Software Requirements Specification (SRS) for
Uber's ETA Computation System

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1. Introduction

1.1 Purpose

The primary objective of this document is to comprehensively specify the software requirements essential for the development of Uber's ETA (Expected Time of Arrival) computation system. It serves as a foundational blueprint, delineating the scope of the project and elucidating the intricate functionalities, constraints, and external interfaces to guide the development process effectively. By providing a detailed overview of the system's requirements, this document aims to ensure clarity, alignment with project objectives, and seamless collaboration among stakeholders involved in the development and deployment of Uber's ETA computation system.

1.2 Document Conventions

This document follows standard software engineering conventions for requirement specification, including clear articulation of functional and non-functional requirements, use of diagrams for visualization, and adherence to industry standards.

1.3 Intended Audience and Reading Suggestions

The intended audience for this document includes software developers, project managers, quality assurance engineers, and other stakeholders involved in the development and maintenance of Uber's ETA computation system. It is recommended to read through the document thoroughly to understand the system requirements comprehensively.

1.4 Product Scope

The product scope encompasses the ambitious goal of developing a high-performance system capable of accurately computing ETA for Uber rides at extreme scales, accommodating up to half a million requests per second. This system will serve as the backbone of Uber's operations, leveraging advanced algorithms and real-time data to provide users with precise and reliable ETAs in various scenarios, including trip planning, driver dispatch, and on-trip updates. By focusing on scalability, accuracy, and real-time responsiveness, the system aims to enhance user experience, optimize operational efficiency, and maintain Uber's reputation as a leader in the ride-sharing industry.

1.5 Product Scope

- Uber Tech Day: What's My ETA? The Billion-Dollar Question

- Map Matching at Uber

- DeeprETA: An ETA Post-processing System at Scale

- Hidden Markov Map Matching Through Noise and Sparseness

- DeepETA: How Uber Predicts Arrival Times Using Deep Learning

2. Overall Description

2.1 Product Perspective

The Uber ETA computation system operates as a vital cornerstone within Uber's expansive ride-sharing platform, fulfilling the crucial role of accurately estimating travel times between pickup and destination points. Despite its integration with various internal and external systems, the ETA computation system functions autonomously to ensure uninterrupted and seamless user experiences. This pivotal system plays a pivotal role in facilitating efficient trip planning, optimizing driver dispatch, and providing real-time updates during the course of a ride. By harnessing advanced algorithms and leveraging extensive data sources, the ETA computation system exemplifies Uber's commitment to reliability, precision, and user satisfaction.

2.2 Product Functions

- Eyeball Scenario: Upon the rider entering a destination in the Uber app, the system computes the ETA to provide an estimated time of arrival.
- Dispatch Scenario: To minimize waiting time for rider pickup, the system dispatches the nearest available driver to the rider's location.
- Pick Up Scenario: The system estimates the time required for the driver to arrive at the user's location for pickup, ensuring efficient service delivery.
- On-Trip Scenario: Throughout the ride, the system provides live updates on the estimated time to reach the destination, taking into account real-time traffic conditions.
- Login: Users authenticate their identity through the login process, ensuring secure access to the Uber app and its functionalities.
- Payment: After the completion of the ride, the system processes the payment transaction securely, ensuring a seamless and hassle-free payment experience for both riders and drivers.
- Feedback: Upon ride completion, users have the option to provide feedback on their experience, enabling Uber to improve its service quality and address any concerns raised by riders.
- Notification: The system sends timely notifications to users, informing them about important updates such as driver arrival, trip status, and payment confirmation, enhancing overall user communication and experience.

2.3 User Classes and Characteristics

- Riders: Users requesting Uber rides, relying on accurate ETAs for trip planning, ensuring punctuality and convenience in their transportation needs.

- Drivers: Providers of transportation services, benefiting from efficient dispatch and route guidance, enabling them to optimize their driving routes and maximize their earning potential.

2.4 Operating Environment

The system operates within Uber's infrastructure, utilizing high-performance servers, network connectivity, and real-time data sources. It interfaces with mobile applications on iOS and Android platforms, ensuring compatibility across devices.

2.5 Design and Implementation Constraints

- Scalability: The system must scale to handle half a million requests per second efficiently.

- Accuracy: ETA predictions must align closely with actual travel times to maintain user trust and satisfaction.

- Real-time Processing: Data processing and ETA computation should occur in real-time to provide timely updates to users.

2.6 User Documentation

Comprehensive user documentation, including FAQs and tutorials, will be provided within the Uber app to assist users in understanding and utilizing the ETA computation features effectively. This documentation will serve as an invaluable resource, empowering users to navigate the app with confidence and make informed decisions regarding their transportation needs.

2.7 Assumptions and Dependencies

The system relies on the assumption of reliable access to real-time traffic data, accurate GPS signals, and a stable network connection for optimal performance. It hinges on continuous updates and improvements to algorithms and data sources to enhance accuracy and reliability. These dependencies underscore the importance of maintaining robust infrastructure and staying abreast of technological advancements to ensure seamless operation and user satisfaction.

3. External Interface Requirements

3.1 User Interfaces

The user interface will be seamlessly integrated into the Uber mobile application, offering riders and drivers an intuitive platform to view and interact with ETA information effortlessly. This integration ensures a cohesive user experience, allowing users to access ETA data seamlessly while navigating the app's various features and functionalities. By embedding ETA information directly within the familiar Uber interface, users can conveniently plan their trips and make informed decisions based on real-time travel estimates, thereby enhancing overall user satisfaction and engagement.

3.2 Hardware Interfaces

The system interfaces with GPS-enabled mobile devices utilized by both riders and drivers, leveraging location data to facilitate ETA computation. By integrating with these mobile devices, the system can access real-time GPS coordinates, enabling accurate estimation of travel times between pickup and destination points. This seamless interaction between the system and GPS-enabled devices ensures that ETA calculations are based on up-to-date location information, enhancing the precision and reliability of the estimated arrival times provided to users.

3.3 Software Interfaces

Integration with external traffic data providers and map services is crucial for accessing real-time traffic information and map data for route planning. These integrations enable the system to stay updated on current traffic conditions and road networks, allowing for accurate ETA computation and route guidance.

3.4 Communications Interfaces

The system communicates with users through the Uber mobile application, delivering timely updates on estimated arrival times (ETAs), notifications regarding trip status changes, and pertinent trip-related information. This communication channel ensures that users stay informed and engaged throughout their Uber rides.

4. System Features

- **Routing Algorithm:** Utilize graph-based routing algorithms to find the shortest path between pickup and destination points.
- **Traffic Information:** Integrate real-time traffic data to adjust ETA predictions based on current road conditions.
- **Map Matching:** Apply map matching techniques to align GPS coordinates with road segments accurately.
- **ETA Prediction:** Employ predictive models to estimate travel times and provide accurate ETAs to users.

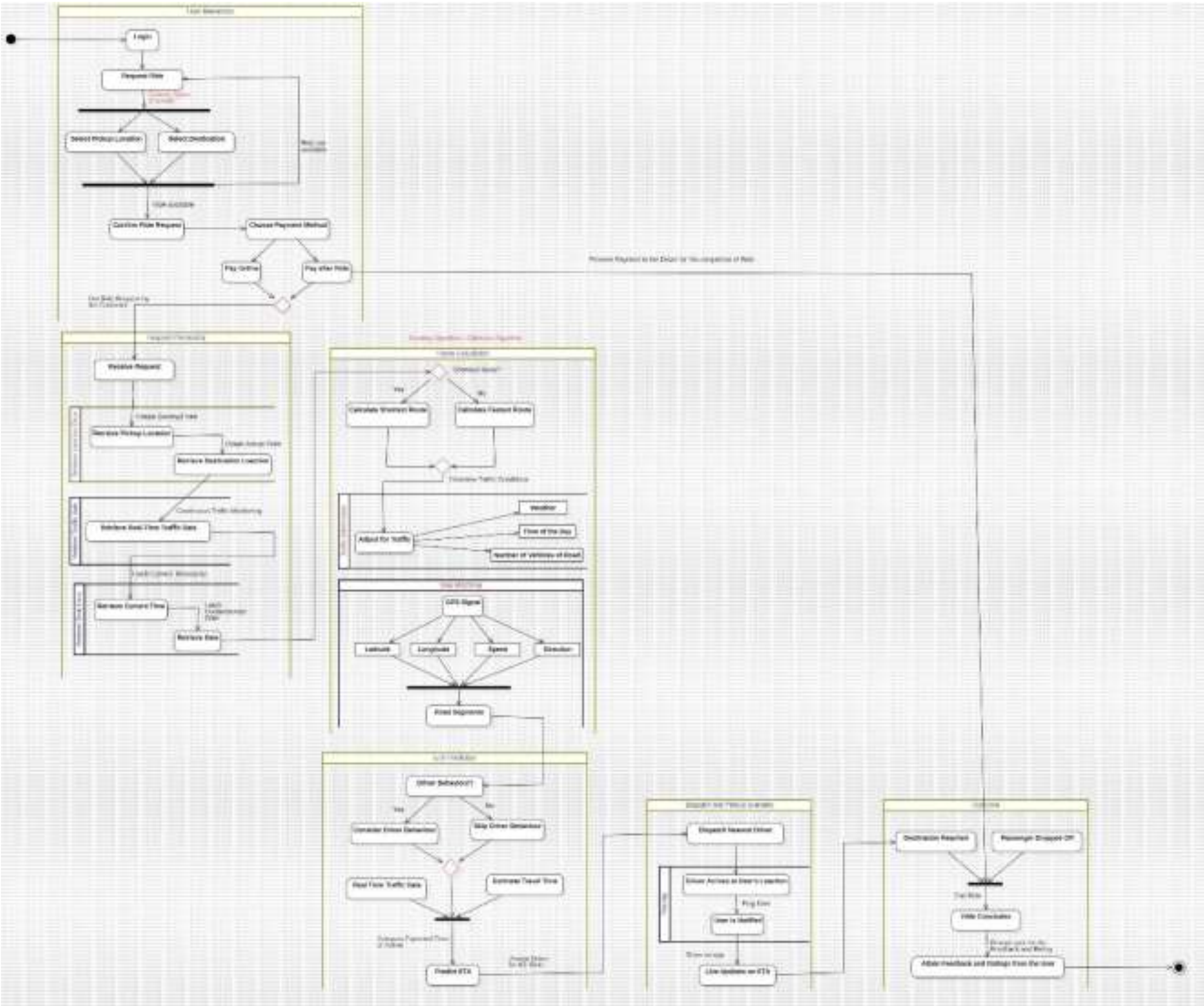


Figure : Activity Flow of Uber ETA

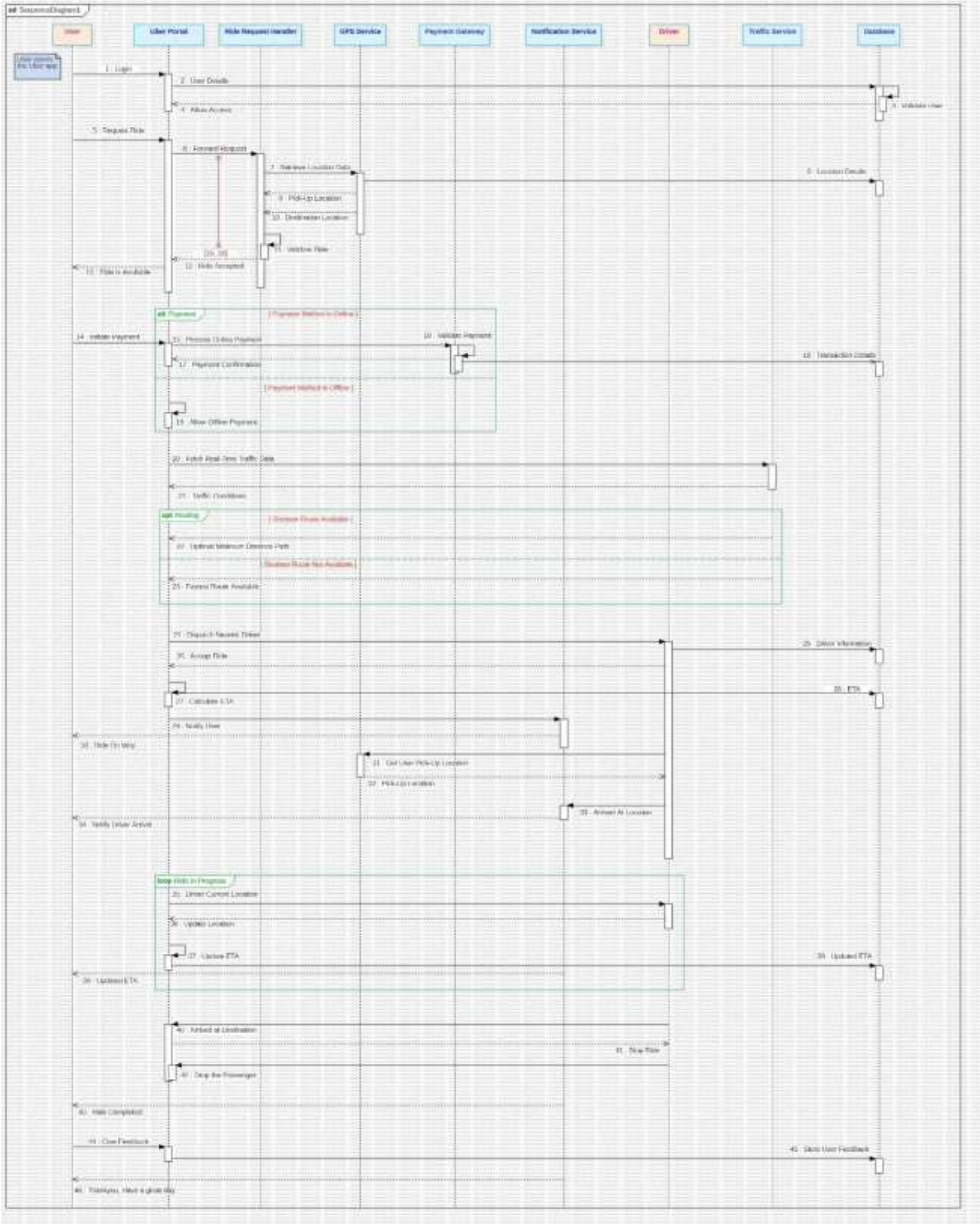


Figure : Sequence Flow of Uber ETA

5. Other Nonfunctional Requirements

5.1 Performance Requirements

- Response Time: Maintain an average response time of under 100 milliseconds for ETA computation requests.

- Scalability: Scale horizontally to handle increasing request volumes without performance degradation.

5.2 Safety Requirements

Data Security: One of the paramount concerns of the system is to ensure the confidentiality and integrity of user data transmitted within the platform. Robust encryption protocols and secure communication channels will be employed to safeguard sensitive information from unauthorized access or tampering.

Reliability: The system is designed to prioritize reliability by minimizing instances of system downtime and errors. This commitment to reliability aims to provide users with a seamless and consistent experience, enhancing trust and confidence in the platform's performance and functionality.

5.3 Security Requirements

- Authentication: Implement robust user authentication mechanisms, such as multi-factor authentication, to ensure secure access to the system and protect sensitive user information.

- Payment Processing: Integrate secure payment processing services to facilitate seamless transactions between riders and drivers, ensuring the confidentiality and integrity of financial data.

5.4 Software Quality Attributes

The system aims to provide a seamless user experience through intuitive interface design and reliable performance. Usability is a key focus, with the interface being designed to facilitate effortless interaction and navigation for both riders and drivers. Additionally, the system prioritizes reliability by consistently delivering accurate ETA predictions, even in dynamic traffic and environmental conditions. This commitment to usability and reliability ensures that users can rely on the system for efficient trip planning and transportation services.

5.5 Business Rules

The system is designed with fairness and compliance in mind, employing algorithms that ensure equitable distribution of ride requests among available drivers. Additionally, strict adherence to legal and regulatory standards regarding data privacy and transportation services is maintained to safeguard user rights and ensure operational integrity.

6. Other Requirements

6.1 Appendix A: Glossary

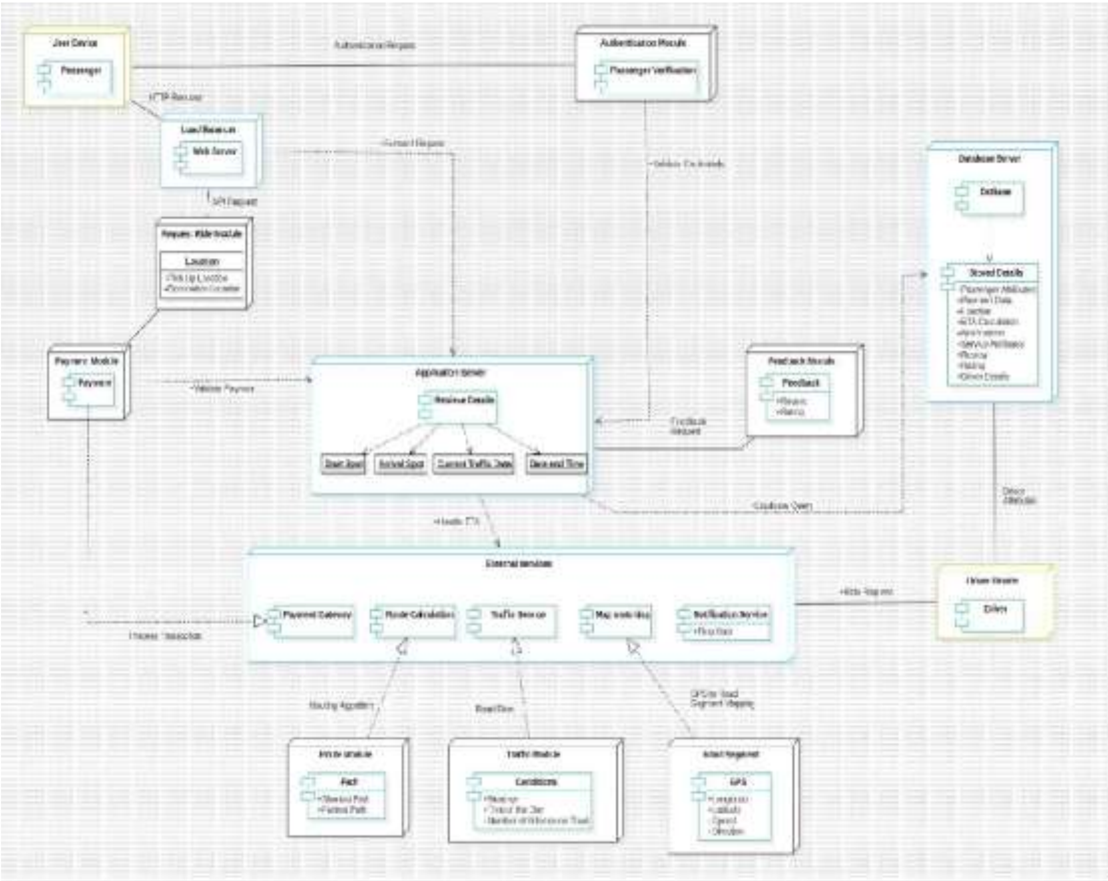
ETA - Expected Time of Arrival

API - Application Programming Interface

GPS - Global Positioning System

6.2 Appendix B: Analysis Models

<u>Deployment Diagram</u>



6.3 Appendix C: Issues List

I. Data Accuracy: Ensure precise computation of ETA by integrating reliable traffic and map data sources, minimizing inaccuracies in travel time predictions.
II. User Engagement: Foster user interaction and engagement by providing real-time ETA updates, personalized notifications, and intuitive user interfaces within the Uber mobile application.
III. Regulatory Compliance: Ensure adherence to legal requirements and regulations governing transportation services, data privacy, and user safety within the Uber ETA computation system.