployment and scaling of microservices in a cloud environment.
2) *Database Management;* SkyLinker uses NoSQL databases to store and retrieve flight information, user preferences, and logs for their applications. By leveraging the versatility of Node.js and its compatibility, with NoSQL databases they streamline data management tasks improve data accuracy boost performance, and simplify maintenance processes. By integrating Node.js as the technology in conjunction with React, for the frontend SkyLinker Aero Pathways designs a user solution that transforms real time flight tracking. This technology combination empowers SkyLinker Aero Pathways to assist users in navigating the skies seamlessly enhancing their flying experience.

IV. FEATURES AND FUNCTIONALITY

SkyLinker Aero Pathways offers a range of features and functionalities that distinguish it from traditional flight-tracking platforms. From user interfaces to predictive analysis and real-time monitoring capabilities SkyLinker Aero Pathways enhances the user experience. Transforms how people engage with aviation data.

A. *Dynamic Front-End Interactions*

1) *J-Powered Interface:* SkyLinker Aero Pathways introduces JavaScript as a front-end technology providing users with a user friendly interface with React frameworks. This innovative approach improves flexibility, efficiency, and ease of maintenance facilitating development and seamless integration with back end services
2) *Maps:* Users can view flights on maps powered by GIS technologies. By integrating JavaScript with mapping libraries such as leaflet the platform enables real time rendering of flight paths, waypoints, and geographical features for an experience.

B. *Real-Time Monitoring and Predictive Insights*

1) *Instant Updates:* By utilizing WebSocket and SSE technologies SkyLinker Aero Pathways provides updates on flight statuses, route adjustments, and potential disruption latency. s ability to handle tasks simultaneously. Its architecture that responds to events, in real time facilitates instant communication, between users and servers ensuring that information reaches them without delay.

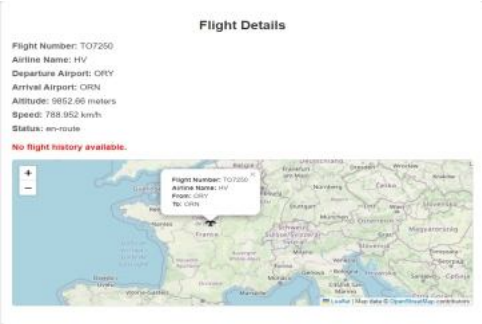

Fig 4.1-Flight details with Map Location

C. Seamless Integration and Customization

1) *Modular Architecture:* SkyLinker Aero Pathways emphasizes integration and personalization, for users. By utilizing an architecture centered on microservices the platform seamlessly integrates with systems and third party APIs using aviation edge using JavaScript flexible design patterns.
2) *API-driven Development:* The platform also prioritizes API driven development offering a range of APIs that empower developers to create custom integrations, plugins and extensions. With JavaScript's user nature developers can efficiently interact with these APIs to enhance SkyLinker Aero Pathways capabilities within their workflows.

D. Enhanced User Experience

1) *Personalized Alerts and Notifications:* Furthermore users can personalize alerts and notifications for flights or events through dynamic subscription management features supported by JavaScipt's event handling mechanisms. Notifications can be. Delivered via email, SMS or push notifications for an user experience.

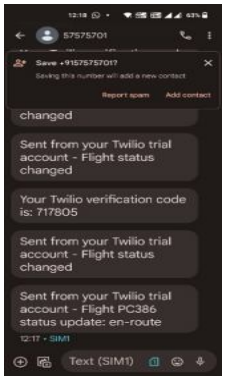

Fig 4.2-Sms of flight status from Twilio

2) *Cross-Platform Compatibility:* Additionally SkyLinker Aero Pathways ensures platform compatibility, across desktops, mobile devices and tablets to cater to diverse user needs. The platform utilizes Twilio for SMS services. JavaScript's adaptability enables it to be easily used on operating systems and devices guaranteeing a consistent user experience regardless of the device being used.

E. Data Security and Privacy

1) *Strong Security Measures:* SkyLinker Aero Pathways gives importance to safeguarding data security and privacy by employing encryption, authentication, and access control methods. JavaScript's wide range of security libraries and frameworks, along with following coding practices ensures that user data remains secure from access and potential threats.
2) *Adherence to Regulations:* SkyLinker Aero Pathways adheres to industry regulations, like GDPR (General Data Protection Regulation) and HIPAA (Health Insurance Portability and Accountability Act) concerning data privacy. JavaScript support for compliance frameworks and maintaining audit logs guarantees that SkyLinker Aero Pathways upholds the standards of data security and privacy.

V. IMPACT AND SIGNIFICANCE

SkyLinker Aero Pathways goes beyond the flight tracking systems making an impact, on both the aviation industry and the overall travel experience. Its unique features user interface and predictive insights are changing how people engage with aviation data leading to outcomes for aviation enthusiasts, travelers, and industry stakeholders.

A. *Safety and Efficiency Enhancement*

1) *Enhanced Situational Awareness:* SkyLinker Aero Pathways offers real-time updates on flight statuses, route adjustments, and possible disruptions to help pilots, air traffic controllers and aviation professionals stay informed. By providing timely information SkyLinker Aero Pathways contributes to more efficient flight operations.
2) *Improved Route Planning:* By using algorithms SkyLinker Aero Pathways allows users to predict flight paths find the routes and avoid potential risks or crowded airspace. This optimization does not reduce fuel consumption and carbon emissions. Also cuts down on flight delays while enhancing overall operational efficiency.

B. *Smooth Travel Experience*

3) *Effortless Travel Planning:* With alerts, notifications, and recommendations at their fingertips thanks, to SkyLinker Aero Pathways services travelers to plan their trips efficiently while addressing any disruptions.SkyLinker Aero Pathways makes travel easier and less stressful by helping with tracking connecting flights keeping an eye, on departure gates, and providing updates on any delays.
4) *Enhanced Customer Satisfaction:* Moreover by providing a user interface SkyLinker Aero Pathways boosts customer satisfaction and loyalty among travelers. Access, to real-time flight details, personalized notifications, and predictive insights enhances the travel experience building trust and confidence in the airline industry.

C. *Industry Innovation and Collaboration*

1) *Driving Technological Advancements:* SkyLinker Aero Pathways plays a role, in driving advancements within the aviation industry by spearheading innovations in real-time data analytics, predictive modeling, and user-centric design. Through its adoption of cutting-edge web technologies and collaboration with ADS B feeds it sets a precedent for industry players to embrace new methodologies and technologies fostering continuous improvement and innovation.
2) *Fostering Collaboration and Integration:* Furthermore, SkyLinker Aero Pathways actively promotes collaboration and integration among aviation stakeholders such as airlines, airports, air traffic management organizations, and regulatory bodies. Its open architecture and API driven development approach facilitate seamless integration with existing systems allowing stakeholders to share real-time data efficiently and coordinate operations effectively. Optimize resource allocation for enhanced efficiency.

D. *Environmental Sustainability*

1) *Reduced Environmental Impact:* In terms of sustainability efforts SkyLinker Aero Pathways significantly reduces the impact of flights by optimizing flight routes to minimize delays and reduce fuel consumption. By utilizing algorithms to help airlines optimize their flight paths for increased fuel efficiency and reduced carbon footprint.
2) *Promoting Sustainable Travel Practices:* Moreover, SkyLinker Aero Pathways also advocates for travel practices by raising awareness about eco-travel choices, among travelers when planning their journeys.SkyLinker Aero Pathways enables travelers to make choices by offering information, on carbon emissions, fuel efficiency, and alternate transportation solutions.

VI. FUTURE OUTLOOK

SkyLinker Aero Pathways is not a fixed solution but a dynamic platform ready, for evolution and innovation. Looking ahead there are ways to enhance expand and integrate the platform paving the path for advancements in real-time flight tracking technology and the wider aviation industry.

A. *Enhanced Predictive Analytics*

1) *Cutting-edge Machine Learning Models:* SkyLinker Aero Pathways aims to utilize machine learning methods to create sophisticated predictive models for forecasting flight paths optimizing route planning and identifying potential disruptions. By analyzing datasets and incorporating real-time factors SkyLinker Aero Pathways can offer users more precise and actionable insights to improve safety and efficiency in air travel.

2) *Incorporation of Weather Data:* By integrating weather data into predictive analysis SkyLinker Aero Pathways can better predict and address weather-related disruptions. Through analyzing weather patterns, wind conditions and atmospheric phenomena SkyLinker Aero Pathways can offer recommendations, for route adjustments and flight planning to reduce delays and enhance efficiency.

B. Expanded Integration and Collaboration

1) *Establishing Partnerships with Industry Stakeholders:* SkyLinker Aero Pathways is dedicated to building partnerships, with airlines, airports, air traffic management organizations, and regulatory authorities to promote collaboration and integration within the aviation community. Through the exchange of data, resources, and insights SkyLinker Aero Pathways aims to improve coordination optimize resource distribution, and enhance efficiency in air traffic management.
2) *Embracing Integration with Emerging Technologies:* SkyLinker Aero Pathways is actively exploring opportunities to incorporate cutting-edge technologies like blockchain, artificial intelligence (AI), and the Internet of Things (IoT) into its operations to bolster its capabilities and uncover value propositions. By leveraging blockchain for data sharing AI for analytics and IoT for real-time sensor data collection SkyLinker Aero Pathways can foster innovation and streamline processes in air travel management.

C. User-Centric Enhancements

1) *Tailored Travel Recommendations:* SkyLinker Aero Pathways is committed to offering personalized travel recommendations tailored to each user's preferences, travel history, and environmental concerns. By analyzing user data and behavior trends SkyLinker Aero Pathways can provide customized suggestions, for destinations, transportation options, and travel plans that enrich the travel experience while encouraging sustainable travel practices.
2) *Enhanced Mobile Experience:* SkyLinker Aero Pathways focuses on improving the mobile user experience by developing applications, for both Android devices. The goal is to provide users with an easy-to-use interface allowing them to access real-time flight updates, alerts, and notifications on the go. This enhances convenience and usability for users wherever they are.

D. Regulatory Compliance and Security

1) *Continuous Compliance Monitoring:* In terms of compliance and security, SkyLinker Aero Pathways is dedicated to meeting standards such as GDPR, HIPAA, and aviation safety regulations. Through audits risk assessments and compliance checks, the company ensures that user data is kept safe, confidential, and compliant with all regulations.
2) *Enhanced Cybersecurity Measures:* To safeguard against cyber threats SkyLinker Aero Pathways has implemented cybersecurity measures. These include encryption techniques, authentication processes, and access controls to protect user data integrity and system confidentiality. By prioritizing security in this way SkyLinker Aero Pathways provides an environment, for its users and stakeholders.

VII. CONCLUSION

SkyLinker Aero Pathways is an example of innovation and excellence, in real time flight tracking technology. Through the use of cutting edge web technologies, predictive analytics, and user friendly design principles SkyLinker Aero Pathways has transformed how users engage with aviation data setting a standard for efficiency, safety, and convenience in air travel.

Looking back on the journey of SkyLinker Aero Pathways it's clear that its impact goes beyond functionality. By improving safety and efficiency in air traffic management and simplifying the travel experience for millions of passengers globally SkyLinker Aero Pathways has made an impression, on the aviation industry and the wider travel community.

Looking ahead, the future of SkyLinker Aero Pathways holds endless possibilities. With a commitment to continuous improvement, innovation, and collaboration, SkyLinker Aero Pathways remains poised to shape the future of air travel and redefine the way we navigate the skies.

As we embark on this journey of exploration and innovation, we invite you to join us in unlocking the full potential of SkyLinker Aero Pathways and ushering in a new era of aviation excellence.

In conclusion, SkyLinker Aero Pathways represents more than just a flight tracking application; it is a testament to human ingenuity, technological advancement, and the relentless pursuit of excellence in air travel. As we soar to new heights with SkyLinker Aero Pathways, the sky is truly the limit.

VIII. ACKNOWLEDGMENT

In the intricate tapestry of innovation, SkyLinker Aero Pathways emerges as a testament to collaboration, dedication, and the relentless pursuit of excellence. We extend our sincere gratitude to all those who have played a pivotal role in shaping the journey of SkyLinker Aero Pathways.

To our remarkable team, your unwavering commitment, ingenuity, and collaborative spirit have been the driving force behind the success of SkyLinker Aero Pathways. Each member's unique talents and tireless efforts have contributed to the realization of our vision, making SkyLinker Aero Pathways a reality.

We also extend our heartfelt thanks to our mentors, advisors, partners, and collaborators, whose guidance, support, and collaboration have been invaluable. Together, we have overcome challenges, seized opportunities, and created something truly remarkable. The journey of SkyLinker Aero Pathways would not have been possible without the contributions of every individual involved, and for that, we are immensely grateful.

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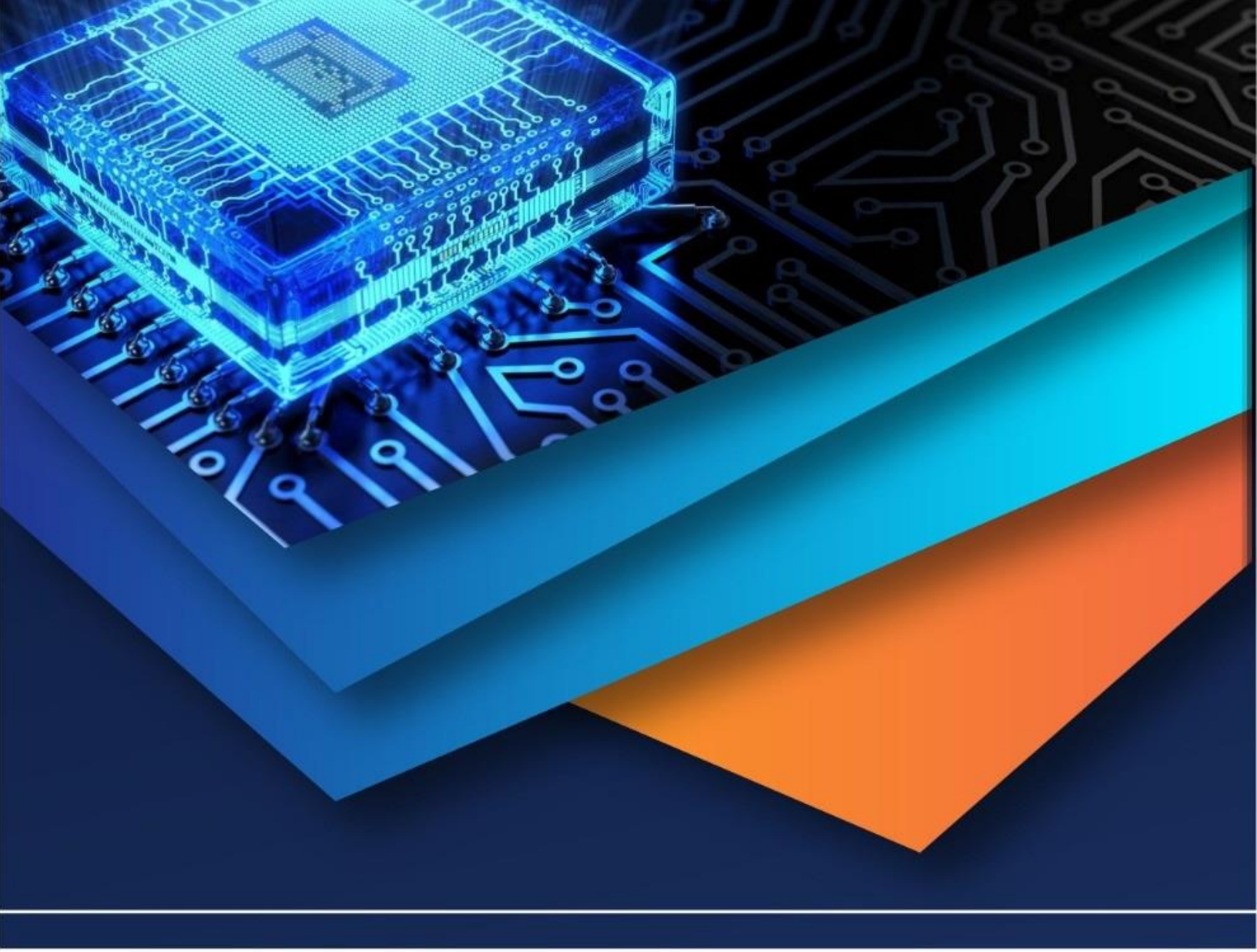

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