

Railway Management System (RMS) Requirements Specification

Version 1.0

March 8th, 2025

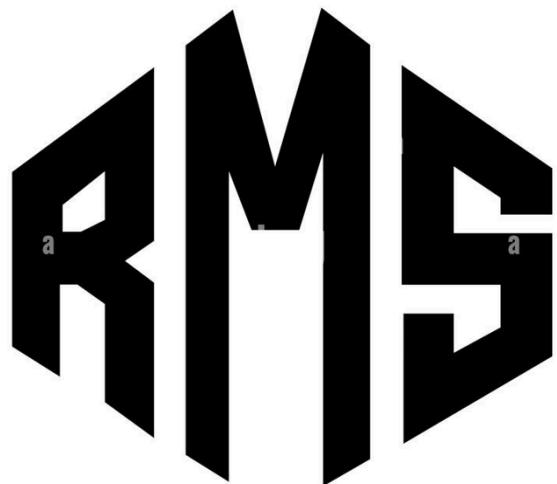


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1. Executive Summary

1.1 Project Overview

This project seeks to model and design a management system that is capable of automating and streamlining the operations of a given railway network, ensuring quicker operations, precise commands, higher security, and general improvements in user experience.

2. Product/Service Description

The Railway Management System is designed to modernize and optimize the operations of railway networks by addressing the core challenges of managing trains, passengers, schedules, and maintenance, ultimately improving efficiency, safety, and customer satisfaction across the entire transportation ecosystem.

2.1 Product Context

RMS does not have to necessarily be a standalone product. During development, we keep in mind functionalities that the system may gain from the use of other parent or child systems. For example, the system may need to serve as a smaller cog in a local public transportation management system in regards to train traffic control (parent system), or it might interact with systems such as embedded systems in the trains and stations to communicate availability (child system). The system should also need to be aware of other neighbouring railway systems that fall outside of its jurisdiction.

2.2 User Characteristics

- Station Managers
- Train and Station Personnel
- Passengers
- Traffic Manager
- Railway and Train Maintenance (External Maintenance)
- Admin

2.3 Assumptions

An assumption is made that the system "owns" and directly controls a fleet of trains. This simplifies the design by reducing the complexity involved in interacting with other external systems or organizations. Under this assumption, the system has full access to operational data, maintenance schedules, and scheduling control for the entire fleet.

2.4 Constraints and Dependencies

In the design and development of the Railway Management System (RMS), we must consider several **constraints** and **dependencies** to ensure that our system operates effectively and meets the required standards. Some examples are:

1. Access, management and security

- ❖ **Access Control:** The system must implement strict access control mechanisms to ensure that only authorized users (e.g., administrators, maintenance personnel, and passengers) can access sensitive information. Role-based access control will be used to enforce security policies.
- ❖ **Data Security:** The system must adhere to industry-standard encryption protocols (e.g., AES, SSL/TLS) to protect passenger data, payment information, and operational data both in transit and at rest.

2. Non-stop operation

- ❖ **Availability:** The system must be highly available and capable of operating 24/7, ensuring no downtime during peak travel times or maintenance windows. High availability solutions like load balancing, failover systems, and backup servers will be implemented.

3. Record Keeping

- ❖ **Data Retention:** The system must maintain historical records of train schedules, passenger transactions, maintenance logs, and other operational data for a specified retention period, as mandated by regulatory requirements and internal policies.

4. Scalability

- ❖ **User Load:** The system must be scalable to handle increased user traffic, especially during peak times (e.g., holiday travel, rush hours). This includes passenger reservations, ticket sales, and administrative access.
- ❖ **Data Volume:** As the railway network expands, the system must scale to accommodate increasing amounts of operational data, such as train schedules, maintenance records, and passenger transactions.

5. Budget and Resource Constraints

- ❖ **Budget Limitations:** The design, development, and deployment of the system must adhere to budget constraints, which may limit the choice of technologies, features, and scale of implementation.

6. Time Sensitivity and Real-Time Data

- ❖ **Real-Time Updates:** The system must provide real-time updates on train schedules, delays, cancellations, and seat availability to passengers, as well as to the administrative team. This requires low-latency data processing and communication protocols.
- ❖ **Synchronization:** Time synchronization across multiple components (trains, stations, servers) is critical to ensure consistent and accurate data for scheduling and reporting purposes.

3. Requirements

3.1 Functional Requirements

Naming Key

Actors

- S = System
- TM = Traffic Manager
- SM = Station Manager
- P = Passenger
- E = Employee
- M = Manager
- U = User (All Users)
- A = Admin

Requirement Types

- MNG = Management (Tracks, Scheduling, etc.)
- INT = Interoperability (External Systems)
- TRK = Tracking (Stations, Railways, Trains, etc.)
- SCH = Scheduling & Timetables
- PER = Personnel & Passenger Management
- TKT = Ticketing (Booking, Cancellation, Loyalty)
- PAY = Payment Processing
- NOT = Notifications & Updates
- WRK = Employee Work & Tasks
- VIW = Information Access & Viewing
- ALR = Alerts & Emergency Responses
- SVC = Passenger Services (Accessibility, Special Requests)
- CAP = Capacity Management (Prevent Overbooking)
- AUTH = Authentication & Logging (Login/Logout)
- FIN = Financial Tracking & Reporting
- LOG = System Logging & Operations
- ADM = Admin-Specific Controls

Railway Management System Requirements Specification

Req#	Requirement	Comments	Priority	Date Rvwd	SME Reviewed / Approved
TM_MNG_01	The system must track and update the status, availability, and condition of constructed tracks under management.	General geographic mapping	1		
S_INT_02	System needs to be able to interact with other external railway systems outside of its jurisdiction	Interaction in this case involves keeping track of trains going from and to, closed railways and stations.	1		
S_TRK_03	The system needs to be able to keep track of its own stations availability and condition	Conditions: onAlert, fullCapacity, underMaintenance. More conditions TBD when other edge cases present themselves.	1		
S_TRK_04	The system must track railway availability and condition to ensure safe and efficient train operations.	Conditions: onAlert, underMaintenance, occupied. More conditions TBD when other edge cases present themselves.	1		
S_TRK_05	The system must maintain accurate data on train car availability and condition for scheduling and maintenance.	Conditions: onAlert, underMaintenance, inUse, outsideBounds More conditions TBD when other edge cases present themselves	1		
S_SCH_06	The system must keep an updated schedule of trains and their specific itineraries to ensure proper route planning.	Keep track of both time and locations.	1		
S_PER_07	The system must securely store and manage passenger information for ticketing, travel records, and customer service.	<i>Passenger information management must comply with data security and privacy regulations</i>	1		
TM_SCH_08	The Traffic Manager must be able to create, update, and delete schedules for trains under their jurisdiction.		1		
SM_PER_09	The Station Manager must be able to allocate human personnel to complete tasks on stations under their jurisdiction.		1		
TM_VIW_10	The Traffic Manager must be able to view train information, station information, and track information.		1		

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Req#	Requirement	Comments	Priority	Date Rvwd	SME Reviewed / Approved
S_ERR_11	The system must prevent Traffic Managers from making critical scheduling or operational errors using validation checks	Main errors include: Routing through stations and tracks under repair or under alert Causing train collisions on tracks	1		
SM_PER_12	The Station Manager needs to be able to access personnel information.		1		
SM_SCH_13	The Station Manager needs to be able to view train schedules under his jurisdiction.		1		
TM_VIW_14	The Traffic Manager needs to be able to view the location of every train in real time		1		
SM_PER_15	The Station Manager must have controlled access to passenger details while ensuring data privacy.		1		
P_TKT_16	Passengers are able to book tickets for trains at an available time, with specifications such as class or sleep accommodation		1		
P_VIW_17	Passengers are able to view train information		1		
P_TKT_18	Passengers are able to cancel their reservations within a reasonable timeframe	Timeframe TBD	1		
S_PAY_19	System must process payment for the booking of a ticket either using card or cash on the ticket booths		1		
S_NOT_20	System must notify all users about changes in the time table according to their jurisdiction.		1		
S_NOT_21	System must notify External Maintenance on scheduled maintenance checks		1		
E_WRK_22	Employees should be able to check specific tasks issued to them from the Station Manager.		2		
SM_WRK_23	All users must be able to see their personal information		2		
S_ALR_24	System must be able to detect Alert sensors on railways, trains, maintenance centers, train depots and stations		2		

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Req#	Requirement	Comments	Priority	Date Rvwd	SME Reviewed / Approved
S_ALR_25	System must notify the correct user for the specific alerts	Railway and Train alerts -> Traffic Manager Station Alert -> Station Manager Train Depots, maintenance Centers -> External Maintenance	2		
M_ALR_26	Managers are allowed to call alerts on their own		2		
P_SVC_27	Passengers can choose to call for accessibility services	“wheelchair accommodation, blindness accommodation, etc”	3		
P_TKT_28	Passengers can opt into loyalty programs or alternate payment methods		3		
S_CAP_29	System must observe train capacity to eliminate overbooking		2		
SM_ALR_30	Station Managers are allowed to alert passengers to any of their alerts		2		
U_AUTH_31	All users must have login logout functionality		1		
S_FIN_32	The system must keep track of expenses and profit.		1		
SM_FIN_33	Station Managers are able to check station revenue and expenses		1		
S_FIN_34	The system must be able to generate detailed reports on revenue and expenses.		1		
S_LOG_35	The system must keep track of all operations done in a specified timeframe		1		
S_SCH_36	The system must keep track of the schedule of everything within a specific timeframe		1		
E_WRK_37	Employees may request a shift change or time off		3		
A_VIW_38	An admin user is allowed to view all info on the system		1		

3.2 Non-Functional Requirements

Performance requirements:

1. System response time :

- The system must respond to user requests, including ticket bookings, schedule lookups, and other operations ,within 4 seconds under typical operational conditions.

2. Scalability:

- The system must support a minimum of 100 concurrent users without performance degradation, ensuring it can handle seasonal or event-based traffic spikes.

3. Data Processing Efficiency:

- The system must be capable of processing large data sets (e.g., real-time train schedules, passenger data) within 3 minutes to facilitate timely decision-making.

Security requirements :

4. Data Encryption:

- All sensitive data, such as passenger details, payment information, and personal records, must be encrypted at rest and in transit using AES-256(Advanced Encryption Standard with a 256-bit key) encryption.

5. Authentication and Authorization

- The system must implement multi-factor authentication (MFA) for all users and enforce role-based access control (RBAC) to restrict sensitive operations based on user roles.

6. Data Integrity

- The system must ensure that data is accurate, complete, and unaltered by unauthorized users. All data modifications should be logged with timestamps and user identifiers.

7. Activity Log

- The system must maintain an audit trail of all critical operations, including user logins, data modifications, and system configurations, with logs retained securely for at least 12 months.

Usability Requirements:

8. User Interface (UI) Design

- The system must feature an intuitive, user-friendly interface for all user types (e.g., passengers, station staff, administrators), minimizing the need for extensive training.

9. Cross-Platform Compatibility

- The system must be fully responsive, providing an optimal user experience on both desktop and mobile platforms, supporting the major browsers and mobile operating systems.

10. Localization and Internationalization

- The system must support multiple languages (at least English, Spanish, and French) and be capable of adapting to different regional settings (e.g., date formats, currency).

11. User Feedback and Support

- The system must incorporate a mechanism for users to provide feedback or report issues. This feedback should be easily accessible to administrators for further analysis.

Scalability and Maintainability Requirements:

12. Modular Architecture

- The system must be designed using a modular architecture, enabling easy addition or removal of features and integration with third-party services without disrupting core functionality.

13. Maintainability

- The system must support regular maintenance activities (e.g., database backups, software updates)

14. Data Backup and Restore

- The system must implement daily backups of critical data, with the ability to restore data within 2 hours in the event of a system failure, ensuring our business continuity.

15. Fault Tolerance and Recovery

- The system must be fault-tolerant, ensuring continuity of service in case of hardware failures. It must provide automatic failover mechanisms.

3.2.1 Product Requirements

3.2.1.1 Usability Requirements

- The system must be detailed to ensure safety in operation
- A future mobile app for passengers should have simple and understandable menus

3.2.1.2 Performance Requirements

Specify static and dynamic numerical requirements placed on the system or on human interaction with the system:

- All traffic control management operations should be instantaneous (under 1 second)
- The system must handle at least 1000 users in every station on the railway grid
- All alert operations must be instantaneous (under 1 second)
- Menu loads must be done in under 3 seconds
- To ensure optimal performance, all stations must have a local server on which the operations and logs are kept.

3.2.1.3 Availability

- System must be able to cover all the geographical area traced by the stations, railways, depots, and maintenance centers within jurisdiction.
- In case of system failure, the traffic control management system must restart itself in 10 minutes or less
- System maintenance should not interfere with traffic control management
- Maximum downtime must be 1 hour every month

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- The system must be operational at all times

3.2.1.4 Security

- All accounts and their respective passwords must be encrypted
- System must keep track of all operations in the form of logs.
- All data must be consistent and avoid duplication or loss of critical information
- All data must be ACID compliant to avoid data corruption
- Hourly backups of traffic control must be performed, and retrieval systems must be in place.
- Logs must be accessed by only the relevant parties, either the management in jurisdiction, or the admin.

3.2.2 Organizational Requirements

- System must support different time zones, units, currencies, and language translations.
- System should be integrated with existing systems for the railway management system.

3.2.3 External Requirements

- System must adhere to the relevant local authorities laws.

4. User Scenarios/Use Cases

Provide a summary of the major functions that the product will perform. Organize the functions to be understandable to the customer or a first time reader. Include use cases and business scenarios, or provide a link to a separate document (or documents). A business scenario:

- ❖ Describes a significant business need
- ❖ Identifies, documents, and ranks the problem that is driving the scenario
- ❖ Describes the business and technical environment that will resolve the problem
- ❖ States the desired objectives
- ❖ Shows the “Actors” and where they fit in the business model
- ❖ Is specific, and measurable, and uses clear metrics for success

Use cases are associated with a particular Functional Requirement. Assuming you have the first functional requirement named BR_01, you will map it into the Use Case called UC_01 and user scenario US_01. Please keep this naming convention throughout all your use cases and diagrams.

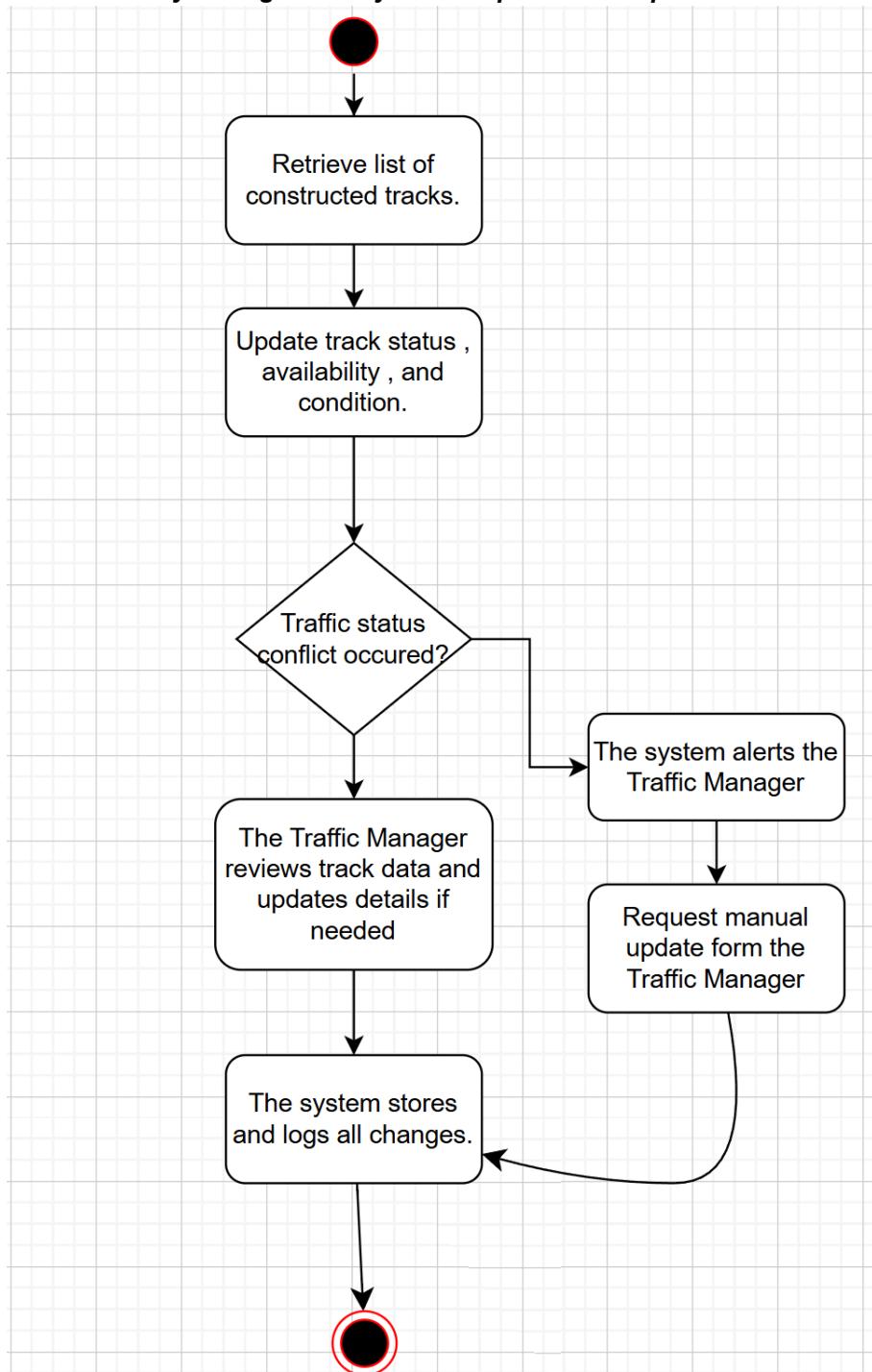
UC Name	<u>UC TM MNG 01 – Track Constructed Tracks Under Management</u>
Summary	The system must track and update the status, availability, and condition of constructed tracks under management to ensure efficient scheduling, maintenance, and safety.
Dependency	<ul style="list-style-type: none">• <i>S_TRK_04 (Track Railway Availability and Condition)</i> → <i>Tracks must be monitored for availability and condition.</i>• <i>S_SCH_06 (Track Train Schedules and Itineraries)</i> → <i>Tracks must be available for scheduled train movements.</i>
Actors	<ul style="list-style-type: none">• Primary Actor: System (S)• Secondary Actor: Traffic Manager (TM) , Station Manager (SM)

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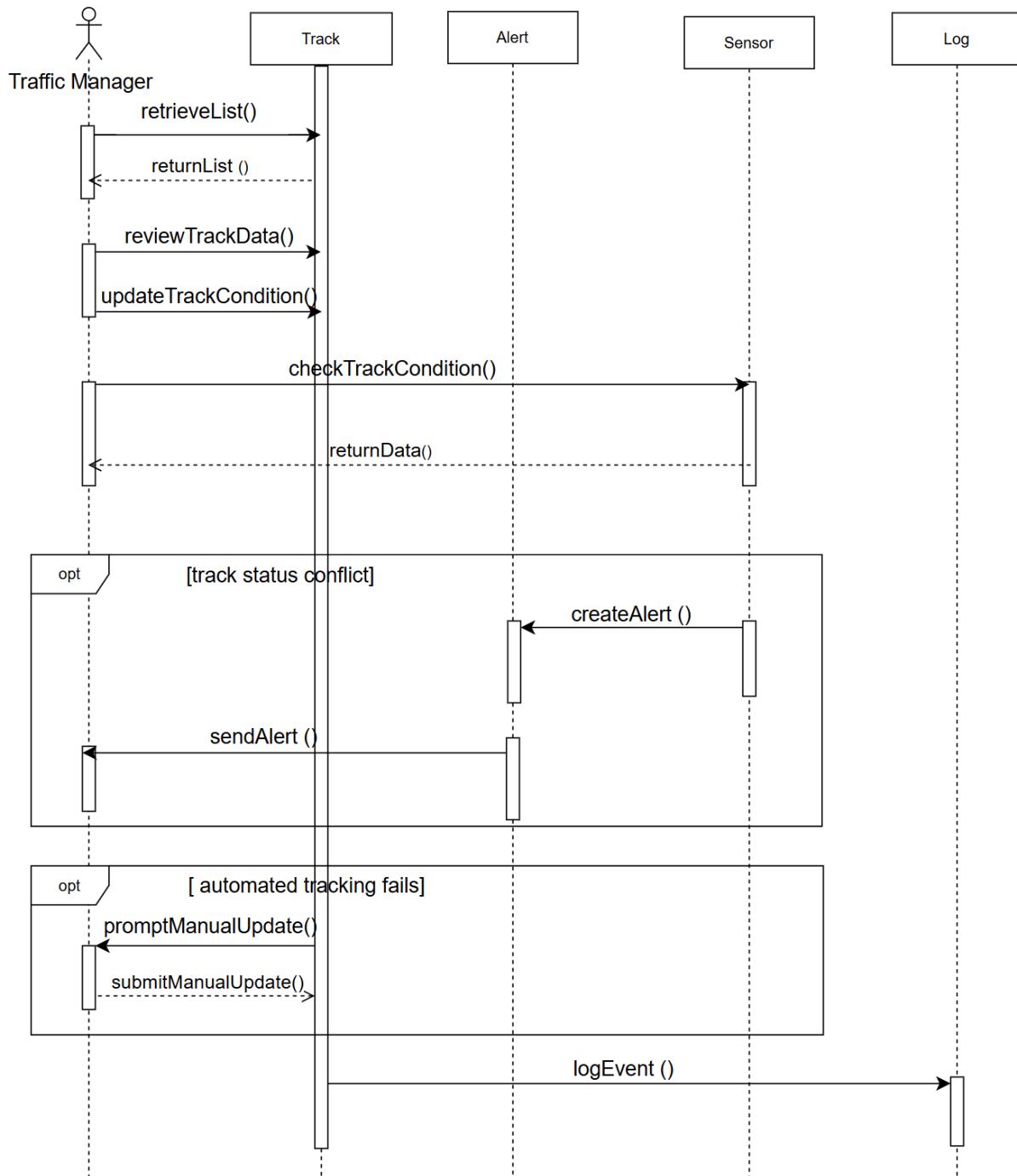
Preconditions	<ul style="list-style-type: none"> → The system must have an updated list of constructed tracks. → The Traffic Manager must have appropriate access rights.
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ 1. The system retrieves the list of constructed tracks. ❖ 2. The system updates track status, availability, and condition in real time. 3. The Traffic Manager reviews track data for planning and maintenance. ❖ 4. The Traffic Manager updates track details if needed (e.g., marking a track as under maintenance). ❖ 5. The system stores and logs all changes.
Description of the Alternative Sequence	<ul style="list-style-type: none"> ❖ 1 . If automated tracking fails, the system requests manual updates from the Traffic Manager. ❖ 2. If a track status conflict occurs, the system alerts the Traffic Manager.
Non functional requirements	<ul style="list-style-type: none"> → Real-time Updates : Track data must be updated immediately. → Reliability : The system must ensure continuous availability. → Security : Only authorized users can modify track information. → Audit Logging : All track updates must be logged.
Postconditions	<ul style="list-style-type: none"> ❖ The system maintains an accurate and up-to-date record of all constructed tracks, including their status, availability, and condition. ❖ The system securely updates and logs all track status changes, ensuring accurate records for monitoring, maintenance, and audits.

1. UC1 : **TM MNG 01 – Track Constructed Tracks Under Management**

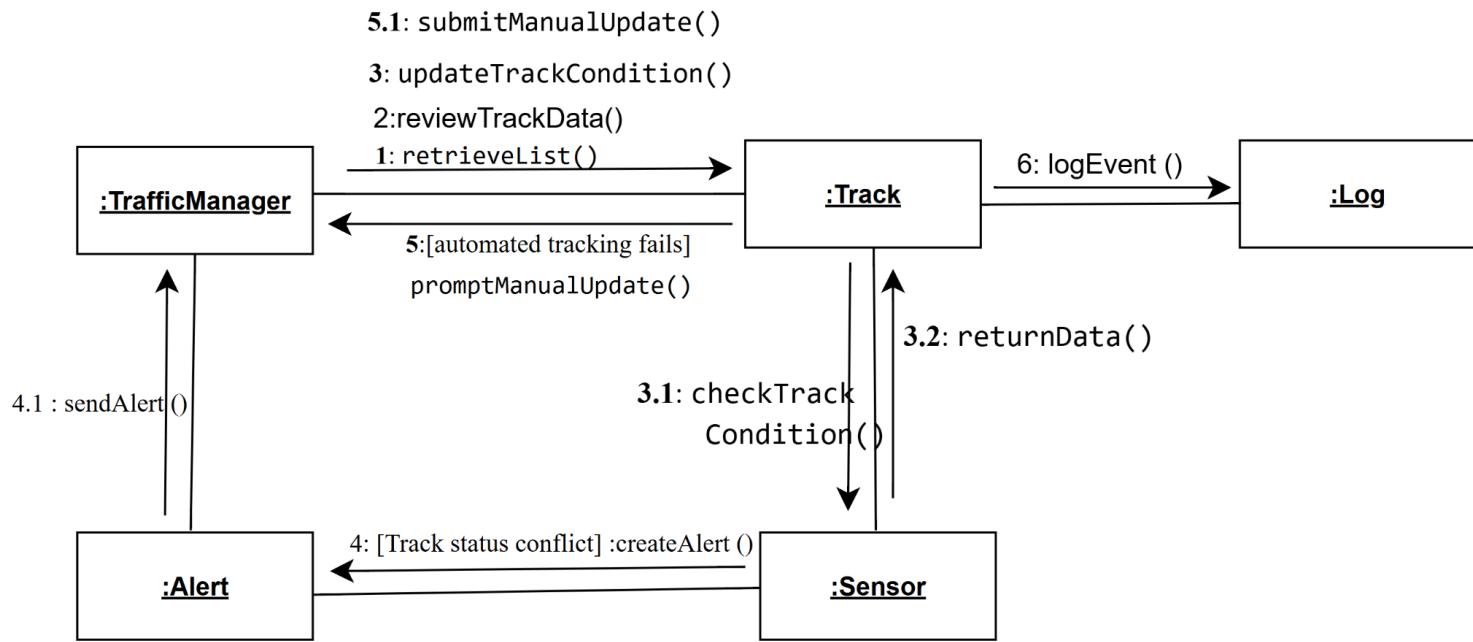
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1. Sequence diagram for UC TM MNG 01 – Track Constructed Tracks Under Management



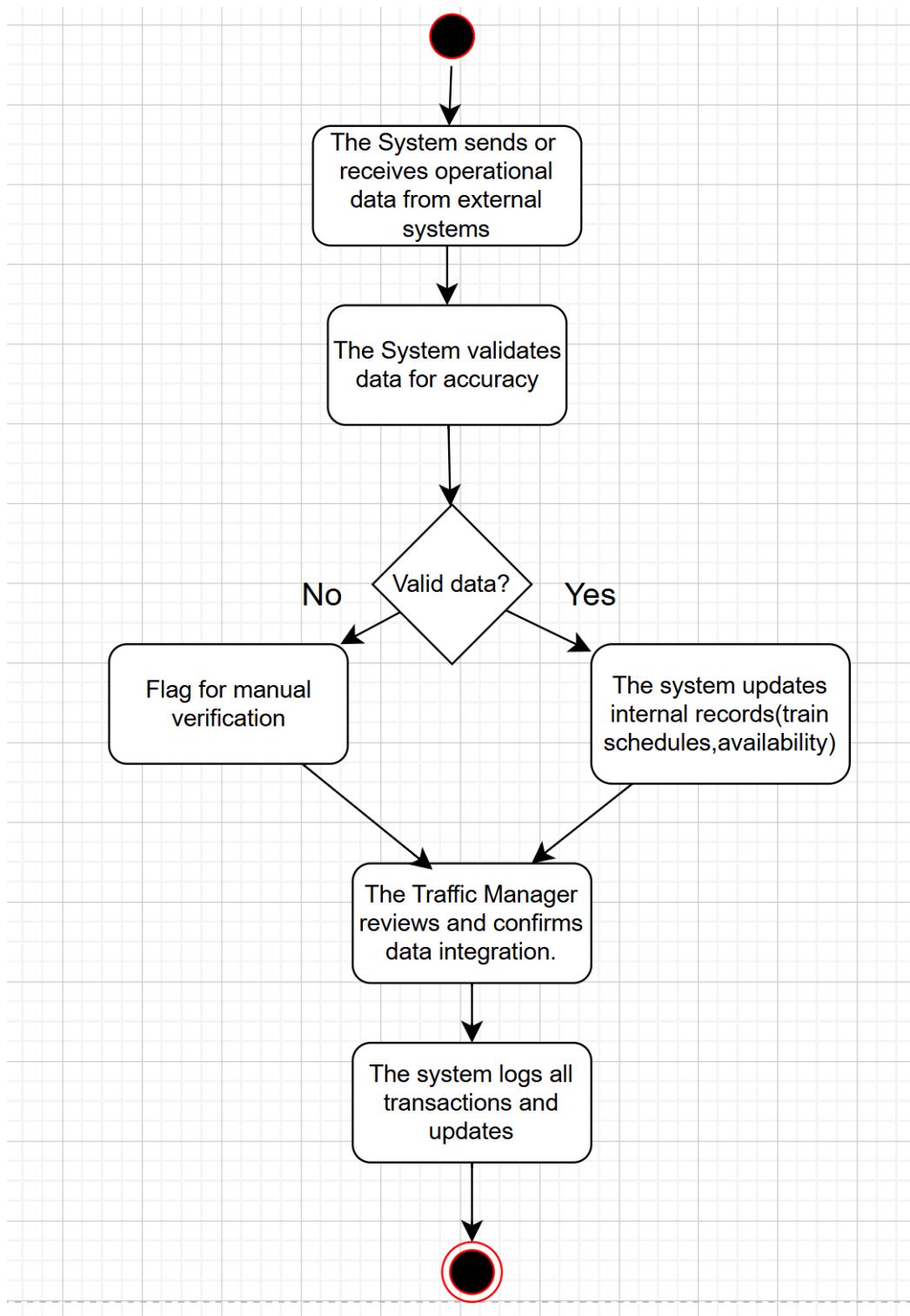
Railway Management System Requirements Specification
Collaboration diagram



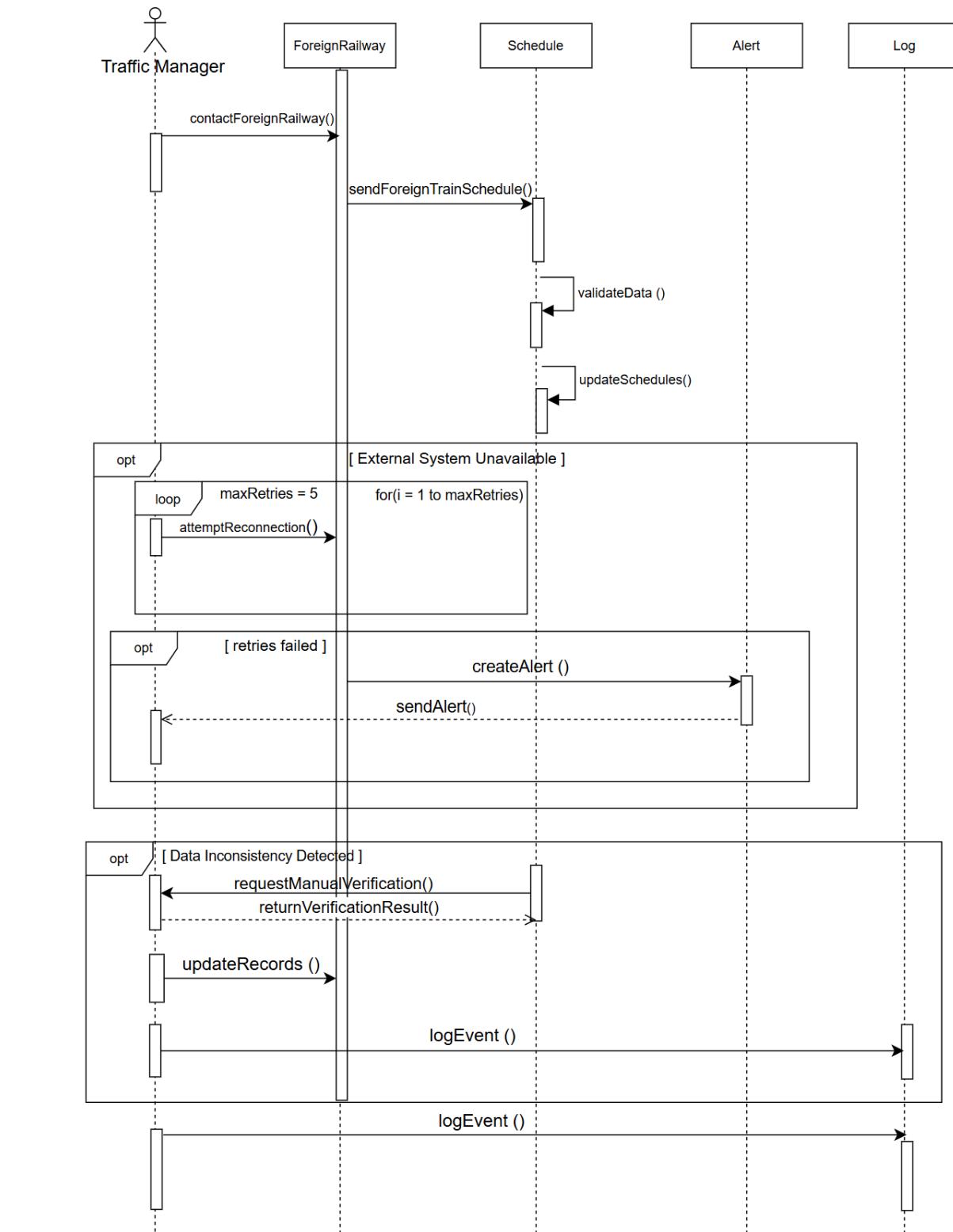
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UC Name	<i>S INT 02 : External Railway System Interaction</i>
Summary	The system must facilitate secure and efficient data exchange with external railway systems to coordinate train operations beyond its jurisdiction.
Actors	<ul style="list-style-type: none"> ● Primary Actor: System (S) ● Secondary Actors: External Railway System (EXT), Traffic Manager (TM)
Preconditions	<p>→ The system must have an established connection with external railway databases or APIs.</p> <p>→ The external system must allow authorized data exchanges.</p>
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ 1. The system sends or receives operational data from external railway systems. ❖ 2. The system validates incoming data for accuracy and consistency. ❖ 3. The system updates relevant internal records (e.g., train schedules, track availability). ❖ 4. If required, the Traffic Manager reviews and confirms data integration. ❖ 5. The system logs all transactions and updates.
Description of the Alternative Sequence	<ul style="list-style-type: none"> ❖ 1. If the external system is unavailable, the system will attempt reconnection and notify the Traffic Manager if retries fail. ❖ 2. If inconsistencies in received data are detected, the system will flag them for manual verification and corrective action.
Non functional requirements	<p>→ Interoperability → The system must integrate with external railway networks using standardized communication protocols (e.g., XML, JSON, API).</p> <p>→ Security → All data exchanges must be encrypted and authenticated to prevent unauthorized access.</p> <p>→ Audit Logging → Every interaction with external systems must be recorded with timestamps and details for monitoring and compliance.</p>
Postconditions	<ul style="list-style-type: none"> ❖ External railway system data is successfully exchanged and integrated. ❖ Any modifications or failures in data exchange are logged for traceability.

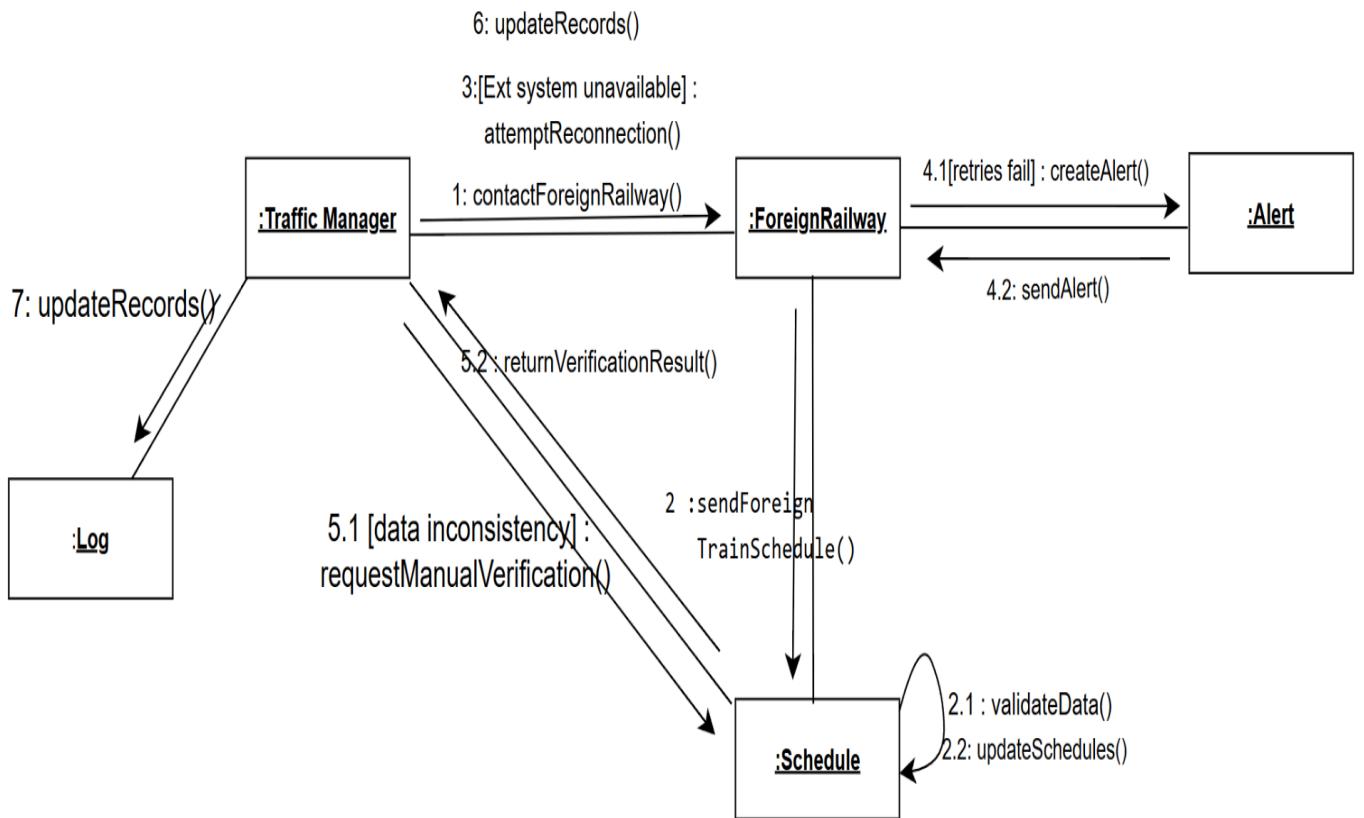
UC2: S INT 02 : External Railway System Interaction



2.Sequence diagram for S INT 02 : External Railway System Interaction

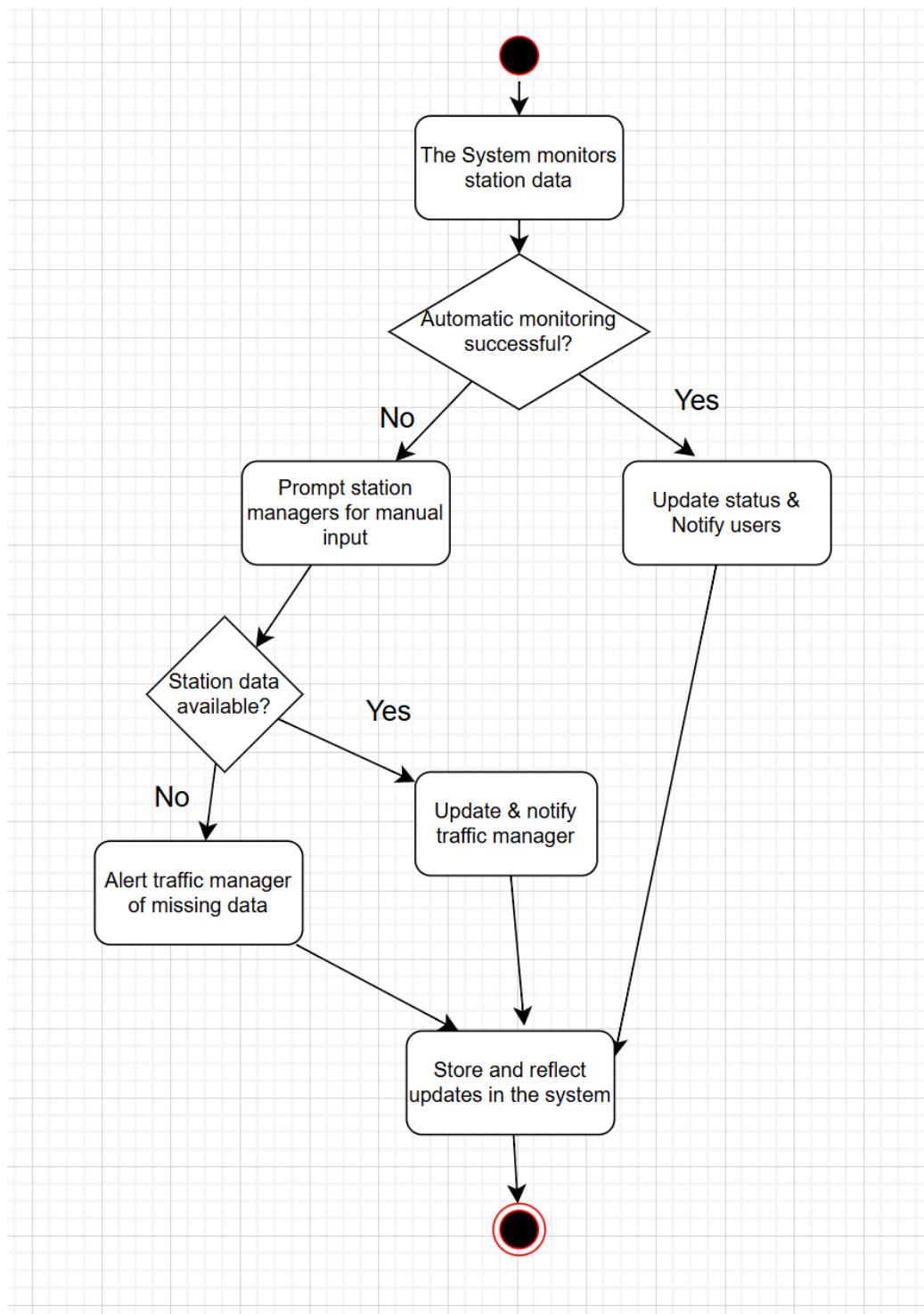


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Collaboration diagram

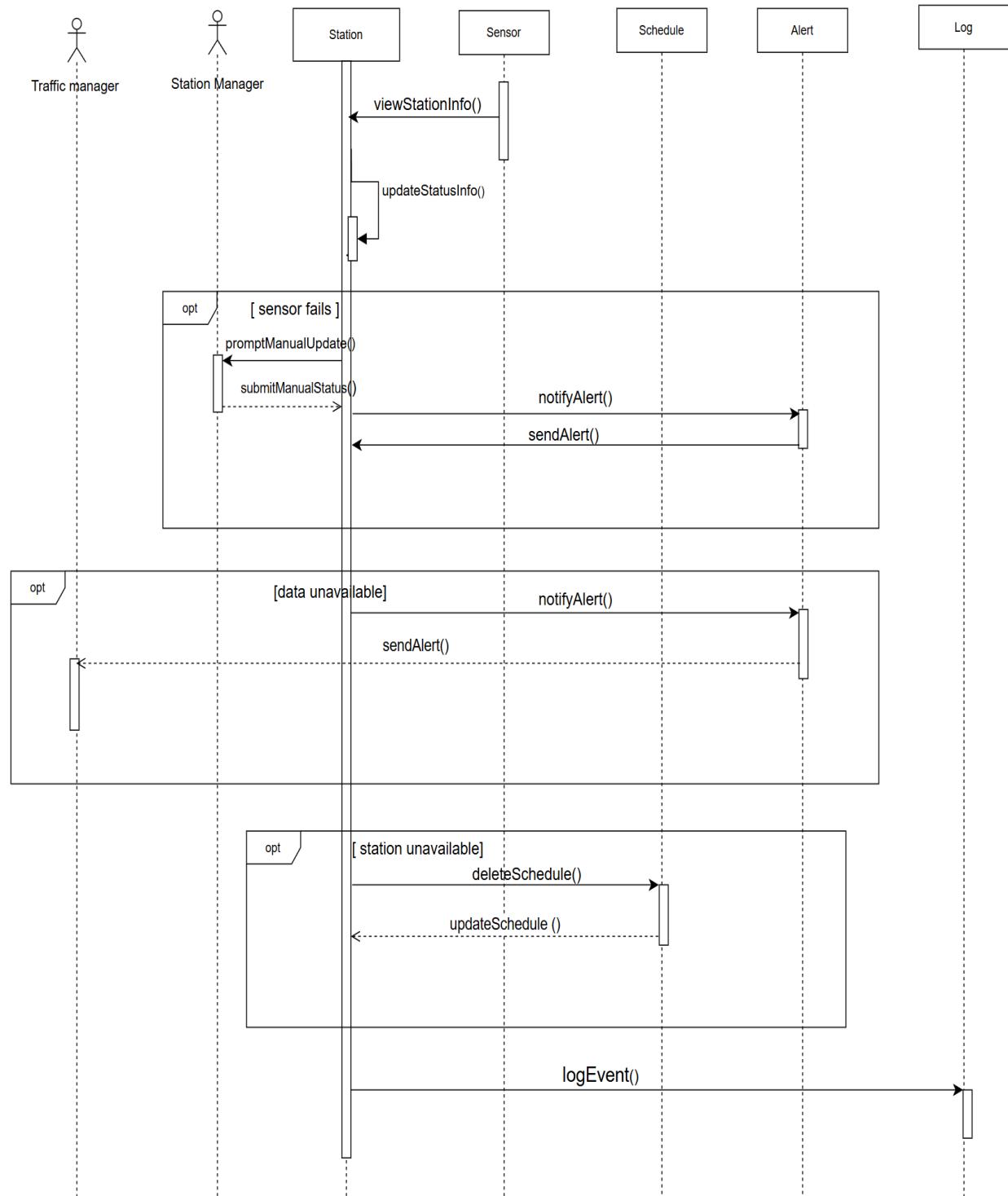


UC Name	<u>S TRK 03: Track Station Availability and Condition</u>
Summary	The system maintains and updates the status and condition of all railway stations, ensuring real-time tracking for management and operational purposes.
Dependency	S_SCH_06 (Track Train Schedules and Itineraries) – If a station is unavailable, it may require schedule adjustments.
Actors	<ul style="list-style-type: none"> ● Primary Actor: System (S) ● Secondary Actor(s): Station Manager (SM), Traffic Manager (TM)
Preconditions	<ul style="list-style-type: none"> → The system is operational and has access to station data. → Station status data must be available or manually inputted by a Station Manager.
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ 1. The system continuously monitors station data (availability and condition). ❖ 2. Station managers can manually update station status if needed. ❖ 3. The system stores updates and alerts relevant users (e.g., traffic managers) of critical station status changes. ❖ 4. The updated station status is reflected across the system in real time.
Description of the Alternative Sequence	<ul style="list-style-type: none"> ❖ If automatic monitoring fails, the system prompts station managers to manually input station status. ❖ If station data is unavailable, the system notifies traffic managers of missing information.
Non functional requirements	<ul style="list-style-type: none"> → High Availability & Reliability → The system must be operational 24/7 to continuously track station conditions without downtime. → Real-time Data Processing → The system must update station availability and condition in real time to ensure accurate and timely information. → Fault Tolerance → The system should handle failures gracefully (e.g., if sensor data is missing, allow manual updates).
Postconditions	<ul style="list-style-type: none"> ❖ The system has an updated record of all station statuses.

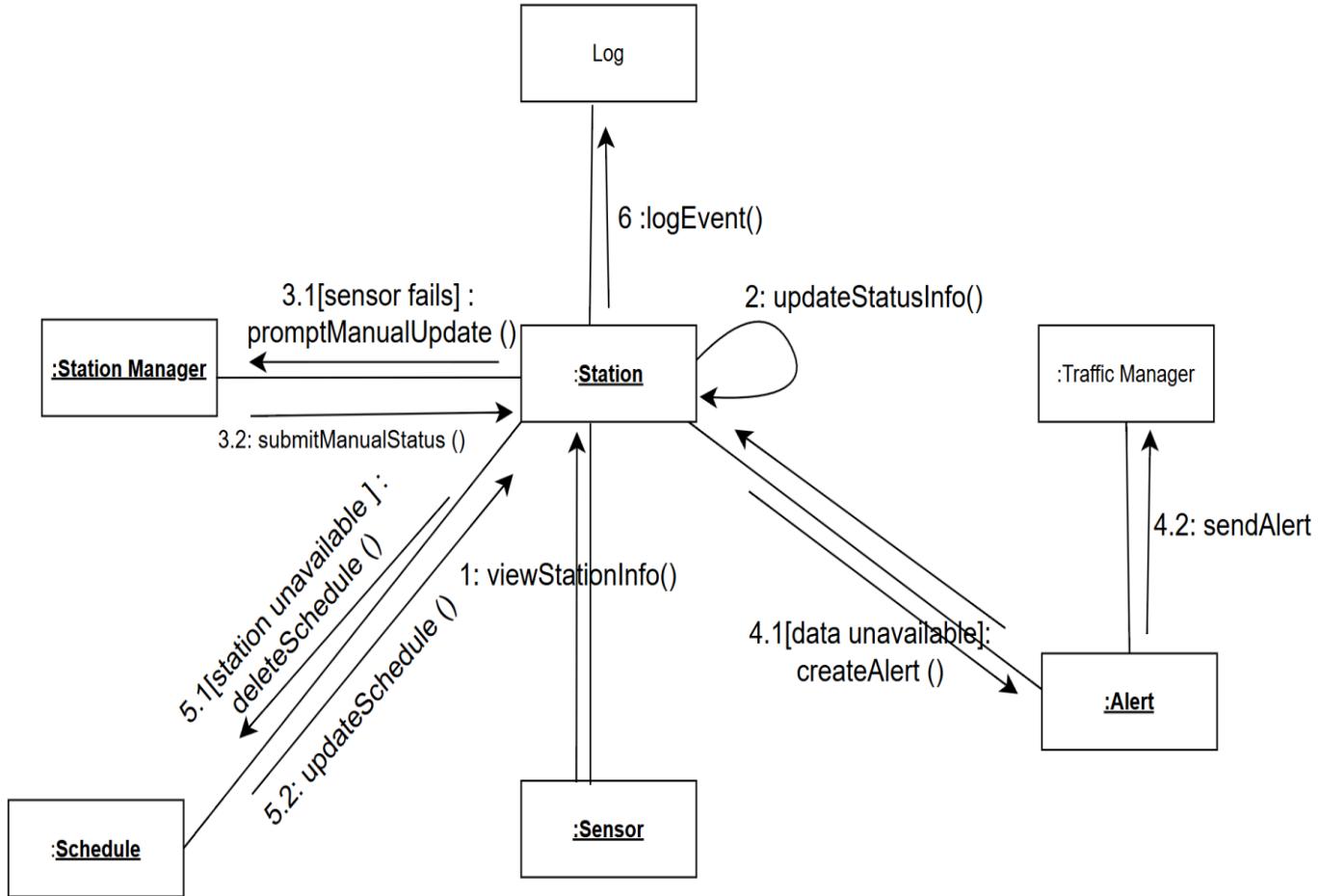
UC3 : S TRK 03: Track Station Availability and Condition



Sequence diagram **Track Station Availability and Condition**

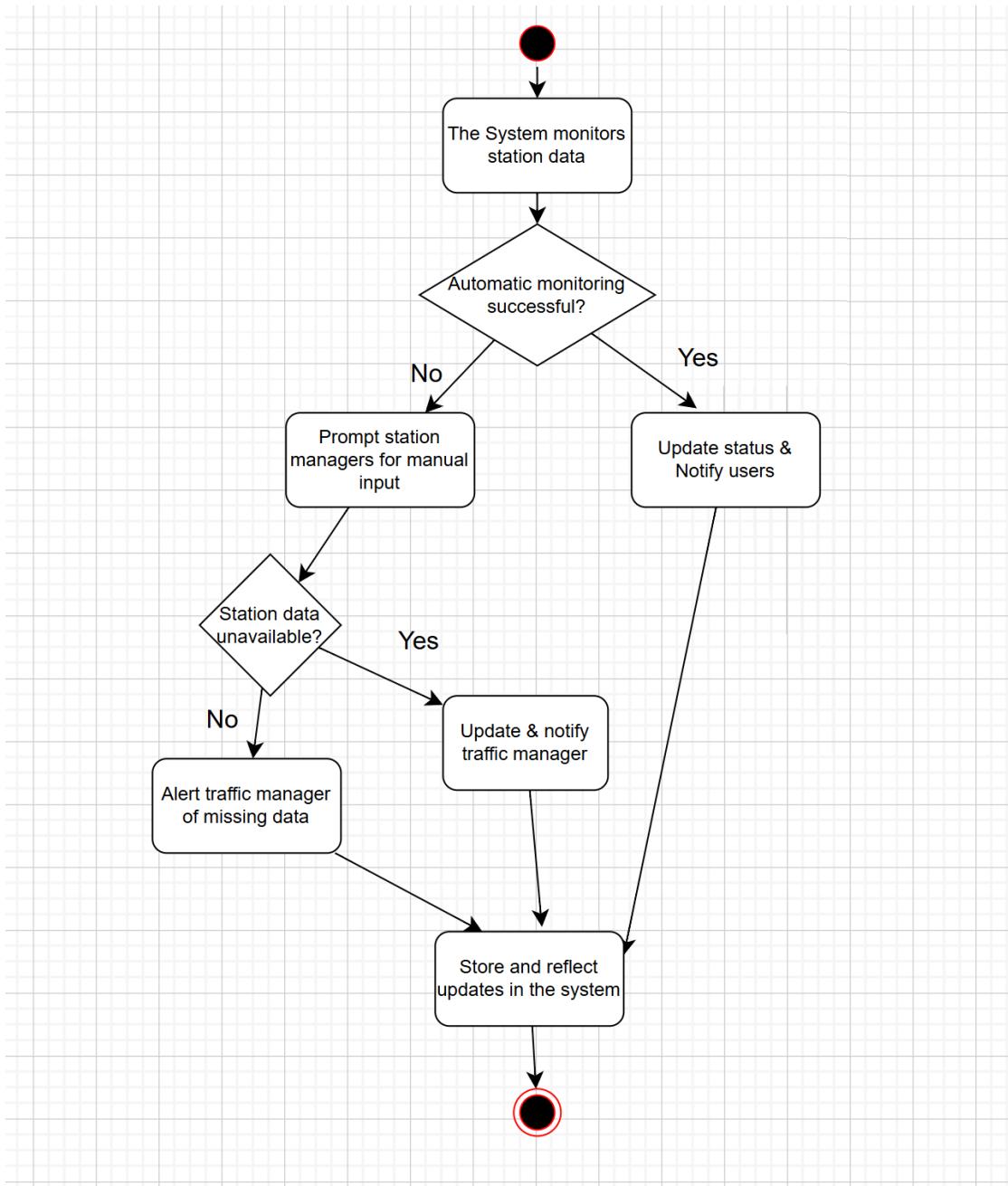


Railway Management System Requirements Specification
Collaboration diagram



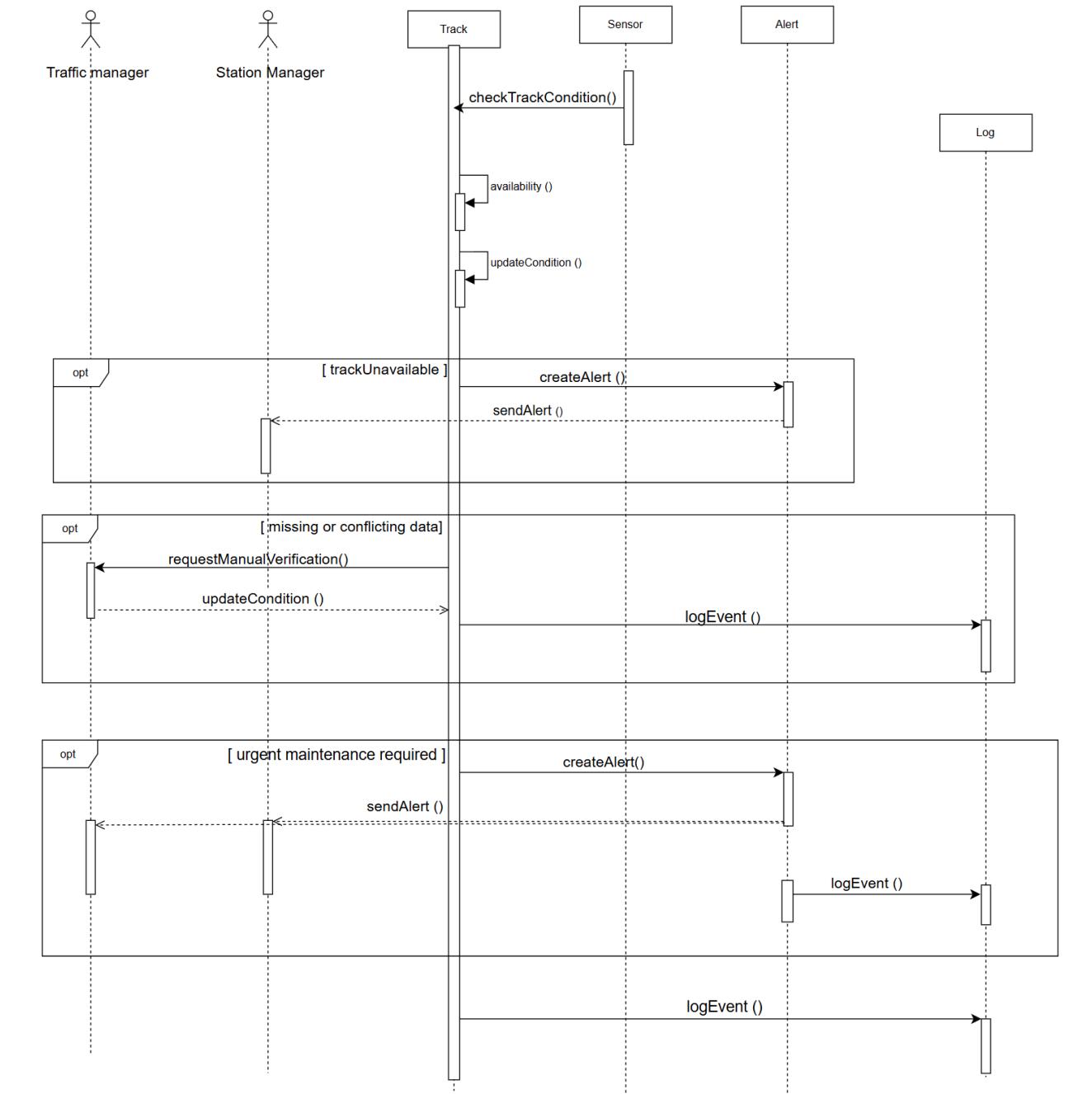
UC Name	<i>S_TRK_04: Railway Availability and Condition Tracking</i>
Summary	The system must continuously monitor and update the availability and condition of railway tracks to ensure safe and efficient train operations.
Dependency	<ul style="list-style-type: none"> ● S_TRK_03 (Track Station Availability and Condition) → Stations depend on track conditions.
Actors	<ul style="list-style-type: none"> ● Primary Actor: System (S) ● Secondary Actor(s): Traffic Manager (TM), Station Manager (SM)
Preconditions	<ul style="list-style-type: none"> → The system must have access to real-time track status data. → Data Sources: Track conditions must be provided by automated sensors (if available) or manual input by authorized personnel. → Access Control : Only authorized Traffic Managers (TM) or system processes can update track condition data.
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ 1. The system collects real-time data on railway track conditions (e.g., damage, obstructions). ❖ 2. The system updates track availability in the database. ❖ 3. If a track is unavailable, the system notifies relevant personnel (Traffic Manager, Station Manager). ❖ 4. The system logs all status updates and notifications.
Description of the Alternative Sequence	<ul style="list-style-type: none"> ❖ 1. If the system detects missing or conflicting data, it requests verification from authorized personnel. ❖ 2. If track conditions require urgent maintenance, the system escalates an alert to maintenance teams.
Non functional requirements	<ul style="list-style-type: none"> → The system must process and store real-time track data with high precision. → The system must provide uninterrupted monitoring to prevent operational delays. → Only authorized users can modify track condition data. → All updates must be recorded with timestamps and user details for audit purposes.
Postconditions	<ul style="list-style-type: none"> ❖ Railway track status is updated and accessible to relevant personnel. ❖ Any maintenance needs or disruptions are logged and communicated.

UC 4: S TRK 04: Railway Availability and Condition Tracking



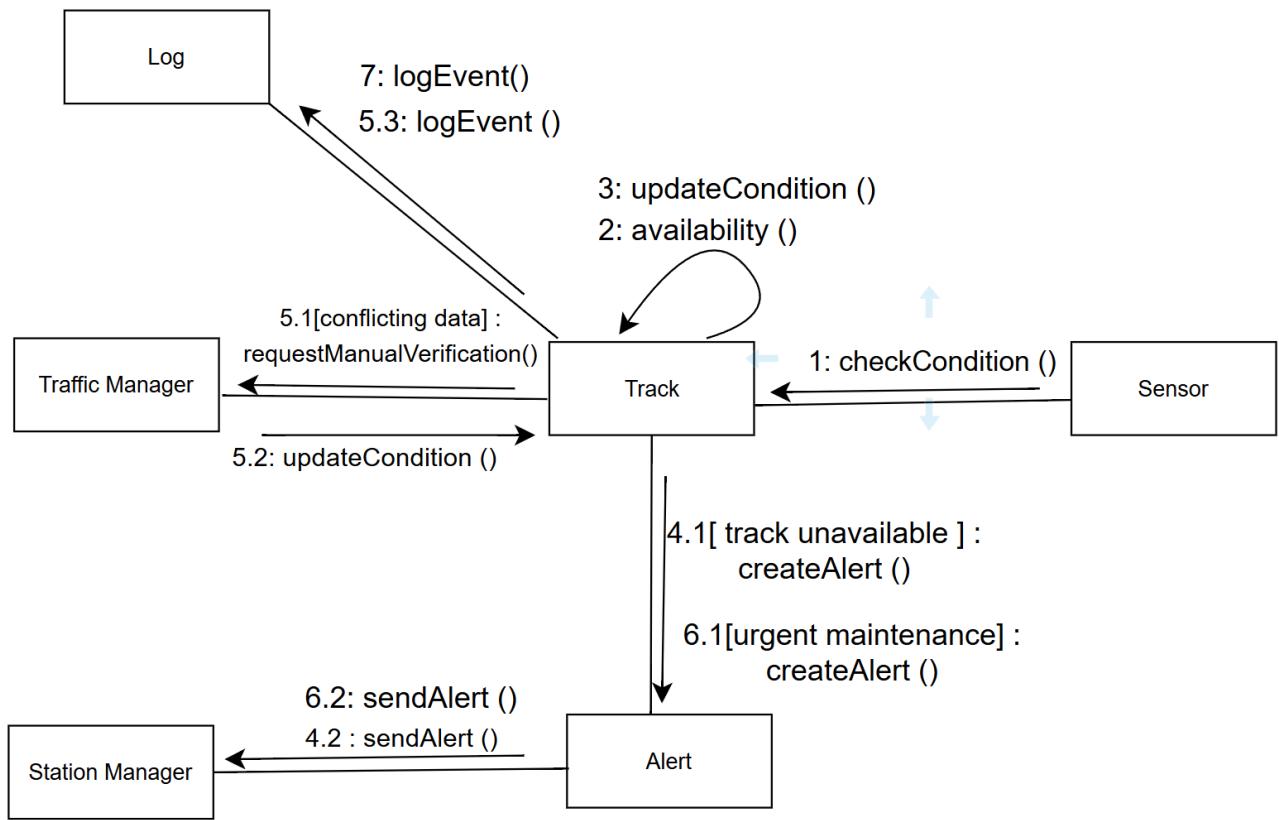
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use case 4



Collaboration diagram

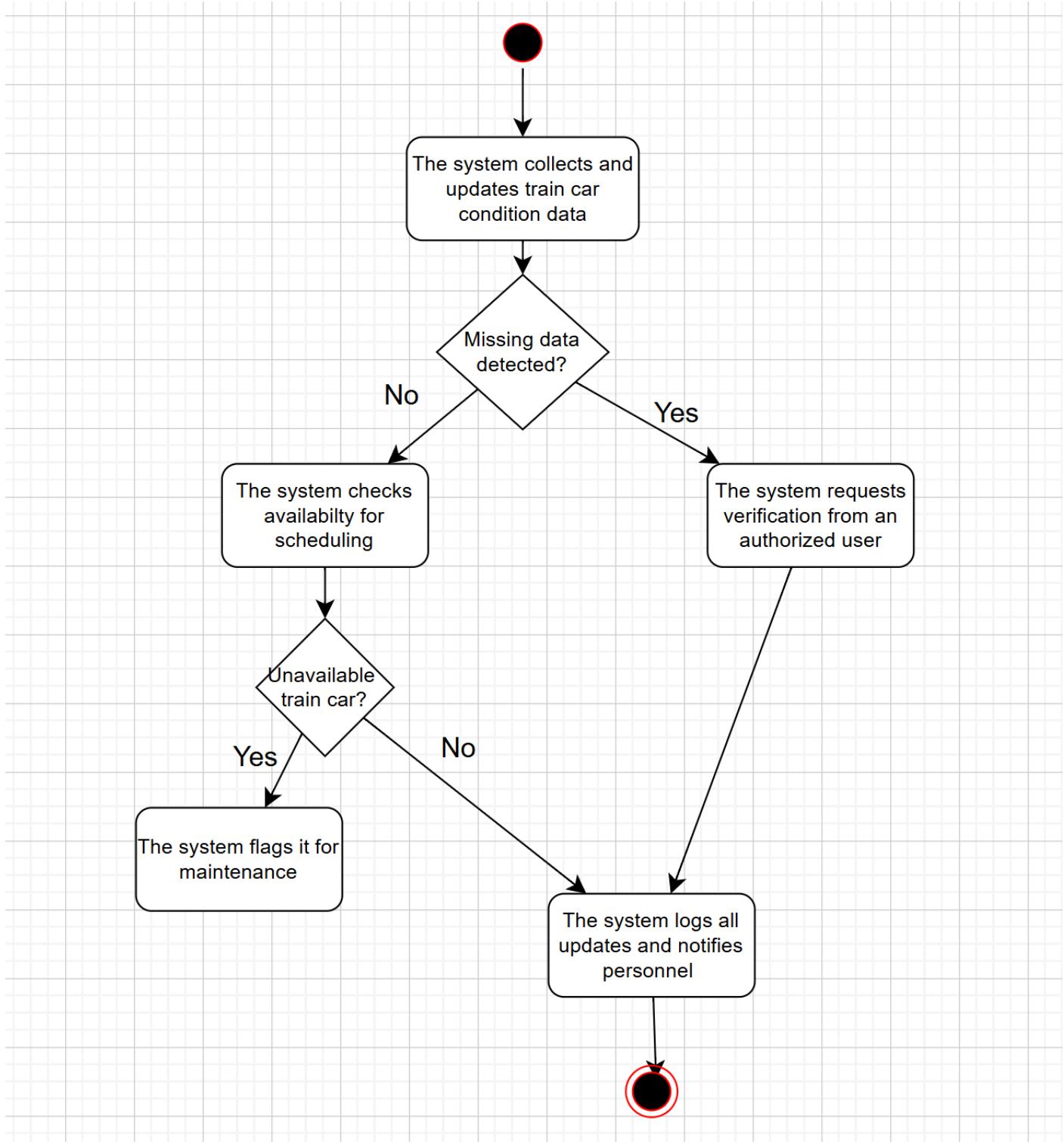
Railway Management System Requirements Specification



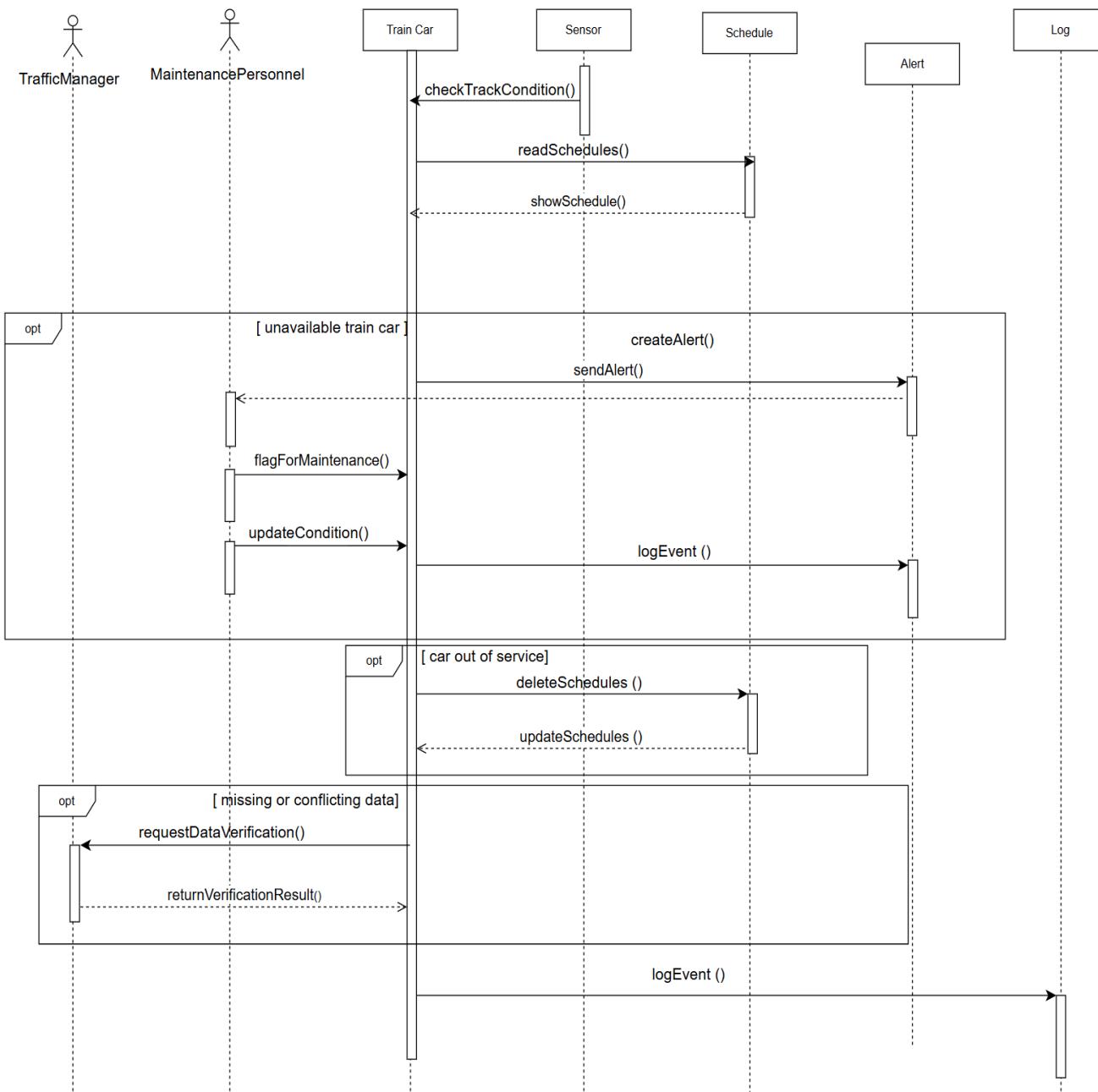
Railway Management System Requirements Specification

UC Name	S TRK 05 : Train Car Availability and Condition Tracking
Summary	The system must monitor, update, and store accurate data on train car availability and condition to support scheduling and maintenance.
Dependency	<ul style="list-style-type: none"> • S_SCH_06 (Track Train Schedules and Itineraries) → Scheduling depends on train car availability. • S_TRK_04 (<i>Track Railway Availability and Condition</i>) → Train cars operate on available tracks. • S_PER_07 (<i>Track Human Personnel Availability and Condition</i>) → Maintenance teams may be needed for repairs.
Actors	<ul style="list-style-type: none"> • Primary Actor: System (S) • Secondary Actor(s): Traffic Manager (TM), Maintenance Personnel (E)
Preconditions	<ul style="list-style-type: none"> → The system must receive data from sensors, manual inputs, or maintenance logs. → Train car statuses (available, in maintenance, or out of service) must be regularly updated. → Only authorized personnel can modify train car condition records
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ 1. The system collects and updates train car condition data. ❖ 2. The system checks availability for scheduling. ❖ 3. If a train car is unavailable, the system flags it for maintenance. ❖ 4. The system logs all updates and notifies relevant personnel if necessary.
Description of the Alternative Sequence	<ul style="list-style-type: none"> ❖ 1. If missing or conflicting data is detected, the system requests verification from an authorized user. ❖ 2. If a train car is out of service, the system automatically excludes it from scheduling.
Non functional requirements	<ul style="list-style-type: none"> → Accuracy : Data must be up-to-date and reliable. → Security : Only authorized users can modify records. → Logging : All updates must be logged with timestamps for auditing. → Performance : The system should process and update train car statuses in real time.
Postconditions	<ul style="list-style-type: none"> ❖ Train car data is updated and stored. ❖ Scheduling and maintenance teams have accurate availability records. ❖ Any unavailable train cars are flagged for attention.

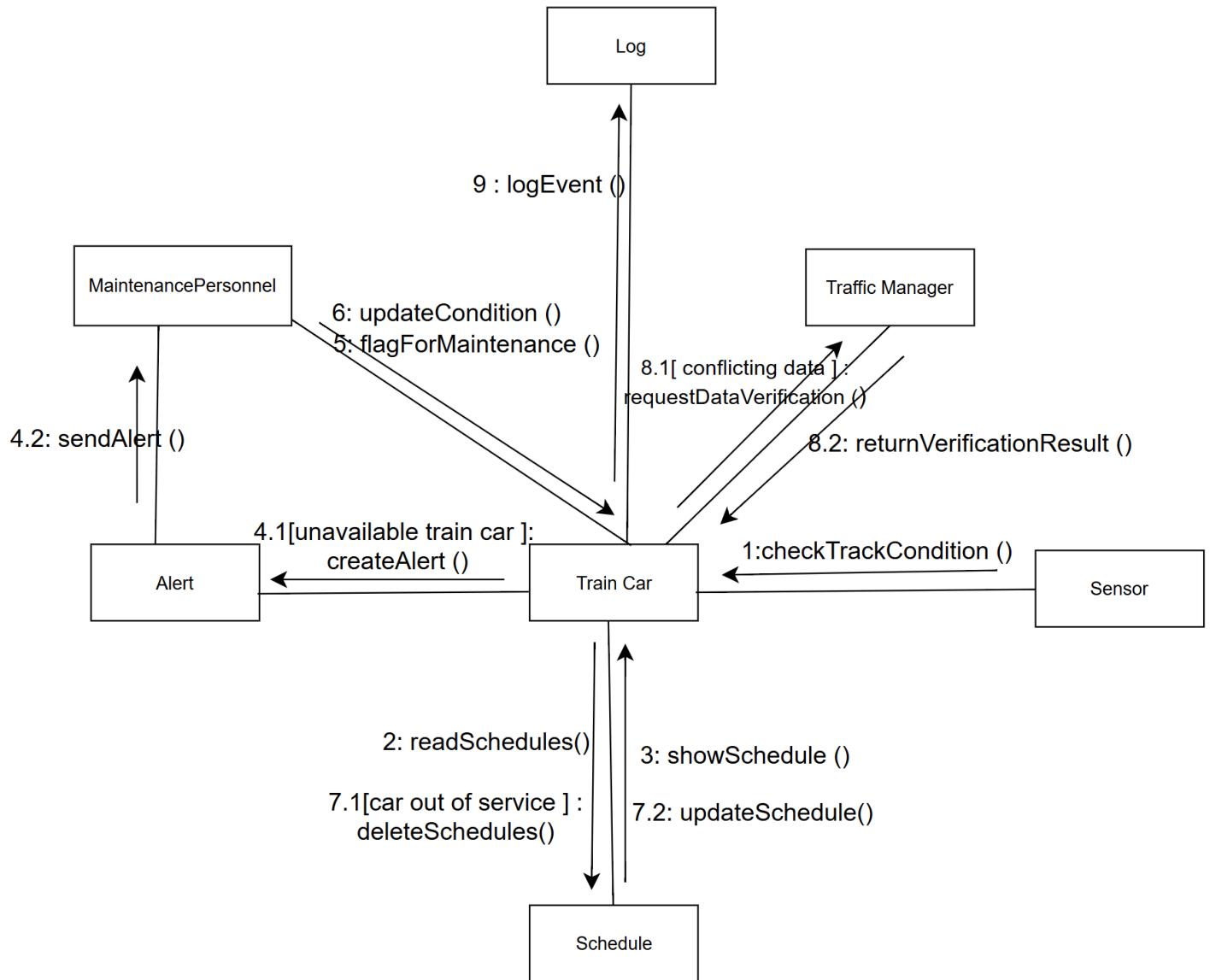
Railway Management System Requirements Specification
UC 5: S TRK 05 : Train Car Availability and Condition Tracking



Sequence diagram : Train Car Availability and Condition Tracking



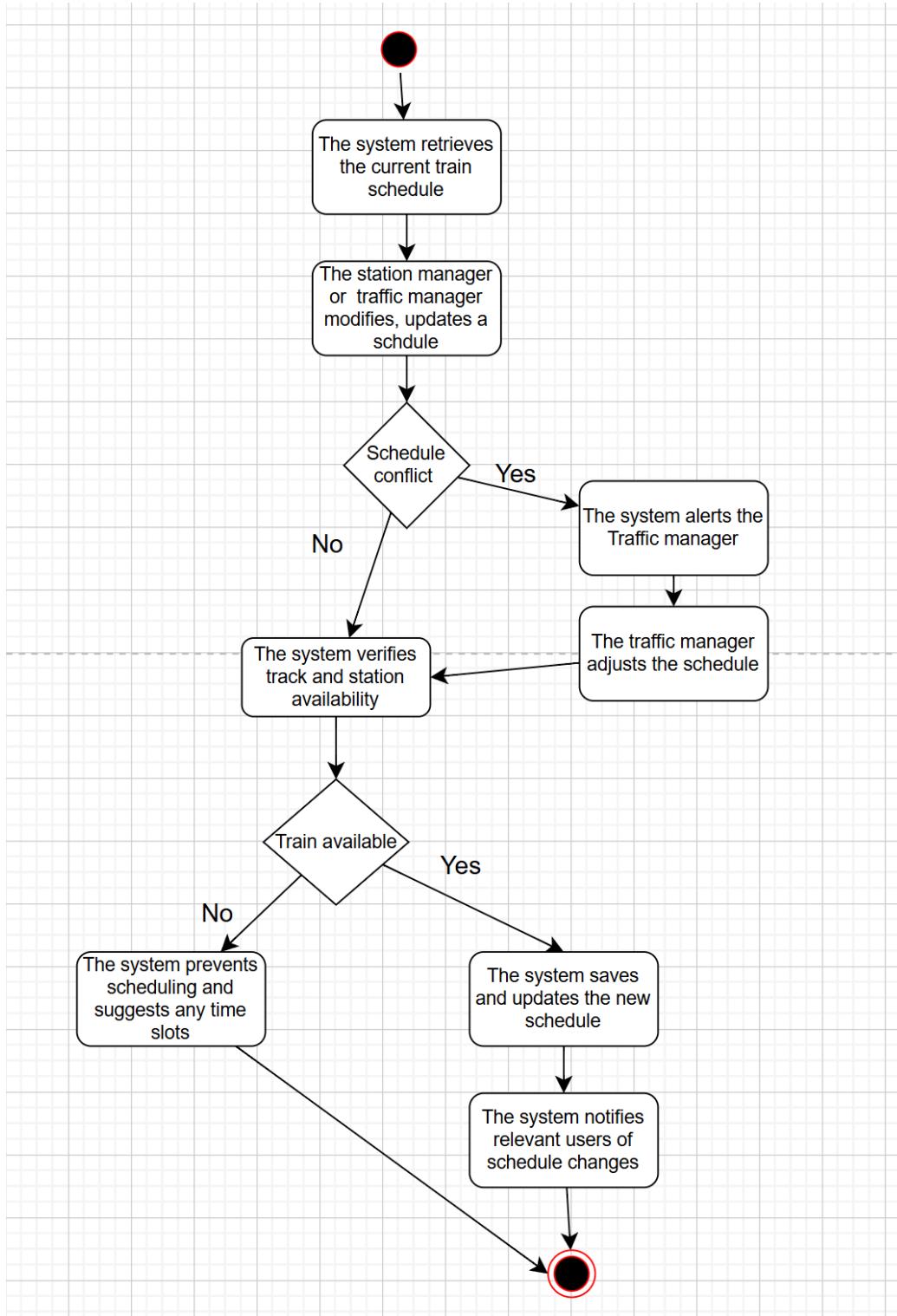
Collaboration diagram



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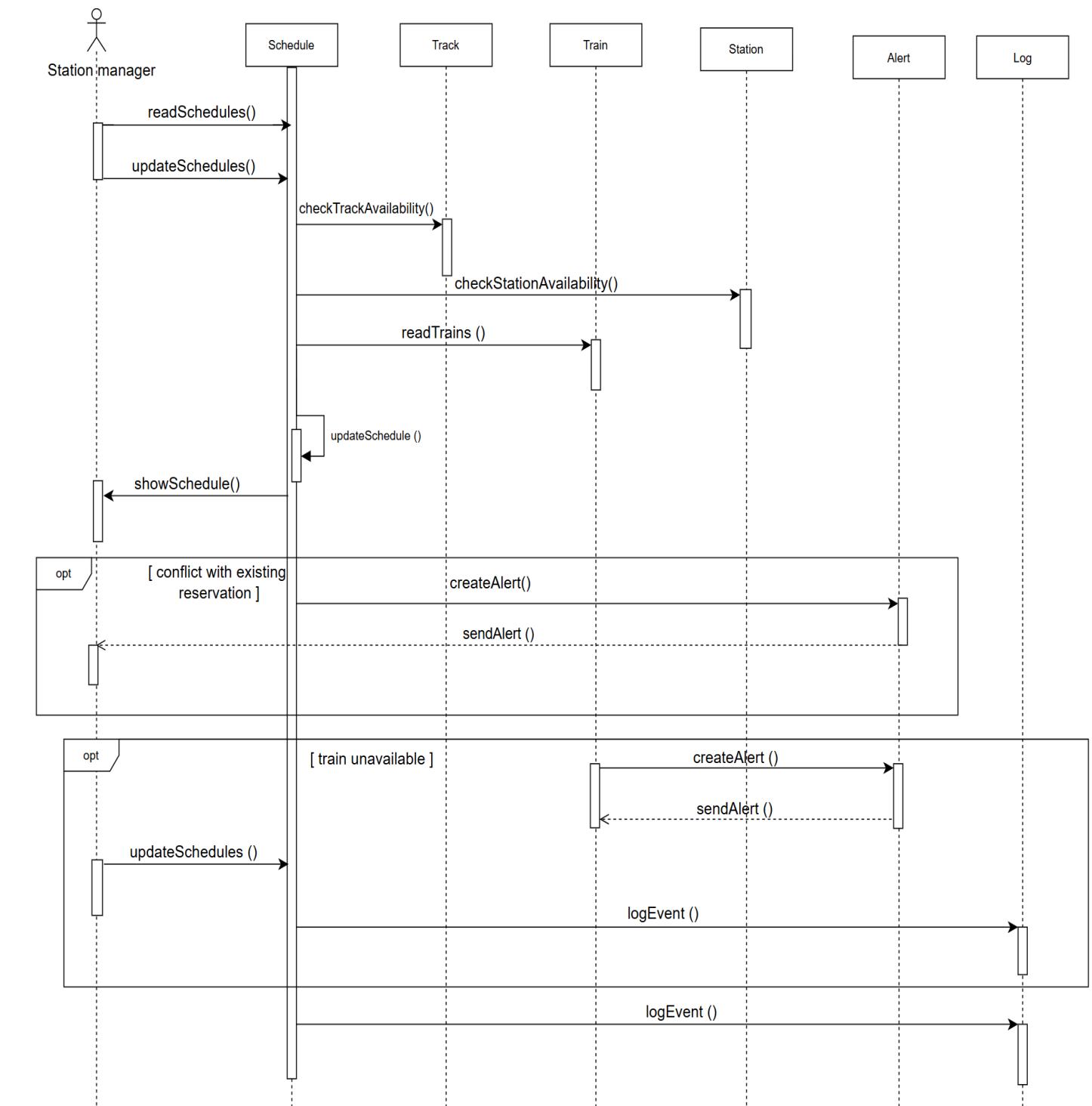
UC Name	<u>S SCH 06: Maintain Train Schedule and Itineraries</u>
Summary	The system must maintain and update the schedule of trains and their specific itineraries to ensure efficient operations and route planning.
Dependency	<ul style="list-style-type: none"> • S_TRK_03 (Station Tracking) and S_TRK_04 (Railway Tracking) for track and station availability..
Actors	Primary Actor: System (S) Secondary Actor (s): Traffic Manager (TM), Station Manager (SM)
Preconditions	<ul style="list-style-type: none"> → The system must store and maintain an up-to-date database of train schedules and itineraries. → Traffic and Station Managers must have the appropriate permissions to access and modify schedules.
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ 1. The system retrieves the current train schedule. ❖ 2. The Traffic Manager or Station Manager modifies or updates a schedule. ❖ 3. The system verifies track and station availability. ❖ 4. The system saves and updates the new schedule. ❖ 5. The system notifies relevant users of schedule changes.
Description of the Alternative Sequence	<ul style="list-style-type: none"> ● 1. If a schedule conflicts with existing reservations: <ul style="list-style-type: none"> a)The system alerts the Traffic Manager. b)The Traffic Manager adjusts the schedule accordingly. ● 2. If a train is unavailable: <ul style="list-style-type: none"> a)The system prevents scheduling. b)The system suggests alternative time slots or trains.
Non functional requirements	<ul style="list-style-type: none"> → Performance: The system must update schedule changes within 5 seconds to ensure real-time accuracy. → Availability: The scheduling feature must be operational 24/7 with minimal downtime. → Security: Only authorized personnel (Traffic Managers and System Admins) can modify train schedules.
Postconditions	<ul style="list-style-type: none"> ❖ The updated schedule is saved and accessible to relevant users. ❖ Notifications are sent to affected personnel and passengers about any schedule changes. ❖ Any scheduling conflicts or errors are logged and flagged for review.

UC 6: S SCH 06: Maintain Train Schedule and Itineraries

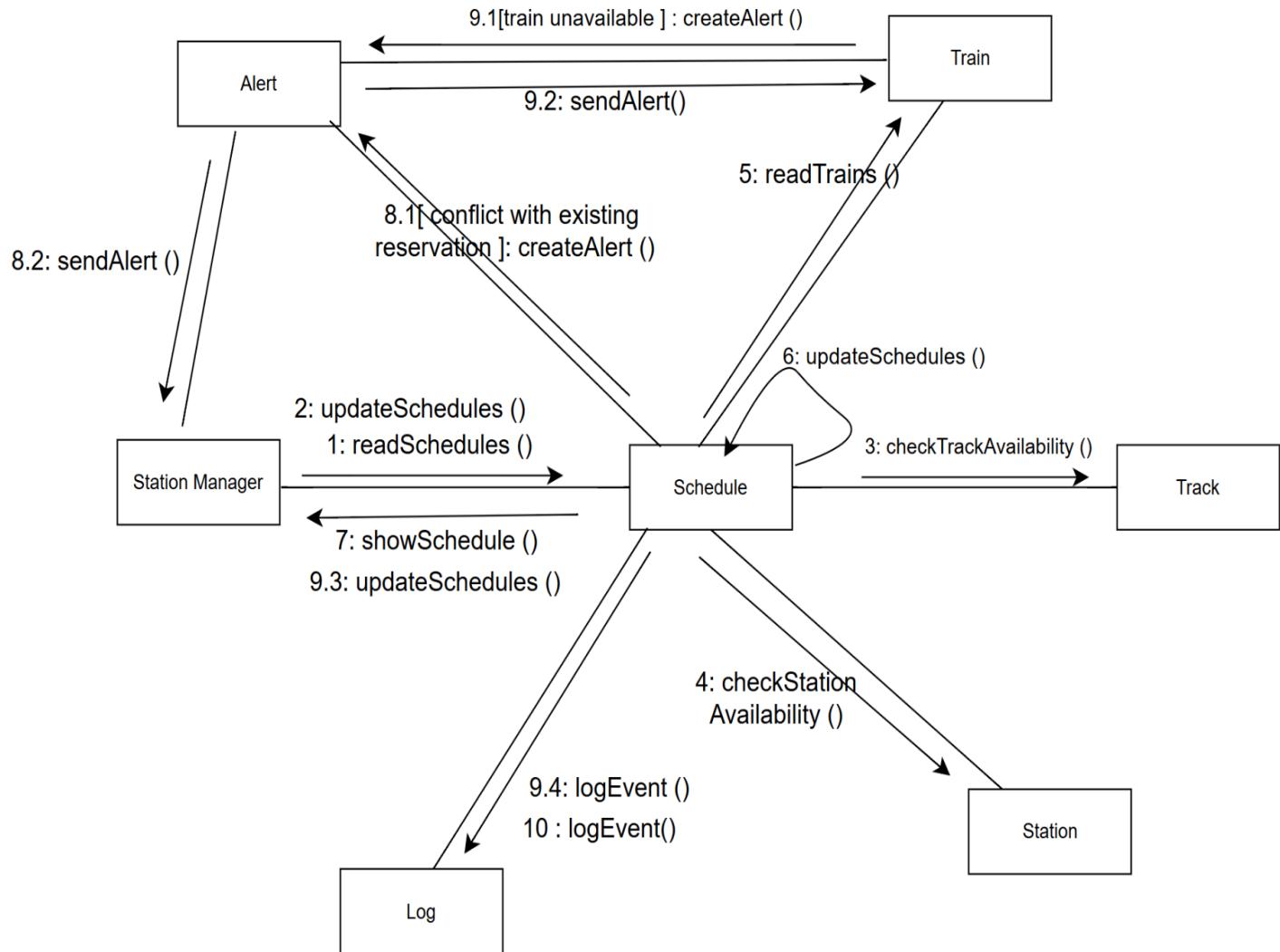


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- Sequence diagram : S SCH 06: Maintain Train Schedule and Itineraries

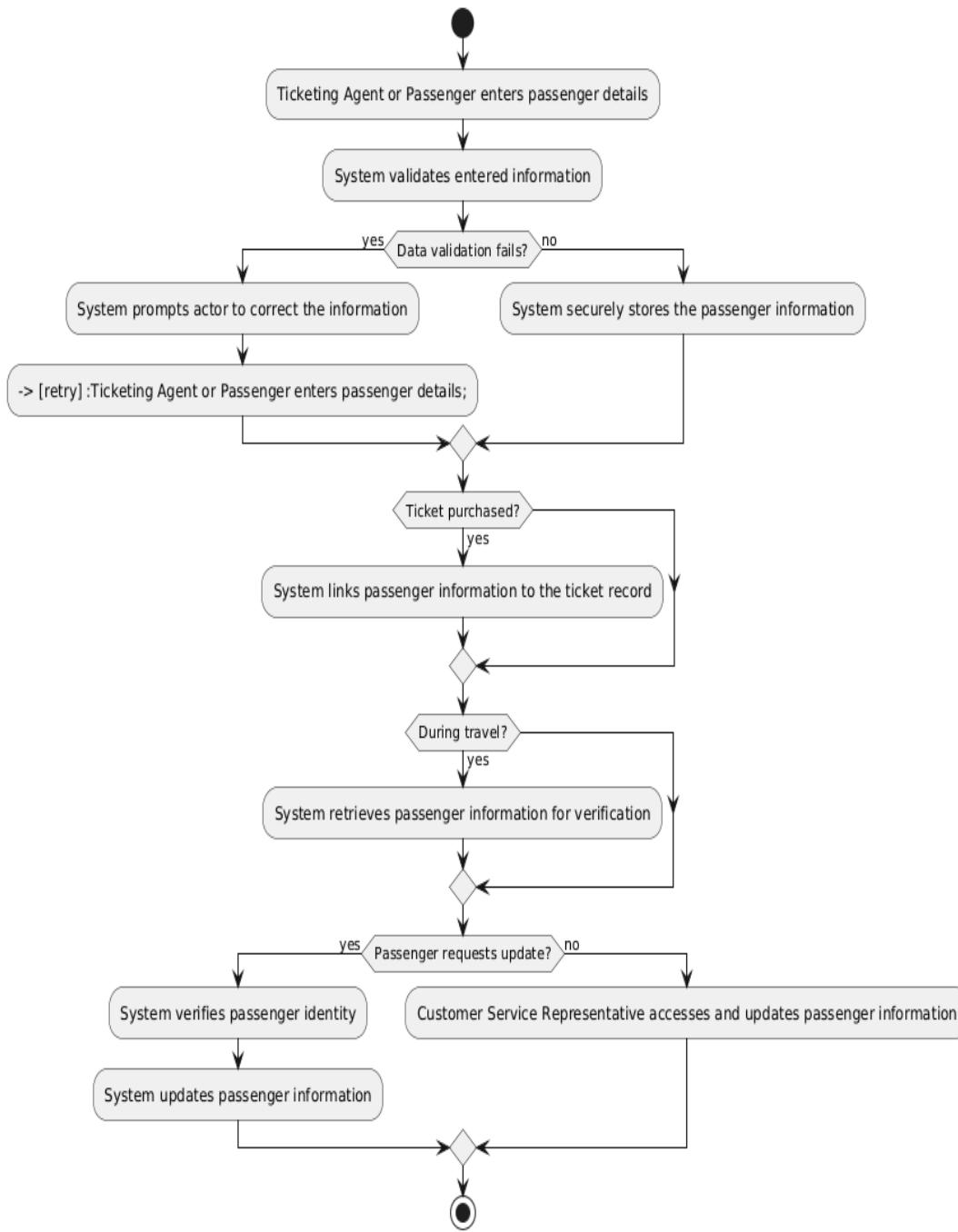


Collaboration diagram



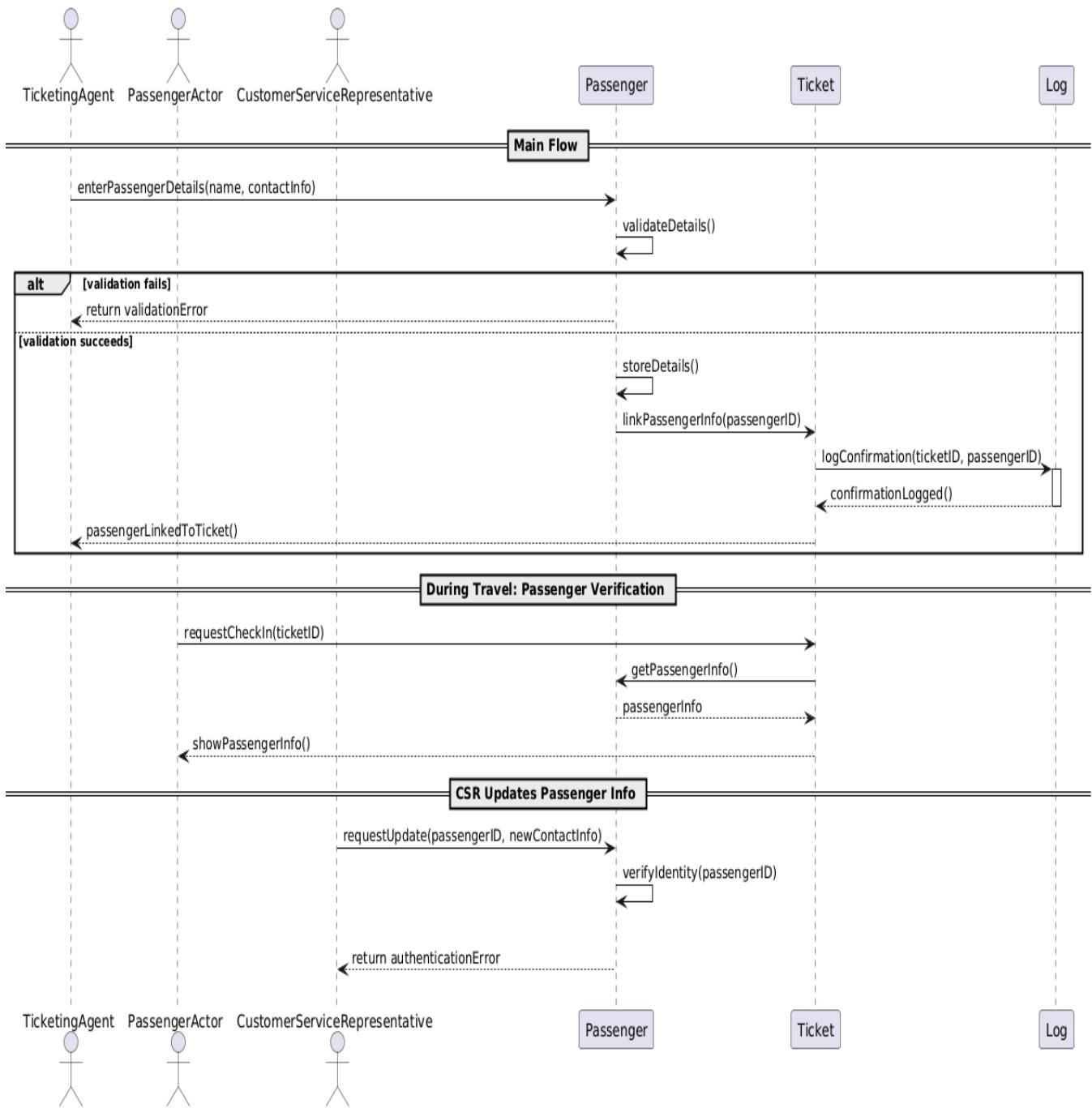
UC Name	<u>TM MNG 07 – Manage Passenger Information</u>
Summary	The system must securely store and manage passenger information for ticketing, travel records, and customer service.
Dependency	<ul style="list-style-type: none"> • None explicitly stated, but likely depends on UC for user authentication and authorization
Actors	Primary Actor: System (S) Secondary Actors: Ticketing Agent (TA), Customer Service Representative (CSR), Passenger (P) Other Actors: Auditor (A), Law Enforcement (LE)
Preconditions	<ul style="list-style-type: none"> → The system must have a secure database for storing passenger information. → Relevant actors (TA, CSR) must be authenticated and authorized. →
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ The Ticketing Agent or Passenger (via online portal) enters passenger details (e.g., name, contact information). ❖ The system validates the entered information. ❖ The system securely stores the passenger information. ❖ When a ticket is purchased, the system links the passenger information to the ticket record. ❖ During travel, the system may retrieve passenger information for verification. ❖ Customer Service Representatives can access and update passenger information (with appropriate authorization) for support purposes.
Description of the Alternative Sequence	<ul style="list-style-type: none"> • If data validation fails, the system prompts the actor to correct the information. • If a passenger requests to update their information, the system verifies their identity before allowing changes.
Non functional requirements	Security: Passenger data must be encrypted and protected from unauthorized access. Data Integrity: The system must ensure the accuracy and consistency of passenger information. Privacy: The system must comply with relevant data privacy regulations.
Postconditions	<ul style="list-style-type: none"> ❖ Passenger information is securely stored and linked to relevant records. ❖ Authorized users can access and manage passenger information as needed. ❖ ❖ Any staff shortages or concerns are flagged for further action. ❖ All actions taken are logged for audit purposes.

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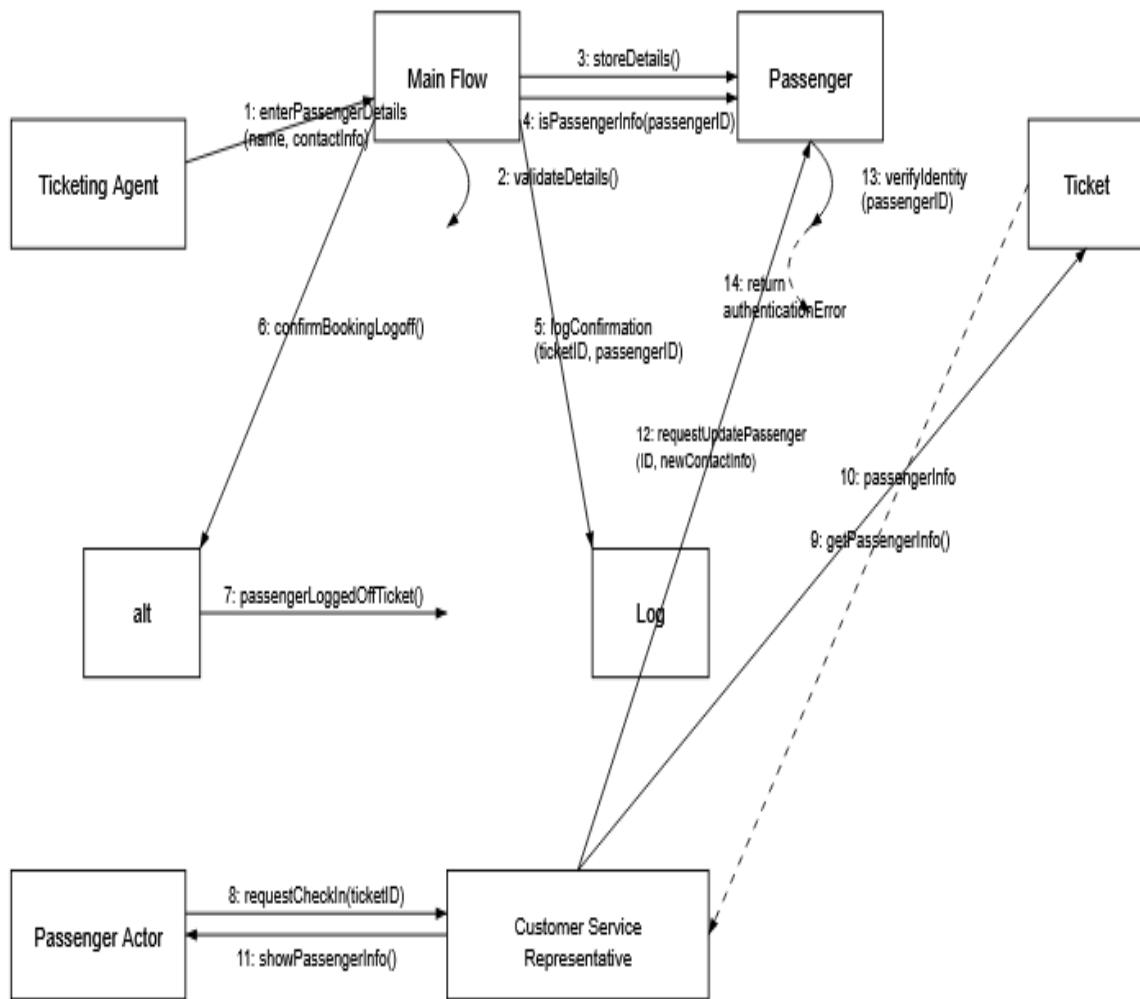


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Railway Management System Requirements Specification

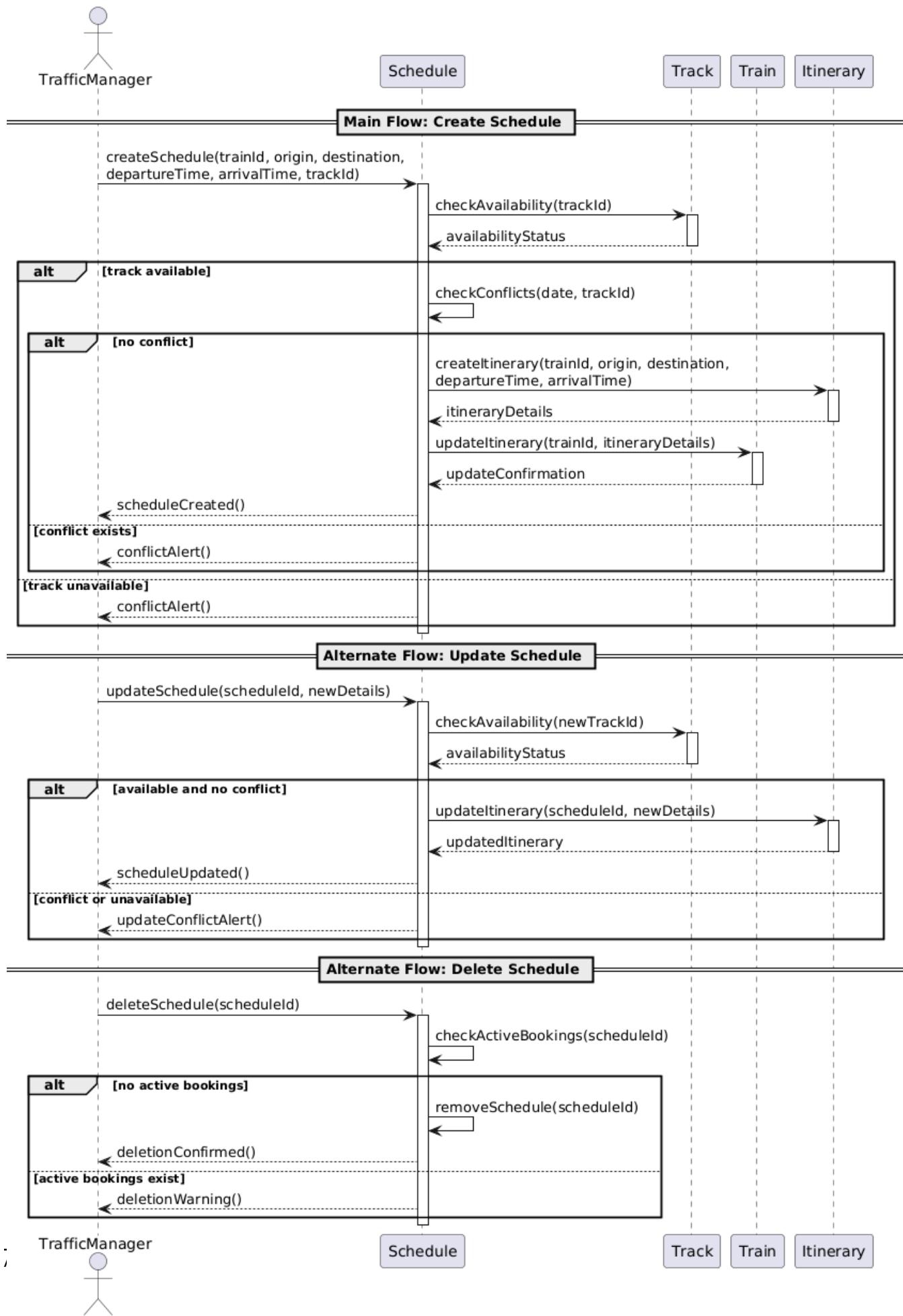


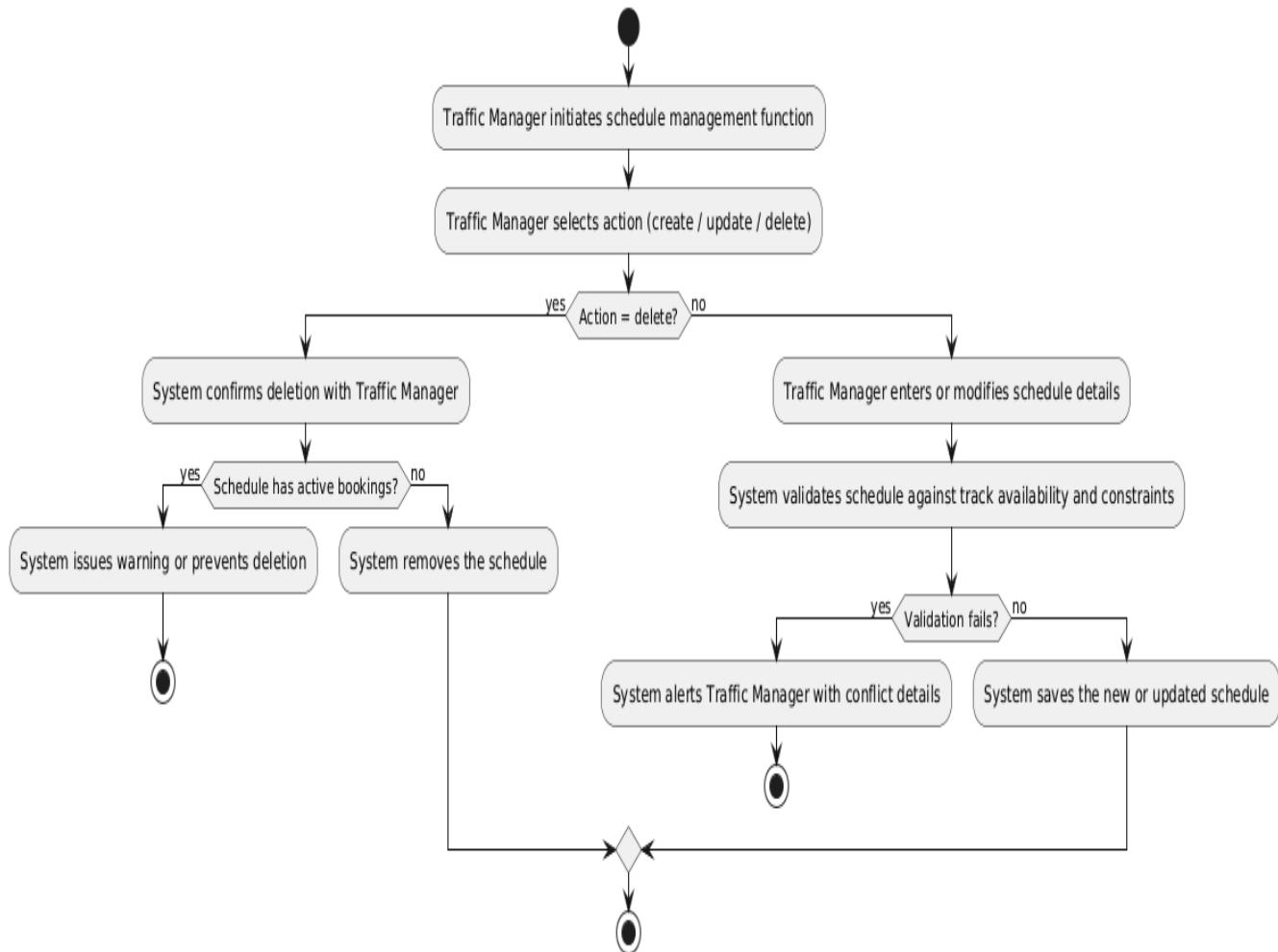
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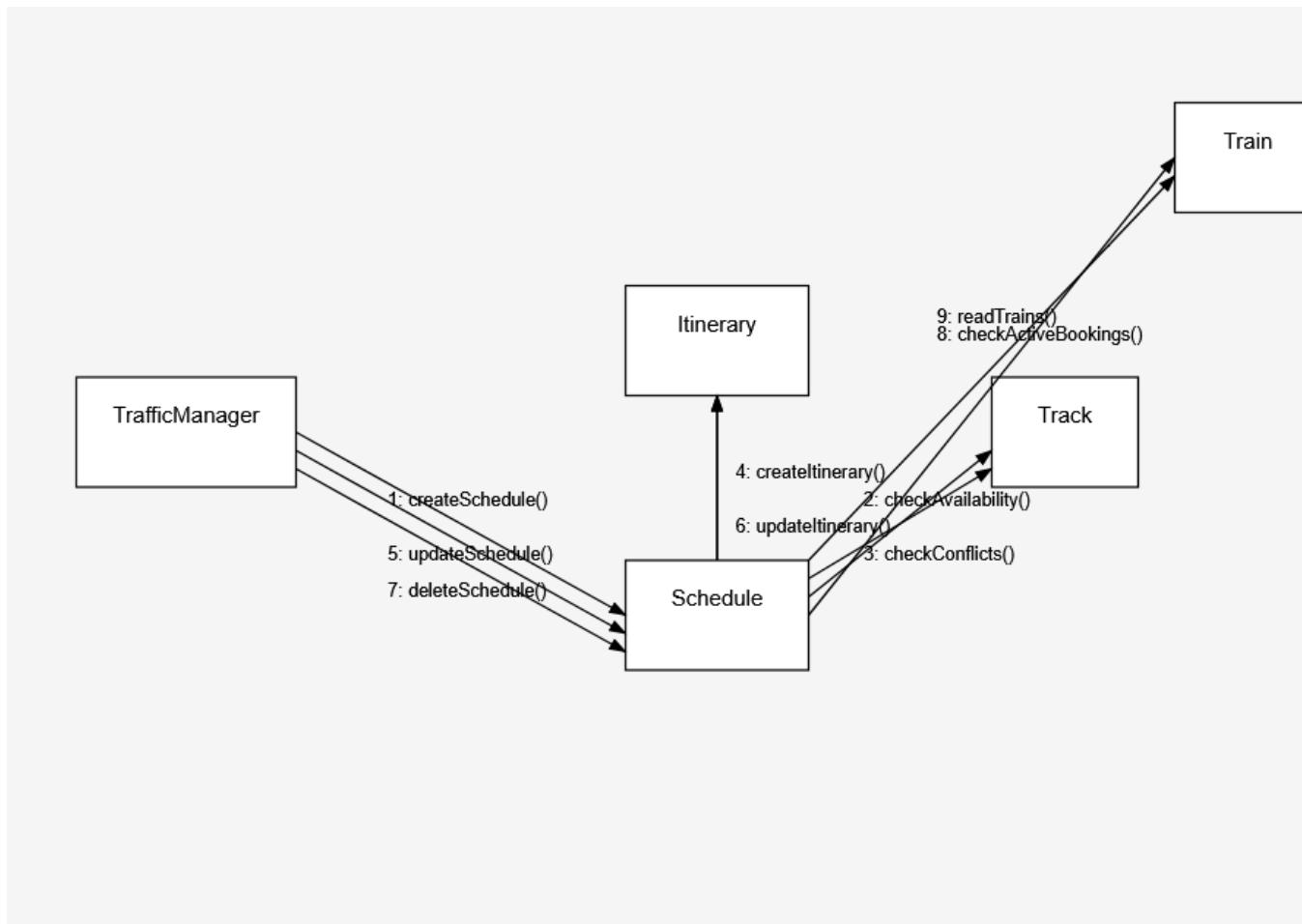


UC Name	<u>TM MNG 8 – Manage Train Schedules</u>
Summary	The Traffic Manager must be able to create, update, and delete schedules for trains under their jurisdiction.
Dependency	<ul style="list-style-type: none"> • TM MNG 01 (Track Constructed Tracks Under Management) → Track availability must be considered when scheduling.
Actors	Primary Actor: Traffic Manager (TM) Secondary Actor: System (S) Other Actors: Train Operator (TO), Maintenance Staff (MS)
Preconditions	<ul style="list-style-type: none"> → The system must have access to track availability and train information. → The Traffic Manager must be authenticated and authorized.
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ The Traffic Manager initiates the schedule management function. ❖ The Traffic Manager selects the action (create, update, delete). ❖ The Traffic Manager enters or modifies schedule details (e.g., train ID, origin, destination, departure/arrival times, track assignment). ❖ The system validates the schedule against track availability and other constraints. ❖ The system saves the new or updated schedule. ❖ If deleting, the system confirms the deletion with the Traffic Manager and removes the schedule.
Description of the Alternative Sequence	<ul style="list-style-type: none"> • If the schedule conflicts with track availability or other existing schedules, the system alerts the Traffic Manager and provides conflict details. • If the Traffic Manager attempts to delete a schedule with active bookings, the system may issue a warning or prevent deletion based on system policy.
Non functional requirements	Validation: The system must perform thorough validation of schedule data to prevent errors. Concurrency Control: The system must manage concurrent schedule modifications by multiple Traffic Managers. Audit Logging: All schedule changes must be logged with timestamps and user information.
Postconditions	<ul style="list-style-type: none"> ❖ Train schedules are created, updated, or deleted as requested by the Traffic Manager, adhering to system constraints. ❖ All schedule changes are logged for auditing purposes.

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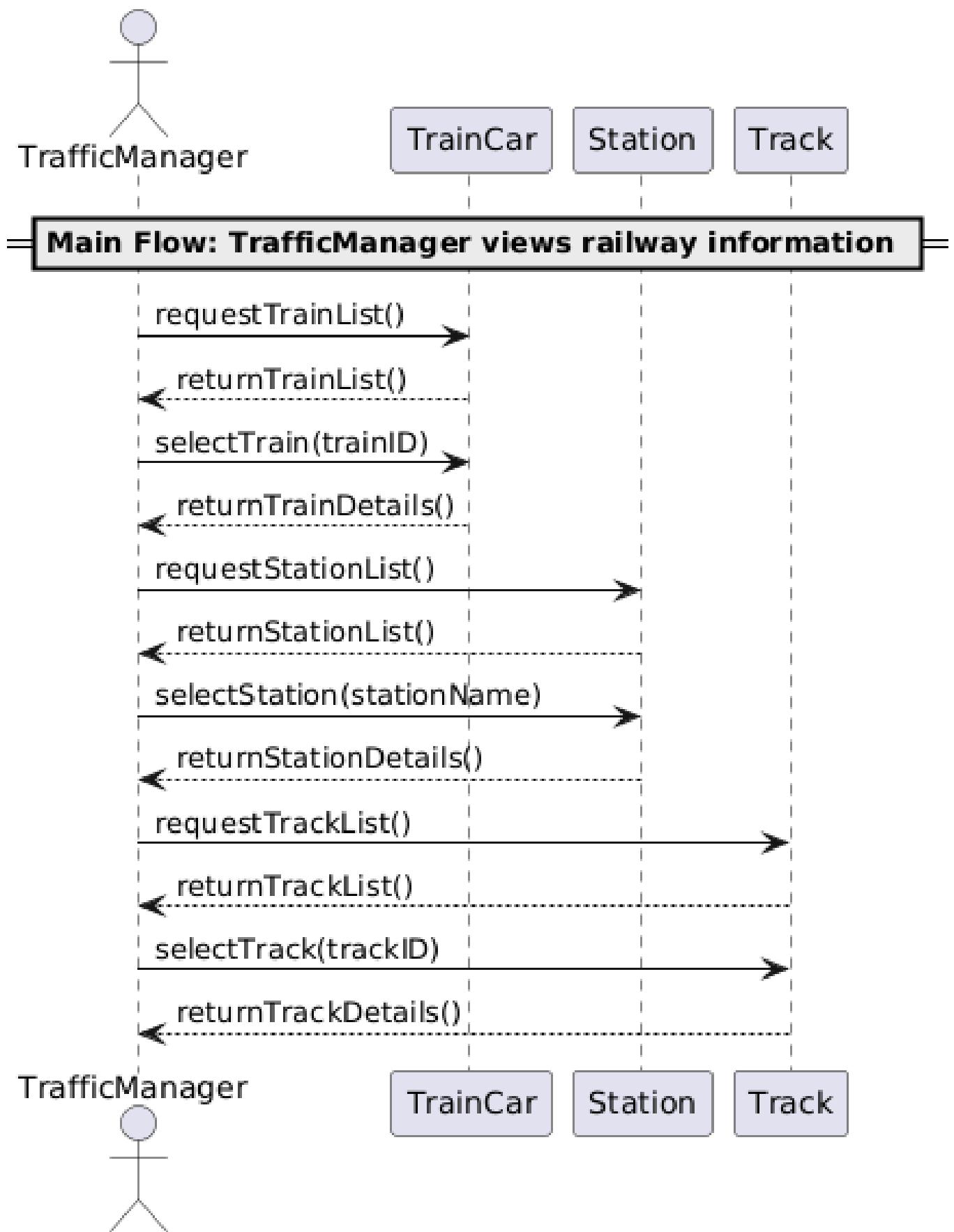




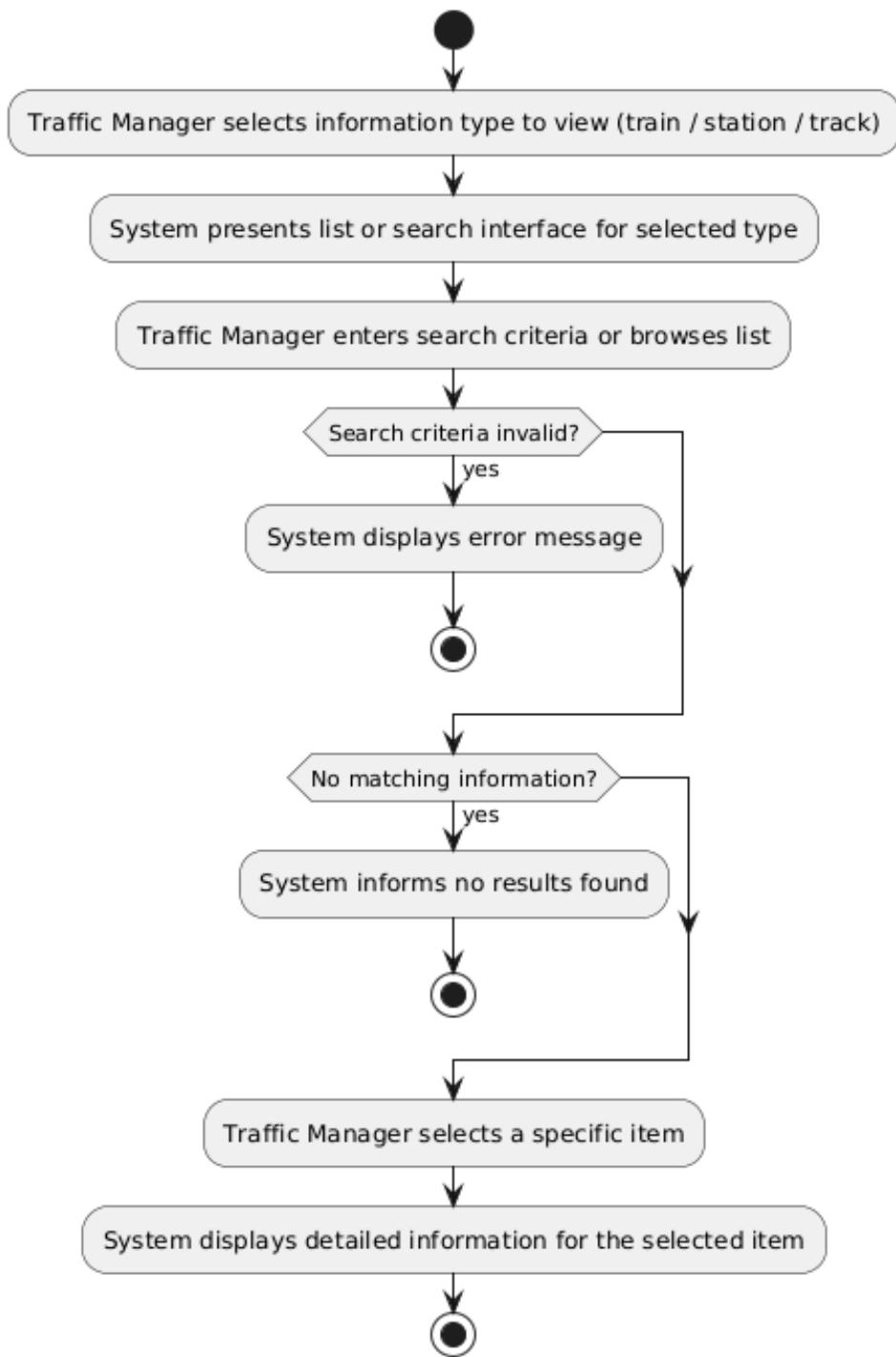


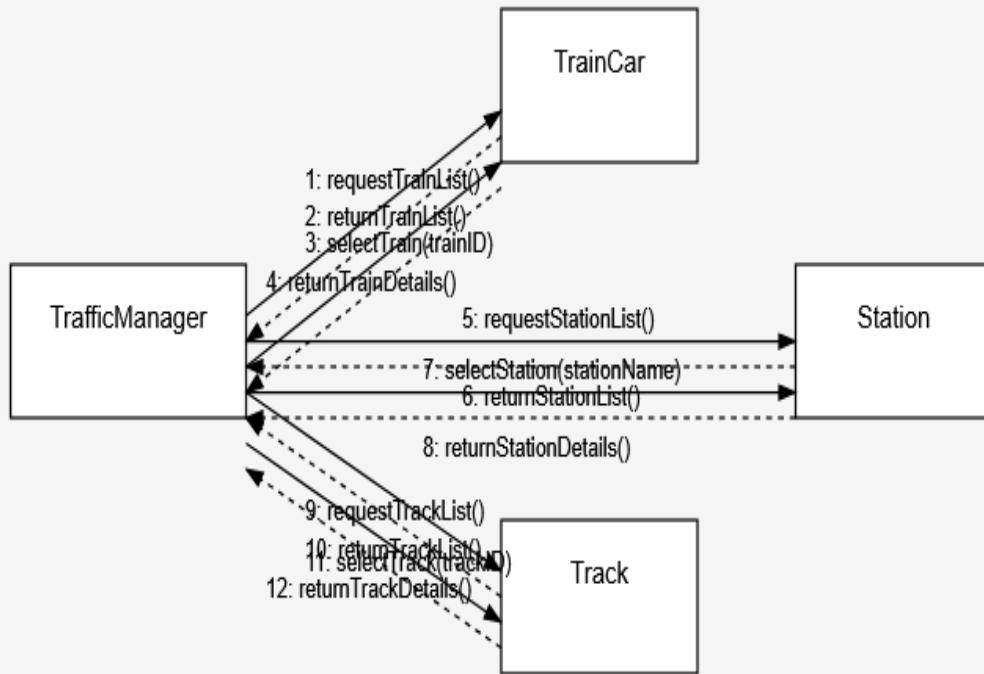
Railway Management System Requirements Specification

UC Name	<u>TM VW 10– View Railway Information</u>
Summary	The Traffic Manager must be able to view train information, station information, and track information.
Dependency	<ul style="list-style-type: none"> • TM MNG 01 (Track Constructed Tracks Under Management) → Access to track information. • Potentially other UCs related to managing train and station data.
Actors	Primary Actor: Traffic Manager (TM) Secondary Actor: System (S) Other Actors: Network Control (NC), Emergency Services (ES)
Preconditions	<ul style="list-style-type: none"> → The system must have stored data for trains, stations, and tracks. → The Traffic Manager must be authenticated and authorized.
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ The Traffic Manager selects the type of information to view (train, station, or track). ❖ The system presents a list or a search interface for the selected information type. ❖ The Traffic Manager selects a specific item (e.g., a train ID, a station name, a track ID). ❖ The system displays the detailed information for the selected item.
Description of the Alternative Sequence	<ul style="list-style-type: none"> • If the Traffic Manager enters invalid search criteria, the system displays an error message. • If no information matches the search criteria, the system informs the Traffic Manager.
Non functional requirements	Performance: Information should be retrieved and displayed efficiently. Security: Access to sensitive information should be controlled based on user roles and permissions.
Postconditions	<ul style="list-style-type: none"> ❖ The Traffic Manager can successfully view the requested train, station, or track information.

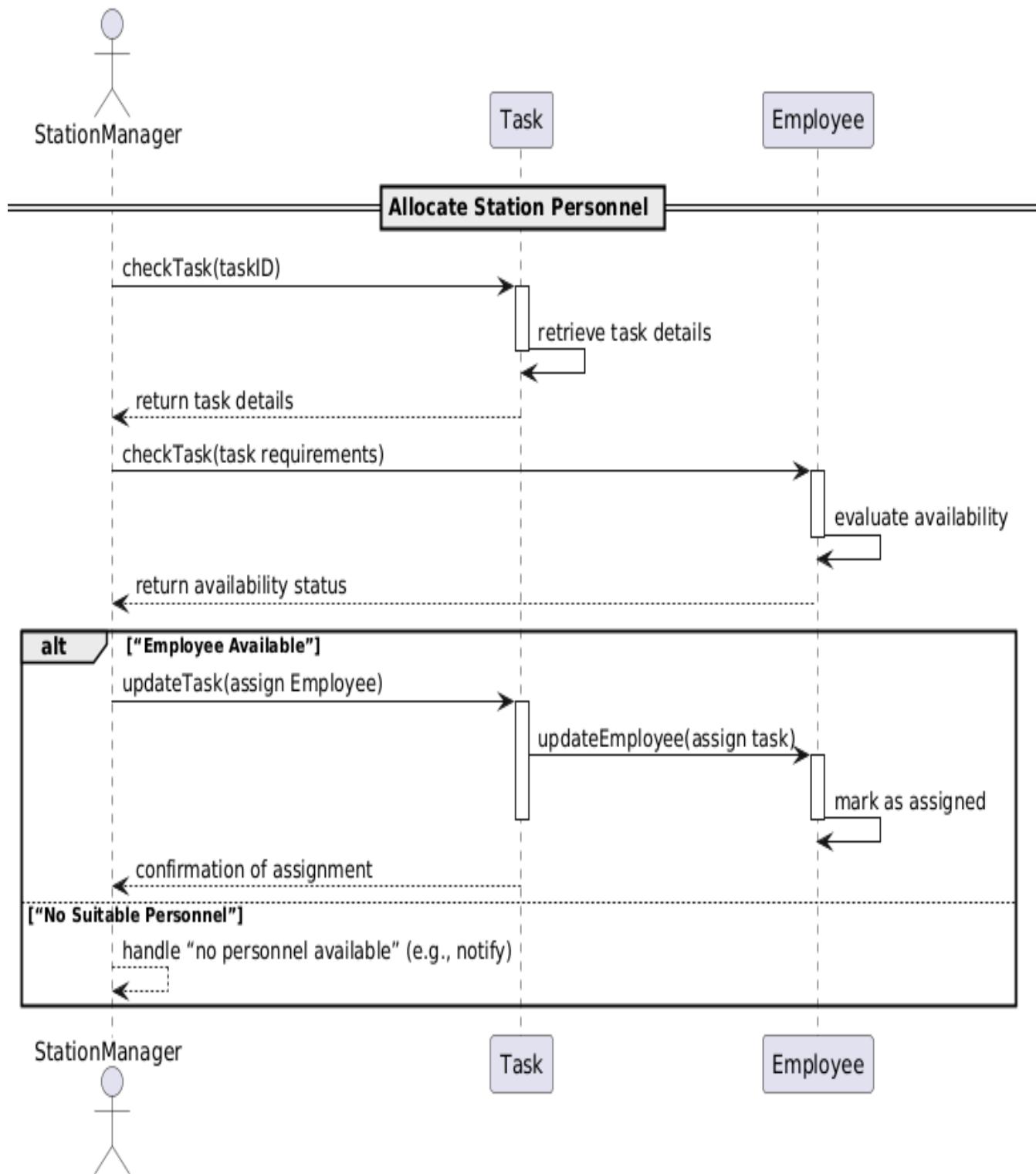


Railway Management System Requirements Specification

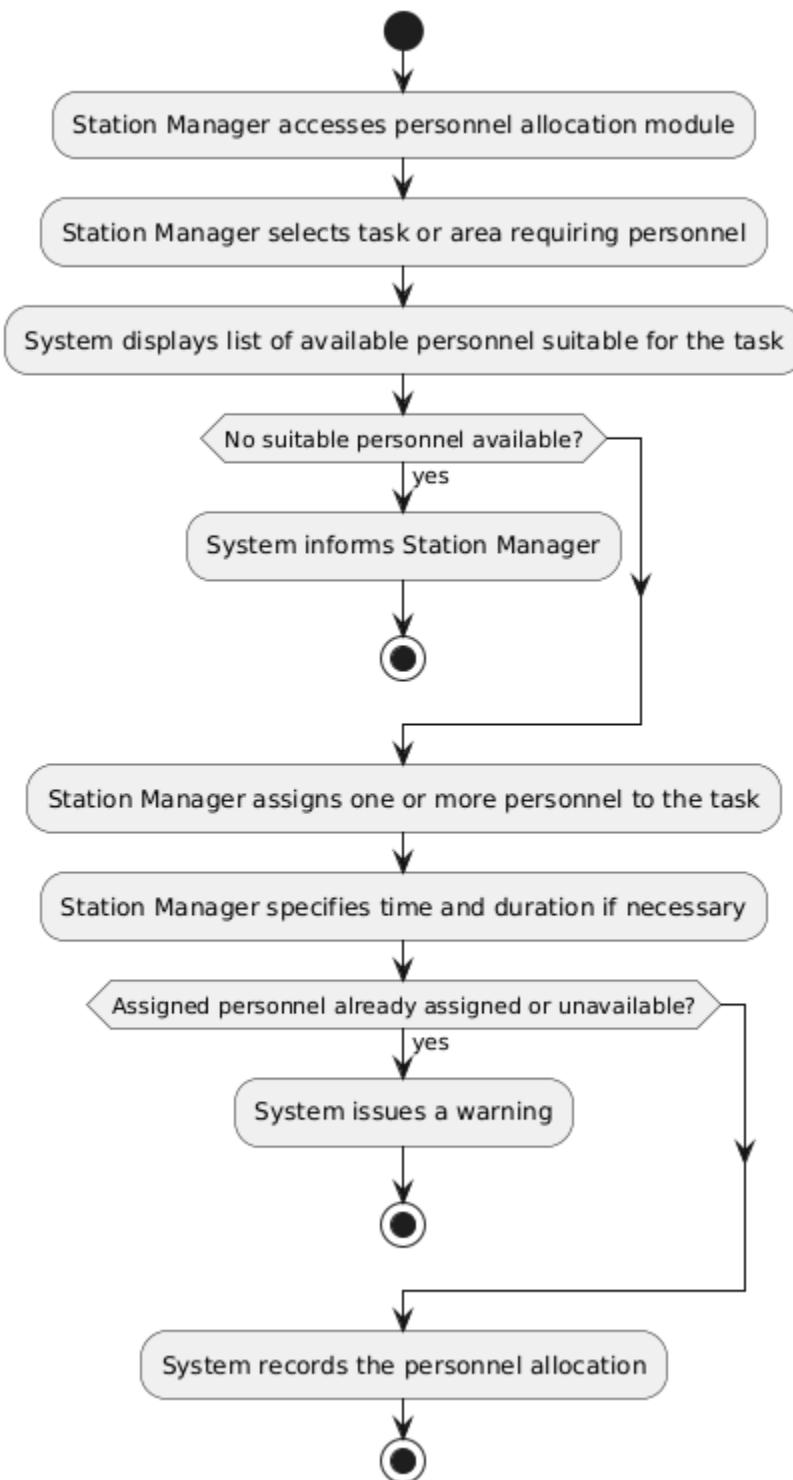


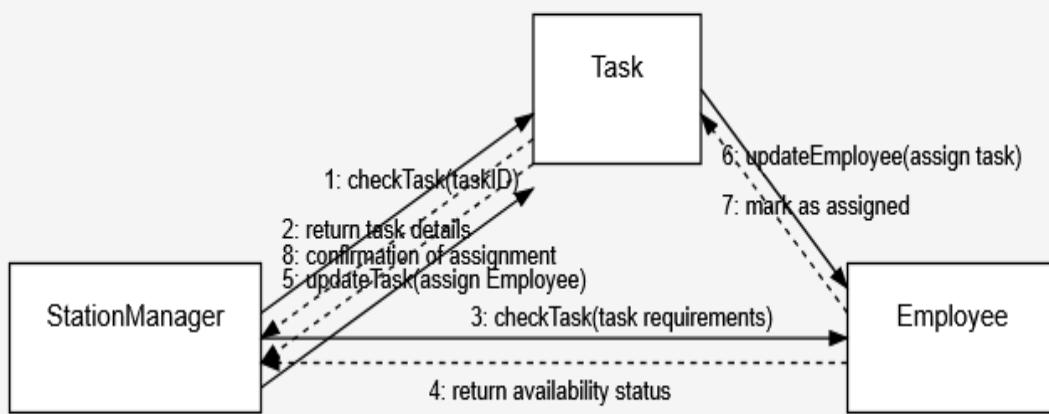


UC Name	<u>SM MNG 9 – Allocate station personnel</u>
Summary	The Station Manager must be able to allocate human personnel to complete tasks on stations under their jurisdiction.
Dependency	<ul style="list-style-type: none"> • SM MNG 02 (Access Personnel Information) → The Station Manager needs to know available personnel.
Actors	Primary Actor: Station Manager (SM) Secondary Actor: System (S) Other Actors: Personnel (P), Security Staff (SS)
Preconditions	<ul style="list-style-type: none"> → The system must have a list of station personnel and their roles/availability. → The Station Manager must be authenticated and authorized for their station(s).
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ The Station Manager accesses the personnel allocation module. ❖ The Station Manager selects a task or area requiring personnel. ❖ The system displays a list of available personnel suitable for the task. ❖ The Station Manager assigns one or more personnel to the task, specifying the time and duration if necessary. ❖ The system records the personnel allocation.
Description of the Alternative Sequence	<ul style="list-style-type: none"> • If no suitable personnel are available, the system informs the Station Manager. • If the Station Manager attempts to allocate personnel who are already assigned or unavailable, the system issues a warning.
Non functional requirements	Usability: The personnel allocation interface should be intuitive and easy to use. Real-time Updates: Personnel availability should be updated in a timely manner.
Postconditions	<ul style="list-style-type: none"> ❖ Personnel are allocated to tasks as specified by the Station Manager. ❖ The system maintains a record of personnel allocations.



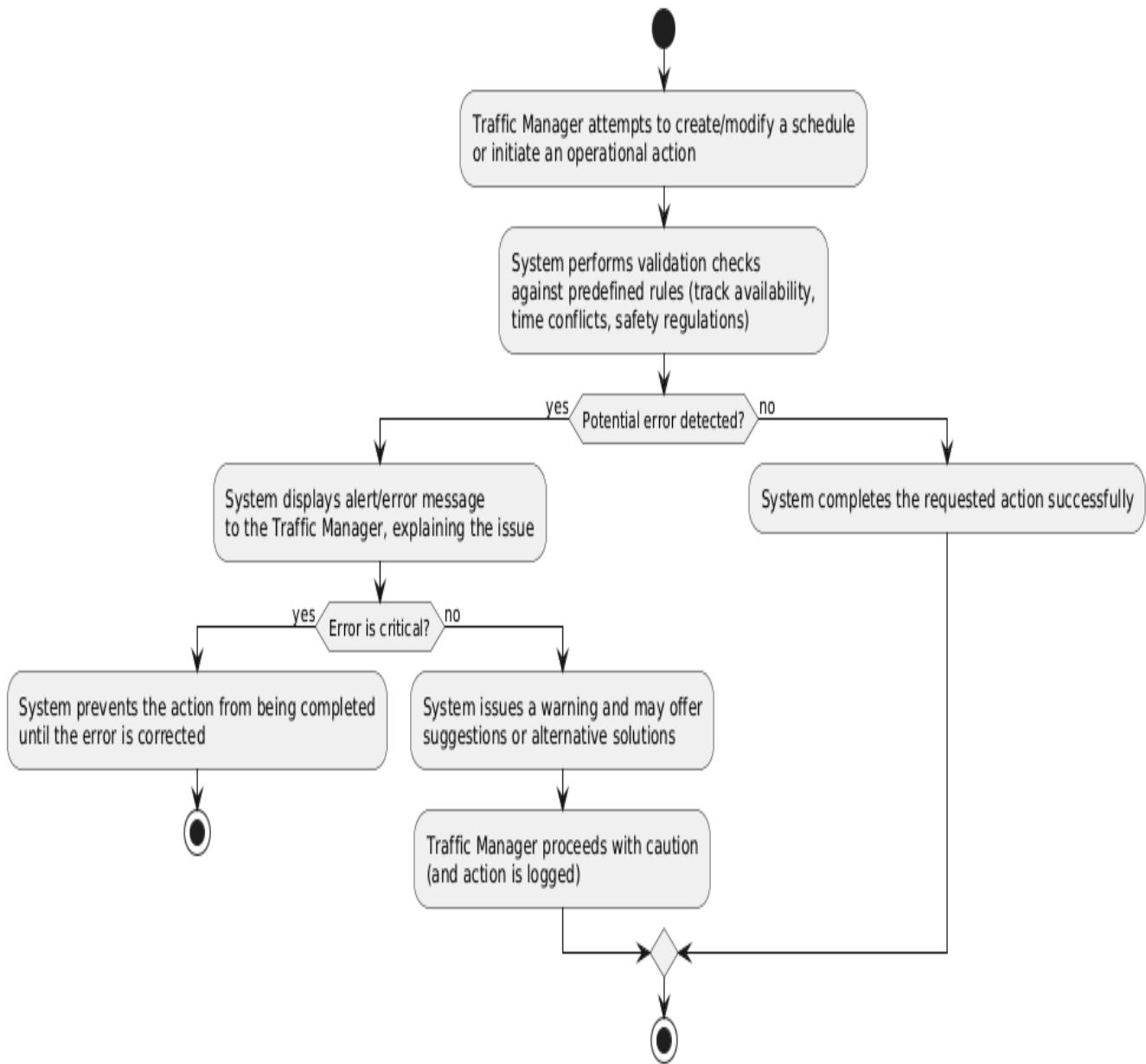
Railway Management System Requirements Specification



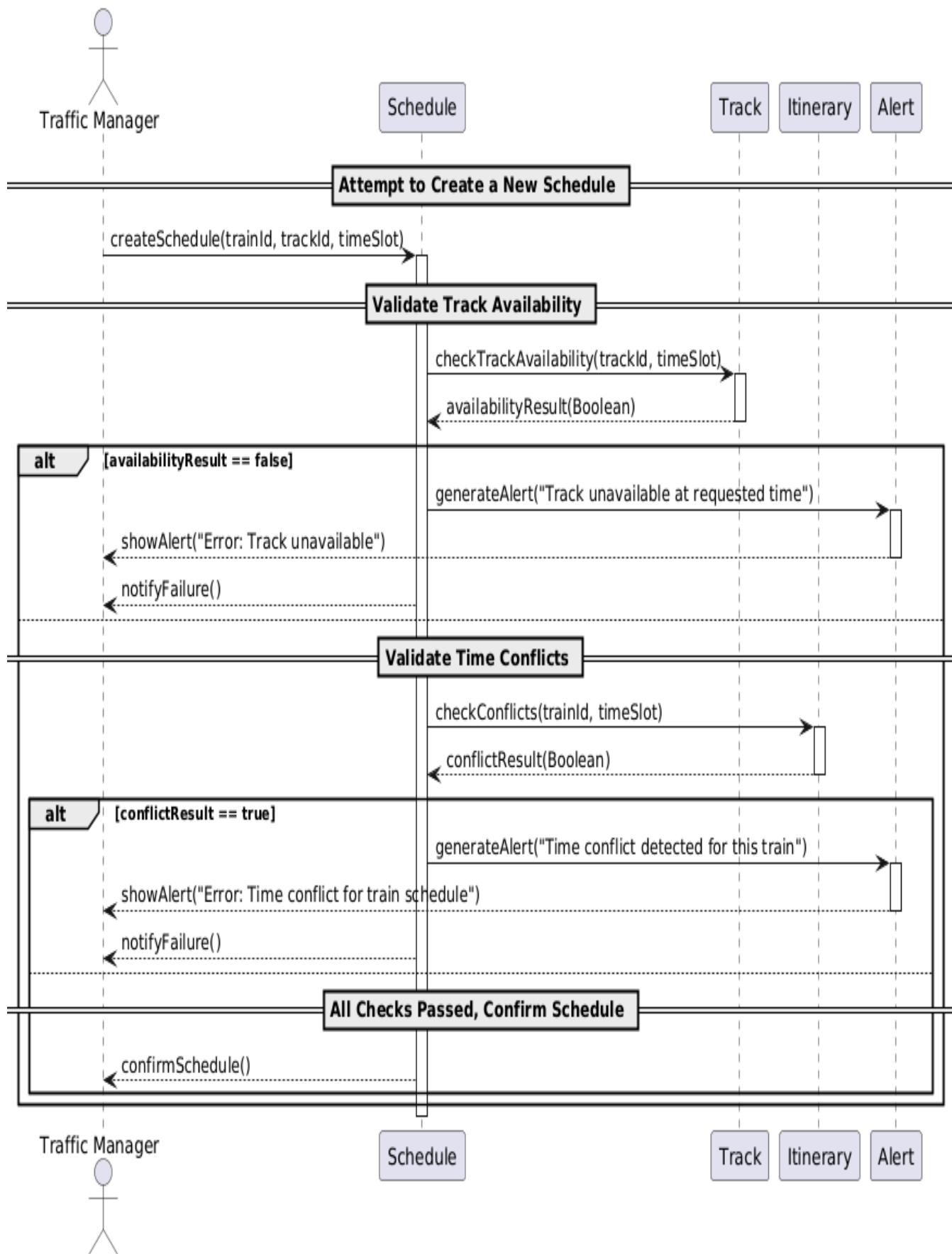


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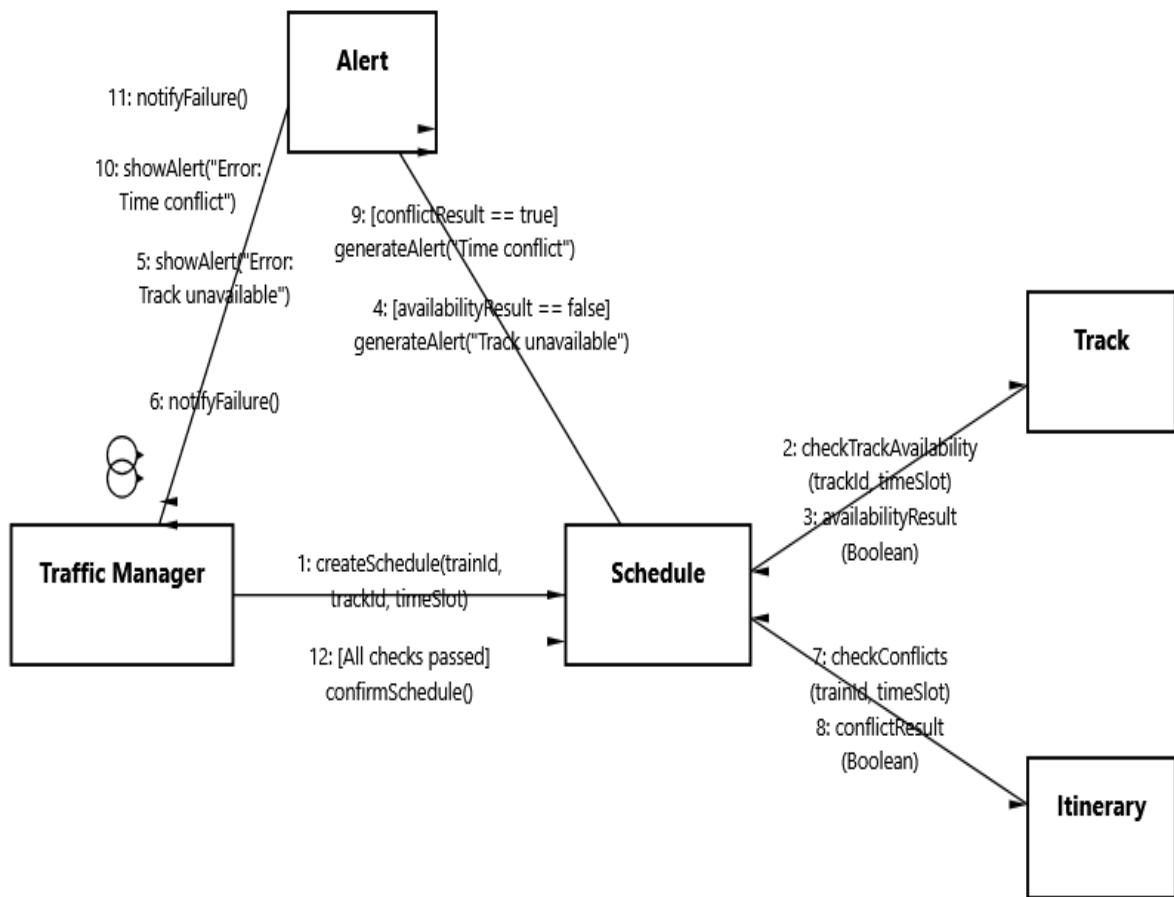
UC Name	<u>TM PRVT 11 – Prevent Scheduling/Operational Errors</u>
Summary	The system must prevent Traffic Managers from making critical scheduling or operational errors using validation checks.
Dependency	<ul style="list-style-type: none"> • TM MNG 03 (Manage Train Schedules) → Validation is applied during schedule creation/modification. • Potentially other UCs involving operational decisions.
Actors	Primary Actor: System (S) Secondary Actor: Traffic Manager (TM) Other Actors: System Administrator (SA), Safety Inspector (SI)
Preconditions	<ul style="list-style-type: none"> → The system must have defined rules and constraints for scheduling and operations. → The Traffic Manager is attempting to perform an action that could lead to an error (e.g., creating an overlapping schedule, assigning a train to an unavailable track).
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ The Traffic Manager attempts to create or modify a schedule or initiate an operational action. ❖ The system automatically performs validation checks against predefined rules (e.g., track availability, time conflicts, safety regulations). ❖ If a potential error is detected, the system displays an alert or error message to the Traffic Manager, explaining the issue. ❖ The system prevents the action from being completed until the error is corrected.
Description of the Alternative Sequence	<ul style="list-style-type: none"> • In some cases, the system might offer suggestions or alternative solutions to resolve the potential error. • For certain less critical errors, the system might issue a warning but allow the Traffic Manager to proceed with caution (with appropriate logging).
Non functional requirements	Reliability: The validation checks must be accurate and effective in preventing errors. Usability: Error messages should be clear, informative, and guide the Traffic Manager on how to resolve the issue.
Postconditions	<ul style="list-style-type: none"> ❖ Critical scheduling or operational errors are prevented by the system's validation checks.



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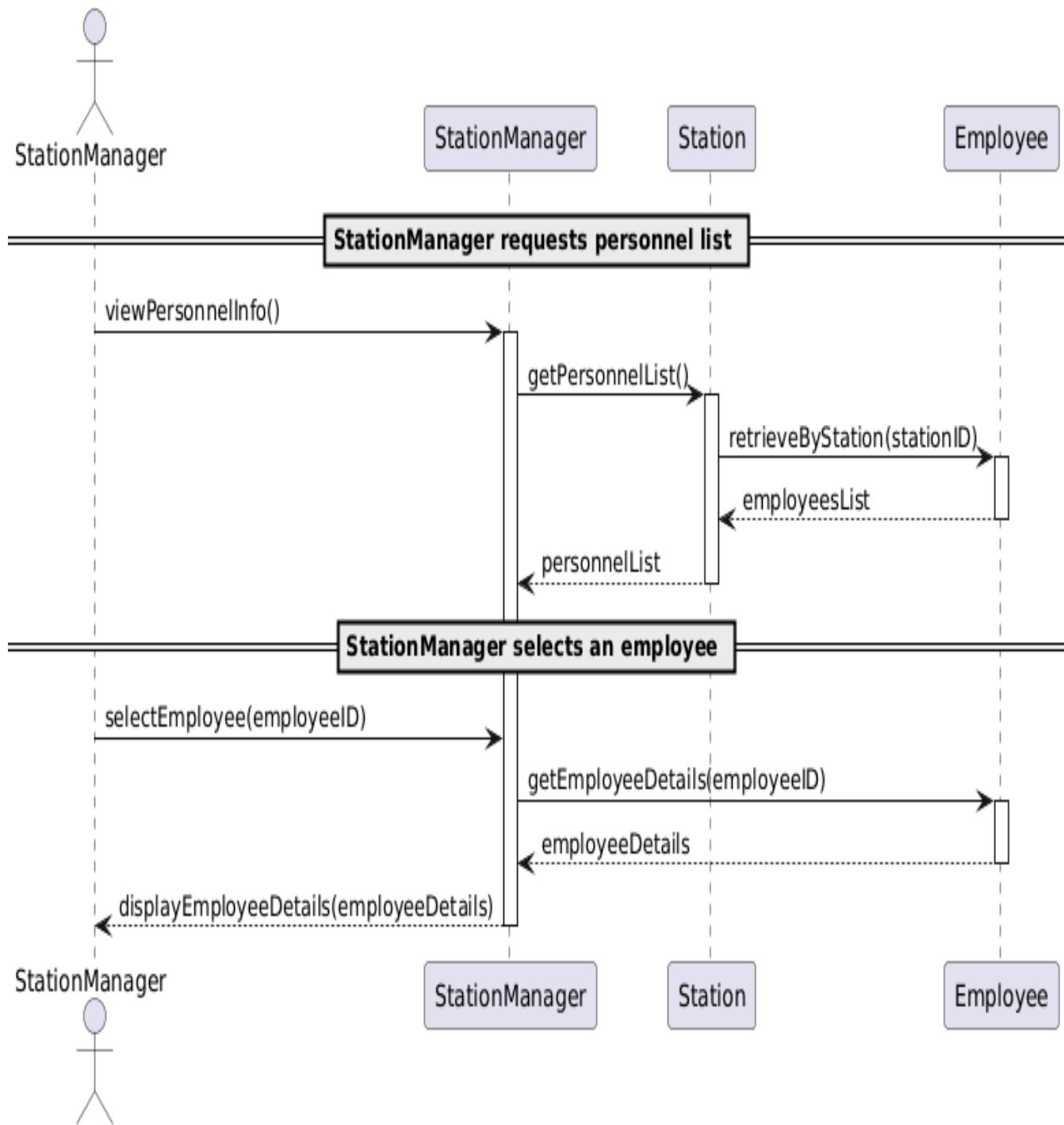
Railway Management System - Collaboration Diagram



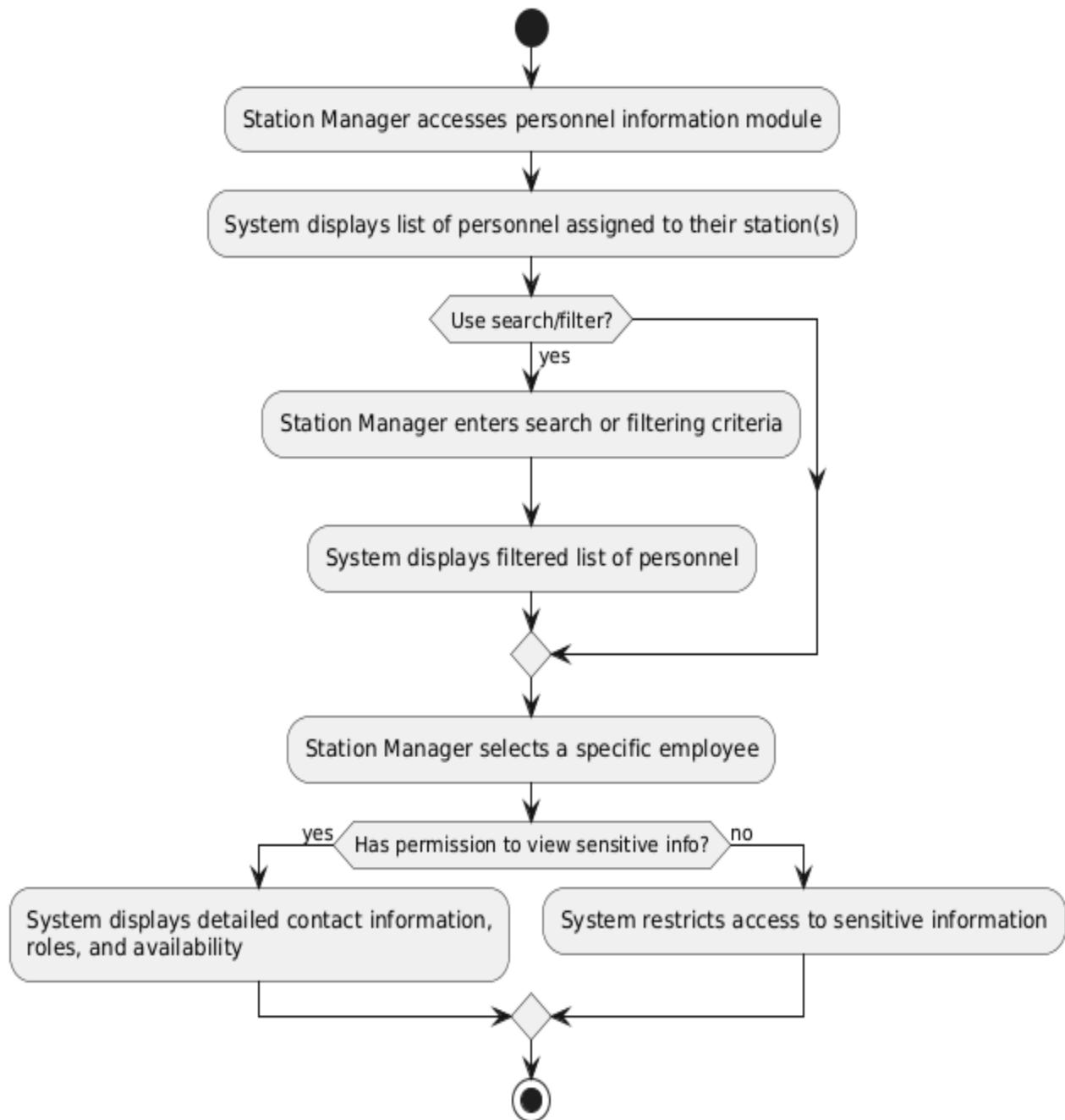
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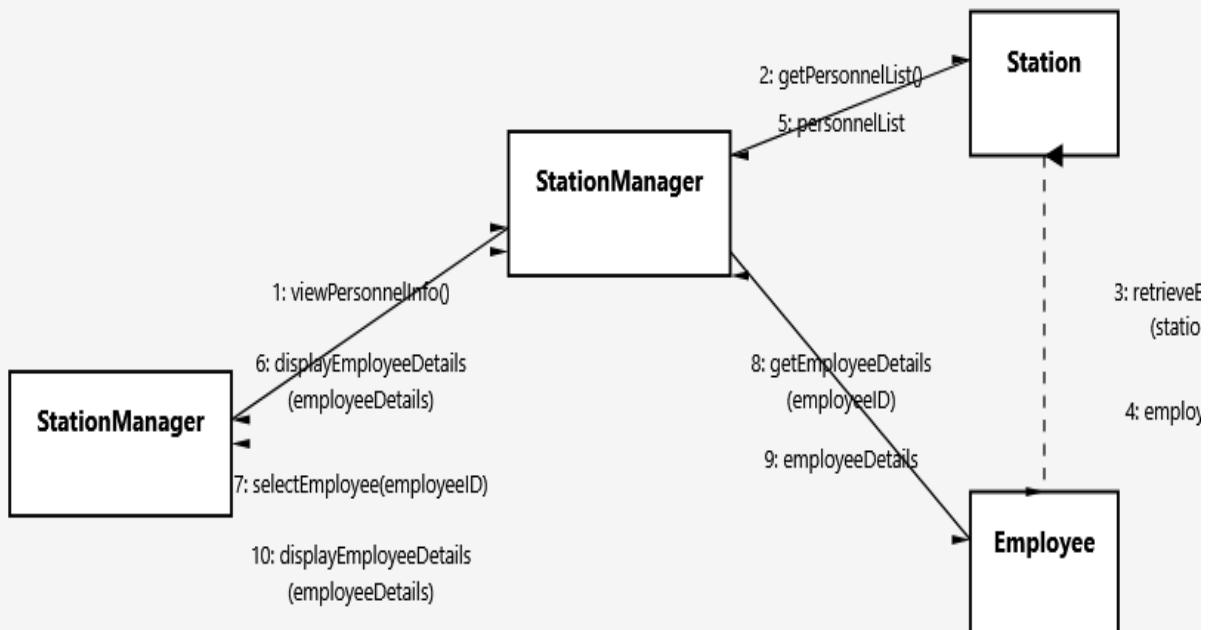
UC Name	<u>SM VW 12 – Access Personnel Information</u>
Summary	The Station Manager needs to be able to access personnel information for staff under their jurisdiction.
Dependency	<ul style="list-style-type: none"> • None explicitly stated, but relies on the system storing personnel data.
Actors	Primary Actor: Station Manager (SM) Secondary Actor: System (S) Other Actors: Human Resources (HR)
Preconditions	<ul style="list-style-type: none"> → The system must have stored personnel information. → The Station Manager must be authenticated and authorized for their station(s).
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ The Station Manager accesses the personnel information module. ❖ The system displays a list of personnel assigned to their station(s). ❖ The Station Manager can select a specific employee to view their details (e.g., contact information, roles, availability).
Description of the Alternative Sequence	<ul style="list-style-type: none"> • The system may provide search or filtering options to help the Station Manager find specific personnel. • Access to certain sensitive personnel information might be restricted based on the Station Manager's role and permissions.
Non functional requirements	Security: Access to personnel information must be controlled to authorized personnel only. Usability: The interface for viewing personnel information should be easy to navigate.
Postconditions	<ul style="list-style-type: none"> ❖ The Station Manager can view the necessary personnel information for their staff.

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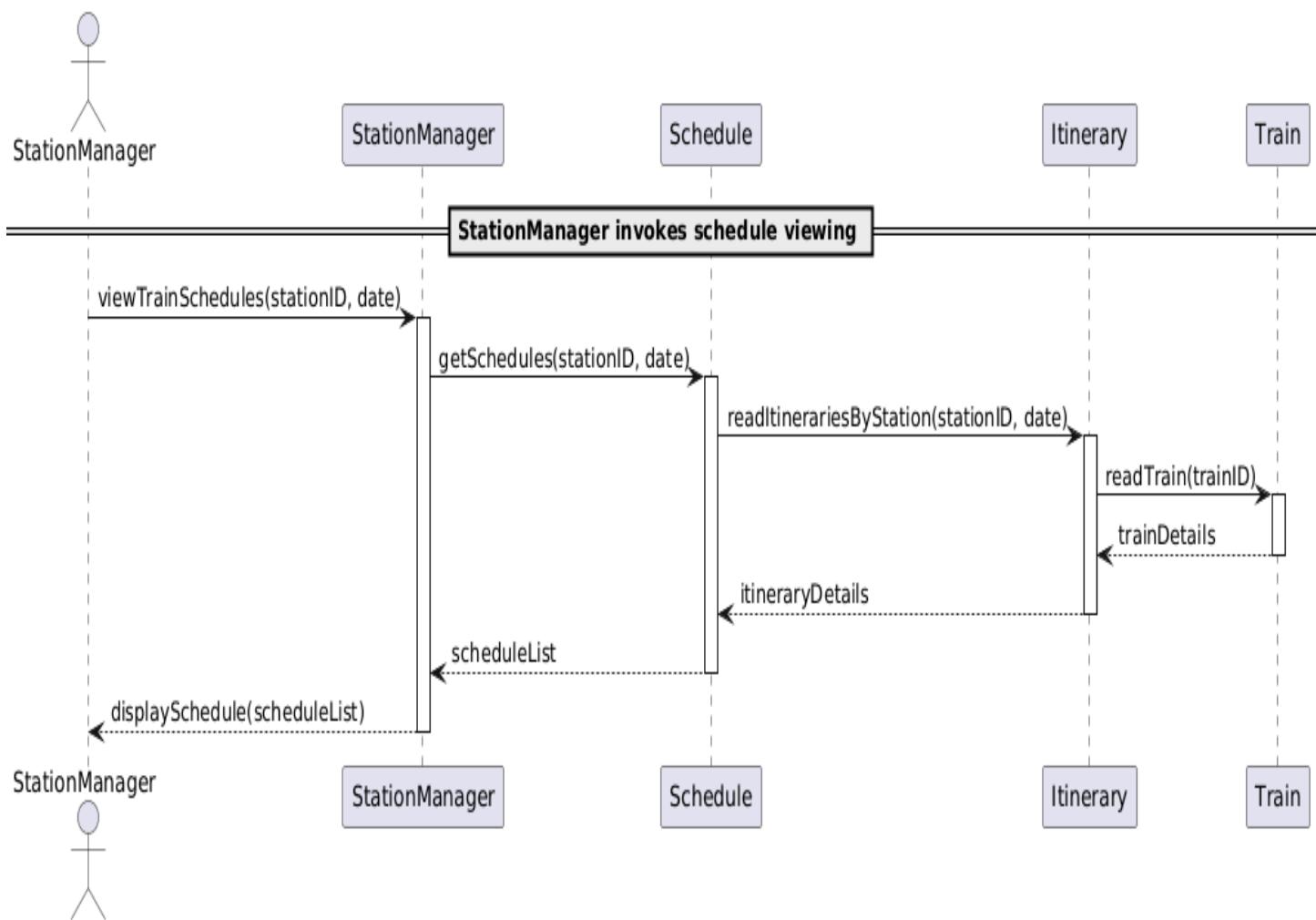




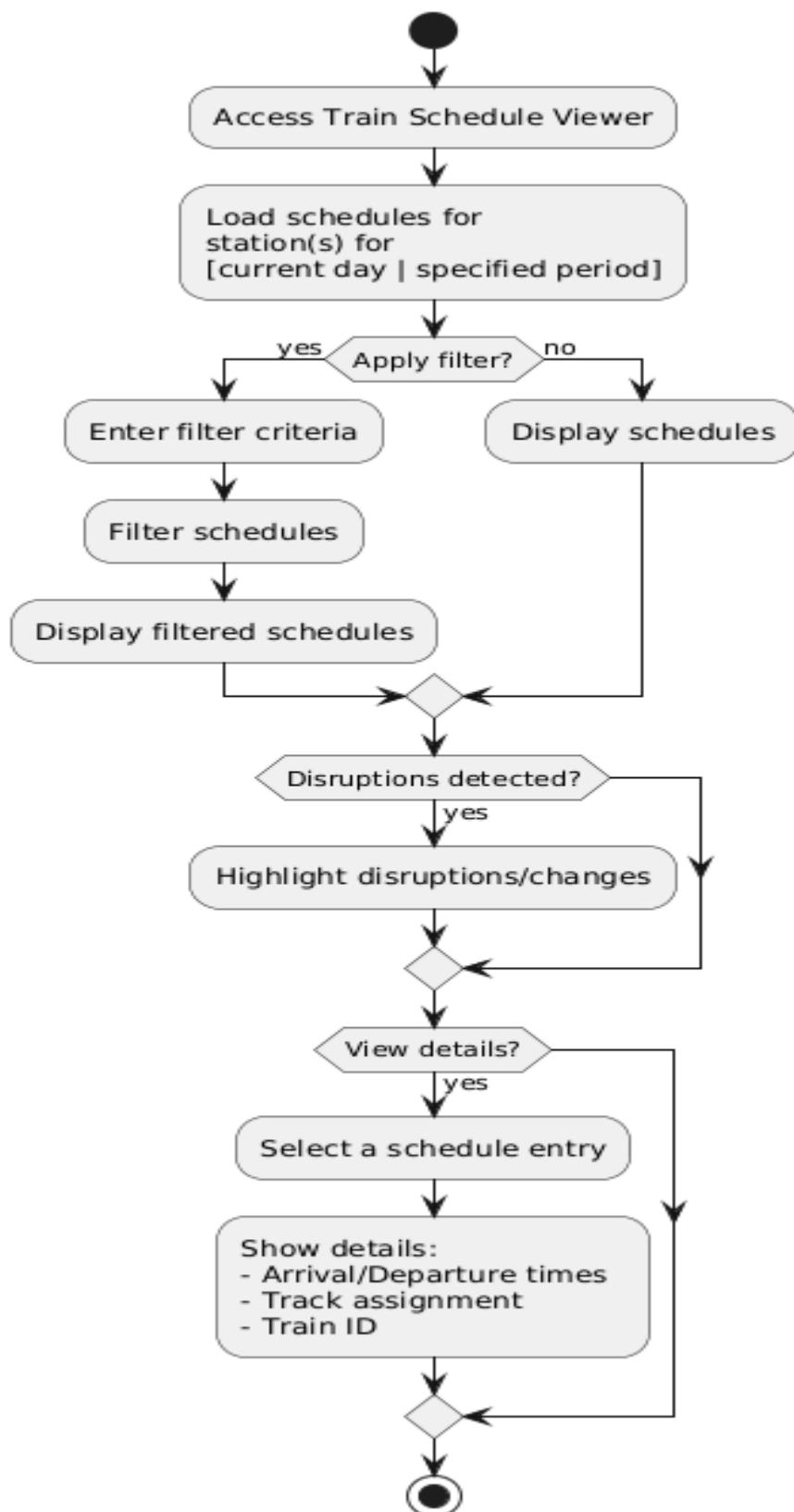
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UC Name	<u>SM VW 13 – View Train Schedules (Station Jurisdiction)</u>
Summary	The Station Manager needs to be able to view train schedules relevant to the station(s) under their jurisdiction.
Dependency	<ul style="list-style-type: none"> • TM MNG 03 (Manage Train Schedules) → Schedules must exist in the system.
Actors	Primary Actor: Station Manager (SM) Secondary Actor: System (S) Other Actors: Customer (C), Information Desk Clerk (IDC)
Preconditions	<ul style="list-style-type: none"> → Train schedules must be stored in the system. → The system must know which trains are scheduled to stop at or pass through the Station Manager's jurisdiction. → The Station Manager must be authenticated and authorized for their station(s).
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ The Station Manager accesses the train schedule viewing module. ❖ The system automatically displays the train schedules relevant to the Station Manager's station(s) for the current day or a specified period. ❖ The Station Manager can view details such as arrival and departure times, track assignments, and train IDs.
Description of the Alternative Sequence	<ul style="list-style-type: none"> • The system may allow the Station Manager to filter the schedule (e.g., by direction, specific train). • If there are disruptions or changes to the schedule, the system should ideally highlight these to the Station Manager.
Non functional requirements	Accuracy: The displayed schedule information must be up-to-date and accurate. Performance: The schedule information should be retrieved and displayed quickly.
Postconditions	<ul style="list-style-type: none"> ❖ The Station Manager can view the train schedules relevant to their station(s).

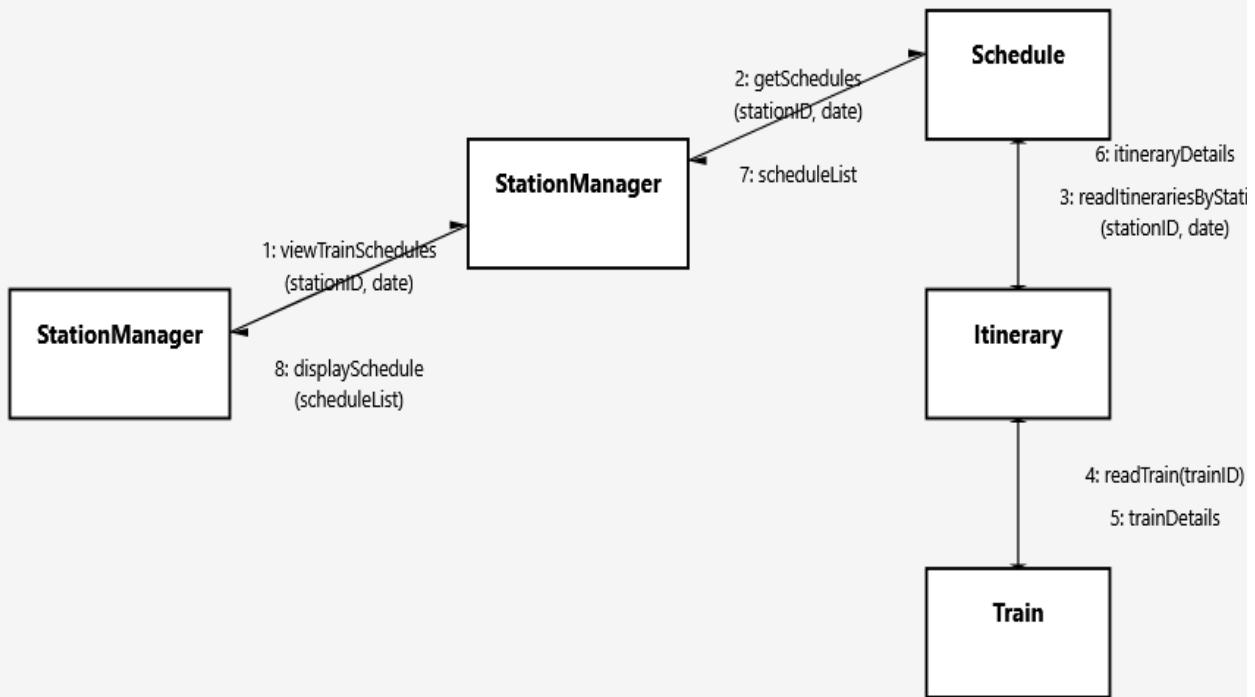
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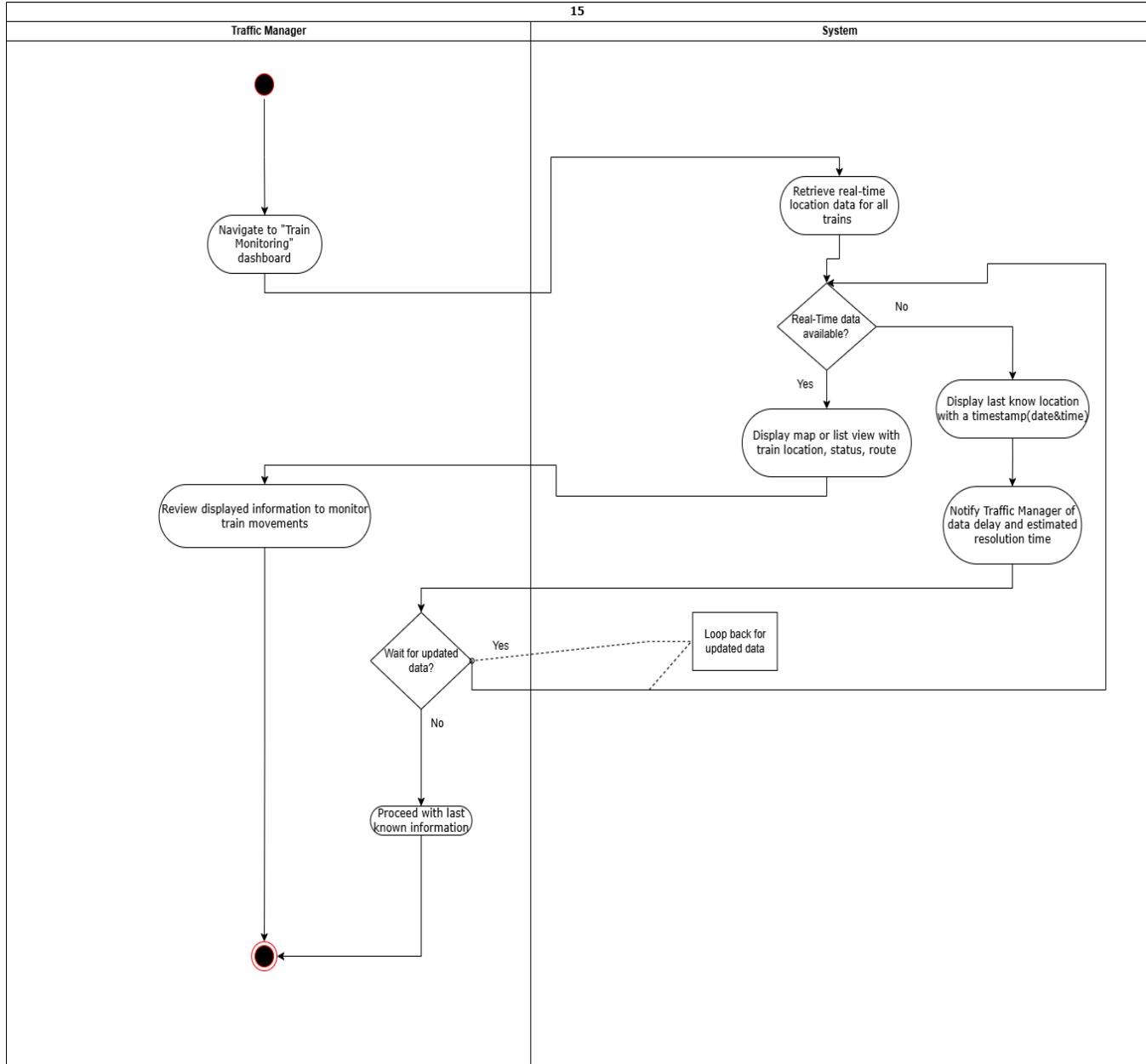


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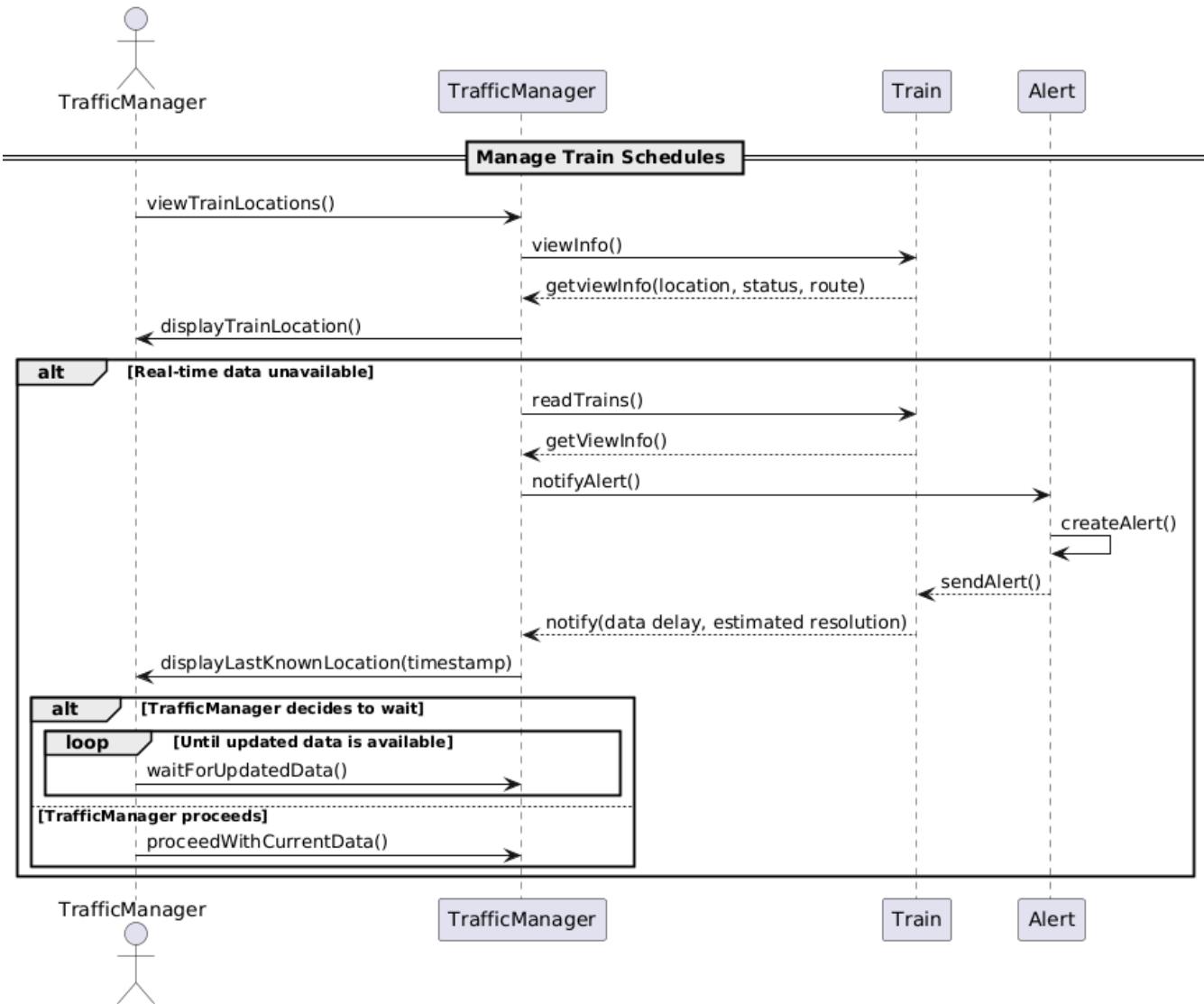
UC Name	<u>TM VIW 14 - Manage Train Schedules</u>
Summary	This use case describes how the Traffic Manager views the real-time location of every train within their jurisdiction to monitor operations and ensure efficient scheduling.
Dependency	<ul style="list-style-type: none"> • S_TRK_05 (<i>system maintaining accurate data on train car availability and condition</i>).
Actors	<ul style="list-style-type: none"> • Primary Actor: Traffic Manager (TM) • Secondary Actor: System (S)
Preconditions	<ul style="list-style-type: none"> → The Traffic Manager is logged into the system with valid credentials. → Real-time tracking data for trains is available and up-to-date. → The system has synchronized location data from trains.
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ 1. The Traffic Manager navigates to the "Train Monitoring" dashboard in the system. ❖ 2. The system retrieves real-time location data for all trains under the Traffic Manager's jurisdiction. ❖ 3. The system displays a map or list view showing each train's current location, status, and route. ❖ 4. The Traffic Manager reviews the displayed information to monitor train movements.
Description of the Alternative Sequence	<ul style="list-style-type: none"> ❖ 1 . If real-time data is temporarily unavailable (e.g., due to a network issue), the system displays the last known location of each train with a timestamp(record time or date of). ❖ 2: The system notifies the Traffic Manager of the data delay and estimated resolution time. ❖ 3: The Traffic Manager decides whether to wait for updated data or proceed with the last known information.
Non functional requirements	<ul style="list-style-type: none"> → Performance: <i>The system must display real-time train locations within 1 second of the request.</i> → Security: <i>Access to train location data is restricted to authorized Traffic Managers via role-based access control and encrypted communication (SSL/TLS).</i> → Reliability: <i>The system must ensure high uptime for real-time tracking features.</i>
Postconditions	<ul style="list-style-type: none"> ❖ The Traffic Manager has successfully viewed the real-time locations of all trains under their jurisdiction(authority).

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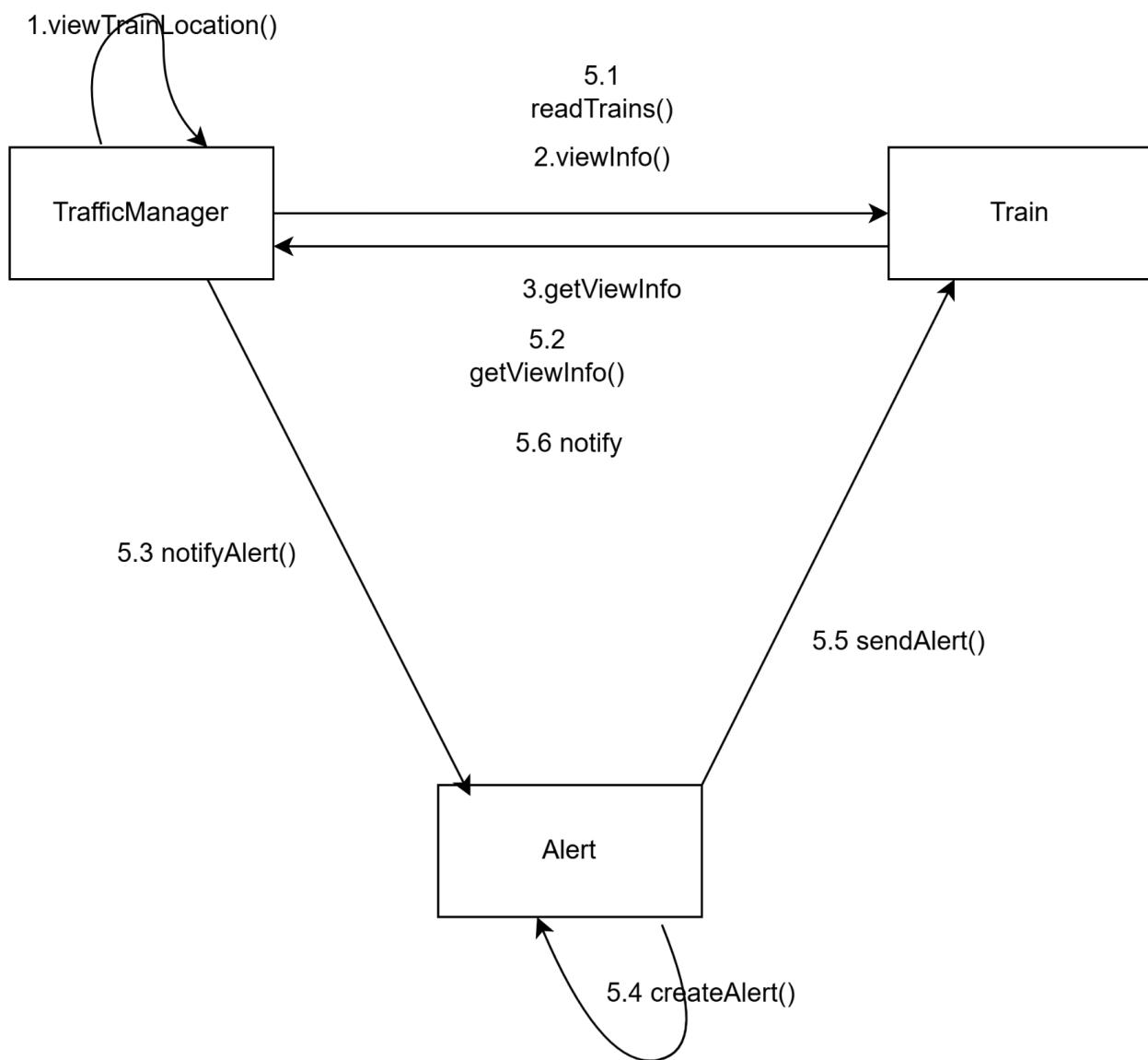
Railway Management System Requirements Specification



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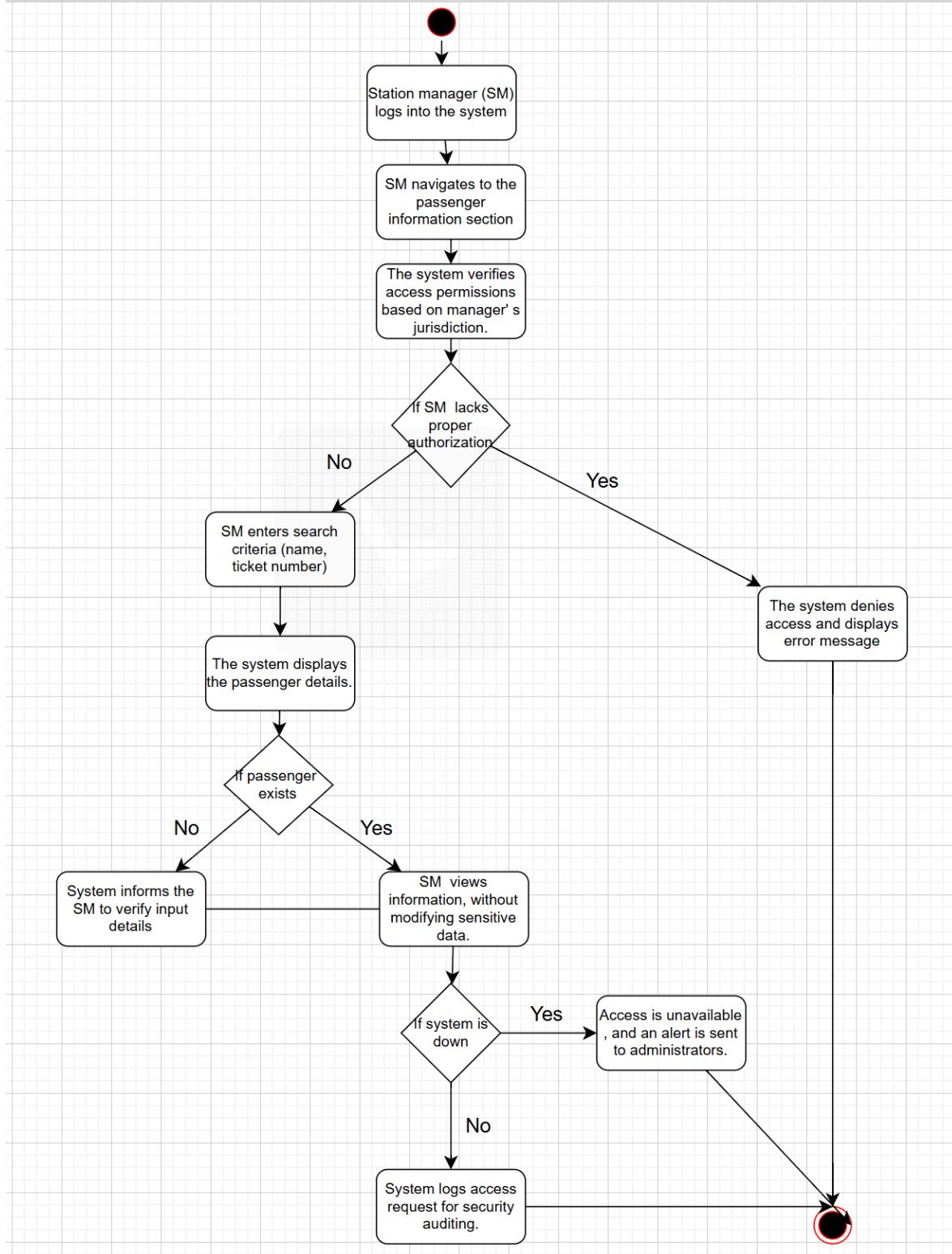
- 7.1 proceedCurrentData
- 6.1 waitForUpdatedData
- 5.7 displayLastKowLocation

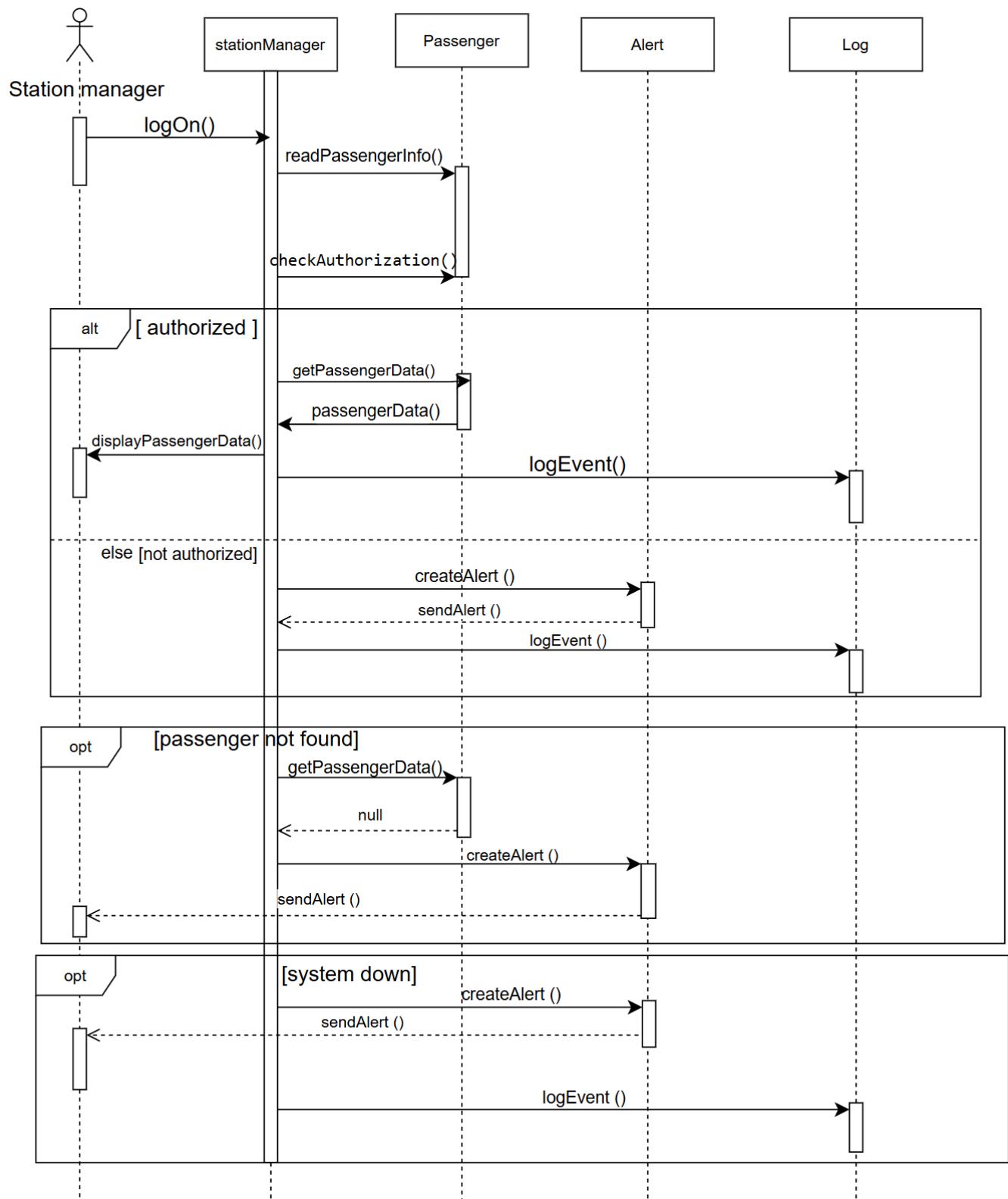
- 4.displayTrainLocation



UC Name	<i>SM PER 15 – Access Passenger Details</i>
Summary	The Station Manager accesses passenger details in a controlled and secure manner to assist with station-related operations while ensuring data privacy and compliance with regulations.
Dependency	<ul style="list-style-type: none"> • S_PER_08 – Track Passenger Information (<i>Passenger details must be stored in the system</i>). • U_AUTH_34 – Login/Logout Functionality (<i>Only authorized personnel can access data</i>).
Actors	<ul style="list-style-type: none"> • Primary Actor: Station Manager (SM) – Requests access to passenger details. • Secondary Actor: System (S) – Verifies authorization and retrieves passenger details.
Preconditions	<p>→ The requested passenger details are relevant to station operations (e.g., ticket verification, lost items, assistance requests).</p>
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ 1. Station Manager logs into the system. ❖ 2. Station Manager navigates to the passenger information section. ❖ 3. System verifies access permissions based on the manager's jurisdiction. ❖ 4. Station Manager enters search criteria (e.g., name, ticket number). ❖ 5. System retrieves and displays the relevant passenger details. ❖ 6. Station Manager views necessary information without modifying sensitive data. ❖ 7. System logs the access request for security auditing.
Description of the Alternative Sequence	<ul style="list-style-type: none"> ❖ If the Station Manager lacks proper authorization the system denies access and displays an error message. ❖ If the requested passenger record does not exist: System informs the Station Manager and suggests verifying input details. ❖ If the system is down: Access is temporarily unavailable, and an alert is sent to administrators
Non functional requirements	<p>→ Security: Access must comply with data privacy laws .</p> <p>→ Logging: All access requests must be tracked and auditable.</p> <p>→ Performance: Passenger details should be retrieved within 3 seconds.</p> <p>→ Usability: Interface should be intuitive and role-restricted.</p>
Postconditions	<ul style="list-style-type: none"> ❖ The system records and logs the access attempt. ❖ Unauthorized attempts trigger security alerts.

UC 17: SM PER 17 – Access Passenger Details





Collaboration diagram

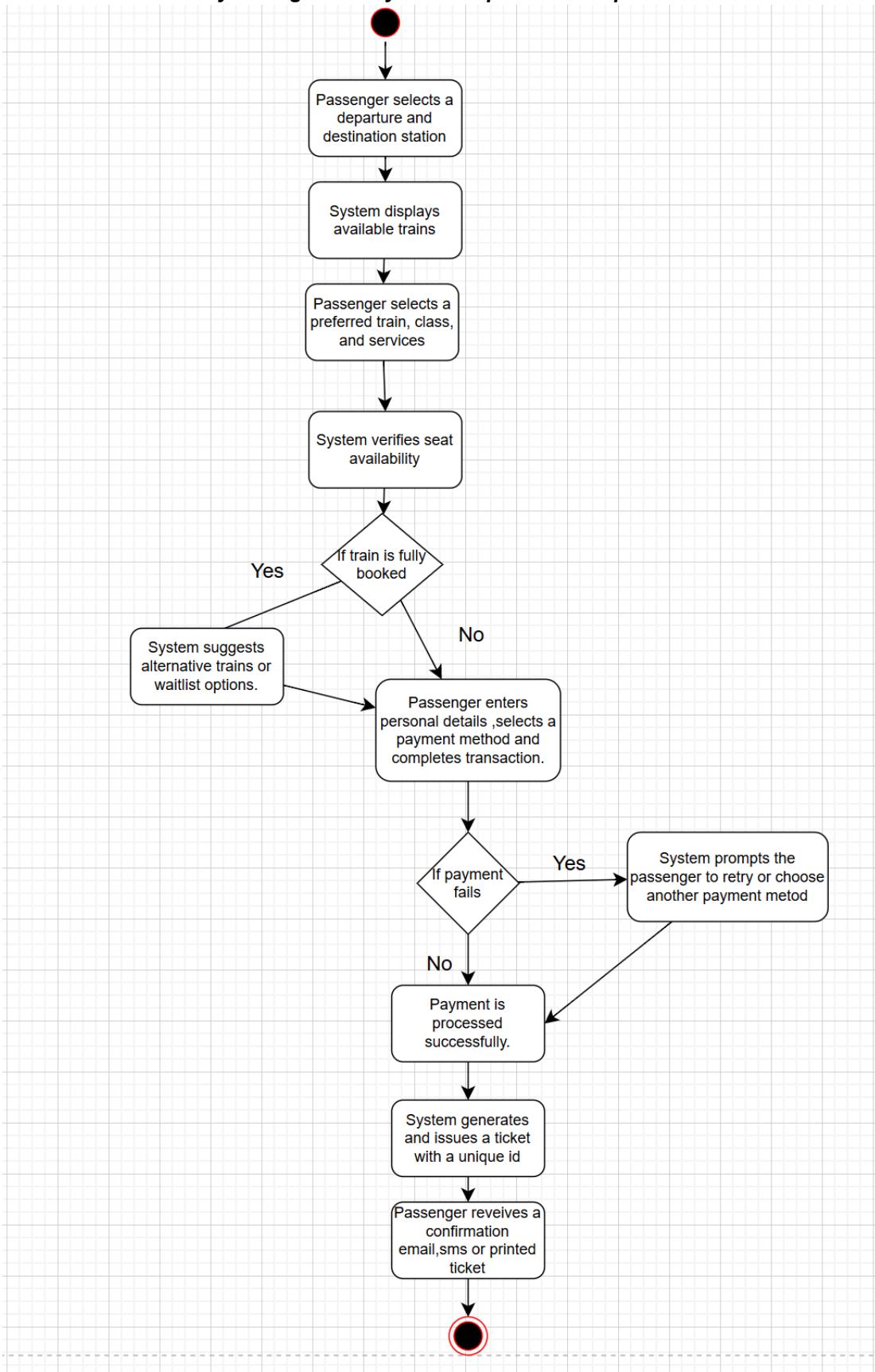
UC Name	<u>P TKT 16 – Book Train Ticket</u>
Summary	A passenger books a train ticket by selecting an available train, specifying travel preferences (class, seating, or sleeping accommodations), and completing the booking process.
Dependency	<ul style="list-style-type: none"> • S_SCH_06 – Maintain Train Schedules (Train schedules must be available). • S_CAP_32 – Capacity Management (Prevents overbooking). • S_PAY_20 – Process Payment (Handles payment for the booking).
Actors	<ul style="list-style-type: none"> • Primary Actor: Passenger (P) – Initiates the ticket booking. • Secondary Actor: System (S) – Processes the booking and verifies availability.
Preconditions	<ul style="list-style-type: none"> ❖ The passenger has access to the system (website, mobile app, or ticket booth). ❖ Train schedules and availability data are up to date. ❖ Passenger account is logged in.
Description of the Main Sequence	<ul style="list-style-type: none"> ● 1. Passenger selects a departure and destination station ● 2. System displays available trains with schedules, seat classes, and accommodations. ● 3. Passenger selects a preferred train, class, and additional services. ● 4. System verifies seat availability. ● 5. Passenger enters personal details , selects a payment method and completes the transaction.

Railway Management System Requirements Specification

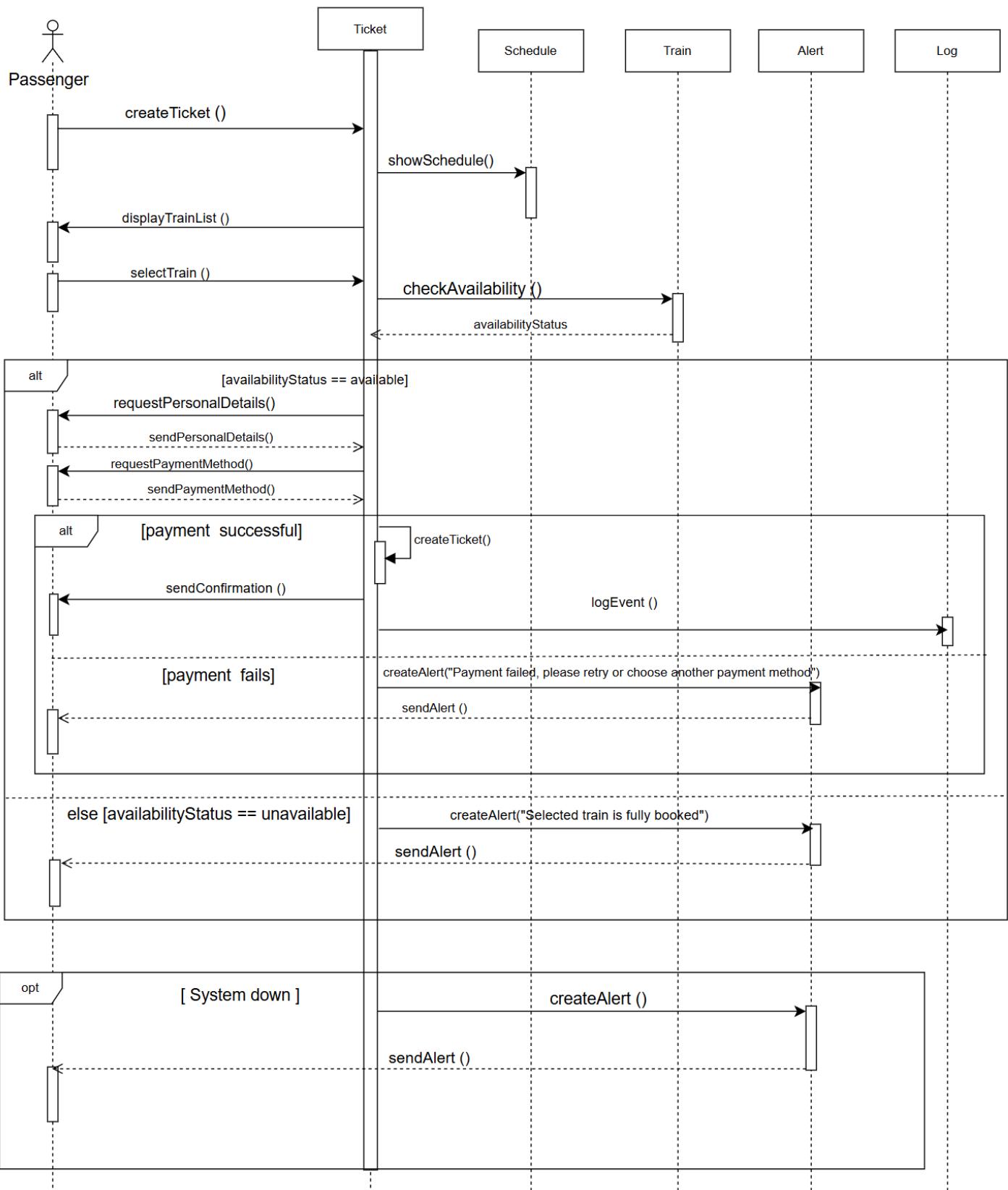
	<ul style="list-style-type: none"> ● 6. Payment is processed successfully. ● 7. System generates and issues a ticket with a unique booking reference. ● 8. Passenger receives a confirmation (email, SMS, or printed ticket).
Description of the Alternative Sequence	<ul style="list-style-type: none"> ❖ 1. If the selected train is fully booked: System suggests alternative trains or waitlist options. ❖ 2. If payment fails: System prompts the passenger to retry or choose another payment method. ❖ 3. If the system is down: Ticket booking is temporarily unavailable, and an error message is displayed.
Non functional requirements	<ul style="list-style-type: none"> → Performance: Ticket booking process should be completed within 10 seconds. → Security: Payment transactions must be secure and comply with industry standards. → Availability: The system should be accessible 24/7. → User Experience: The booking interface should be intuitive and mobile-friendly.
Postconditions	<ul style="list-style-type: none"> ❖ The ticket is successfully booked and stored in the system. ❖ The passenger receives a confirmation with booking details. ❖ Seat availability is updated to reflect the new booking.

UC 18: P TKT 18 – Book Train Ticket

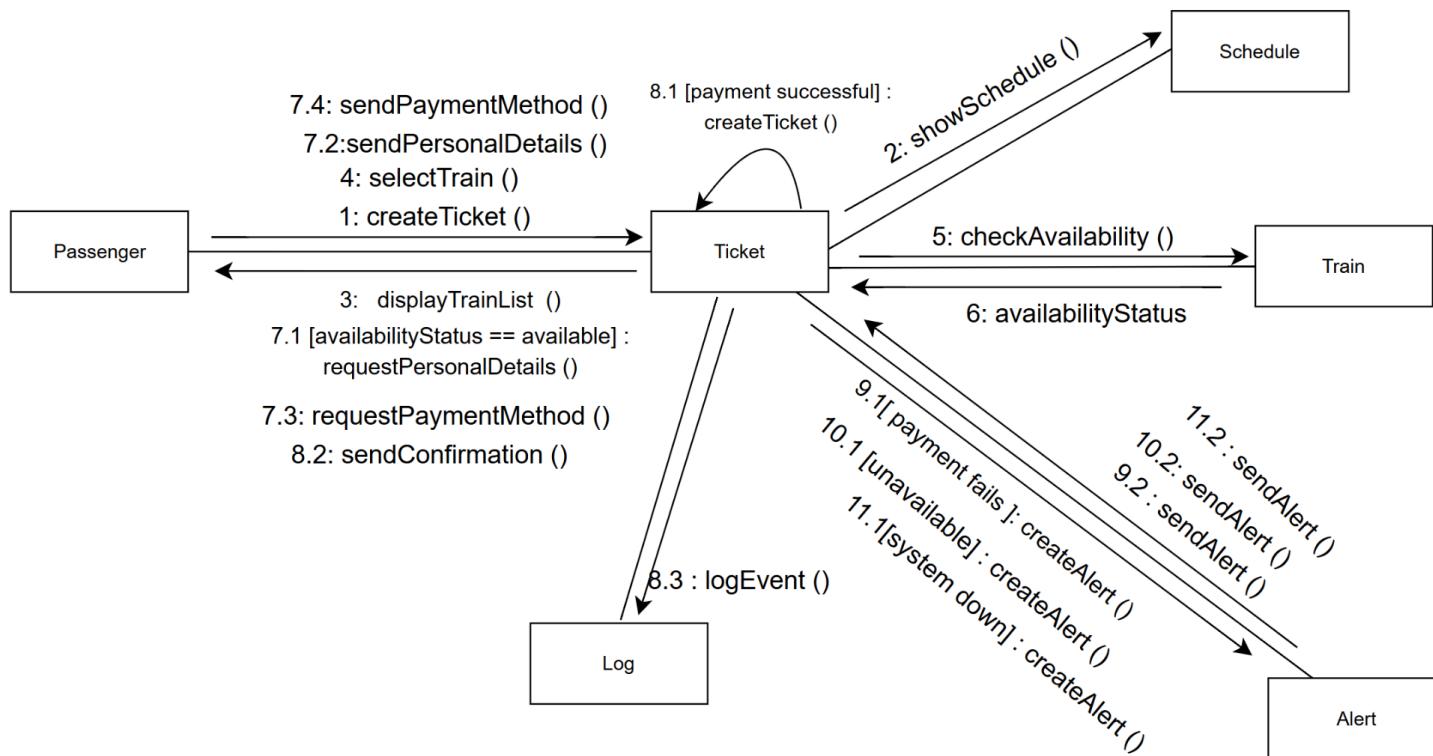
Railway Management System Requirements Specification



Railway Management System Requirements Specification



Collaboration diagram

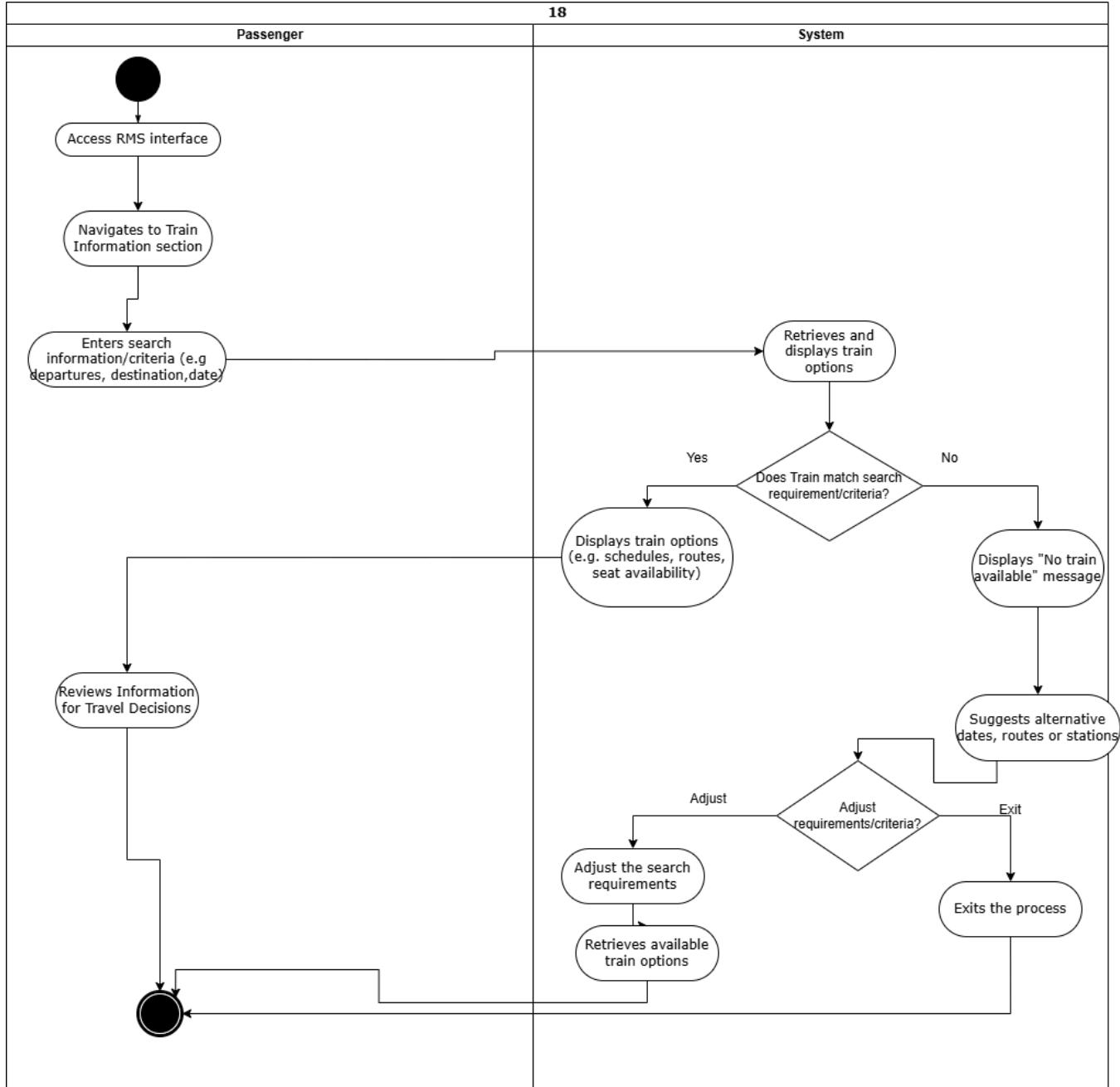


Railway Management System Requirements Specification

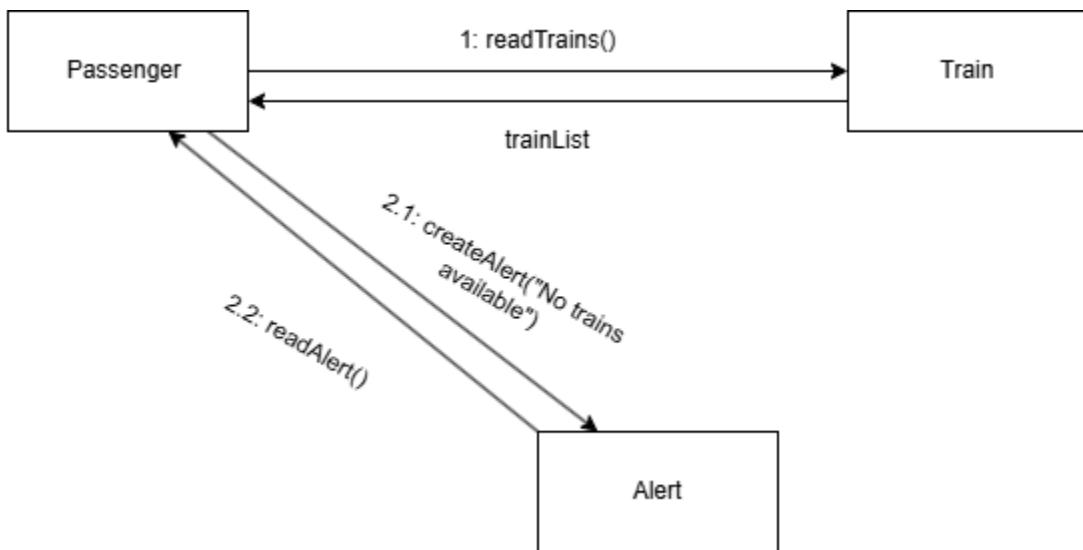
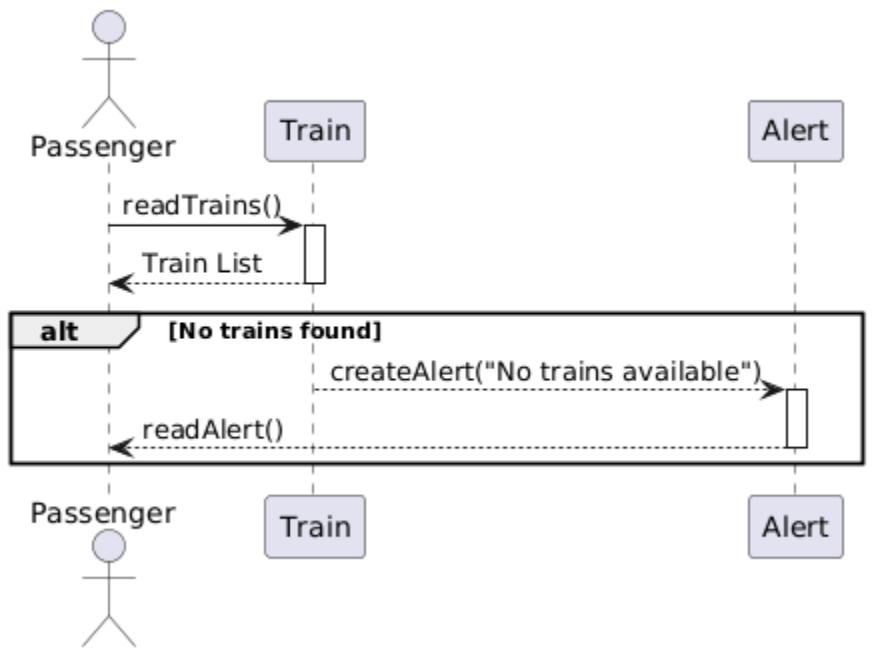
UC Name	<u>P VIW 17 - Passenger Views Train Information</u>
Summary	This use case outlines how a Passenger accesses train information, such as schedules, routes, and availability, to plan their travel.
Dependency	<ul style="list-style-type: none"> • <i>S_SCH_06 (system maintaining an updated schedule of trains and itineraries).</i>
Actors	<ul style="list-style-type: none"> • Primary Actor: Passenger (P) • Secondary Actor: System (S)
Preconditions	<p>→ The Passenger has access to the RMS interface (e.g., website or mobile app).</p> <p>→ Train schedule and status data are available in the system.</p>
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ 1: The Passenger navigates to the "Train Information" section of the RMS interface. ❖ 2: The Passenger enters search criteria (e.g., departure station, destination, date). ❖ 3: The system retrieves and displays available train options, including schedules, routes, and seat availability. ❖ 4: The Passenger reviews the information to make travel decisions.
Description of the Alternative Sequence	<ul style="list-style-type: none"> ❖ 1: If no trains match the search criteria, the system displays a "No trains available" message. ❖ 2: The system suggests alternative dates, routes, or nearby stations. ❖ 3: The Passenger adjusts their search criteria or exits the process.
Non functional requirements	<p>→ Performance: Train information must load within 3 seconds of the search request.</p> <p>→ Usability: The interface must be intuitive and responsive on both desktop and mobile devices.</p> <p>→ Security: Passenger interactions with the system must be encrypted.</p>
Postconditions	<ul style="list-style-type: none"> ❖ The Passenger has successfully viewed available train information for their travel planning.

Railway Management System Requirements Specification

18



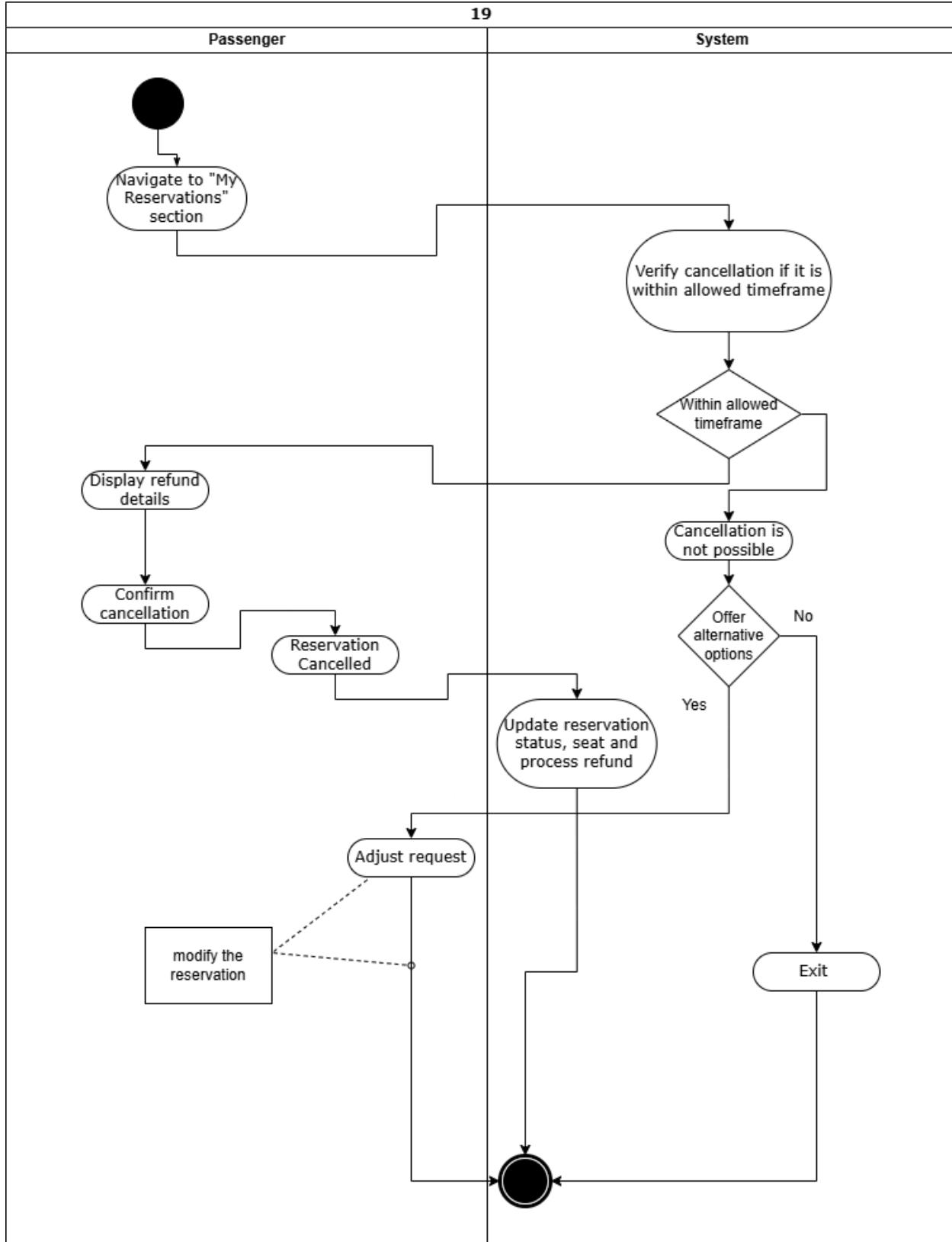
Railway Management System Requirements Specification



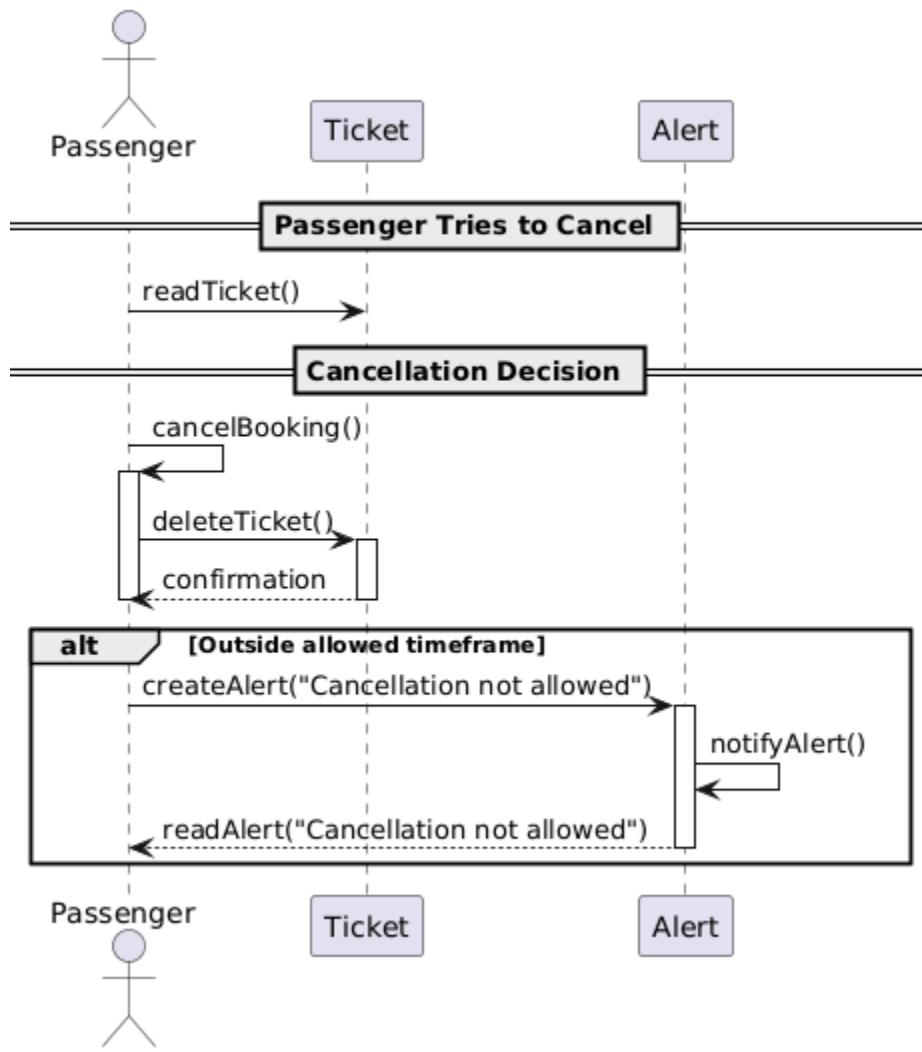
UC Name	<u>P_TKT_18 - Passenger Cancels Reservation</u>
Summary	Passengers that cancel their train reservation within a reasonable timeframe, ensuring flexibility in travel plans.
Dependency	<ul style="list-style-type: none"> • <i>P_TKT_17 (Passenger booking tickets)</i> • <i>S_PAY_20 (payment processing)</i>.
Actors	<ul style="list-style-type: none"> • Primary Actor: Passenger (P) • Secondary Actor: System (S)
Preconditions	<p>→ The Passenger has an active reservation in the system. → The cancellation request is made within the allowed timeframe (TBD). → The Passenger is logged into their account or has a reservation reference number.</p>
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ 1. The Passenger navigates to the "My Reservations" section of the RMS interface. ❖ 2. The system verifies that the cancellation is within the allowed timeframe and displays refund details (if applicable). ❖ 3: The Passenger confirms the cancellation. ❖ 4. The system updates the reservation status, releases the seat, and processes any refund.
Description of the Alternative Sequence	<ul style="list-style-type: none"> ❖ 1. If the cancellation request is outside the allowed timeframe, the system displays a message indicating that cancellation is not possible. ❖ 2: The system offers alternative options (e.g., modifying the reservation if permitted). ❖ 3: The Passenger either adjusts their request or exits the process.
Non functional requirements	<p>→ Performance: Cancellation processing must complete within 4 seconds.</p> <p>→ Security: Reservation data and payment refunds must be encrypted and logged securely.</p> <p>→ Usability: The cancellation process must be straightforward with clear instructions.</p>
Postconditions	<ul style="list-style-type: none"> ❖ The Passenger's reservation is canceled, and the seat is made available for other bookings.

Railway Management System Requirements Specification

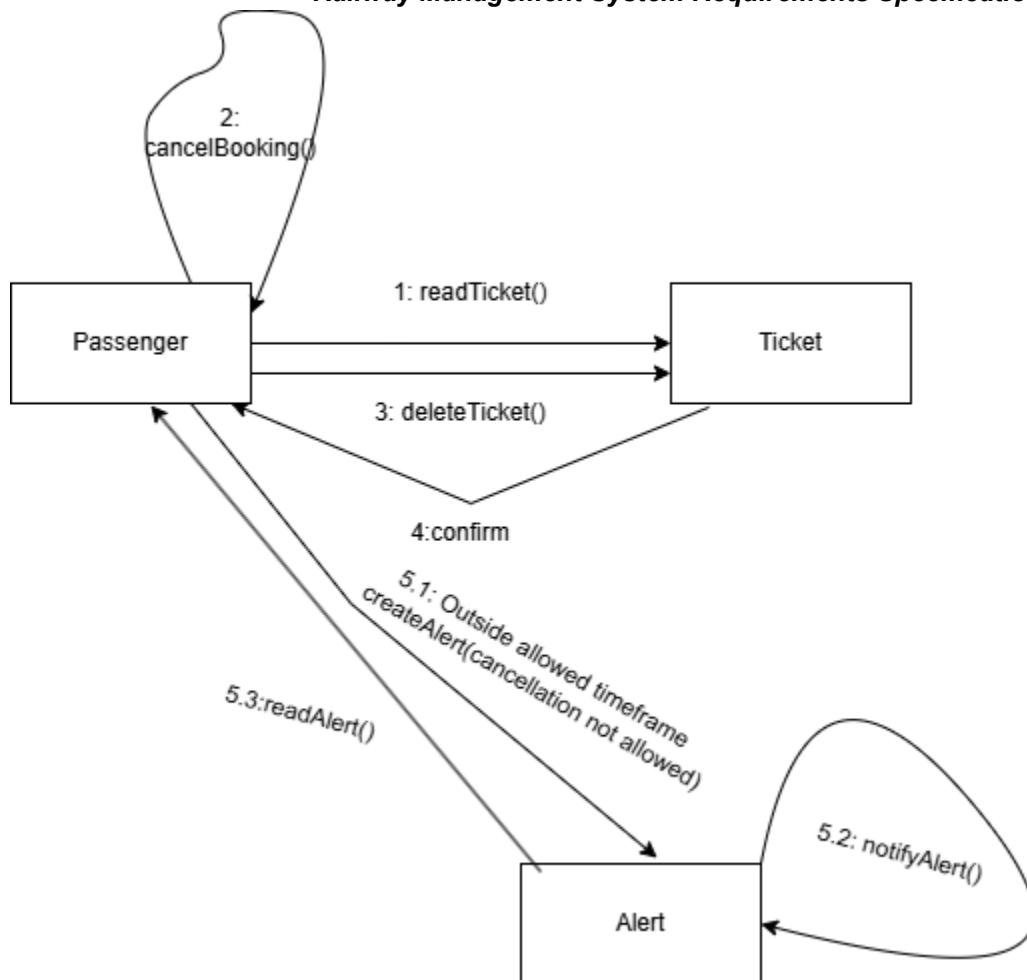
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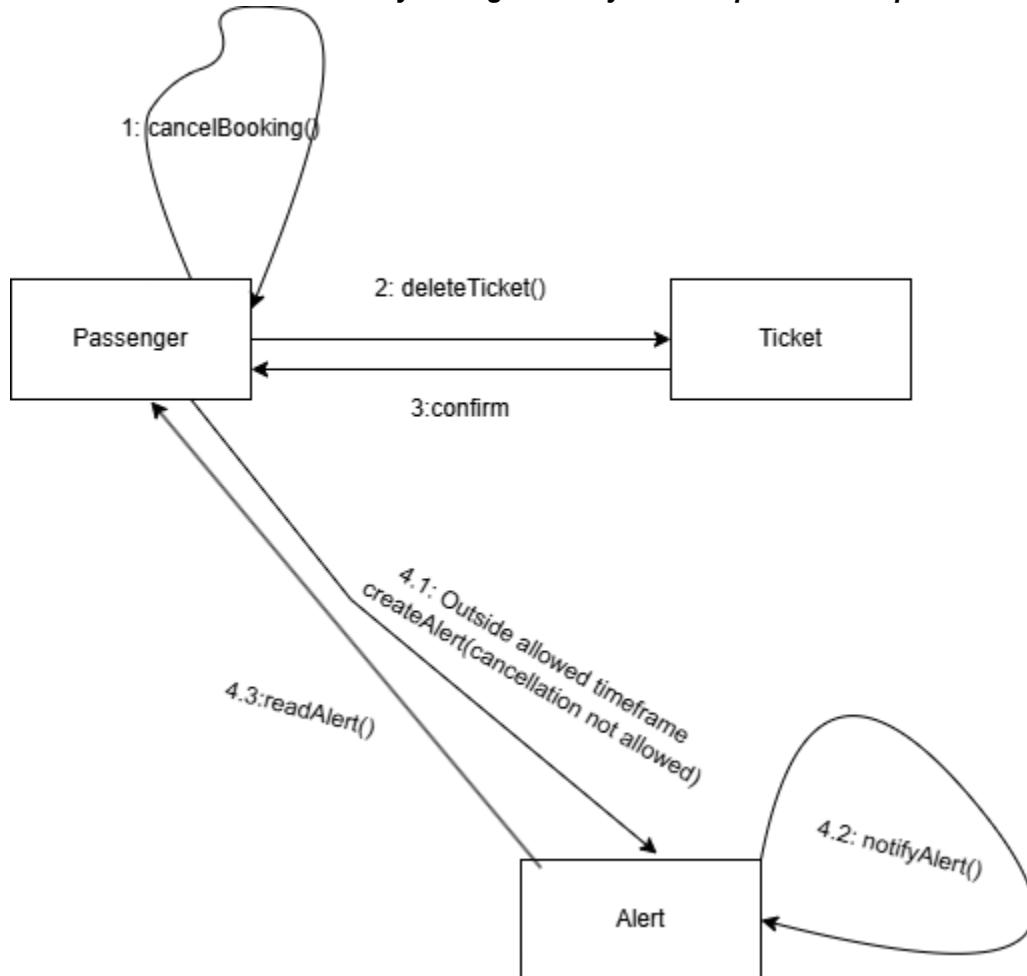
Railway Management System Requirements Specification



Railway Management System Requirements Specification



Railway Management System Requirements Specification



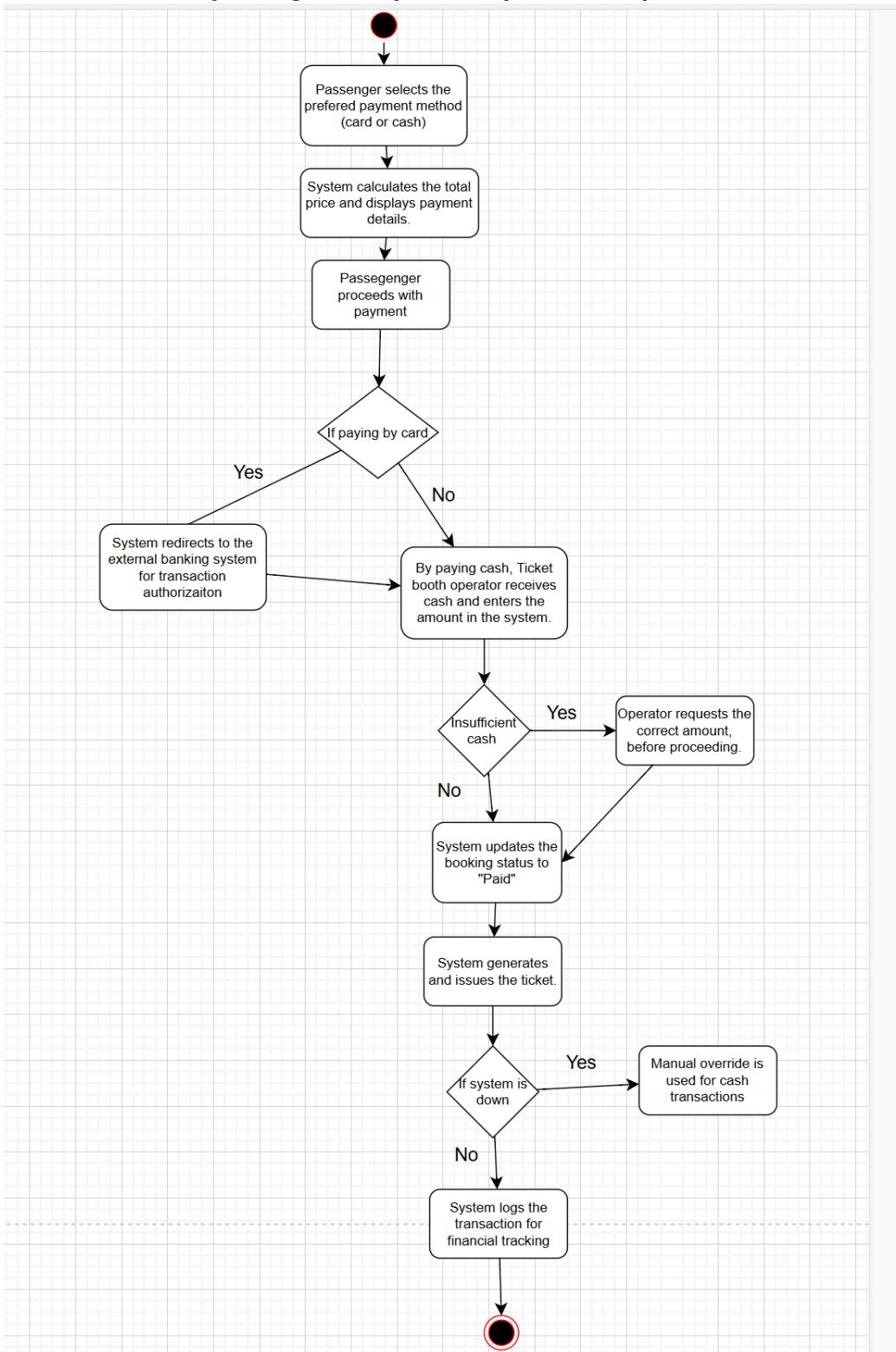
UC Name	<u>S PAY 19 – Process Ticket Payment</u>
Summary	The system processes ticket payments made by passengers using card or cash at ticket booths to confirm bookings and issue valid tickets.
Dependency	<ul style="list-style-type: none"> P_TKT_17 – Book Ticket (Payment is required to complete the booking). S_FIN_35 – Track Expenses and Profit (Payments contribute to financial tracking).
Actors	<ul style="list-style-type: none"> Primary Actor: Passenger (P) – Initiates the payment process. Secondary Actors: <ul style="list-style-type: none"> System (S): Verifies payment, processes the transaction, and confirms booking. Ticket Booth Operator (E) Banking System (External): Processes card transactions.
Preconditions	<ul style="list-style-type: none"> → The passenger has a valid ticket reservation. → The system is connected to the payment processing service.
Description of the Main	<ul style="list-style-type: none"> 1. Passenger selects the preferred payment method (card or cash). 2. System calculates the total price and displays payment details.

Railway Management System Requirements Specification

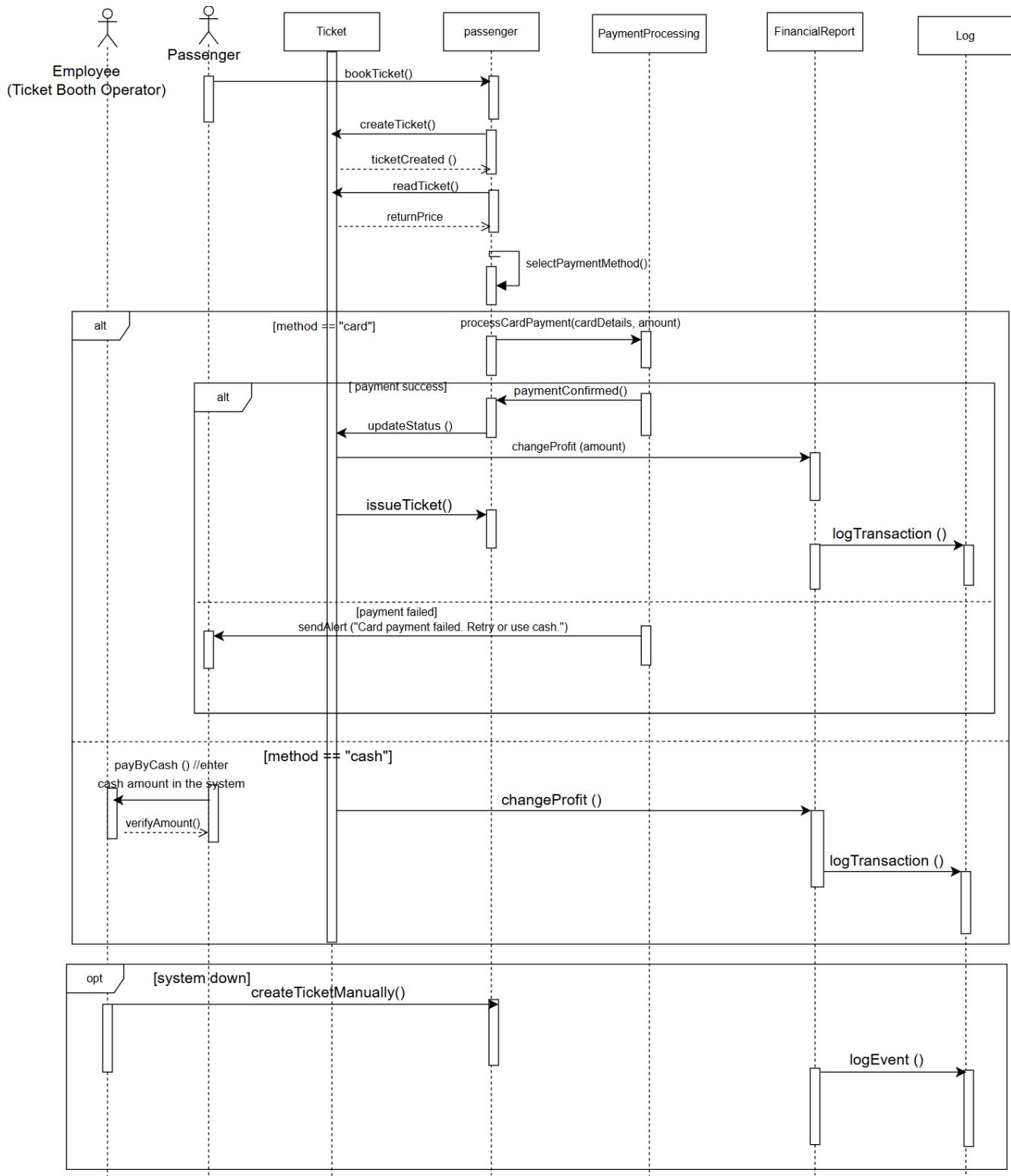
Sequence	<ul style="list-style-type: none"> ● 3. Passenger proceeds with payment: If paying by card: System redirects to the external banking system for transaction authorization. If paying by cash: Ticket Booth Operator receives the cash and enters the amount into the system. System verifies the amount and confirms payment. ● 4. System updates the booking status to "Paid." ● 5. System generates and issues the ticket (digital or printed) ● 6. System logs the transaction for financial tracking.
Description of the Alternative Sequence	<ul style="list-style-type: none"> ● 1.If card payment fails: System notifies the passenger and prompts them to retry or choose another payment method. ● 2.If insufficient cash is provided: Ticket Booth Operator requests the correct amount before proceeding. ● 3.If system is down: Manual override is used for cash transactions, with records updated later.
Non functional requirements	<p>→ Performance: Transaction processing should take no more than 5 seconds for card payments.</p> <p>→ Security: Card payments must be secure and encrypted to protect passenger information.</p> <p>→ Reliability: System should have 99.9% uptime for payment processing</p>
Postconditions	<ul style="list-style-type: none"> ❖ The passenger receives a valid ticket upon successful payment. ❖ The system updates booking records and logs the transaction. ❖ Failed payments trigger appropriate error messages and retries.

UC 21: S PAY 19 – Process Ticket Payment

Railway Management System Requirements Specification

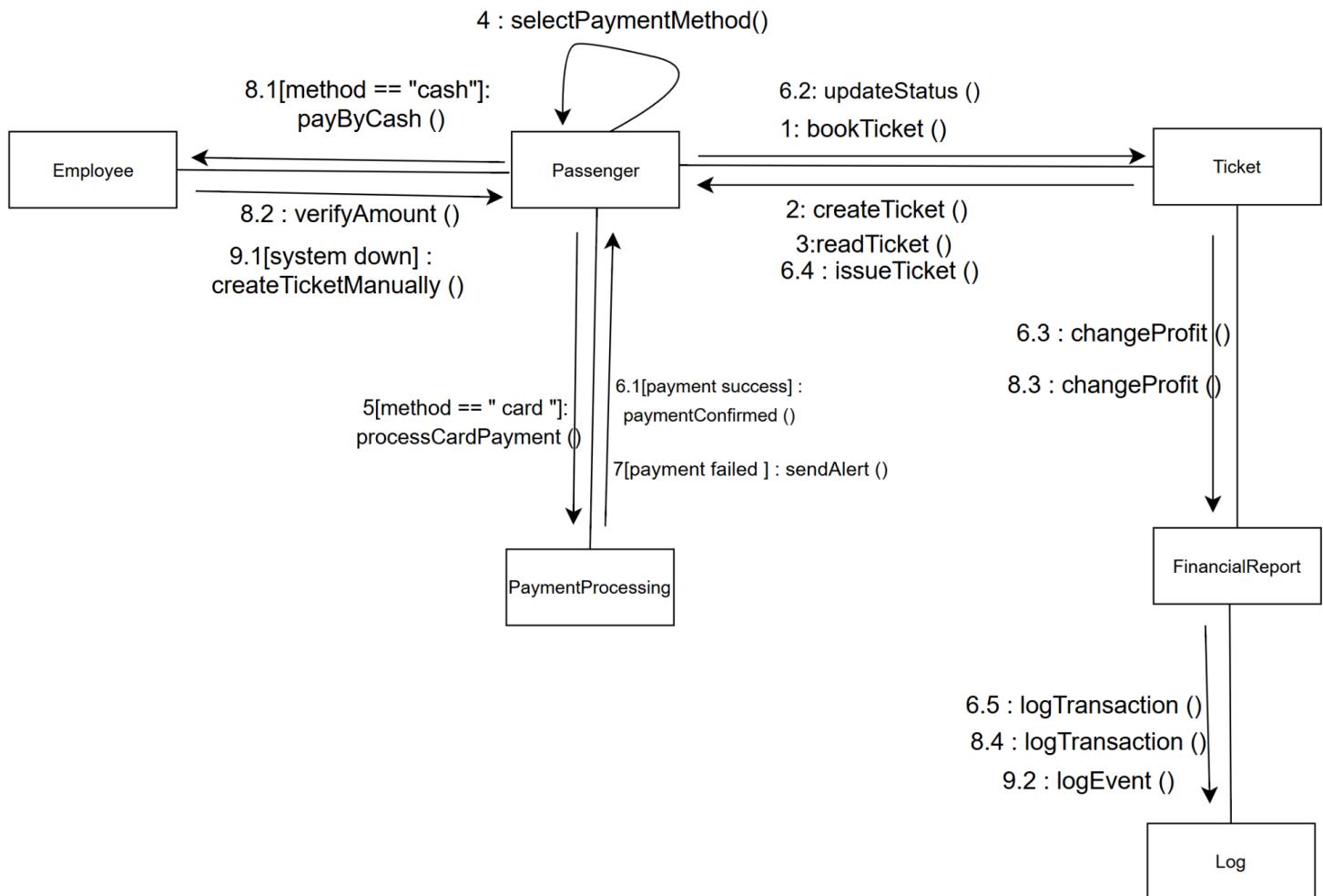


Railway Management System Requirements Specification
Sequence diagram : S PAY 19 – Process Ticket Payment



Collaboration diagram

Railway Management System Requirements Specification



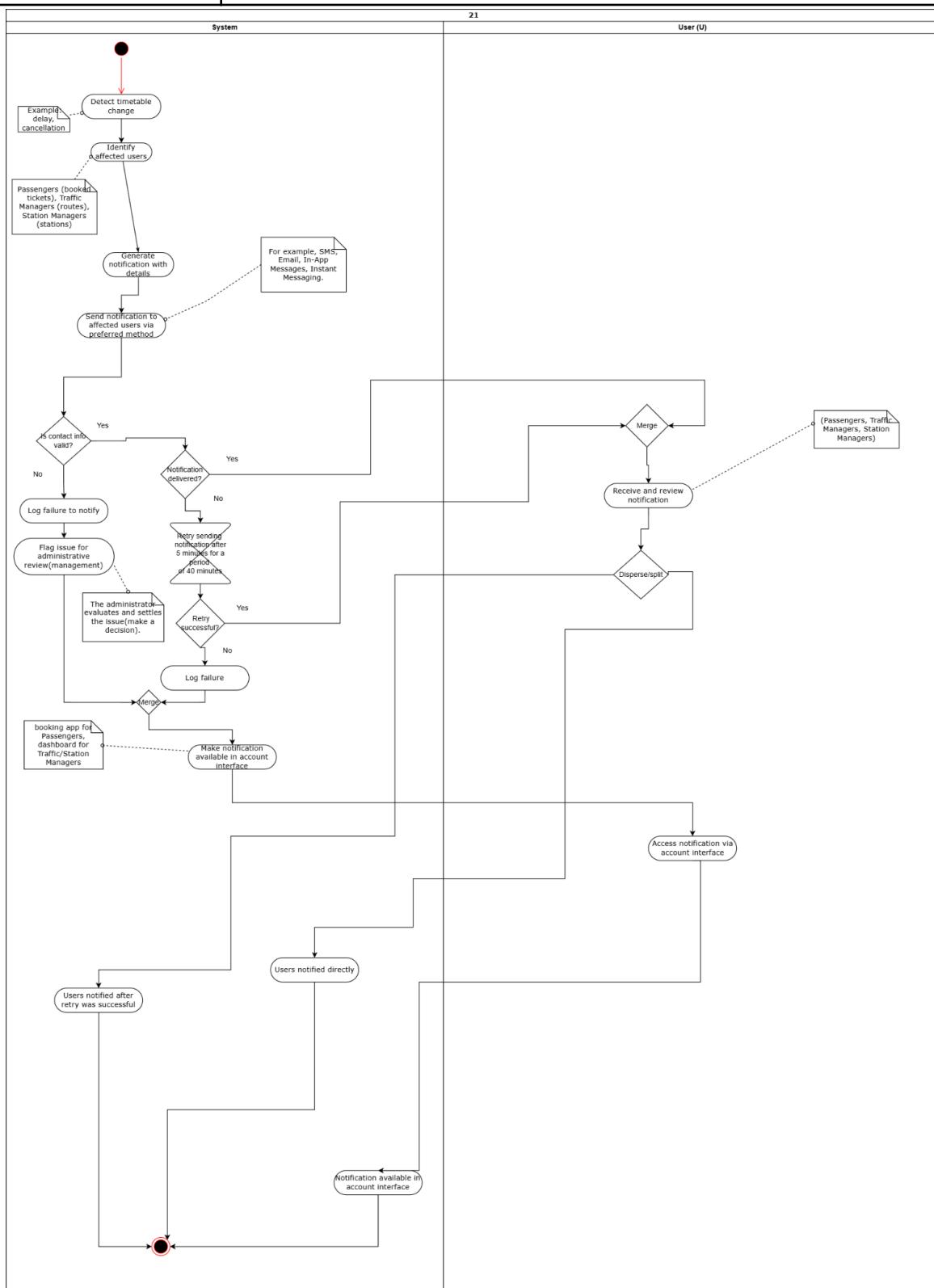
Railway Management System Requirements Specification

UC Name	<u>S_NOT_20 - System Notifies Users of Timetable Changes</u>
Summary	Details on how the system notifies all relevant users (e.g., Passengers, Traffic Managers, Station Managers) about changes in the train timetable based on their jurisdiction.
Dependency	<ul style="list-style-type: none"> • <i>S_SCH_06 (system maintaining updated train schedules)</i>
Actors	<ul style="list-style-type: none"> • Primary Actor: System (S) • Secondary Actor: User (U) -> (includes Passengers (P), Traffic Managers (TM), Station Managers (SM))
Preconditions	<ul style="list-style-type: none"> ➔ A change in the train timetable (e.g., delay, cancellation) has been recorded in the system. ➔ Users have provided contact preferences (e.g., email, SMS, in-app notifications). ➔ User jurisdiction data is up-to-date.
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ 1. The system detects a timetable change (e.g., a delay or cancellation). ❖ 2. The system identifies all affected users based on their jurisdiction or booked tickets. ❖ 3. The system generates a notification with details of the change (e.g., new time, reason). ❖ 4. The system sends the notification to affected users via their preferred method(e.g., SMS,Email,In-app notification) ❖ 5. Users receive and review the notification.
Description of the Alternative Sequence	<ul style="list-style-type: none"> ❖ 1 . If a user's contact information is invalid or missing, the system logs the failure to notify. ❖ 2. The system flags the issue for (administrative) review. ❖ 3. The notification is made available in the user's account as a backup(The notification is a backup plan, if the first method fails {is missed or unavailable}).
Non functional requirements	<ul style="list-style-type: none"> ➔ Performance: Notifications must be sent within 1 minute of the timetable change. ➔ Reliability: The system must ensure high delivery success for notifications. ➔ Security: Notification data must be encrypted in transit.

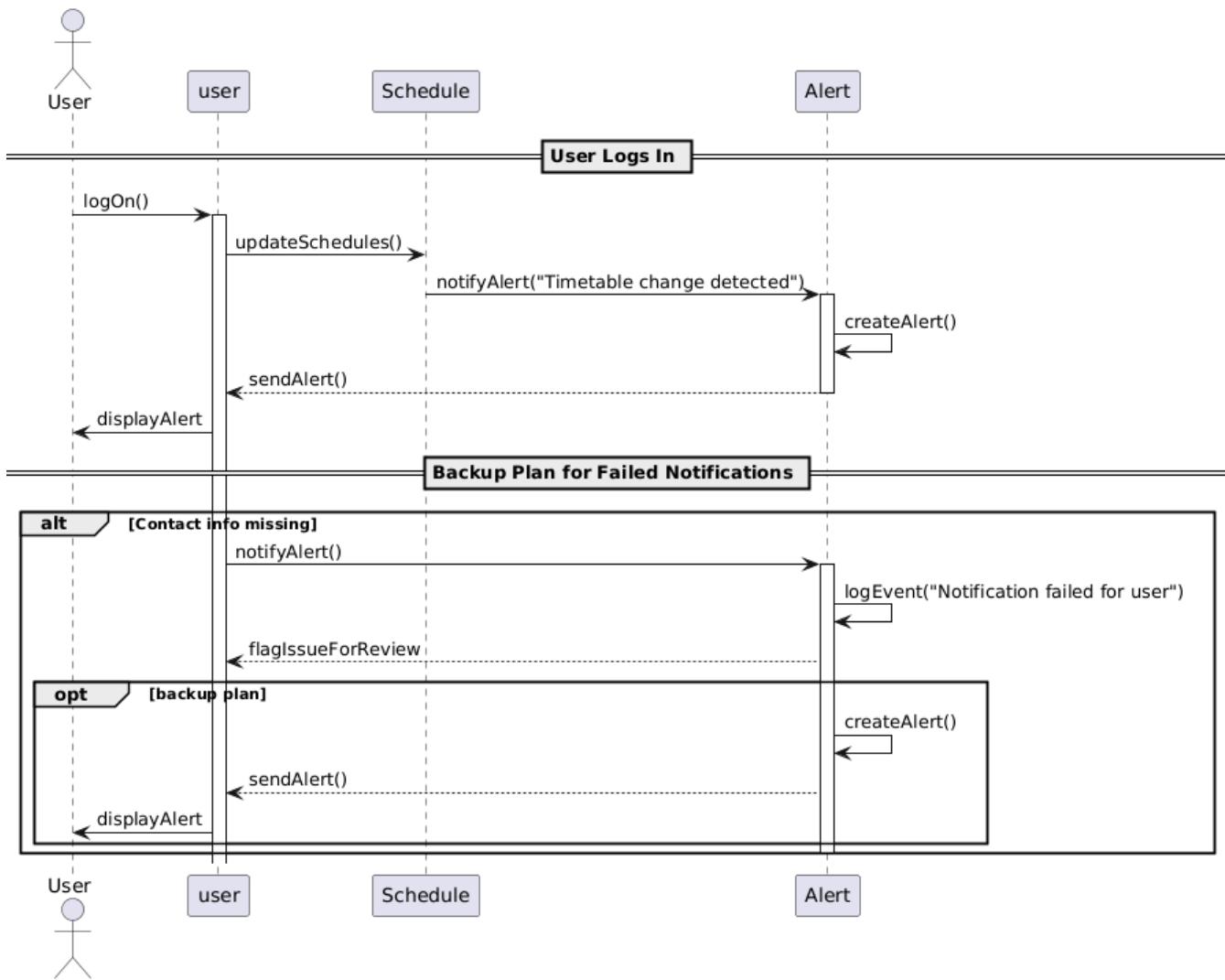
Railway Management System Requirements Specification

Postconditions

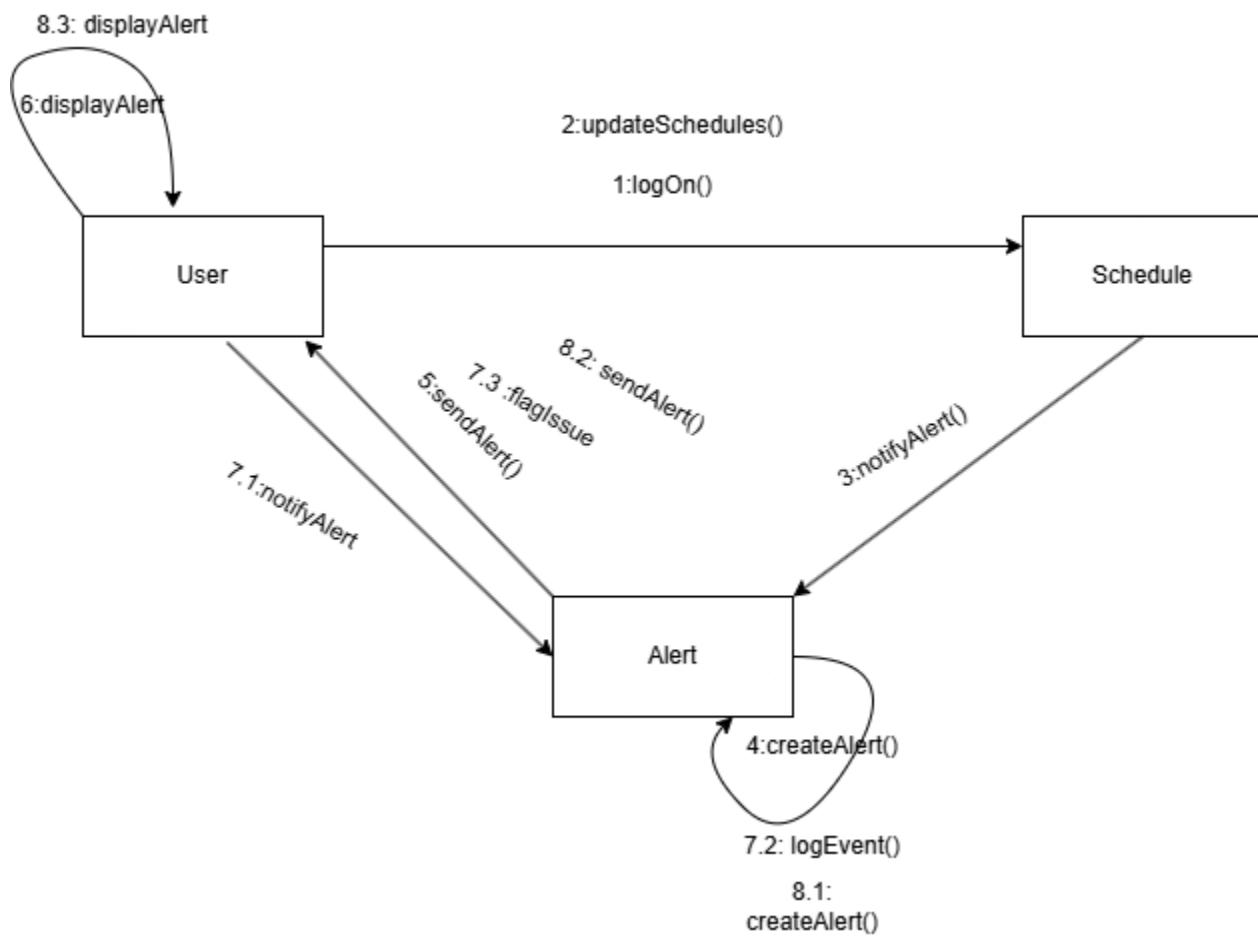
❖ All relevant users have been notified of the timetable change.



Railway Management System Requirements Specification



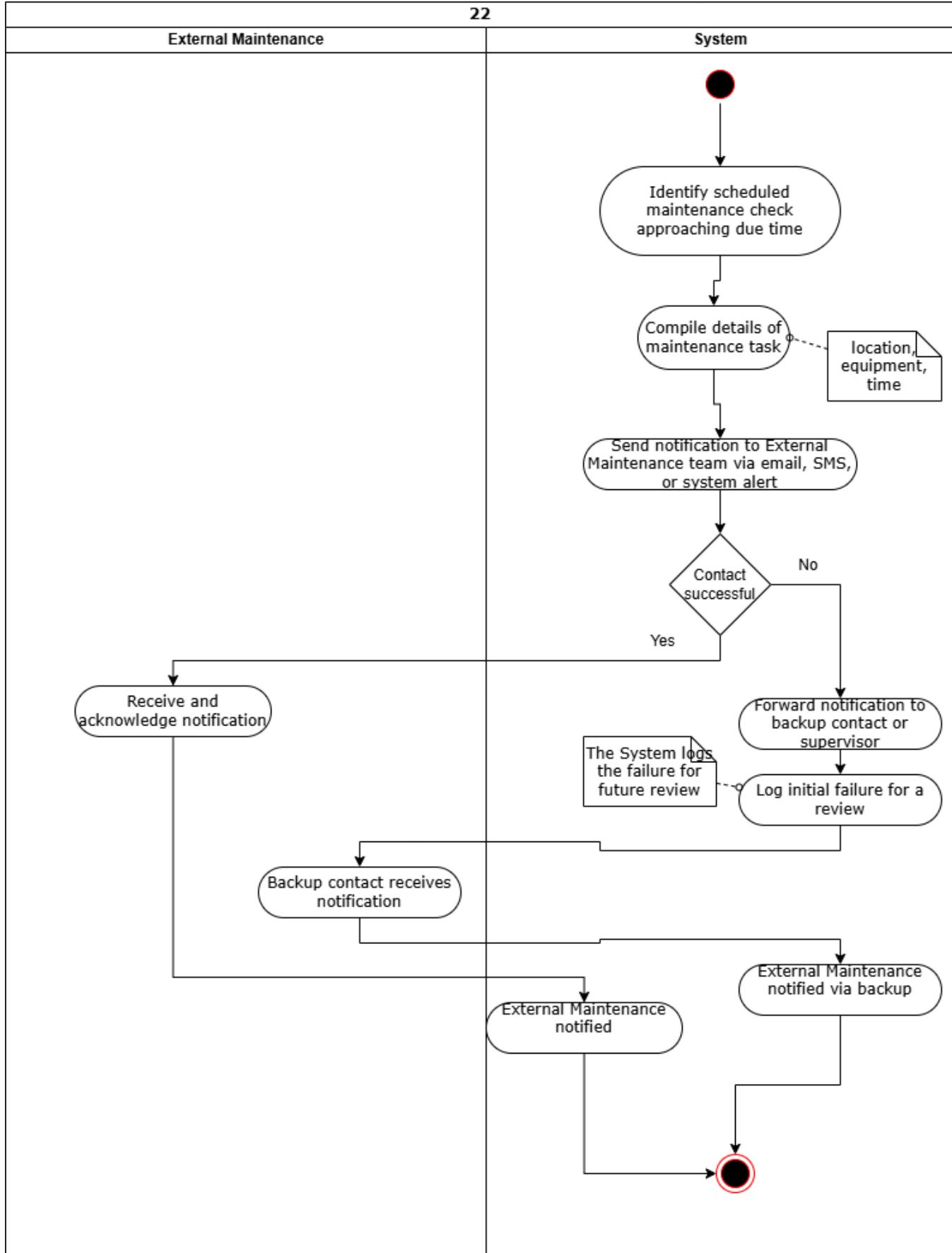
Railway Management System Requirements Specification



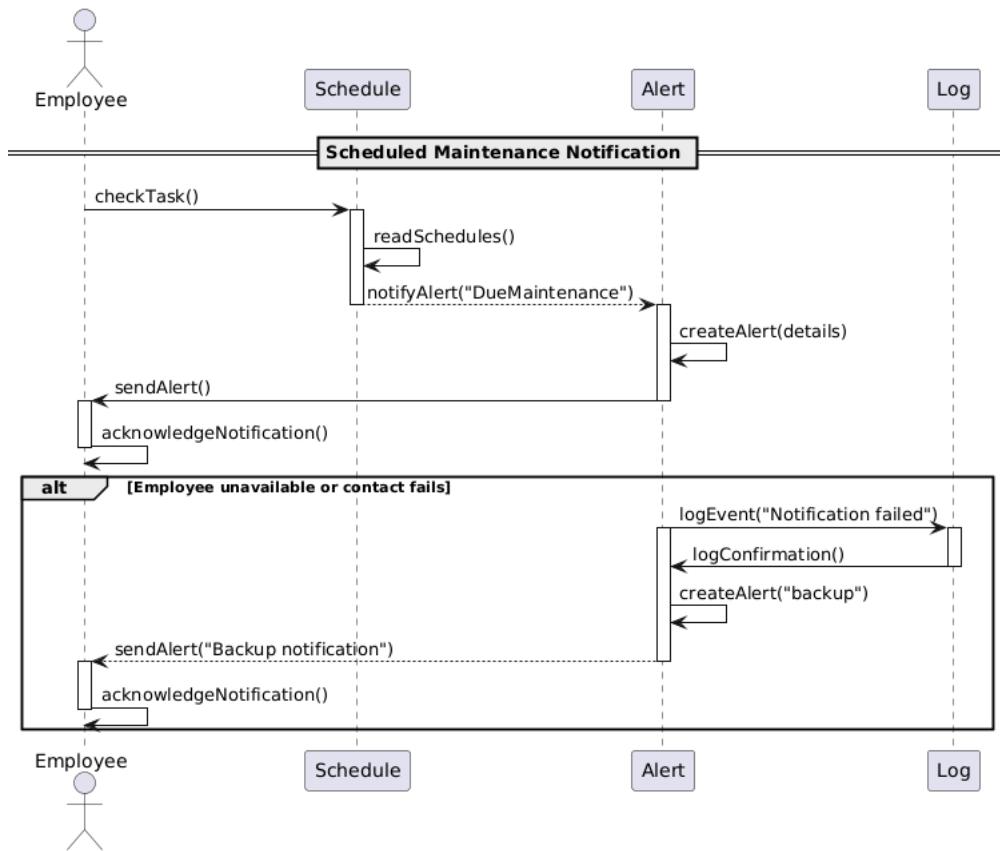
UC Name	<u>S NOT 21 - System Notifies Employees of Scheduled Checks</u>
Summary	How the system notifies maintenance employees about scheduled maintenance checks for trains, tracks, or stations.
Dependency	<ul style="list-style-type: none"> • <i>S_TRK_05 (train car availability and condition)</i> • <i>S_SCH_06 (scheduling).</i>
Actors	<ul style="list-style-type: none"> • Primary Actor: System (S) • Secondary Actor: Employee (E)
Preconditions	<ul style="list-style-type: none"> → A maintenance check has been scheduled in the system. → Contact information for maintenance employees is available.

Railway Management System Requirements Specification

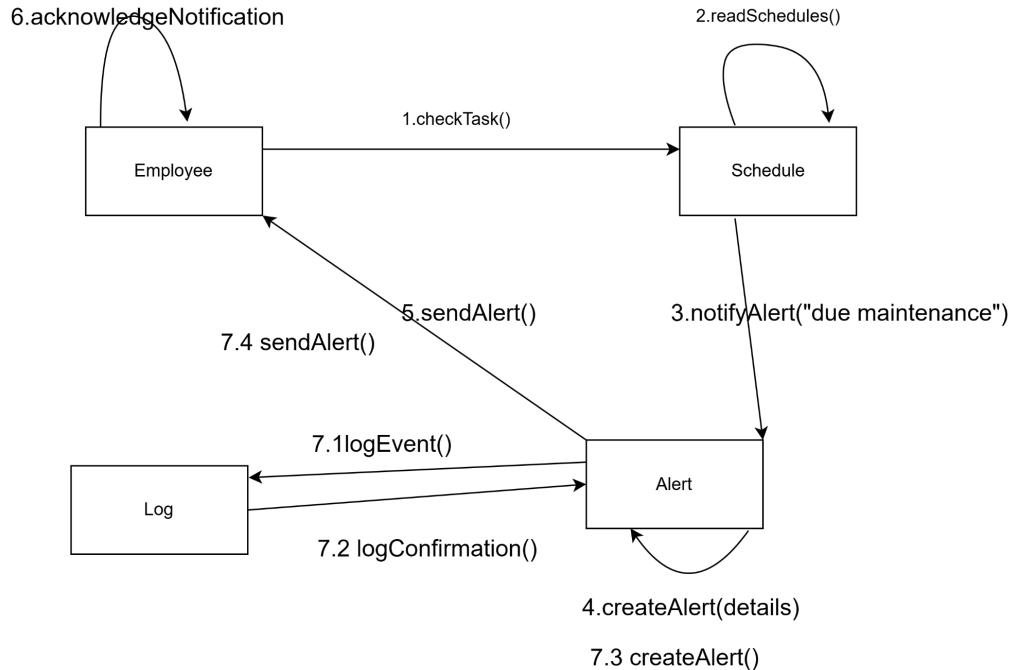
	<p>→ The system has up-to-date maintenance schedules.</p>
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ 1. The system identifies a scheduled maintenance check approaching its due time. ❖ 2. The system compiles details of the maintenance task (e.g., location, equipment, time). ❖ 3. The system sends a notification to the designated employee via email, SMS, or system alert. ❖ 4. The maintenance employee receives and acknowledges the notification.
Description of the Alternative Sequence	<ul style="list-style-type: none"> ❖ 1 . If the employee is unavailable or contact fails, the system escalates the notification to a backup contact or supervisor. ❖ 2. The system logs the initial failure for review. ❖ 3. The backup contact receives the notification and acknowledges the notification
Non functional requirements	<p>→ Performance: <i>Notifications must be sent at least 24 hours before the scheduled maintenance, with real-time delivery within 1 minute of generation.</i></p> <p>→ Security: <i>Maintenance schedules and notifications must be encrypted.</i></p> <p>→ Reliability: <i>The system must ensure high notification delivery for critical maintenance tasks.</i></p>
Postconditions	<ul style="list-style-type: none"> ❖ The designated employee (or their backup contact) have been notified and acknowledged the scheduled maintenance check.



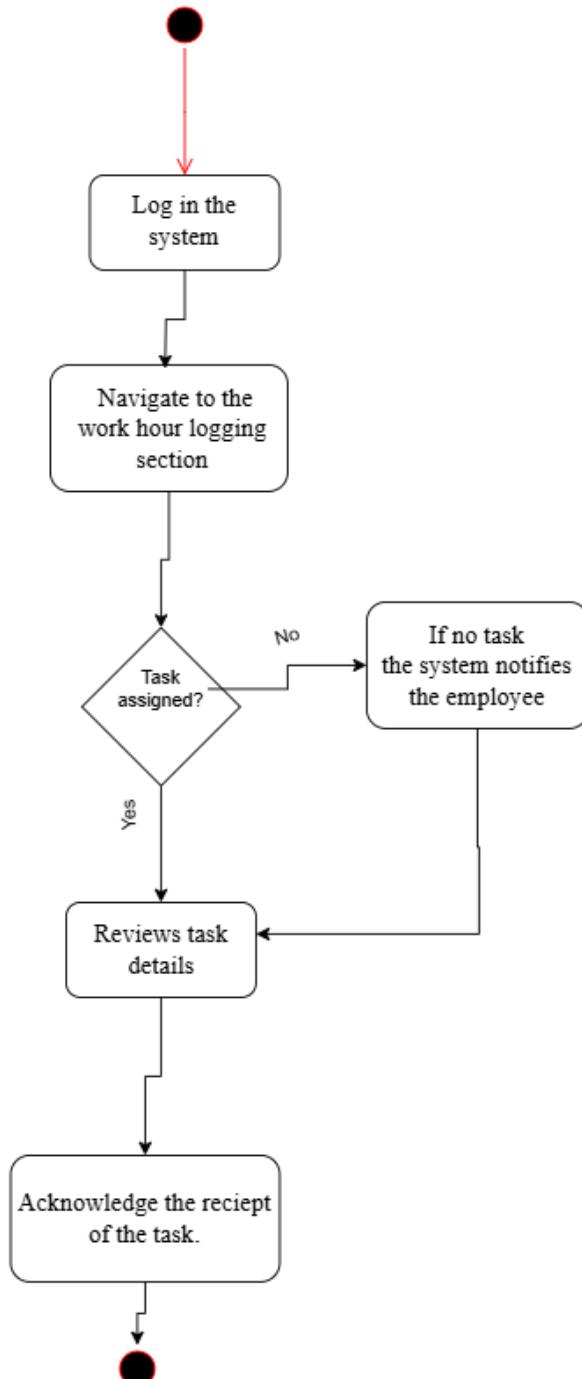
Railway Management System Requirements Specification



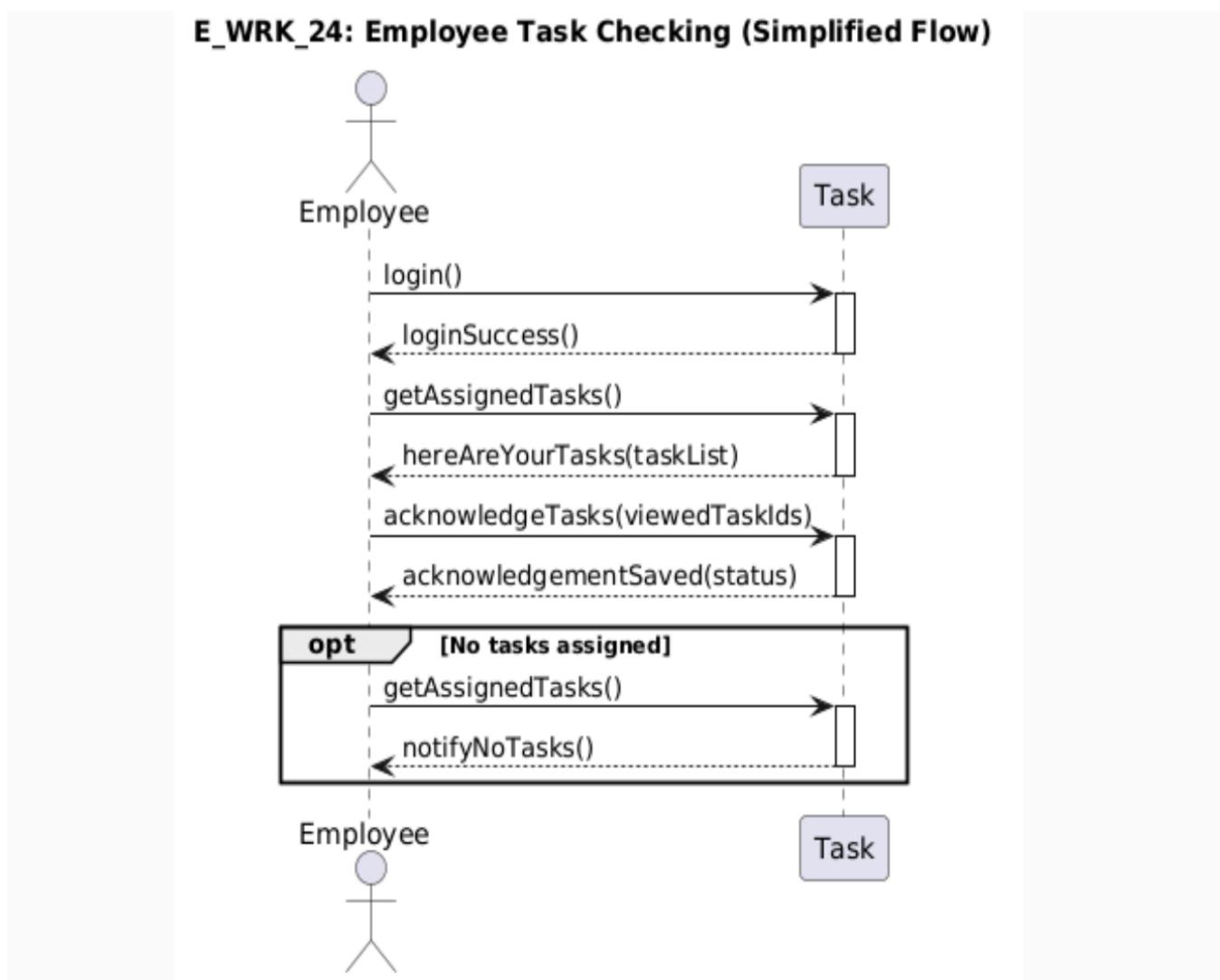
7.5.acknowledgeNotification



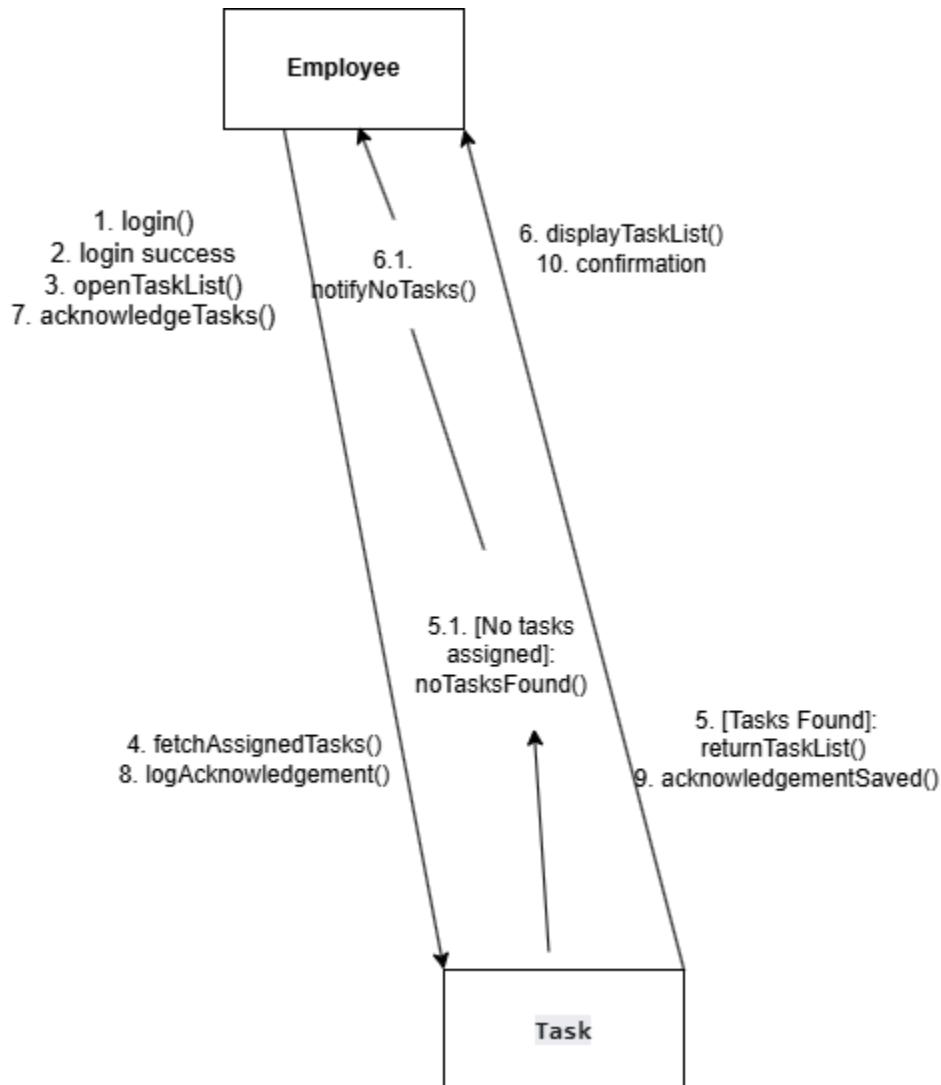
UC Name	E WRK 22 – Employee Task Checking
Summary	Employees must be able to check specific tasks assigned to them by the Station Manager.
Dependency	• SM_WRK_25 (Station Managers Assign Tasks) → Tasks must be assigned before employees can check them.
Actors	<ul style="list-style-type: none"> • Primary Actor: Employee (E) • Secondary Actor: System (S)
Preconditions	<p>→ <i>The employee must have valid credentials to access the system.</i></p> <p>→ <i>The Station Manager must have assigned tasks to employees.</i></p>
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ • Step 1: The employee logs into the system. ❖ • Step 2: The employee navigates to the task list section. ❖ • Step 3: The system displays assigned tasks. ❖ • Step 4: The employee reviews task details (e.g., deadline, priority). ❖ • Step 5: The employee acknowledges receipt of the task.
Description of the Alternative Sequence	<ul style="list-style-type: none"> ❖ • Step 1: If no tasks are assigned, the system notifies the employee.
Non functional requirements	<p>→ Responsiveness: Task lists must load quickly.</p> <p>→ Security: Only authorized employees can access their tasks.</p>
Postconditions	<ul style="list-style-type: none"> ❖ • The employee is aware of assigned tasks.



Sequence Diagram

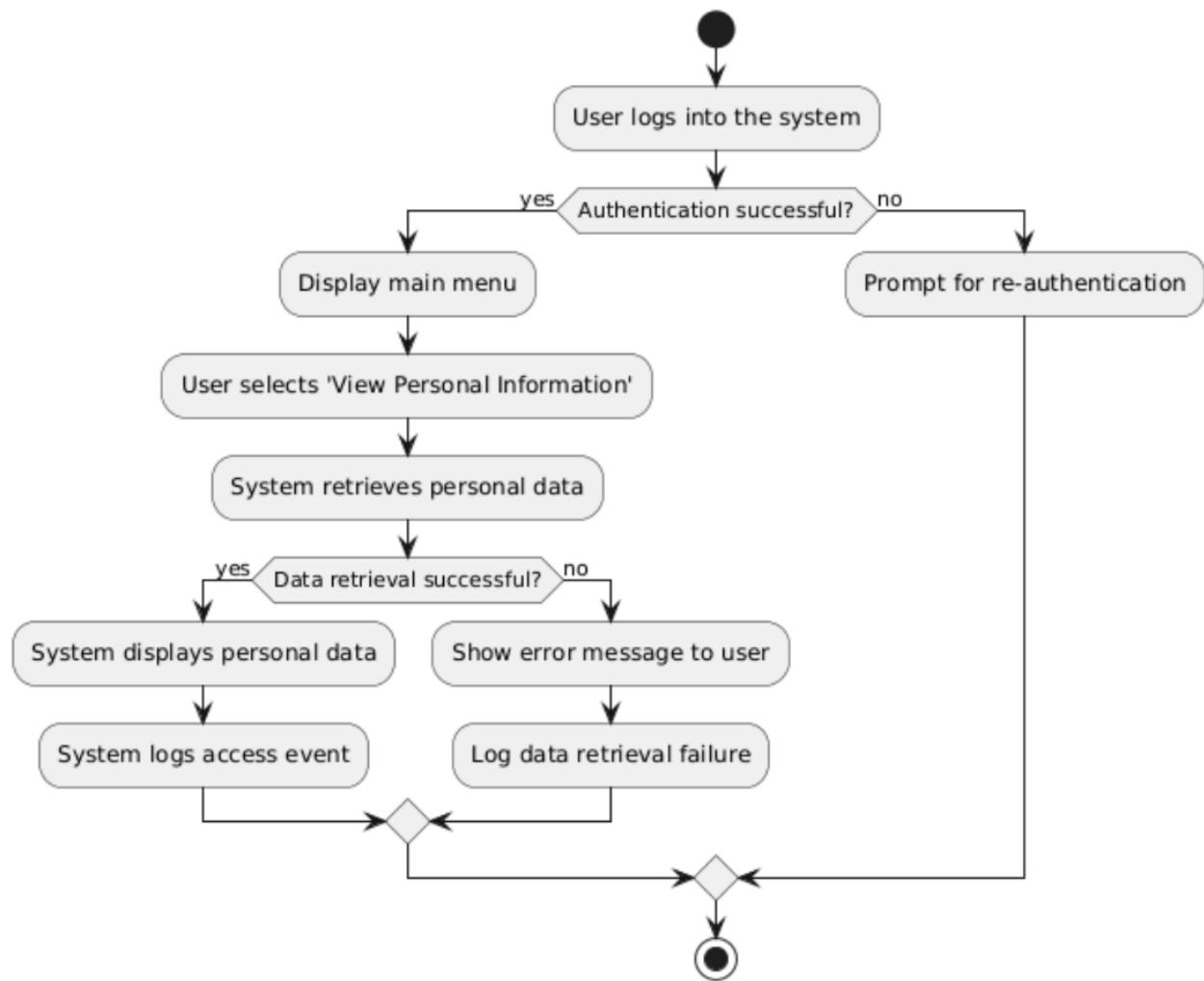


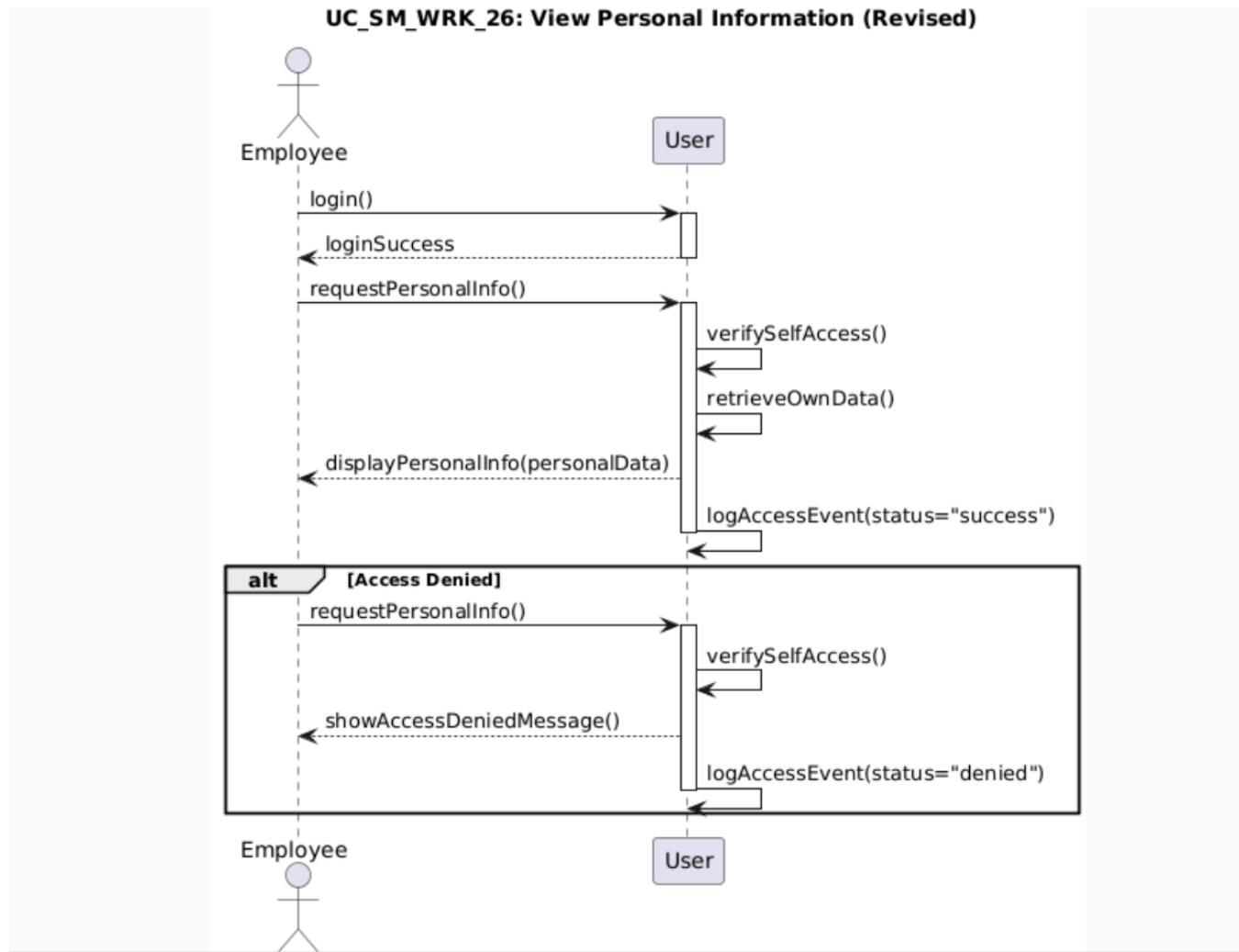
Collaboration Diagram: E_WRK_22 – Employee Task Checking



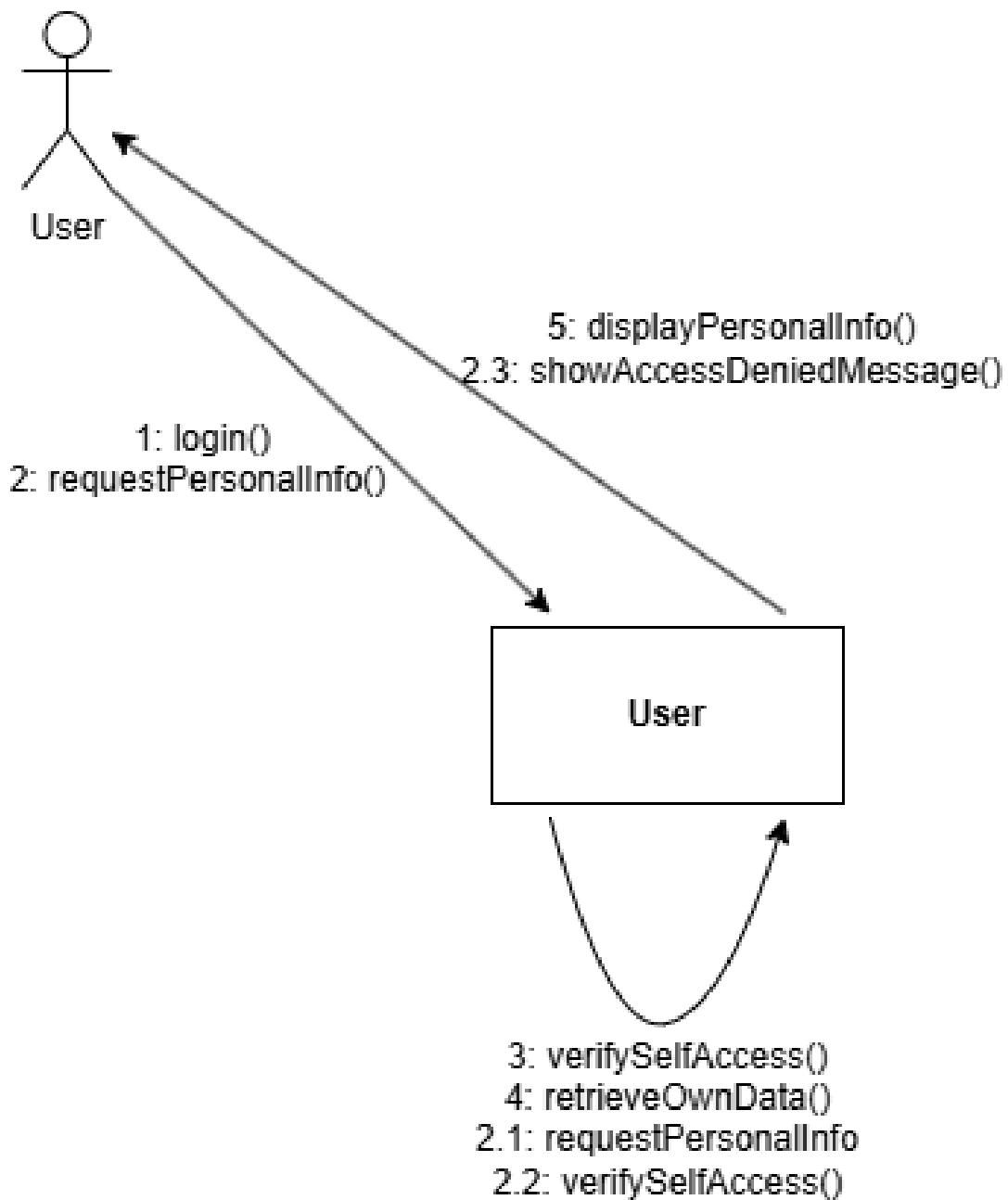
UC Name	<u>UC_SM_WRK_23 – View Personal Information</u>
Summary	All users must be able to access and view their personal information within the system, ensuring transparency, accuracy, and data control.
Dependency	<ul style="list-style-type: none"> - S_PER_08 (Passenger Info Management) - U_AUTH_34 (Login/Logout Functionality) - S_LOG_38 (System Operation Logging)
Actors	<ul style="list-style-type: none"> ● Primary: User (U) – includes P, E, SM, TM, M, A ● Secondary: System (S)
Preconditions	<ul style="list-style-type: none"> - <i>User must be authenticated (logged in).</i> - <i>User's personal information must be available in the system.</i>
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ 1. User logs in. ❖ 2. User selects “View Personal Information.” ❖ 3. System retrieves personal data. ❖ 4. System displays data. ❖ 5. System logs access.
Description of the Alternative Sequence	<ul style="list-style-type: none"> ❖ 1. Invalid session → System prompts re-login. ❖ 2. Data retrieval fails → System shows error and logs it. ❖ 3. Unauthorized access → Blocked and Admin alerted.
Non functional requirements	<ul style="list-style-type: none"> - Security (authenticated access only) - Privacy (only self-access) - Availability (always accessible while logged in) - Auditability (log each access)
Postconditions	<ul style="list-style-type: none"> ❖ - Personal info is shown to the user. ❖ - Access is securely logged. ❖ - Data privacy and integrity are preserved.

Railway Management System Requirements Specification
Activity Diagram - View Personal Information



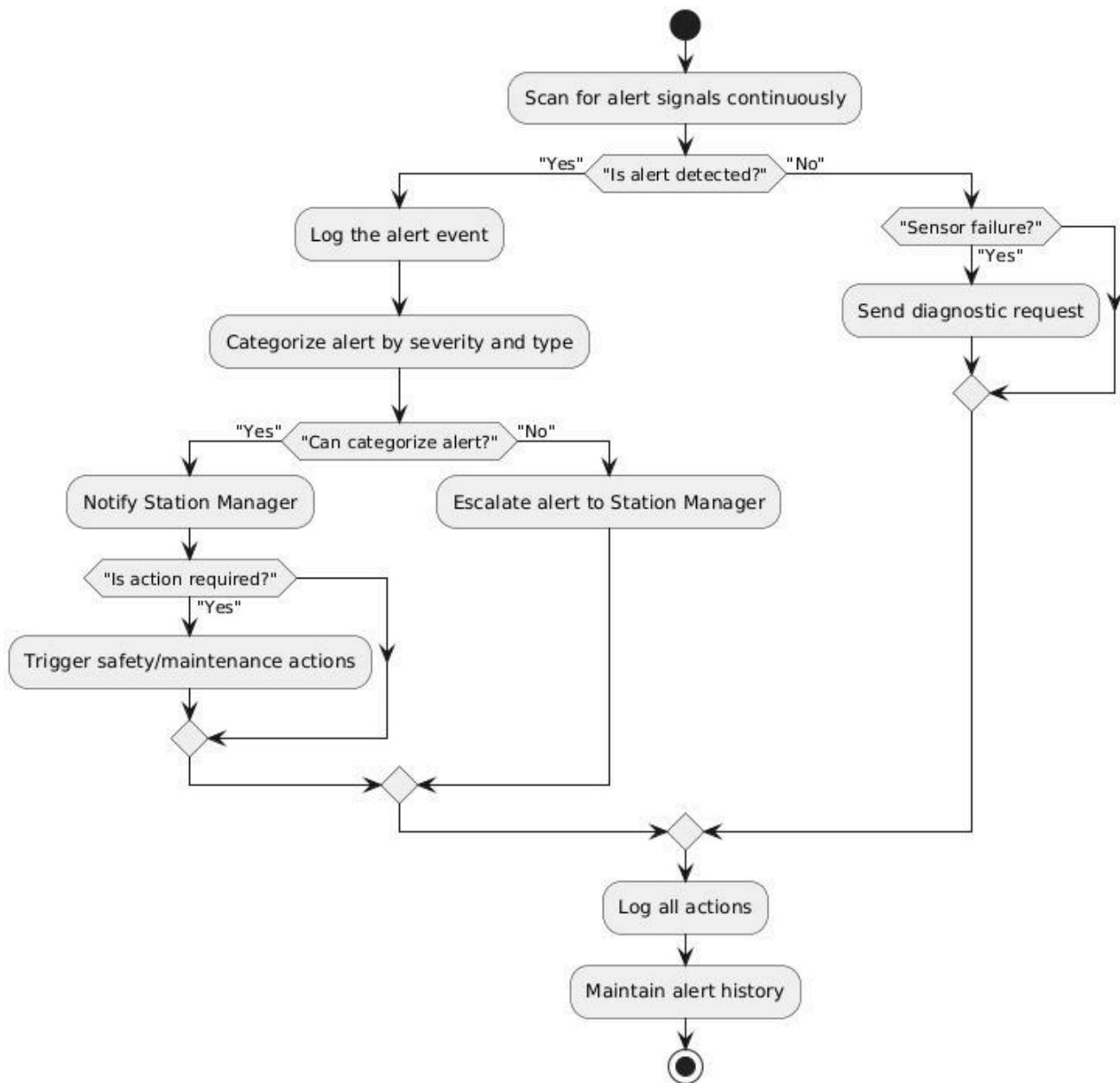


UC_SM_WRK_23 – View Personal Information

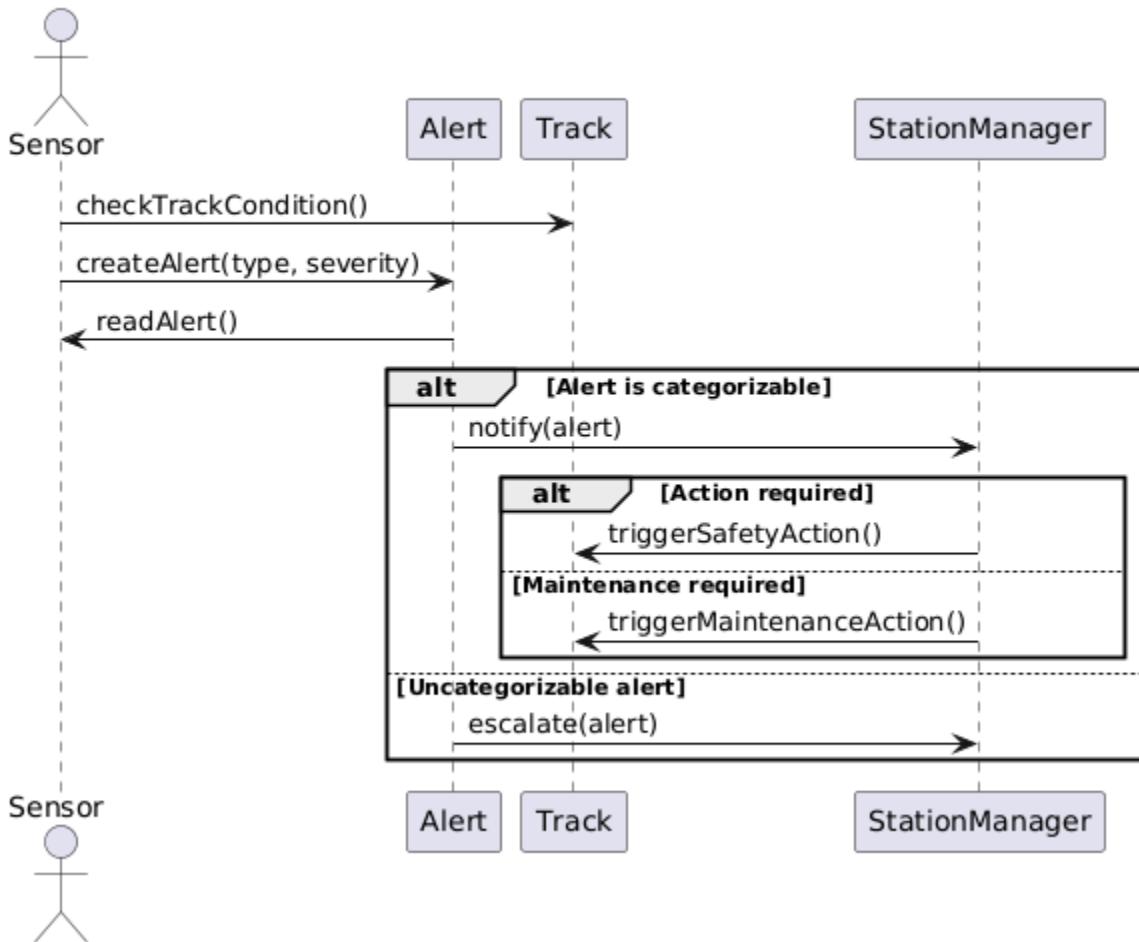


UC Name	S_ALR_24 – Detect Alert Sensors in Railways, Trains, and Stations
Summary	All users must be able to see their personal information
Dependency	S_SAF_12 (Railway Safety Monitoring) → Alerts must be detected for safety measures. S_MNT_09 (Maintenance Alert System) → Alerts must trigger maintenance actions if needed.
Actors	<ul style="list-style-type: none"> • Primary Actor: System (S) • Secondary Actor: Station Manager (SM), Employee (WRK)
Preconditions	<ul style="list-style-type: none"> ➔ The system must be connected to all relevant alert sensors. ➔ The Station Manager and Employees must have appropriate access rights.
Description of the Main Sequence	<ol style="list-style-type: none"> 1. The system continuously scans for alert signals from sensors. 2. When an alert is detected, the system logs the event. 3. The system categorizes the alert based on severity and type. 4. The Station Manager is notified immediately. 5. If required, the system triggers automated safety or maintenance actions.
Description of the Alternative Sequence	<ol style="list-style-type: none"> 1. If an alert sensor fails, the system sends a diagnostic request. 2. If the system cannot categorize an alert, it escalates the issue to the Station Manager.
Non-functional Requirements	<ul style="list-style-type: none"> ➔ Real-time Alerts: Alerts must be detected and reported immediately. ➔ Reliability: The system must operate continuously without failure. ➔ Security: Only authorized personnel can access or modify alert settings. ➔ Audit Logging: All detected alerts and responses must be logged
Postconditions	<ul style="list-style-type: none"> ✓ The system maintains an up-to-date record of all detected alerts. ✓ The system ensures safety by promptly notifying responsible personnel and triggering automated responses when necessary.

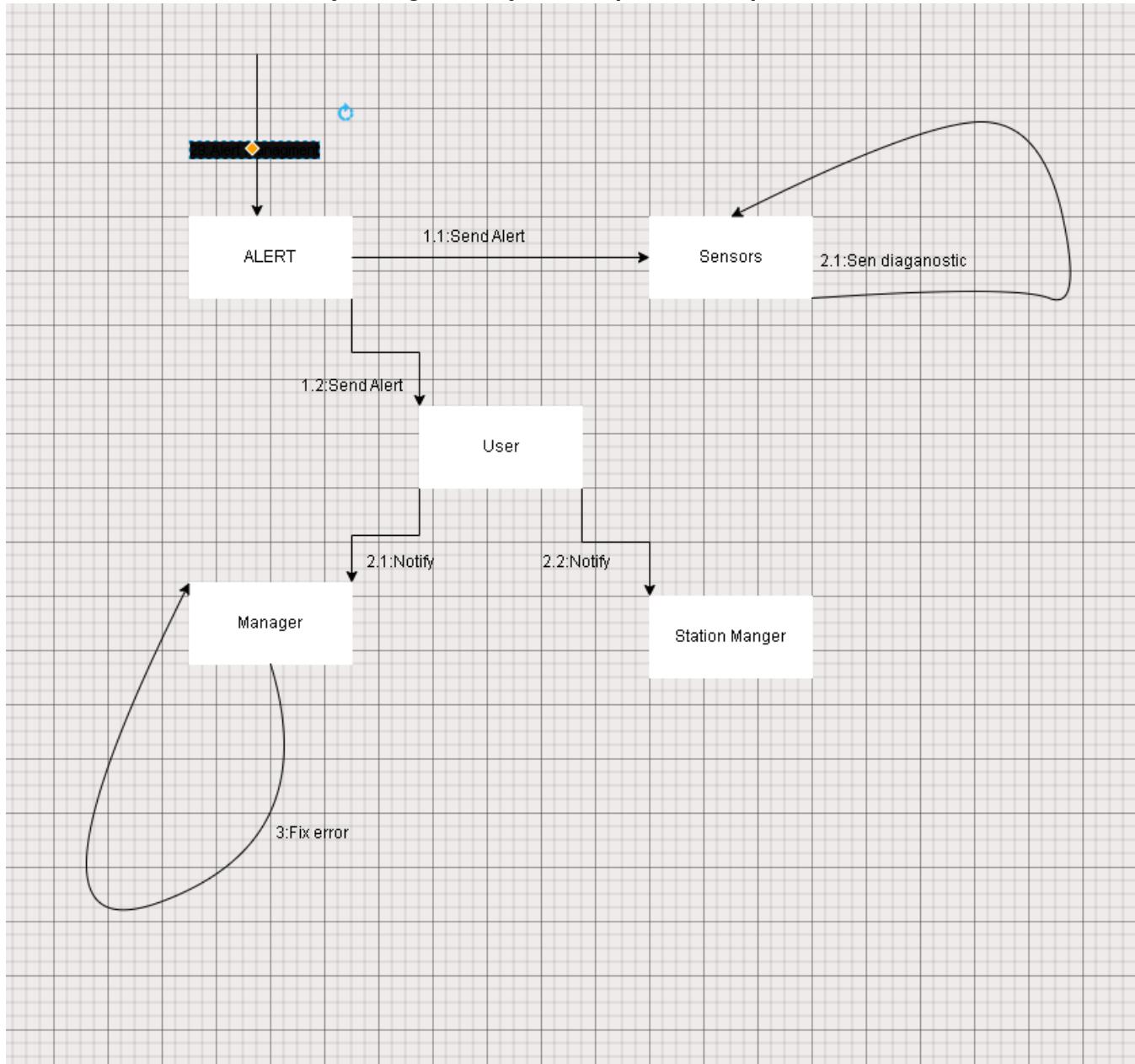
Railway Management System Requirements Specification



Alert Creation from Sensor



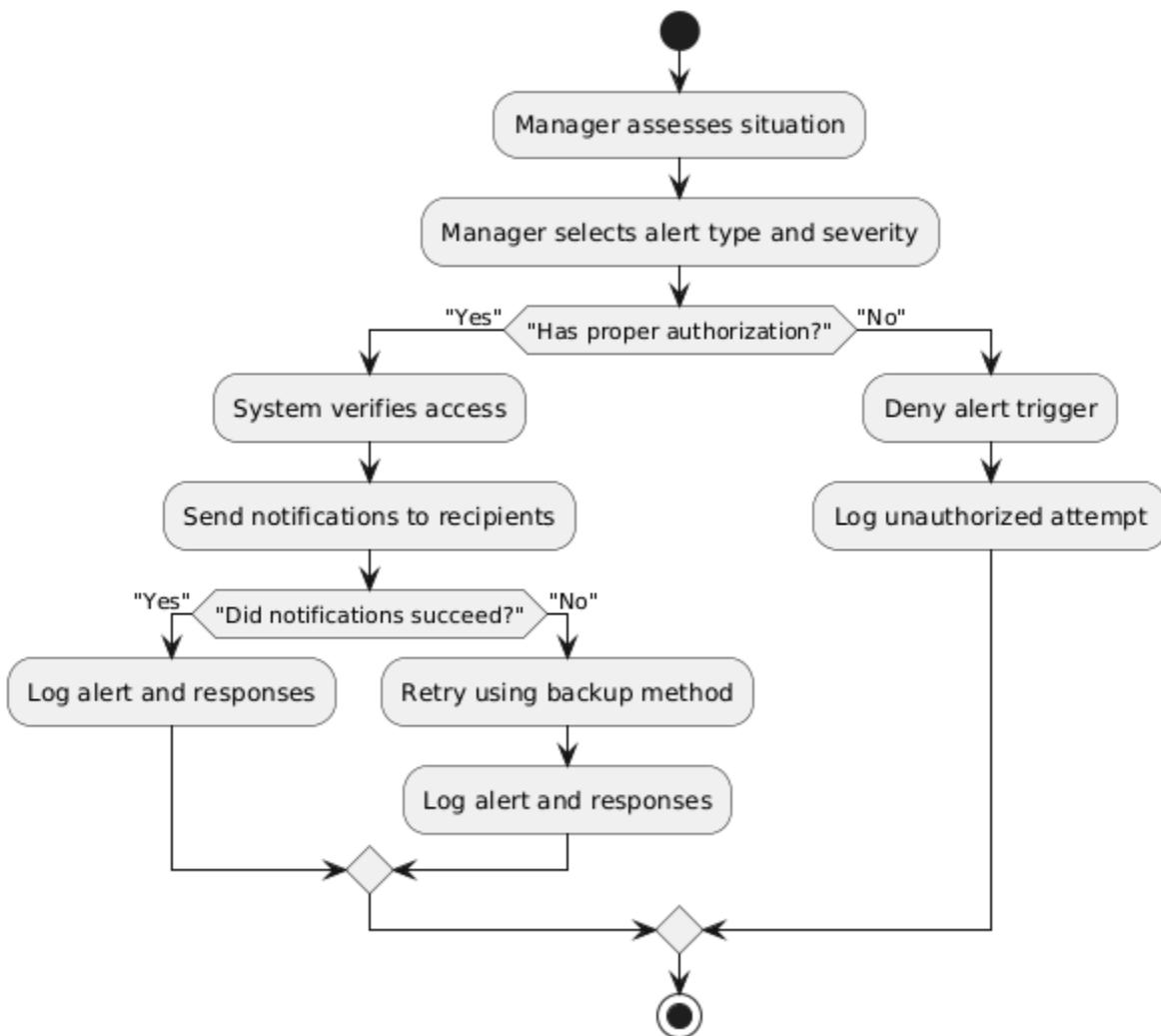
Railway Management System Requirements Specification



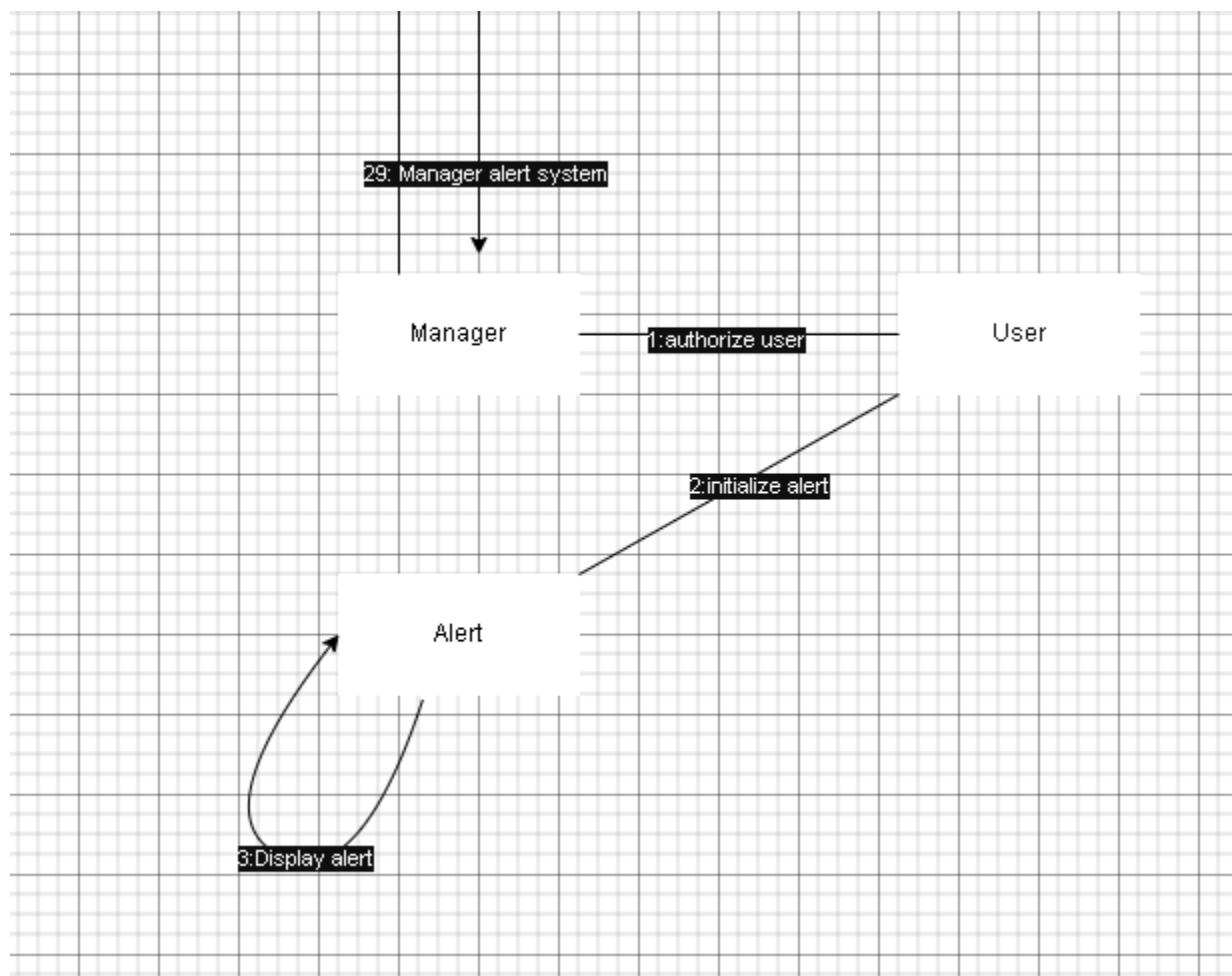
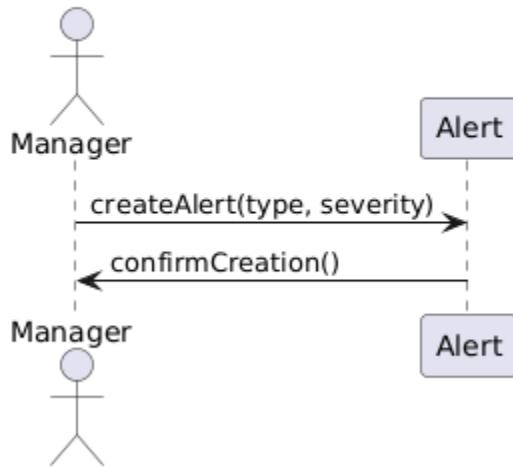
UC Name	M_ALR_26 – Managers Can Initiate Alerts
Summary	Managers must have the ability to manually trigger alerts based on situational assessments to ensure proactive safety measures and operational control.
Dependency	<ul style="list-style-type: none"> • S_ALR_27 (Detect Alert Sensors) → Alerts must be detected automatically when applicable. • S_COM_05 (Communication Module) → Notifications must be delivered to the correct recipients.
Actors	Primary Actor: Manager (M) • Secondary Actor: System (S), Station Manager (SM), Maintenance Staff (WRK), Emergency Responders

Railway Management System Requirements Specification

Preconditions	→ The manager must have appropriate access rights. → The system must provide an interface for manual alert initiation.
Description of the Main Sequence	1. The manager assesses the situation and decides to trigger an alert. 2. The manager selects the appropriate alert type and severity. 3. The system verifies the manager's authorization. 4. The system sends notifications via the appropriate communication channels. 5. The system logs the manually triggered alert and its responses.
Description of the Alternative Sequence	1. If the manager lacks proper authorization, the system denies the request and logs the attempt. 2. If the alert fails to be sent, the system retries using an alternative method (e.g., backup server)
Non-functional Requirements	→ Real-time Execution: Manually triggered alerts must be processed immediately. → Reliability: The system must ensure all alerts reach the intended recipients. → Security: Only authorized managers should be able to initiate alerts. → Audit Logging: All manually triggered alerts and actions must be recorded for accountability
Postconditions	✓ The system ensures that manager-initiated alerts are delivered to the appropriate users. ✓ The system maintains a log of all manual alert triggers for review and compliance.



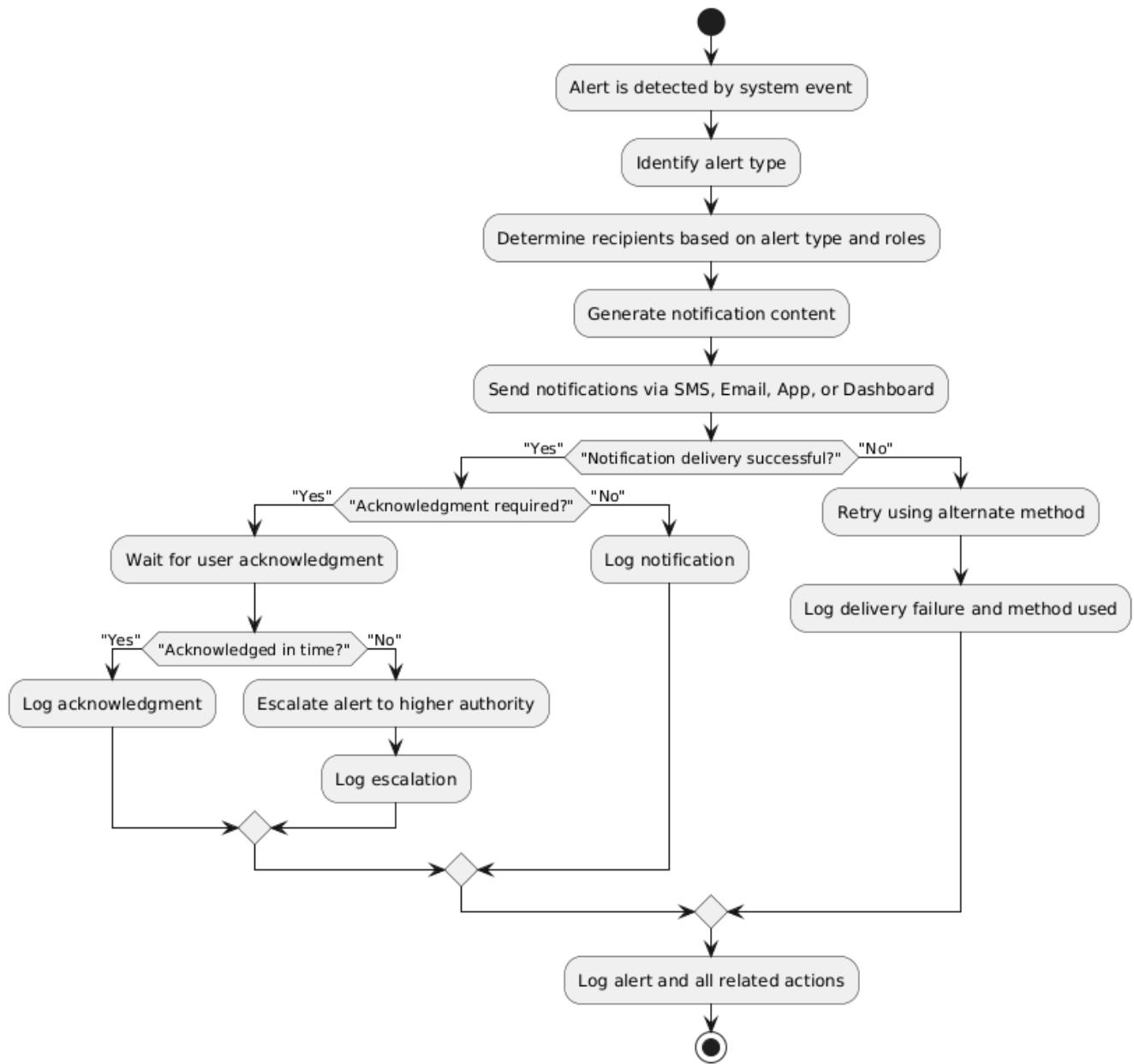
Simple Alert Creation by Manager

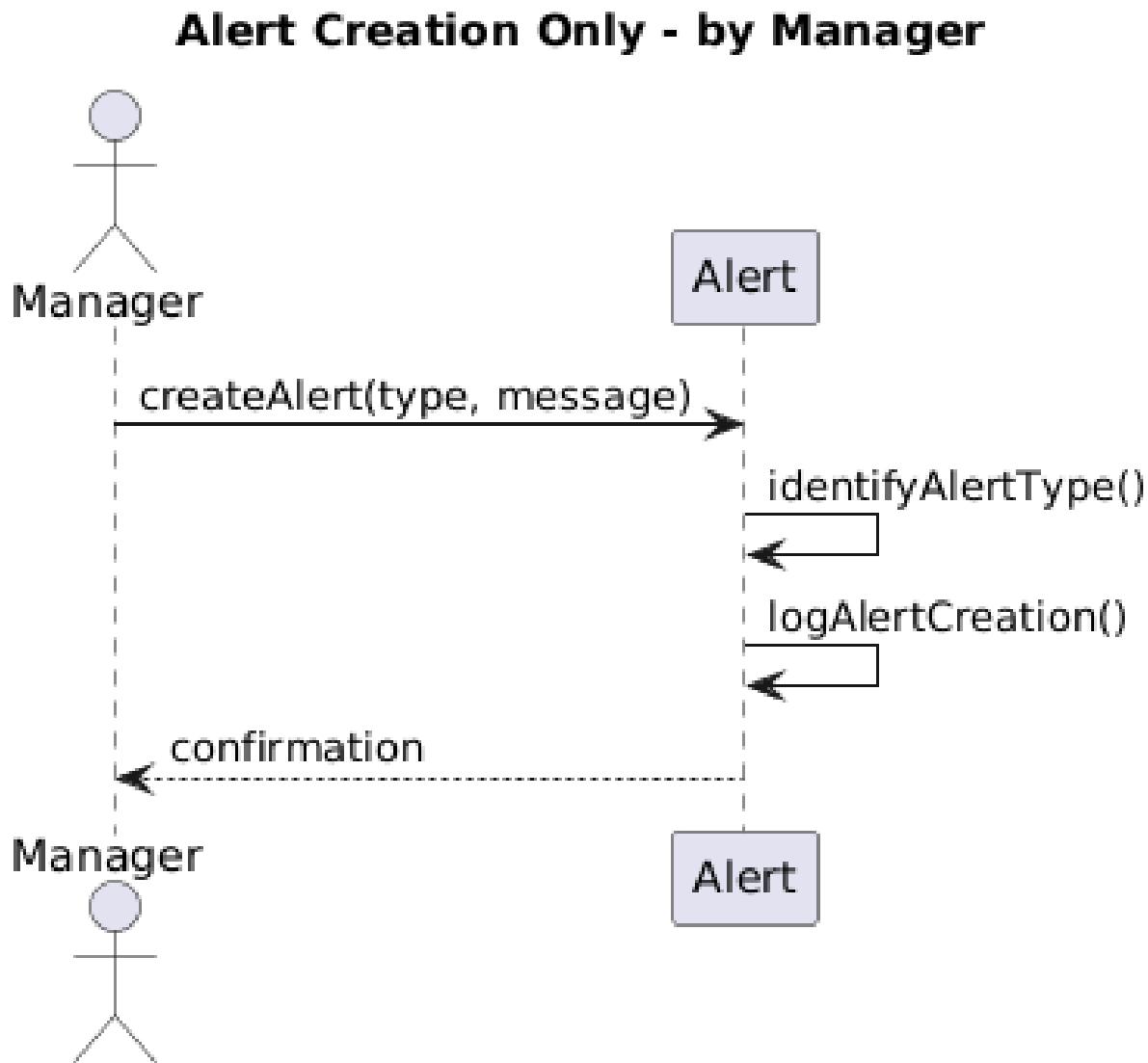


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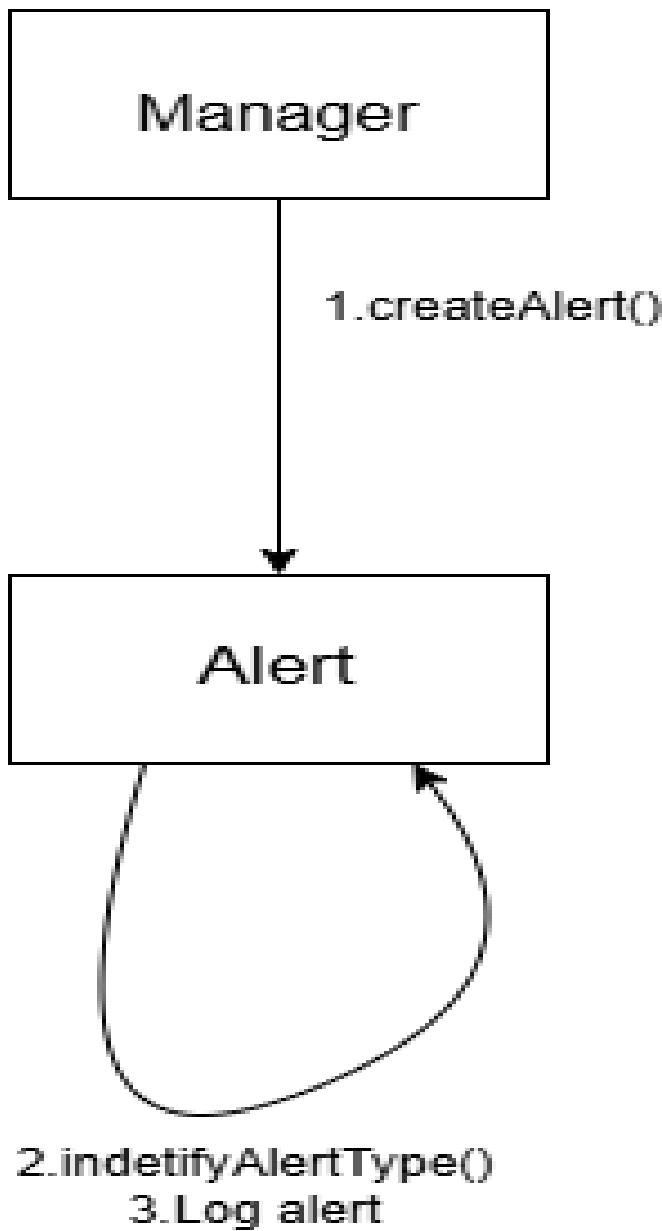
UC Name	<i>S_ALR_29 – Notify Users for Specific Alerts</i>
Summary	The system detects an alert and notifies the appropriate user(s) based on the alert type and their role.
Dependency	<ul style="list-style-type: none"> • <i>S_ALR_27 – Detect Alert Sensors</i> (<i>Alerts must be detected first</i>).
Actors	<ul style="list-style-type: none"> • <i>Primary Actor: System (S)</i> – Identifies alerts and sends notifications. • <i>Secondary Actors:</i> Traffic Manager (TM), Station Manager (SM), Employees (E), Passengers (P), Managers (M)
Preconditions	<ul style="list-style-type: none"> • Alert detection mechanisms are active and functional. • User contact information (email, SMS, app notifications) is configured in the system. • Users have the necessary permissions to receive alerts.
Description of the Main Sequence	<ul style="list-style-type: none"> ❖ 1. An alert is triggered by a system event (e.g., track obstruction, train delay, safety breach). ❖ 2. System identifies the nature of the alert. ❖ 3. System determines the appropriate recipient(s) based on the alert type. ❖ 4. System generates and sends notifications via SMS, email, app, or system dashboard. ❖ 5. Recipient acknowledges the alert (if required). ❖ 6. System logs the notification and any user response.
Description of the Alternative Sequence	<ul style="list-style-type: none"> ❖ 1. If the notification system fails: The system retries or uses an alternative notification method. ❖ 2. If the designated user does not acknowledge the alert: System escalates the alert to a higher authority.
Non functional requirements	<ul style="list-style-type: none"> ➔ Real-time Processing: Alerts must be sent within 5 seconds of detection. ➔ Security: Only authorized users should receive relevant alerts. ➔ Scalability: The system should handle multiple alerts simultaneously.
Postconditions	<ul style="list-style-type: none"> ➢ <i>The correct user(s) receive the alert notification.</i> ➢ <i>The system logs the alert and any actions taken.</i> ➢ <i>If required, the system escalates the issue to the next level.</i>

Railway Management System Requirements Specification





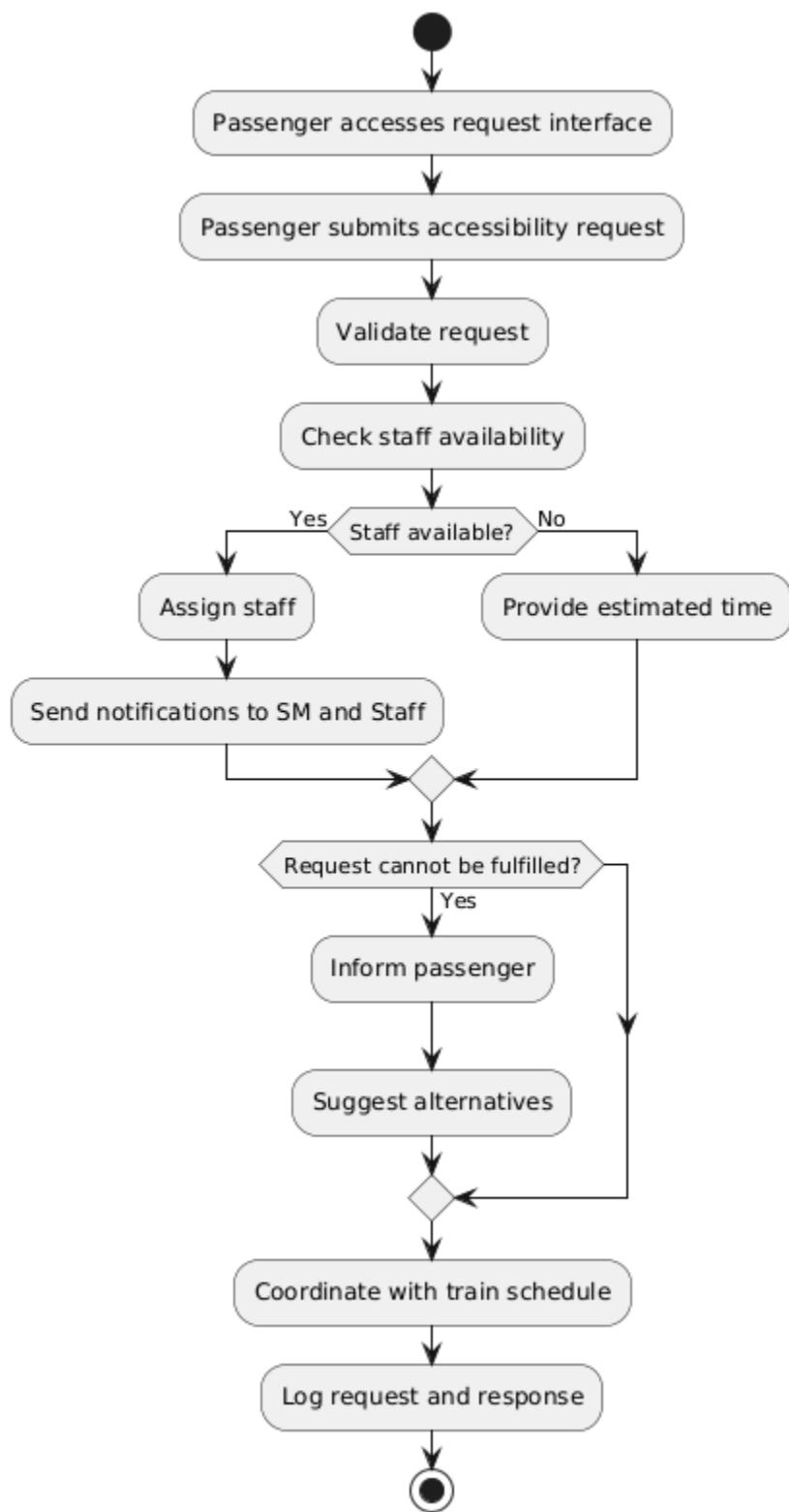
Collaboration Diagram



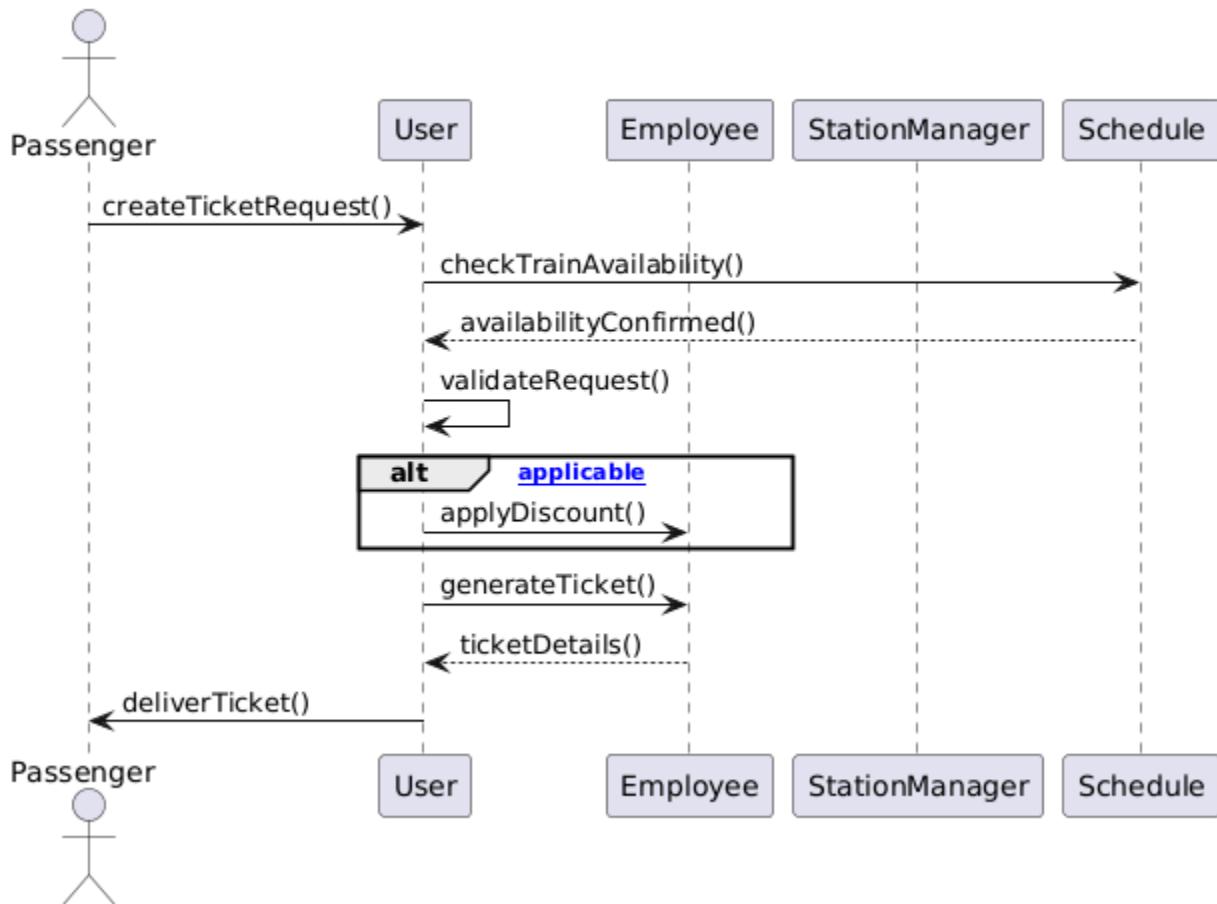
Railway Management System Requirements Specification

UC Name	P_SVC_27– Passengers Can Request Accessibility Services
Summary	Passengers must have the ability to request accessibility services, such as wheelchair assistance, priority seating, or other special accommodations, to ensure an inclusive travel experience.
Dependency	• S_SCH_10 (Train Scheduling System) → The system must coordinate accessibility service requests with train schedules. • S_COM_05 (Communication Module) → Notifications must be sent to the appropriate railway staff.
Actors	• Primary Actor: Passenger (P) • Secondary Actor: System (S), Station Manager (SM), Accessibility Service Staff
Preconditions	<p>→ The passenger must have access to a service request interface (e.g., mobile app, kiosk, or ticket counter).</p> <p>→ The system must support real-time processing of accessibility requests.</p>
Description of the Main Sequence	<p>Description of the Main Sequence :</p> <ul style="list-style-type: none"> ❖ 1. Passenger accesses the service request interface. ❖ 2. Passenger submits an accessibility request. ❖ 3. System validates the request and logs it. ❖ 4. System coordinates with the train schedule 5. System sends request notification to accessibility service staff using S_COM_05. ❖ 6. Service staff prepare to fulfill the request.
Description of the Alternative Sequence	<p>1. If no service staff is available, the system provides the passenger with an estimated wait time.</p> <p>2. If the request cannot be fulfilled, the system notifies the passenger and suggests alternatives.</p>
Non-functional Requirements	<p>→ Real-time Processing: Requests must be handled immediately.</p> <p>→ Reliability: The system must ensure all requests are processed correctly.</p> <p>→ Security: Passenger data must be protected.</p> <p>→ Audit Logging: All service requests and responses must be recorded</p>
Postconditions	<p>✓ The system ensures that accessibility service requests are assigned and fulfilled.</p> <p>✓ The system maintains a log of all accessibility service requests for monitoring and improvement.</p>

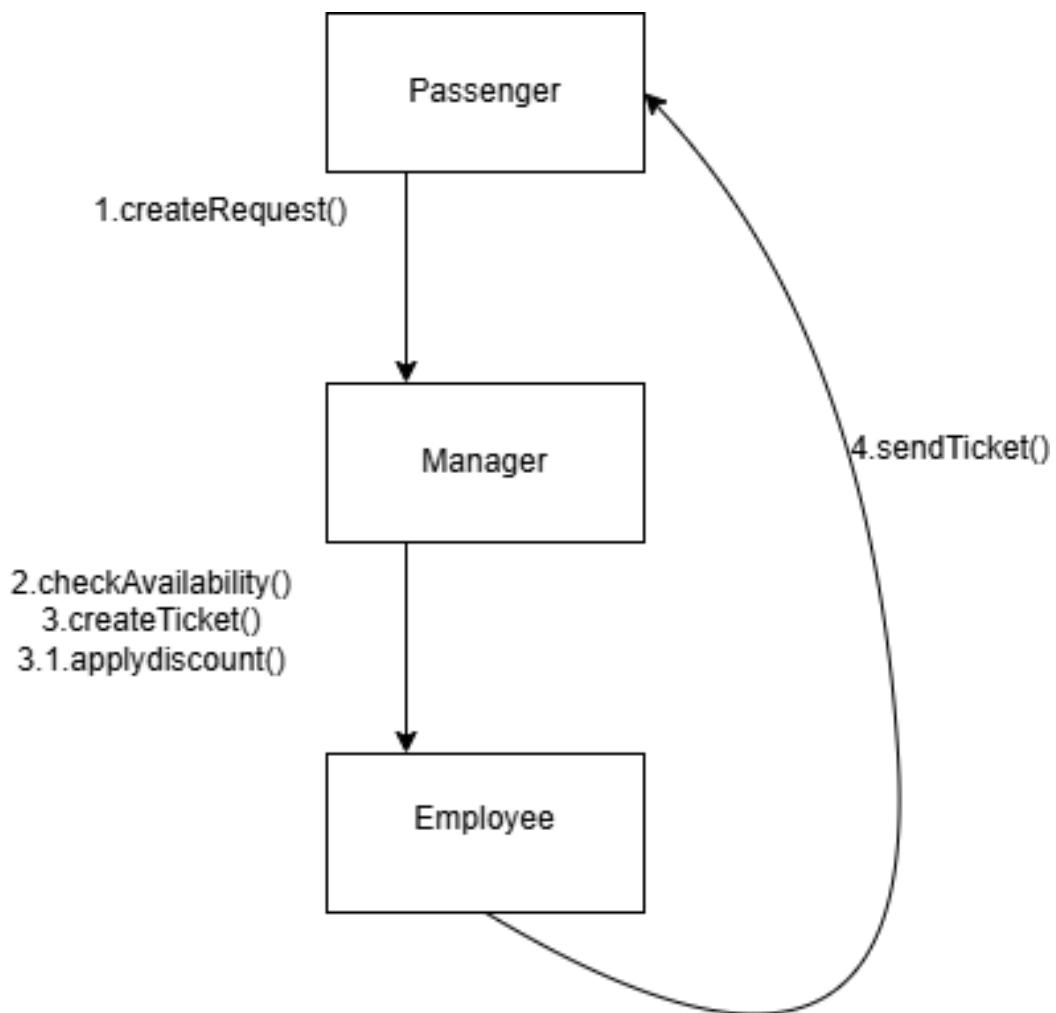
Railway Management System Requirements Specification



Railway Management System - Ticket Creation with Discount Step



Collaboration Diagram

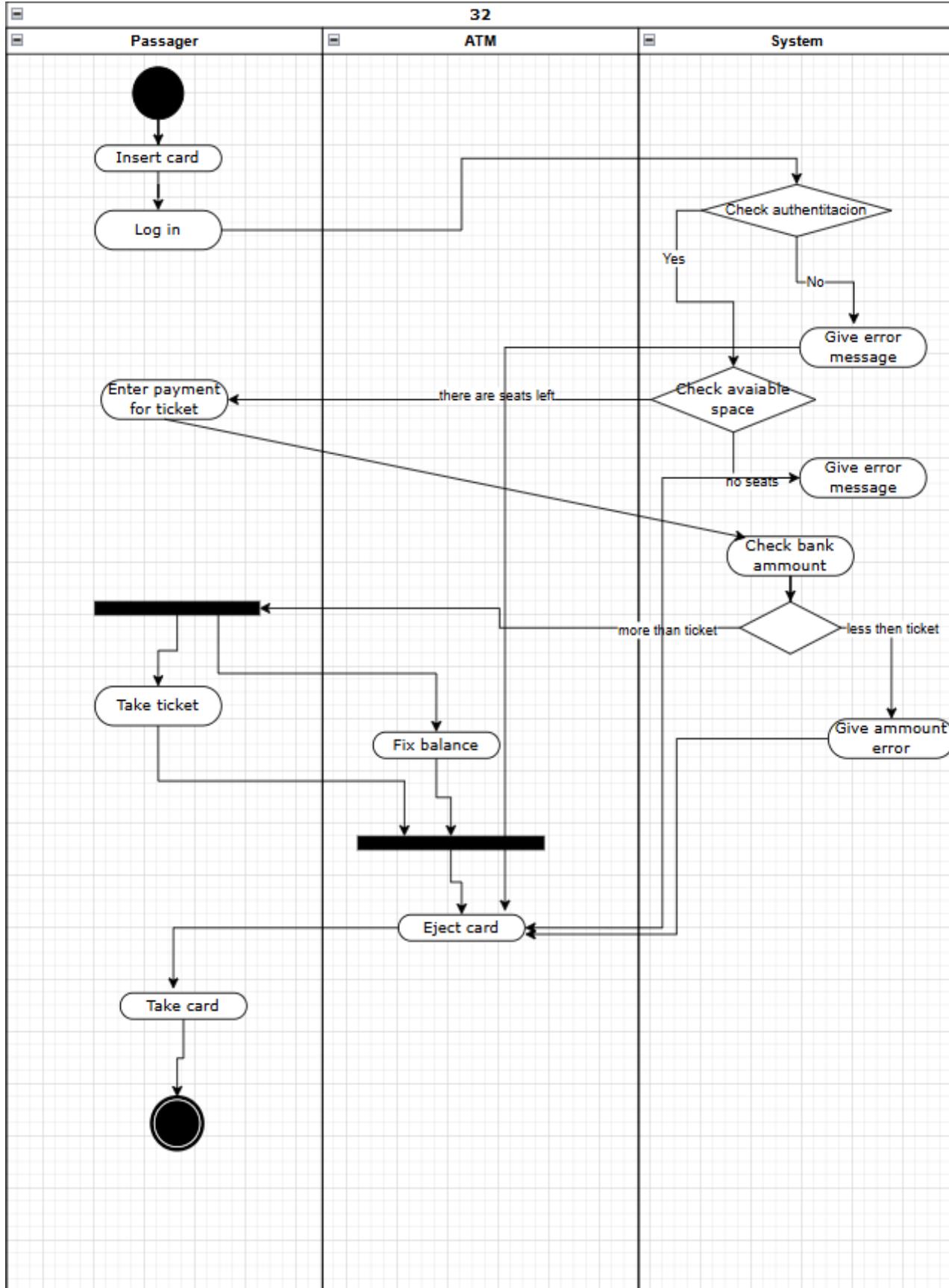


UC Name	P_TKT_28 – Passengers Can Opt into Loyalty Programs or Alternate Payment Methods
Summary	Passengers must have the ability to enroll in loyalty programs and use alternate payment methods for ticketing, ensuring flexibility and rewards for frequent travelers.
Dependency	• S_TKT_12 (Ticketing System) → The system must integrate loyalty programs and multiple payment options. • S_COM_05 (Communication Module) → Notifications regarding loyalty points and payment confirmations must be sent.
Actors	• Primary Actor: Passenger (P) • Secondary Actor: System (S), Ticketing Manager (TKT), Financial Service Providers
Preconditions	→ The passenger must have access to a booking interface (e.g., mobile app, website, ticket counter). → The system must support various payment methods and loyalty program registration.
Description of the Main Sequence	1. The passenger selects a ticket for booking. 2. The system offers loyalty program enrollment and alternative payment methods. 3. The passenger chooses to enroll in a loyalty program or selects a preferred payment method. 4. The system processes the selection and updates the passenger's profile. 5. The system confirms the transaction and sends a notification.
Description of the Alternative Sequence	1. If the selected payment method fails, the system prompts the passenger to choose another method. 2. If the passenger is already enrolled in a loyalty program, the system applies available rewards automatically.
Non-functional Requirements	→ Real-time Processing: Enrollment and payments must be handled instantly. → Reliability: The system must ensure successful processing of all transactions. → Security: Payment and personal data must be protected. → Audit Logging: All transactions and enrollments must be recorded.
Postconditions	✓ The system ensures that accessibility service requests are assigned and fulfilled. ✓ The system maintains a log of all accessibility service requests for monitoring and improvement.

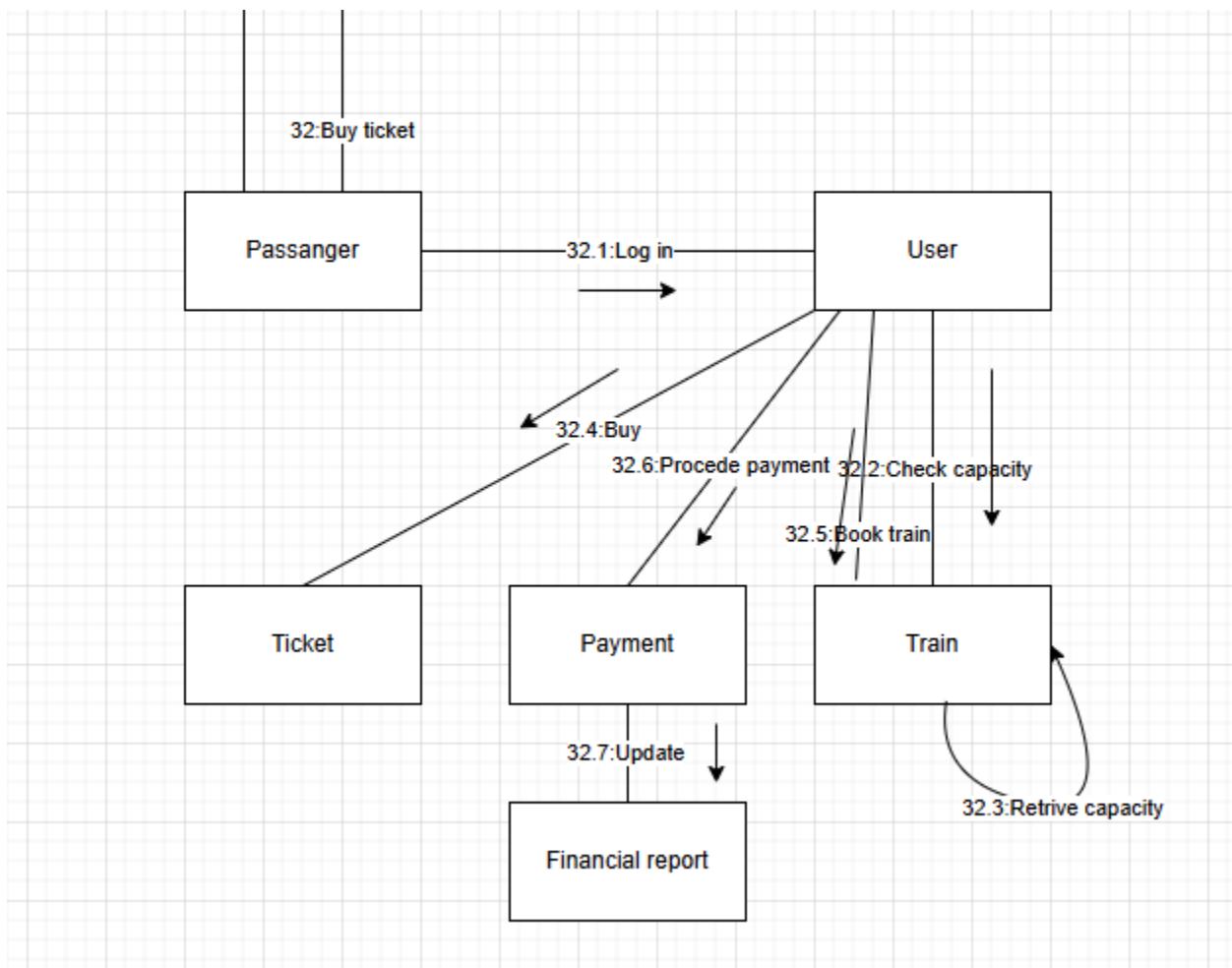
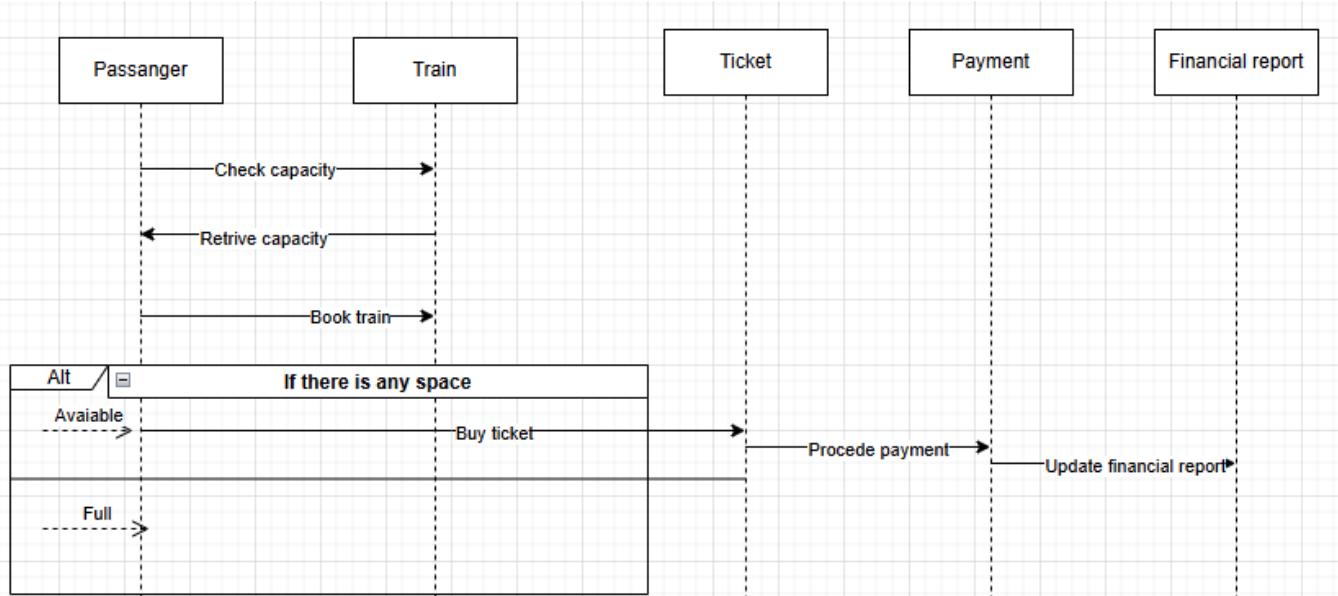
UC Name	S_CAP_29
Summary	System must observe train capacity to eliminate overbooking
Dependency	S_TRK_03 S_TRK_05
Actors	Passenger, System
Preconditions	The train capacity data must be available.
Description of the Main Sequence	<ol style="list-style-type: none"> 1. User logs in. 2. System checks authentication. 3. System retrieves data about boarding. 4. Passenger confirms payment 5. If capacity allows, booking is confirmed.
Description of the Alternative Sequence	If system fails to retrieve train capacity, an error message is displayed.
Non functional requirements	<ul style="list-style-type: none"> ● System must update capacity in real time. ● System must handle multiple concurrent booking requests.
Postconditions	The train booking system reflects updated capacity status.

Railway Management System Requirements Specification

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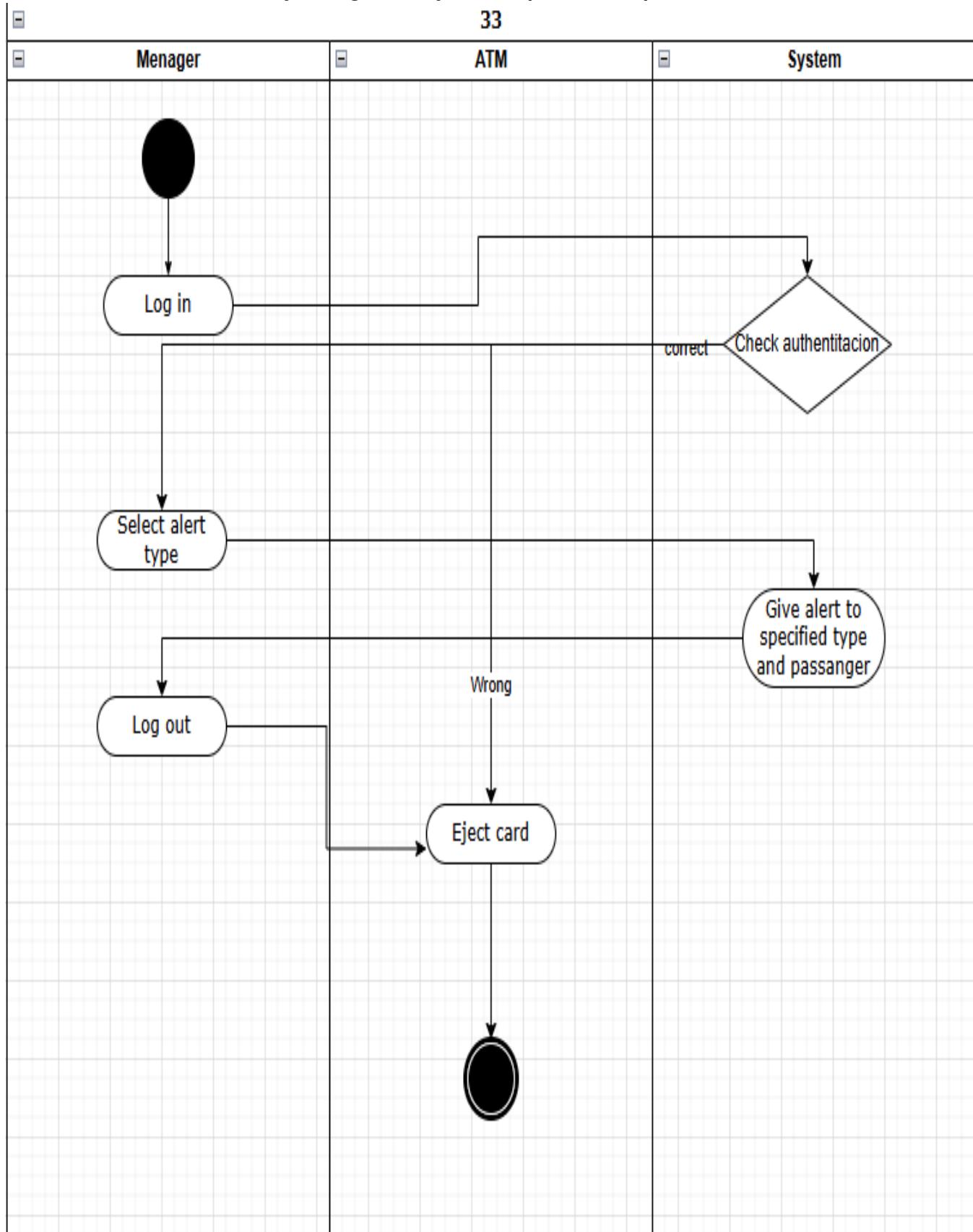


Railway Management System Requirements Specification

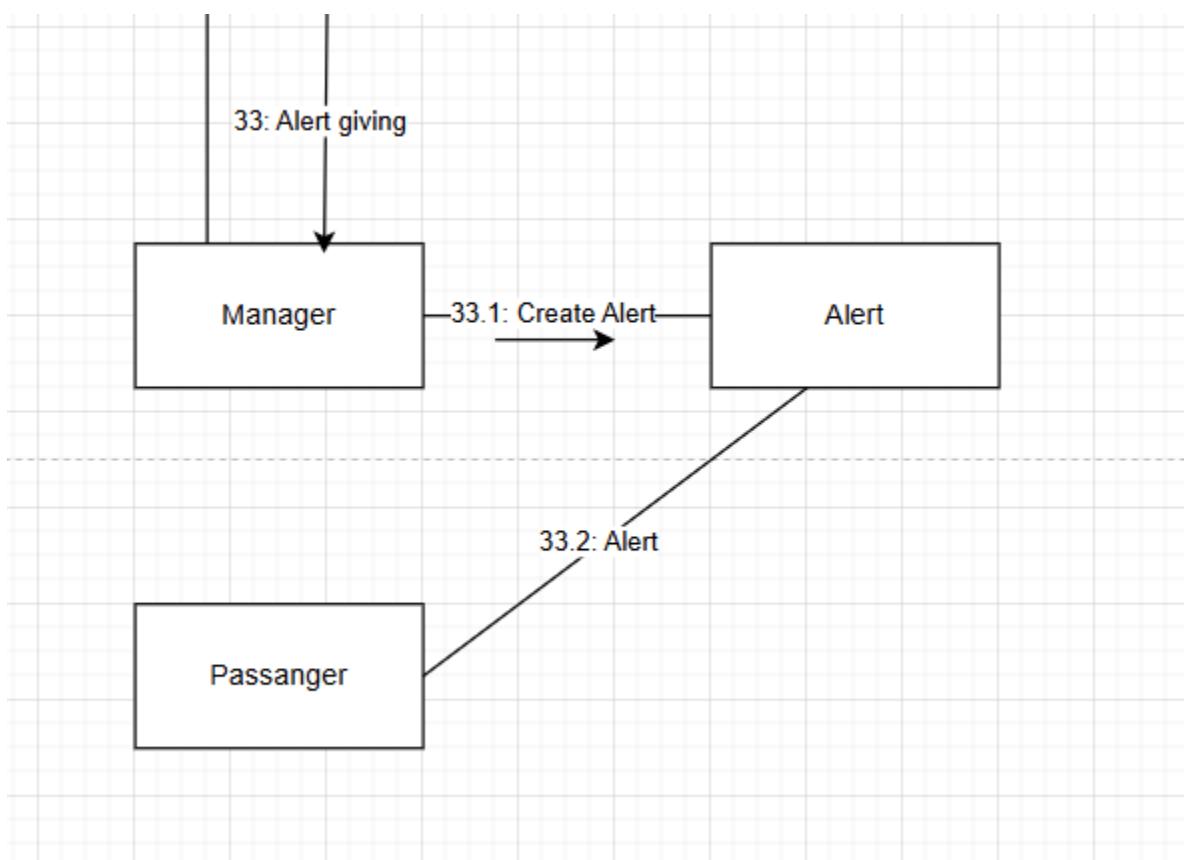
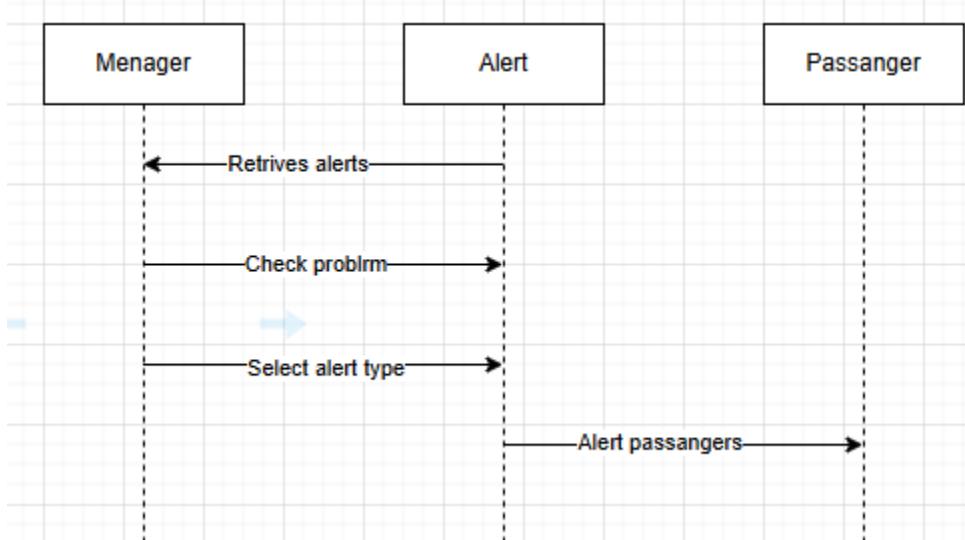


Railway Management System Requirements Specification

UC Name	SM_ALR_30
Summary	Station Managers are allowed to alert passengers to any of their alerts
Dependency	TM_MNG_01 S_TRK_05 S_ALR_26 S_ALR_27
Actors	Station Manager, Passenger, System
Preconditions	Station Manager must be logged in.
Description of the Main Sequence	<ol style="list-style-type: none"> 1. Station Manager accesses the alert system. 2. Station Manager selects or inputs an alert message. 3. System sends alert notification to relevant passengers.
Description of the Alternative Sequence	If system cannot send alert, an error message is displayed.
Non functional requirements	<ul style="list-style-type: none"> • System must deliver alerts in real time. • System must ensure alert visibility to passengers.
Postconditions	Passengers receive alerts from the station manager.

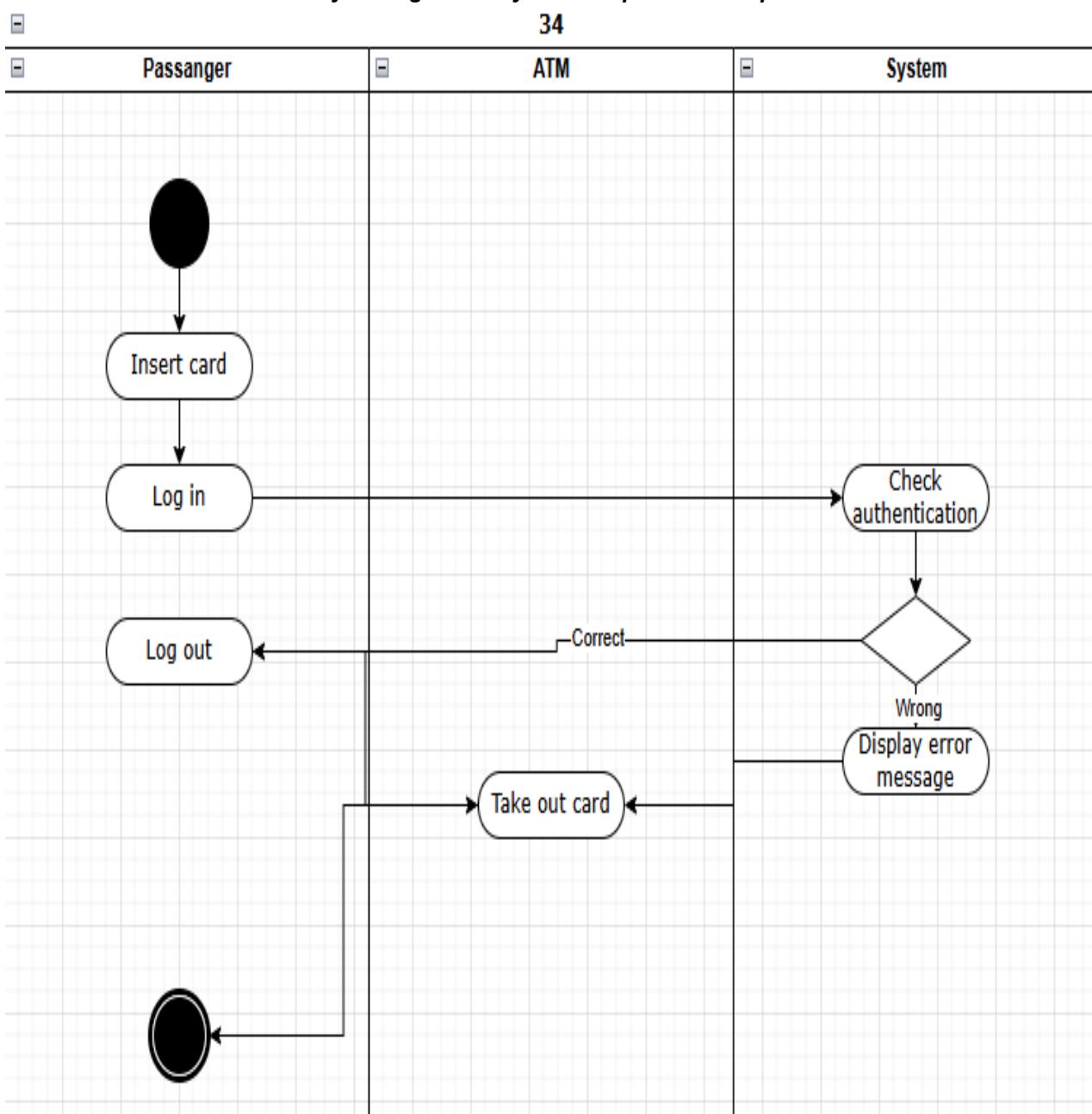


Railway Management System Requirements Specification

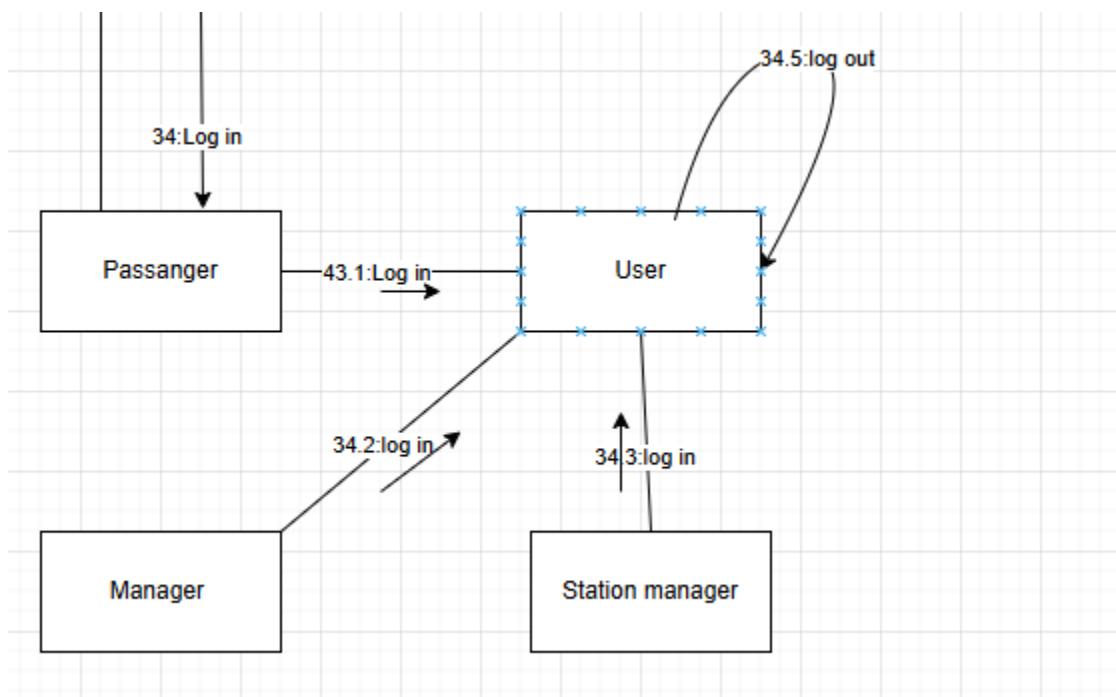
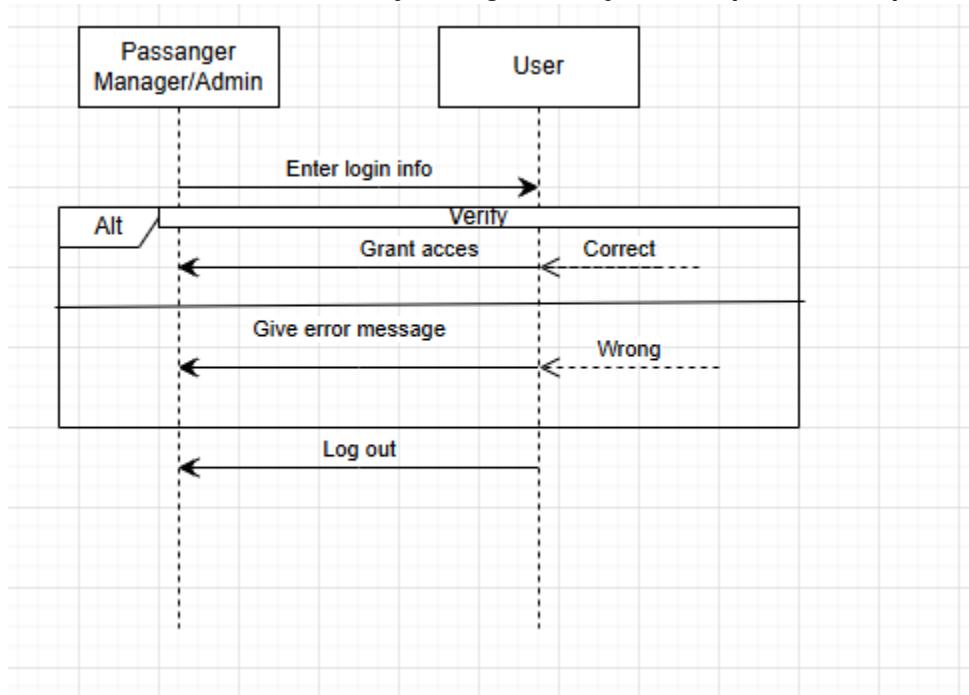


Railway Management System Requirements Specification

UC Name	U_AUTH_31
Summary	All users must have login logout functionality
Dependency	U_VIW_25
Actors	All Users, System
Preconditions	User must have valid credentials.
Description of the Main Sequence	<ol style="list-style-type: none"> 1. User enters login credentials. 2. System verifies credentials. 3. If valid, user is granted access.
Description of the Alternative Sequence	If credentials are invalid, an error message is displayed.
Non functional requirements	<ul style="list-style-type: none"> • System must securely store user credentials. • Authentication should be completed within 3 seconds.
Postconditions	User is successfully logged in or out.



Railway Management System Requirements Specification

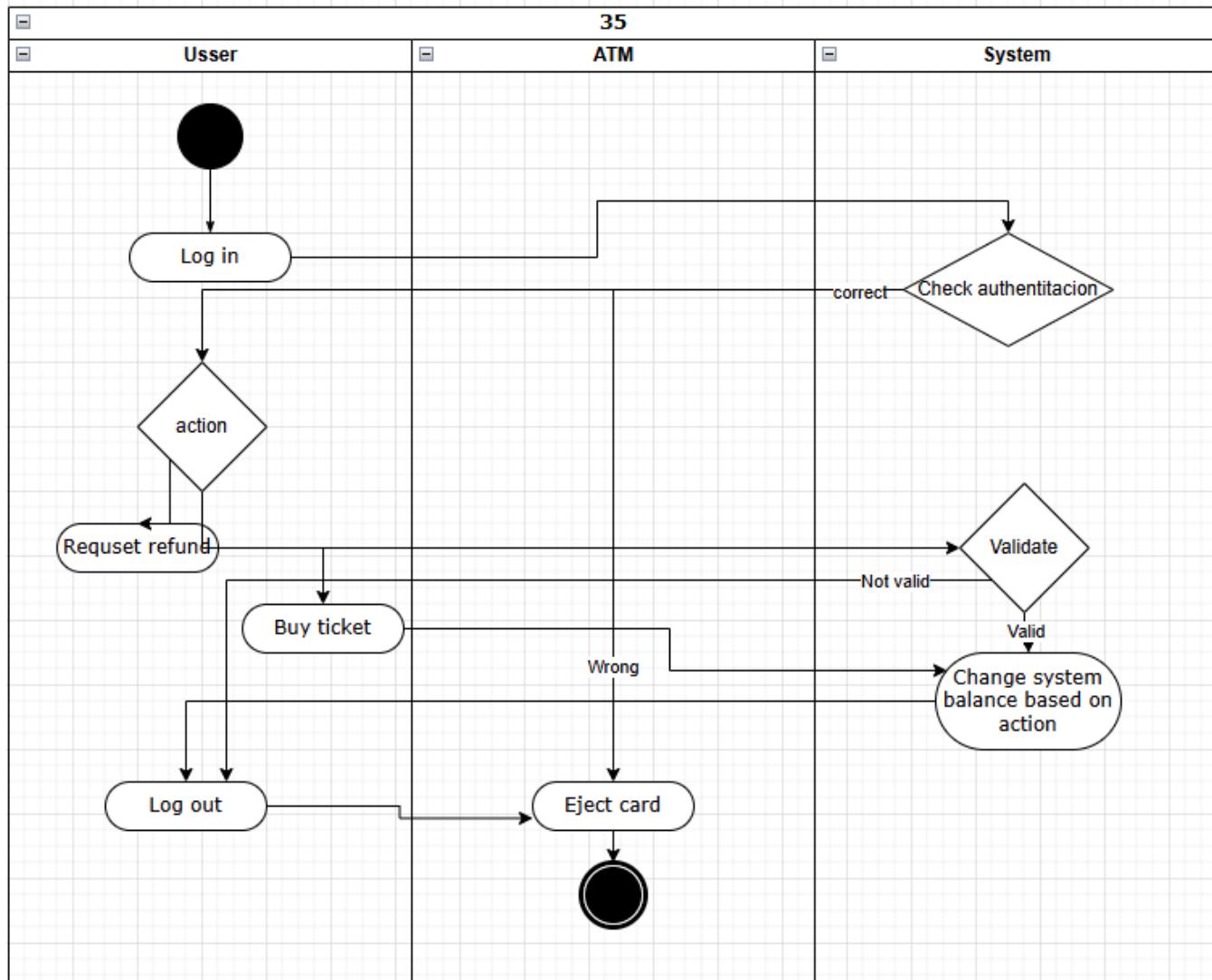


Railway Management System Requirements Specification

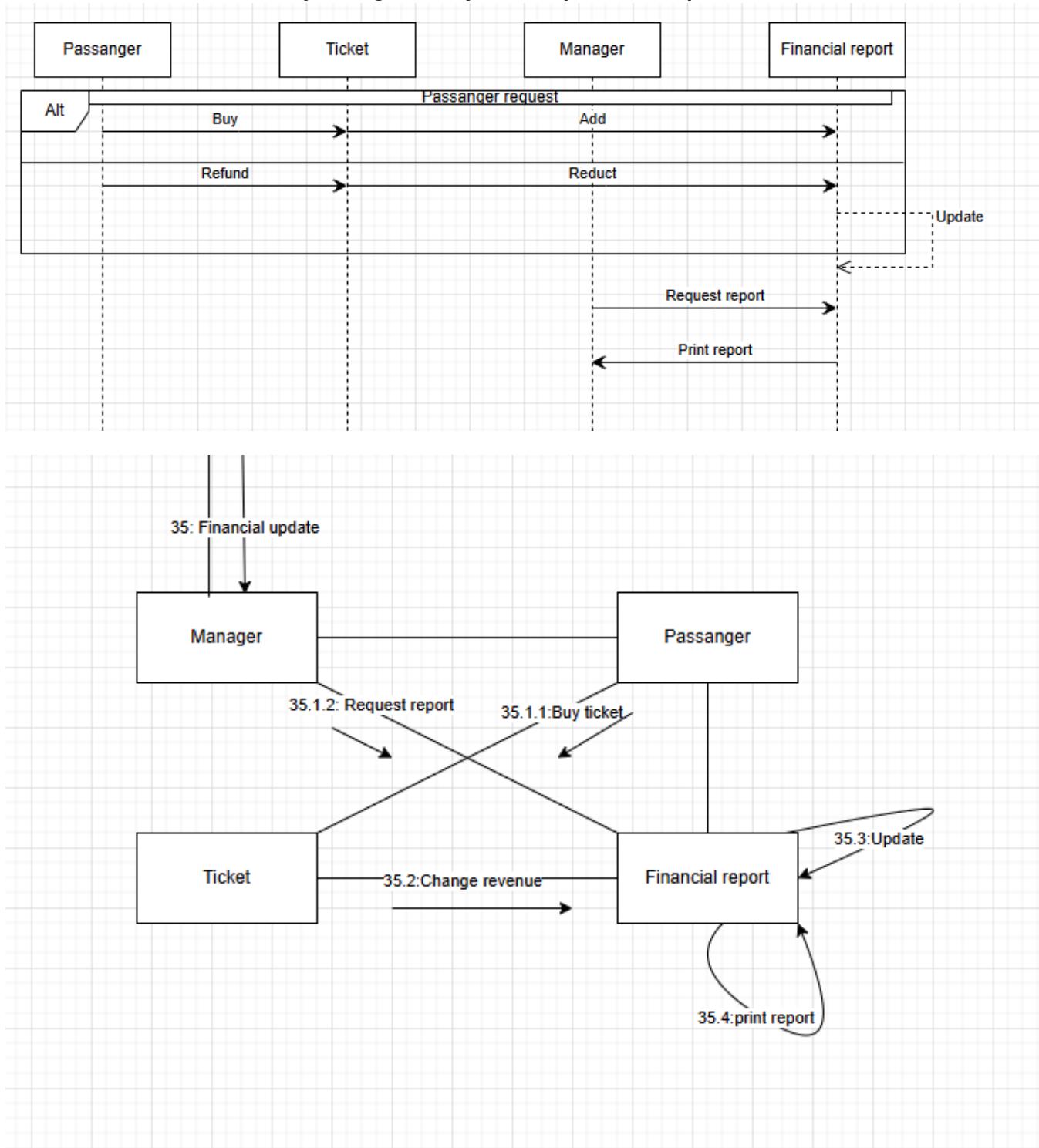
UC Name	S_FIN_32
Summary	The system must keep track of expenses and profit.
Dependency	S_PER_08 P_TKT_29
Actors	System, Manager
Preconditions	Financial data must be available.
Description of the Main Sequence	<ol style="list-style-type: none"> 1. System collects financial data from transactions. 2. System generates reports on revenue and expenses.
Description of the Alternative Sequence	If the system cannot fetch data, an error message is displayed.
Non functional requirements	<ul style="list-style-type: none"> ● System must ensure data integrity. ● Financial reports must be generated within 10 seconds.
Postconditions	Revenue and expense data is updated in the system.

Railway Management System Requirements Specification

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Railway Management System Requirements Specification



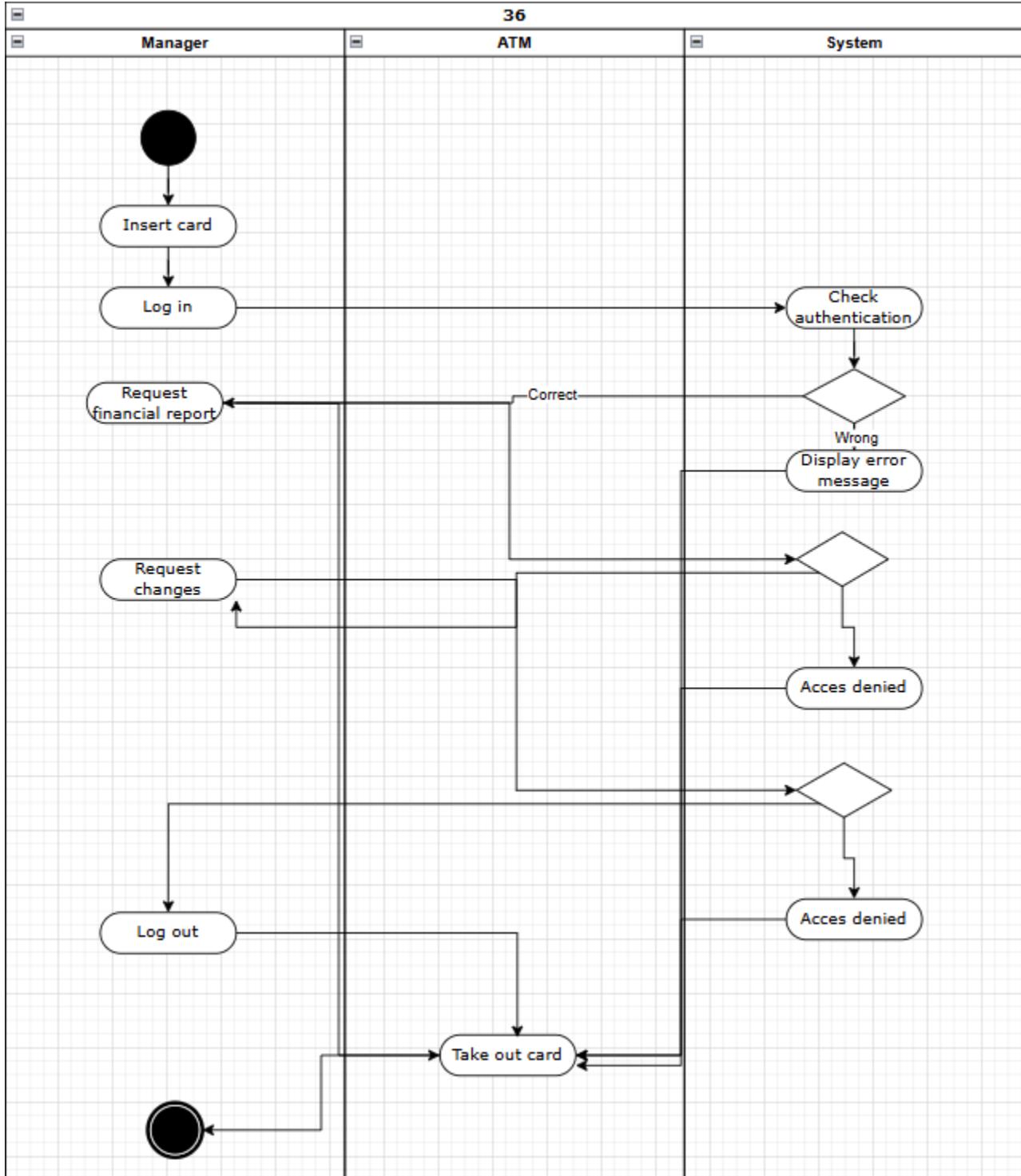
UC Name	SM_FIN_33
Summary	Station Managers are able to check station revenue and expenses

Railway Management System Requirements Specification

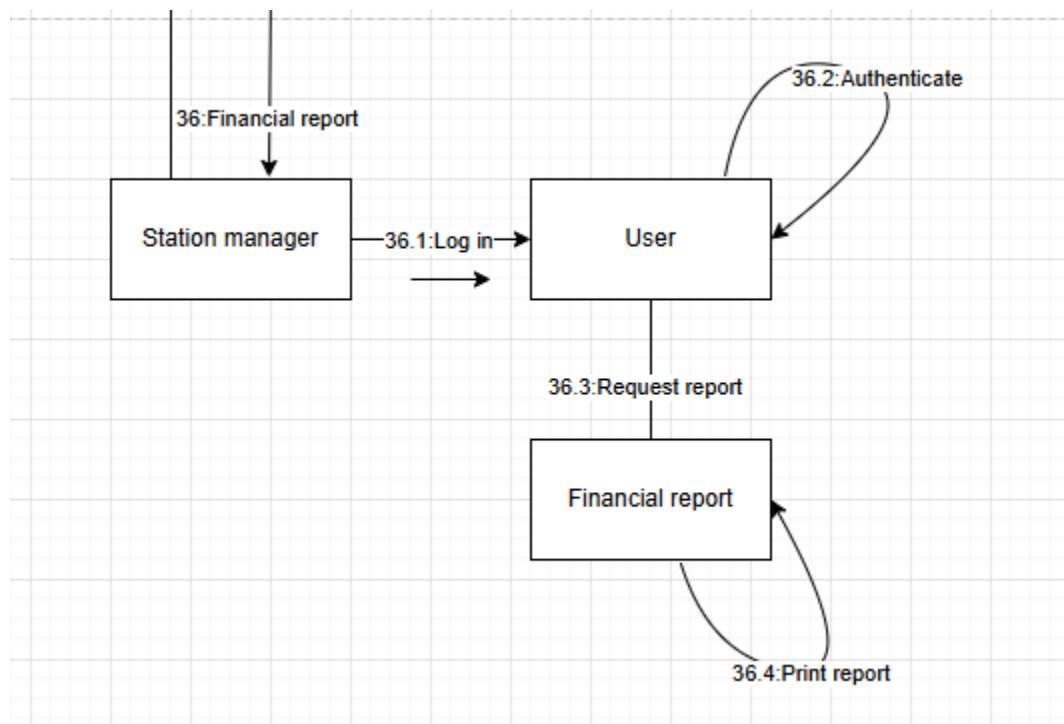
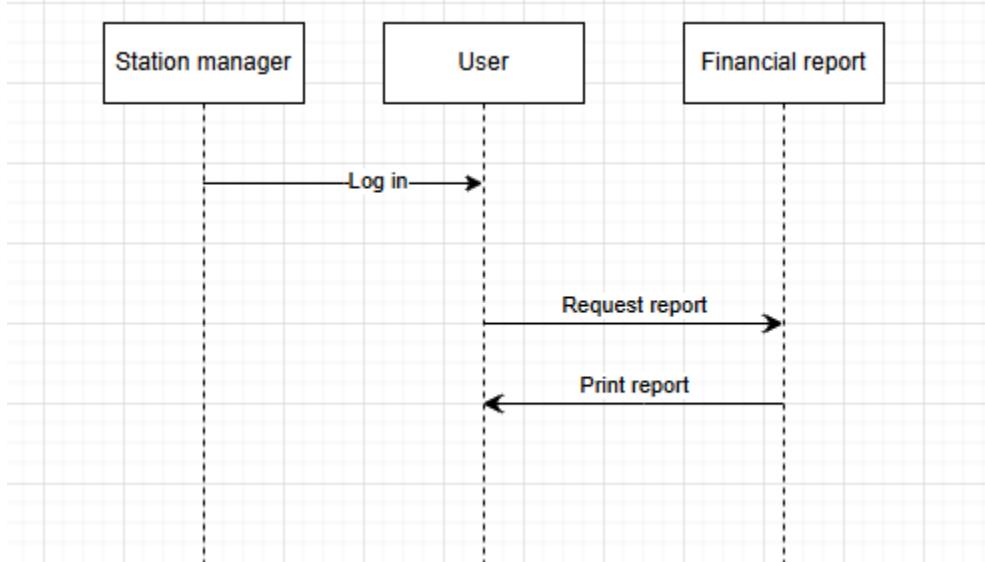
Dependency	S_FIN_34
Actors	Station Manager, System
Preconditions	Station Manager must be logged in.
Description of the Main Sequence	<ol style="list-style-type: none">1. Station Manager requests financial report.2. System retrieves and displays relevant financial data.
Description of the Alternative Sequence	If financial data is unavailable, an error message is displayed.
Non functional requirements	System must ensure financial data confidentiality.
Postconditions	Station Manager has access to financial data.

Railway Management System Requirements Specification

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Railway Management System Requirements Specification



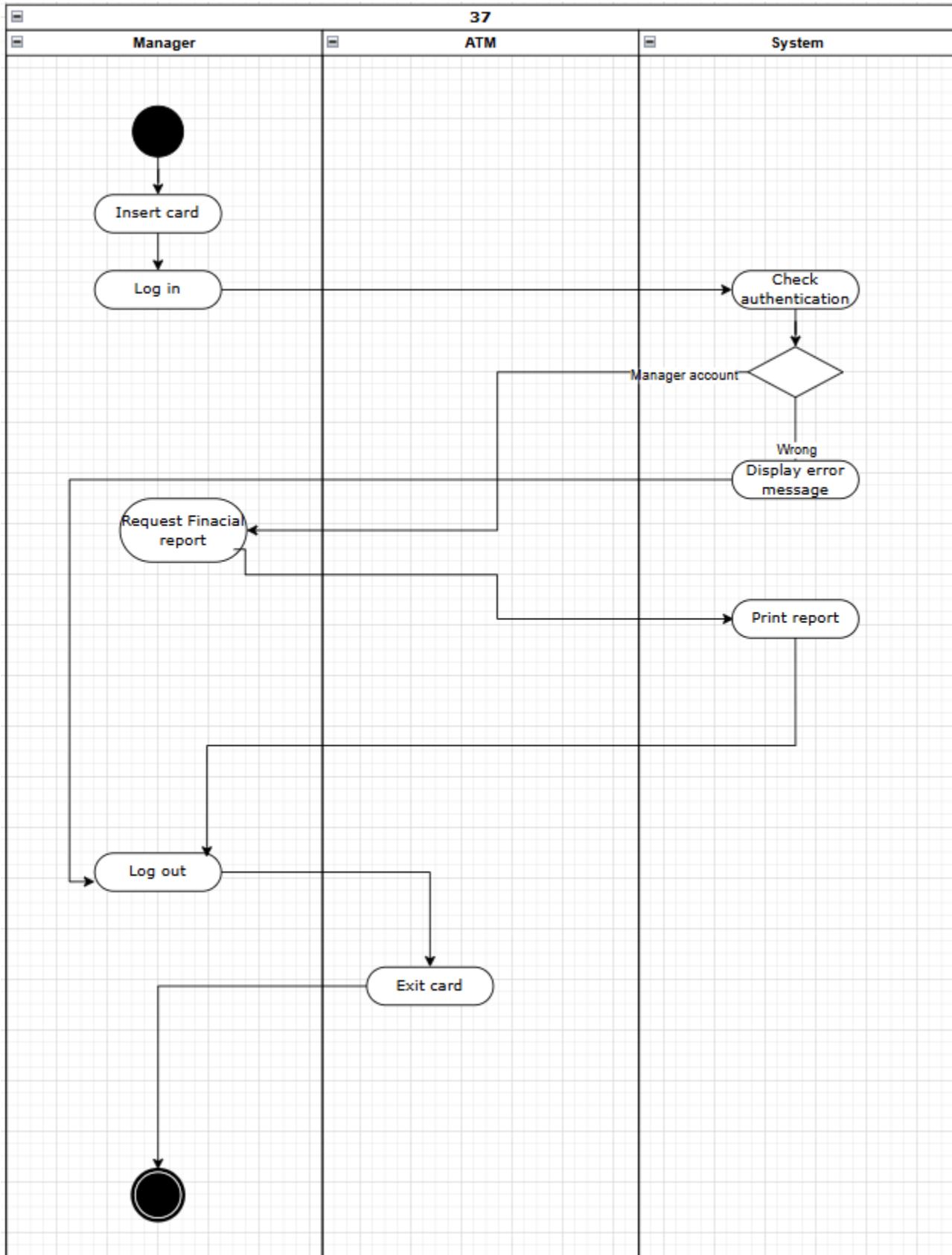
UC Name	S_FIN_34
Summary	The system must be able to generate detailed reports on revenue and expenses.
Dependency	S_FIN_33

Railway Management System Requirements Specification

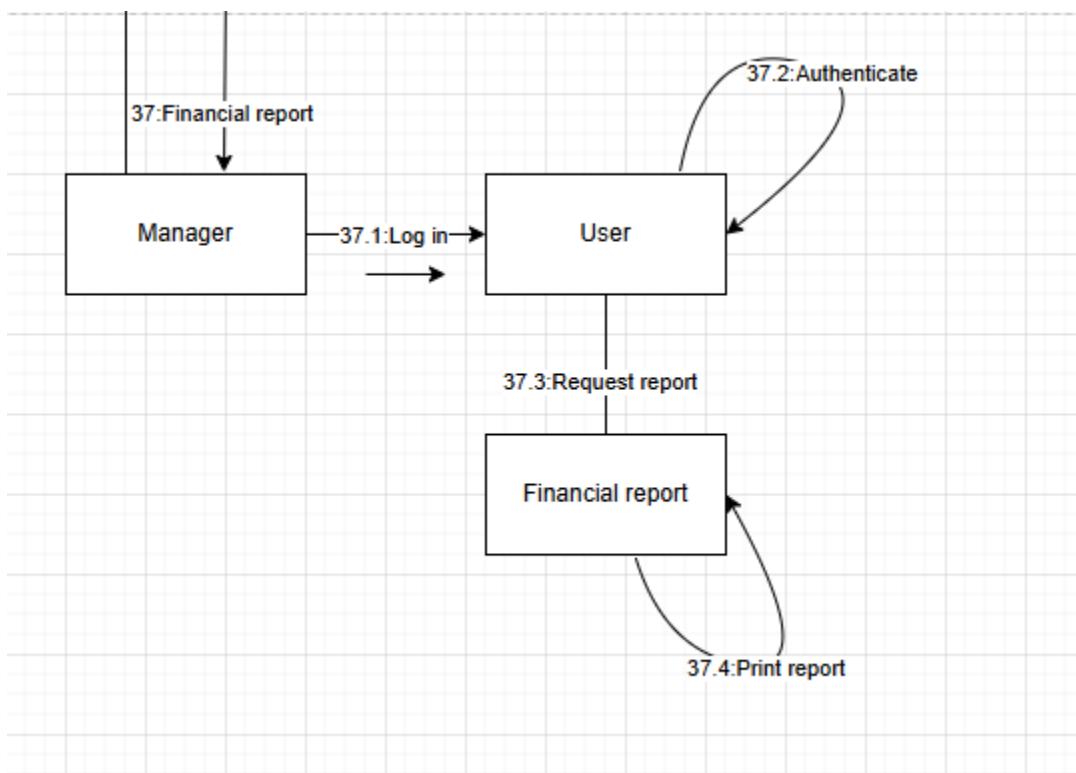
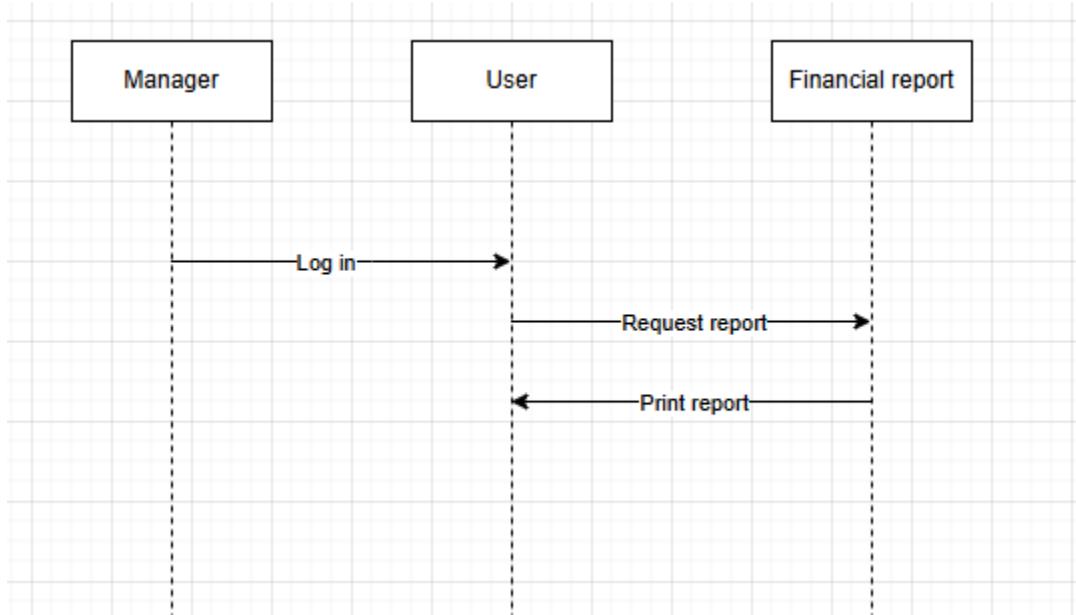
Actors	Manager, System
Preconditions	Financial data must be available.
Description of the Main Sequence	<ol style="list-style-type: none">1. Manager requests a financial report.2. System compiles revenue and expense data.3. System generates a detailed report.
Description of the Alternative Sequence	If report generation fails, an error message is displayed.
Non functional requirements	Reports must be generated within 10 seconds.
Postconditions	The financial report is available for review.

Railway Management System Requirements Specification

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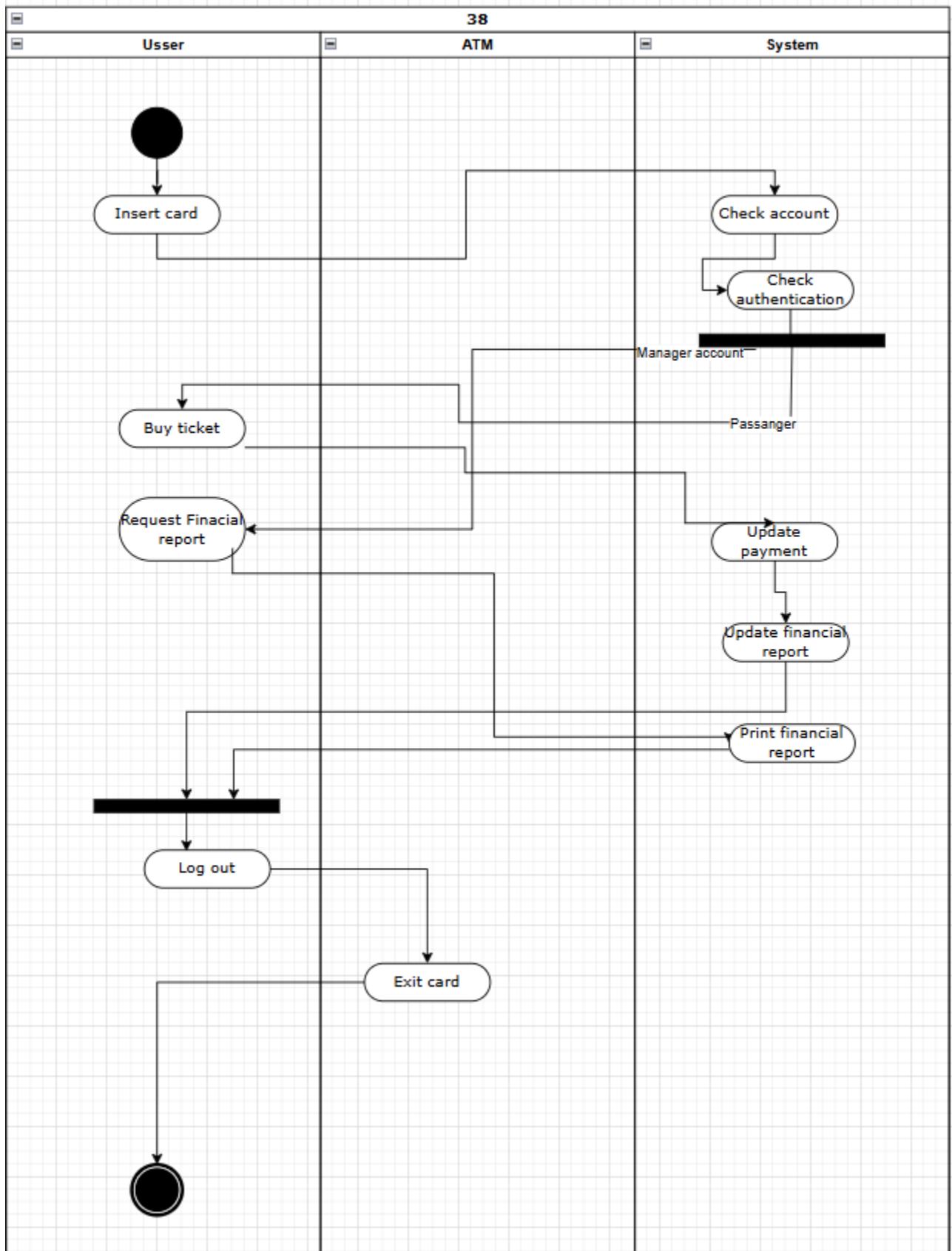
Railway Management System Requirements Specification



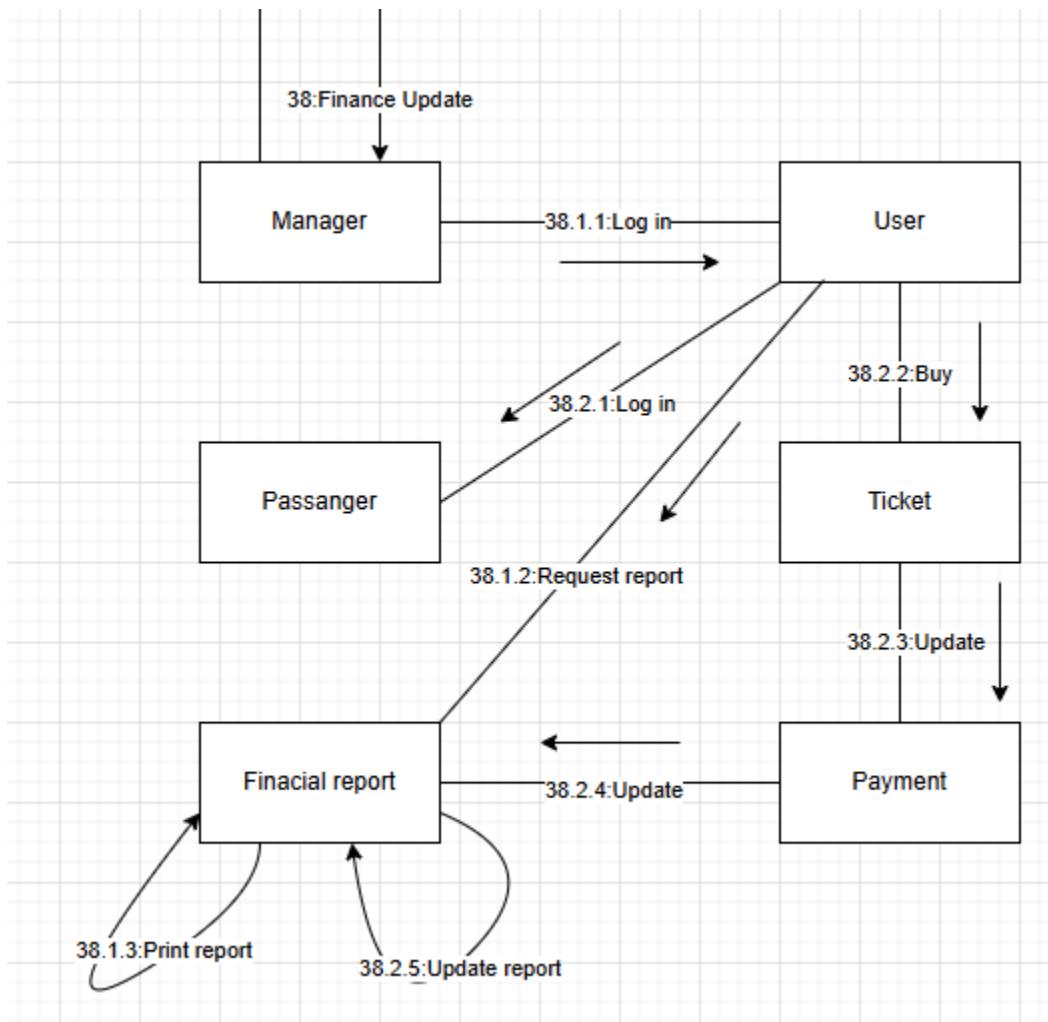
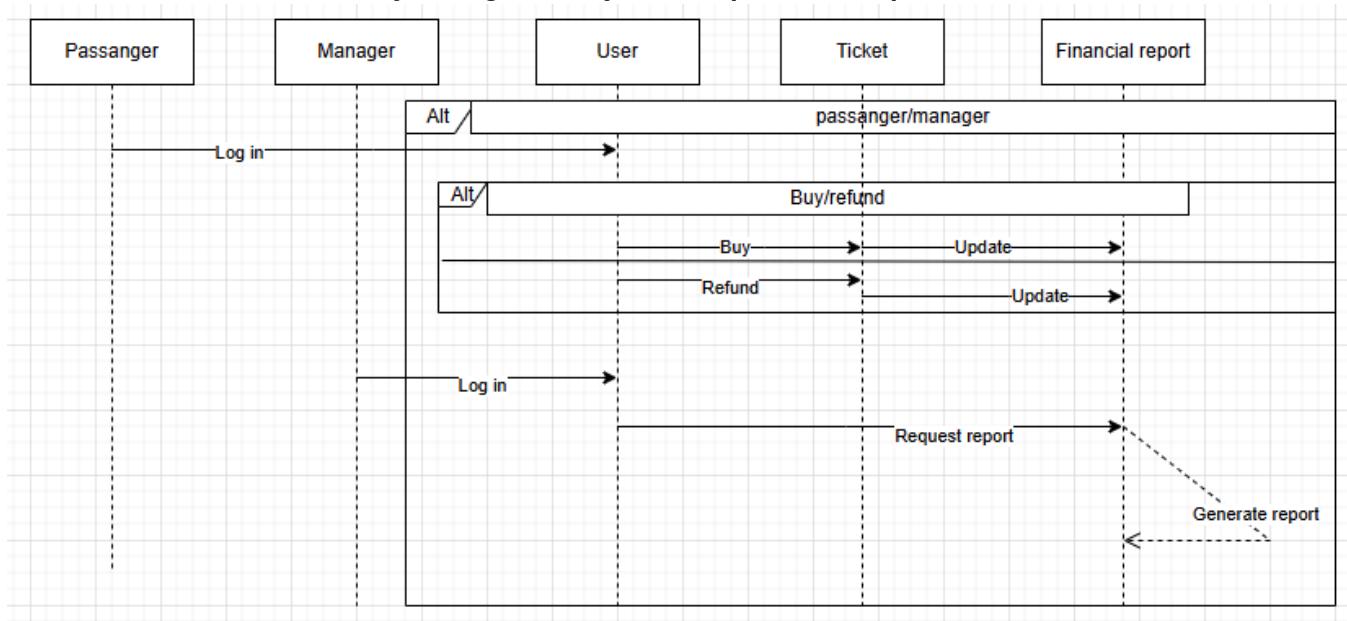
UC Name	S_LOG_35
Summary	The system must keep track of all operations done in a specified timeframe
Dependency	S_FIN_33
Actors	System, Manager
Preconditions	System must have access to operation logs.
Description of the Main Sequence	<ol style="list-style-type: none"> 1. System records all operations performed. 2. System organizes and stores the log data. 3. Manager can retrieve and review the logs.
Description of the Alternative Sequence	If log retrieval fails, an error message is displayed.
Non functional requirements	<ul style="list-style-type: none"> ● System must ensure log integrity and security. ● Logs must be retrievable within 5 seconds.
Postconditions	Operations are recorded and available for audit.

Railway Management System Requirements Specification

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Railway Management System Requirements Specification

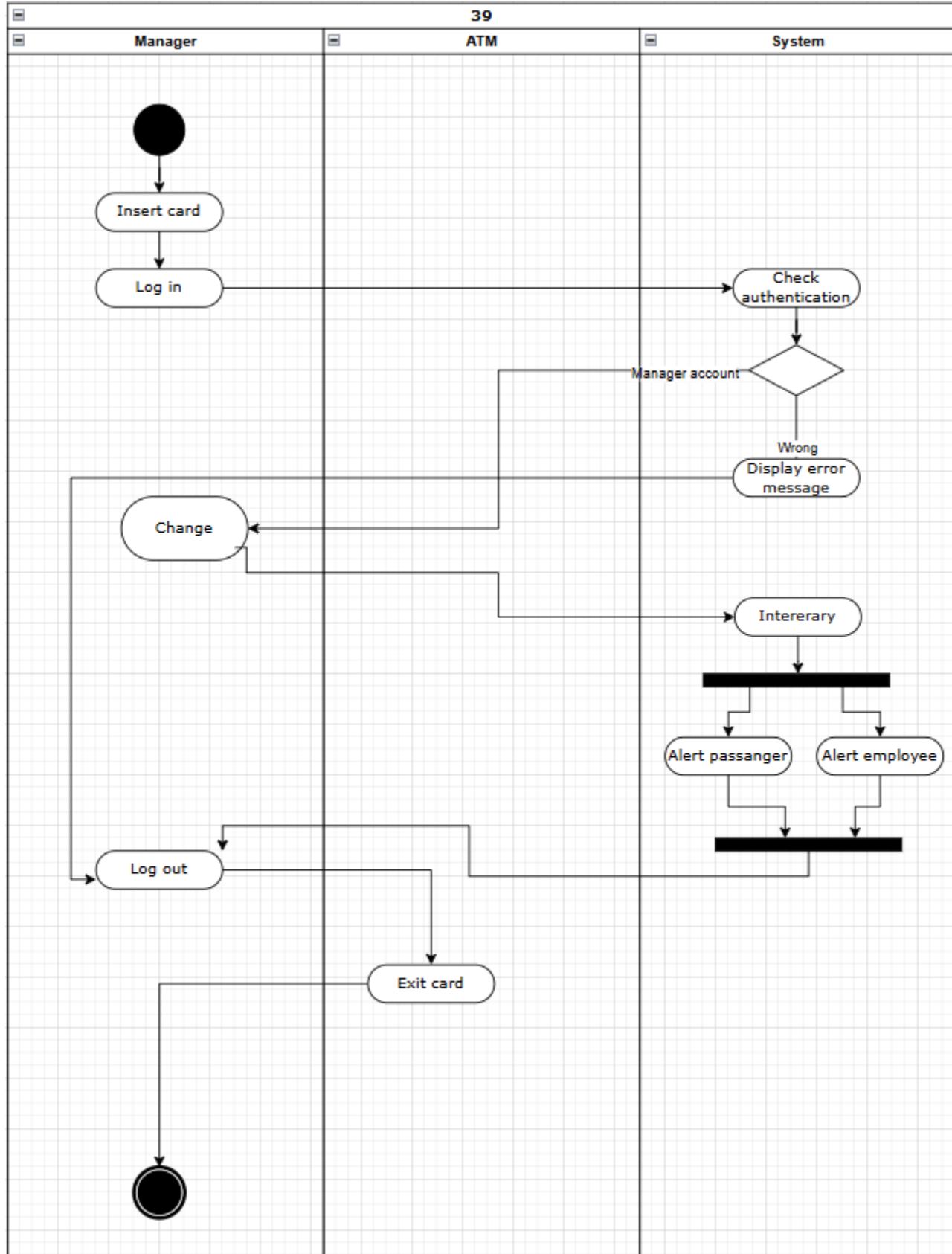


Railway Management System Requirements Specification

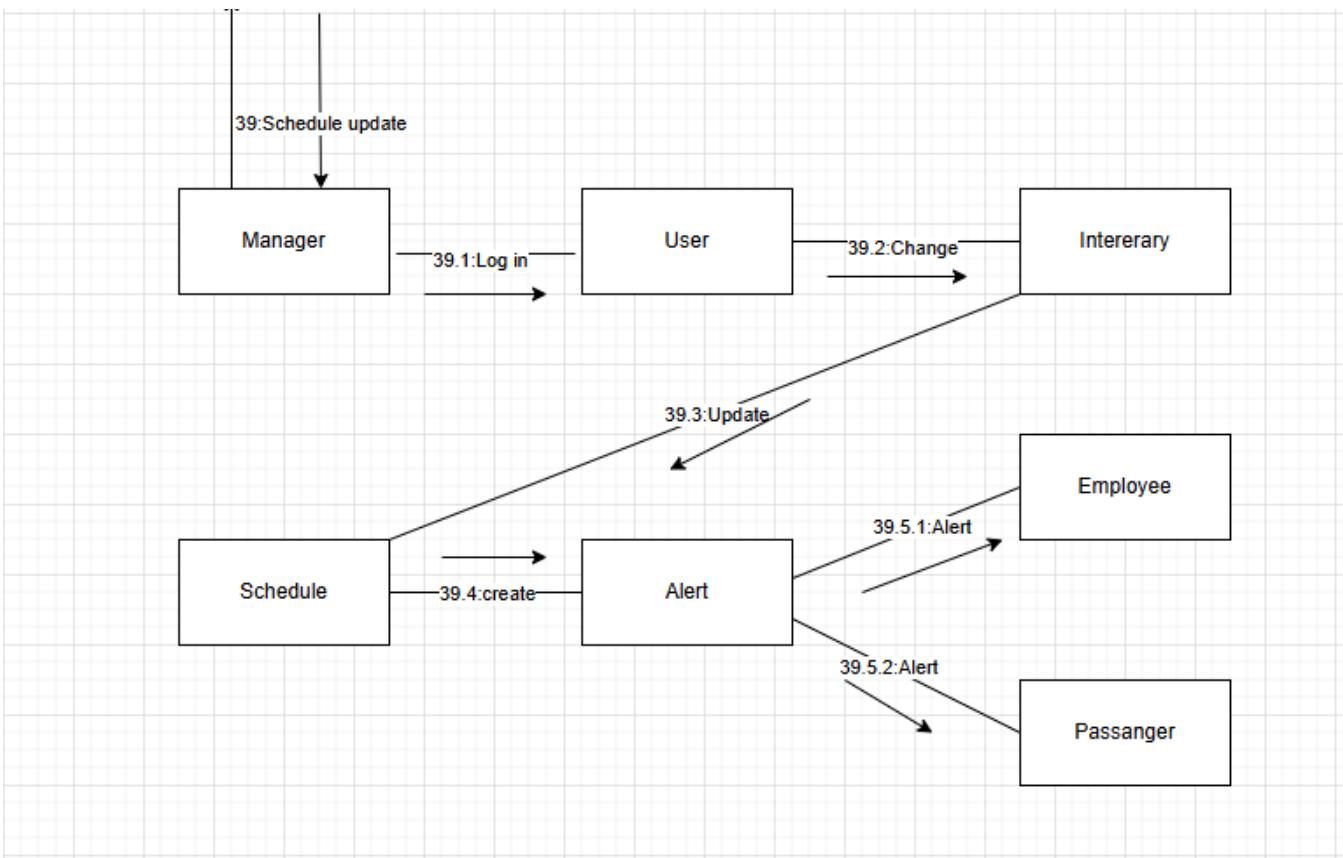
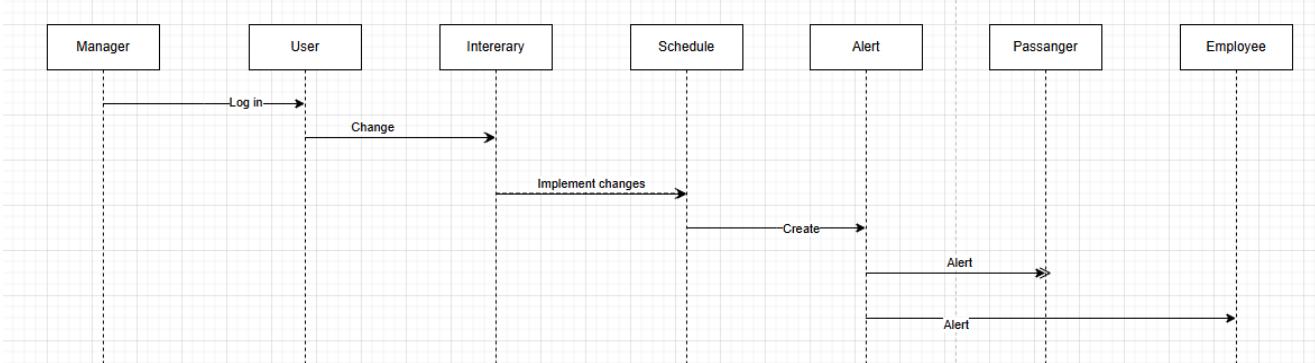
UC Name	S_SCH_36
Summary	The system must keep track of the schedule of everything within a specific timeframe
Dependency	TM_MNG_01 S_INT_02 S_TRK_03 S_TRK_04 S_TRK_05 S_SCH_06
Actors	System, Manager
Preconditions	Schedule data must be available.
Description of the Main Sequence	1. System retrieves the schedule from the itinerary. 2. System updates schedule changes in real time. 3. if changes are made update and alert parties included.
Description of the Alternative Sequence	If system fails to retrieve schedule, an error message is displayed.
Non functional requirements	System must ensure schedule accuracy.
Postconditions	Schedule data is up-to-date.

Railway Management System Requirements Specification

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Railway Management System Requirements Specification

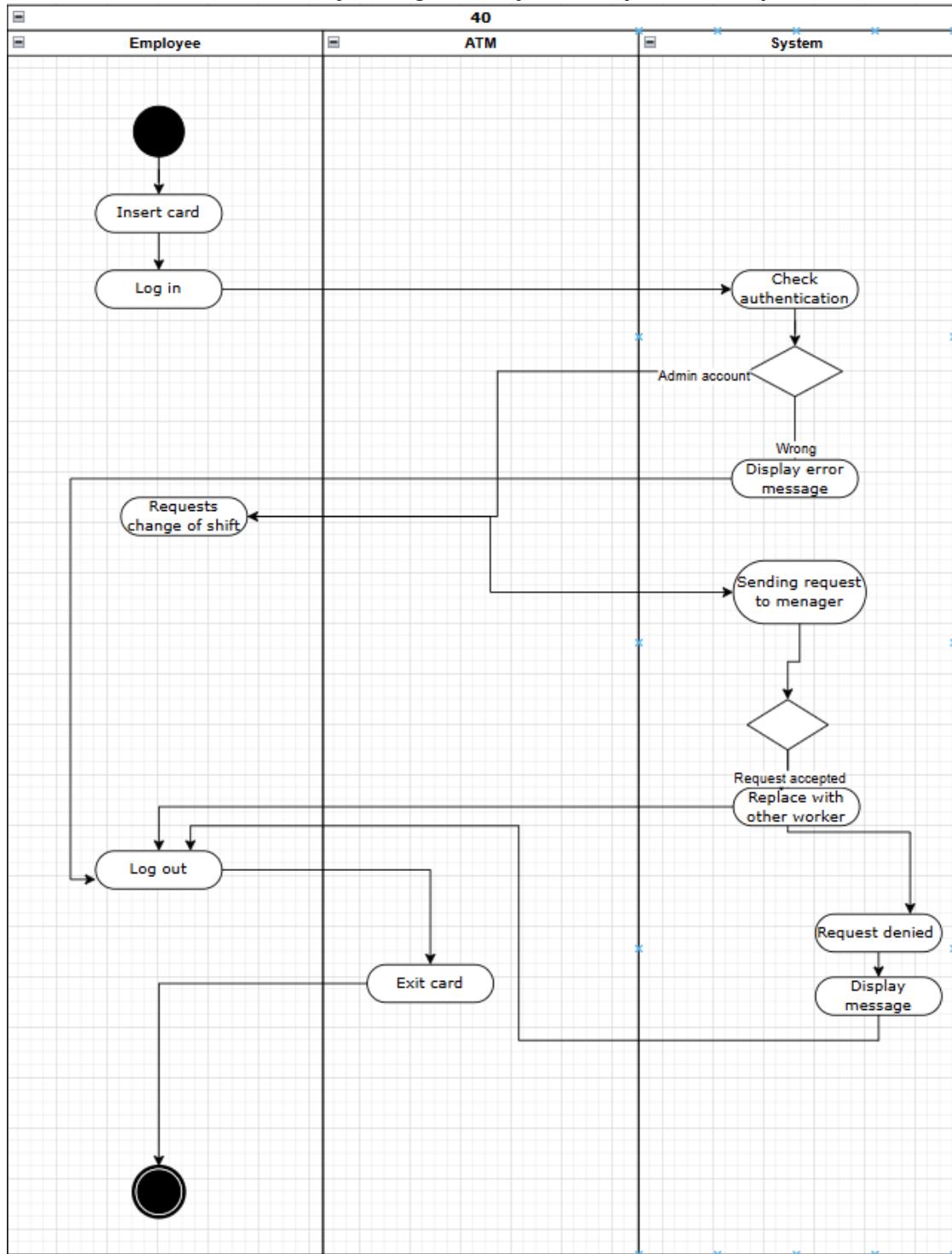


UC Name	E_WRK_37
Summary	Employees may request a shift change or time off
Dependency	S_SCH_36
Actors	Employee, System

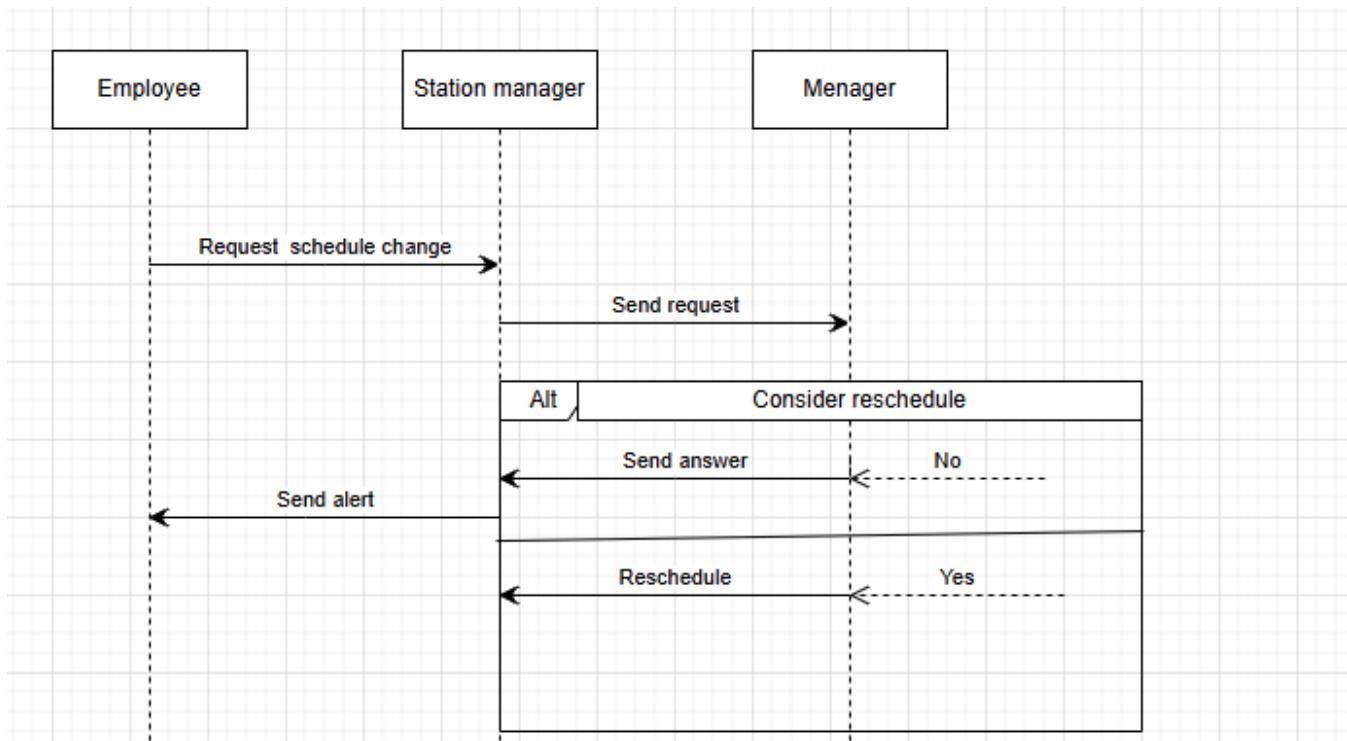
Railway Management System Requirements Specification

Preconditions	Employee must be logged in.
Description of the Main Sequence	<ol style="list-style-type: none">1. Employee submits a shift change request.2. station manager processes request and updates schedule.3. Alert employee of the status of their request.
Description of the Alternative Sequence	If request fails, an error message is displayed.
Non functional requirements	System must notify employees of request status.
Postconditions	Shift request is processed.

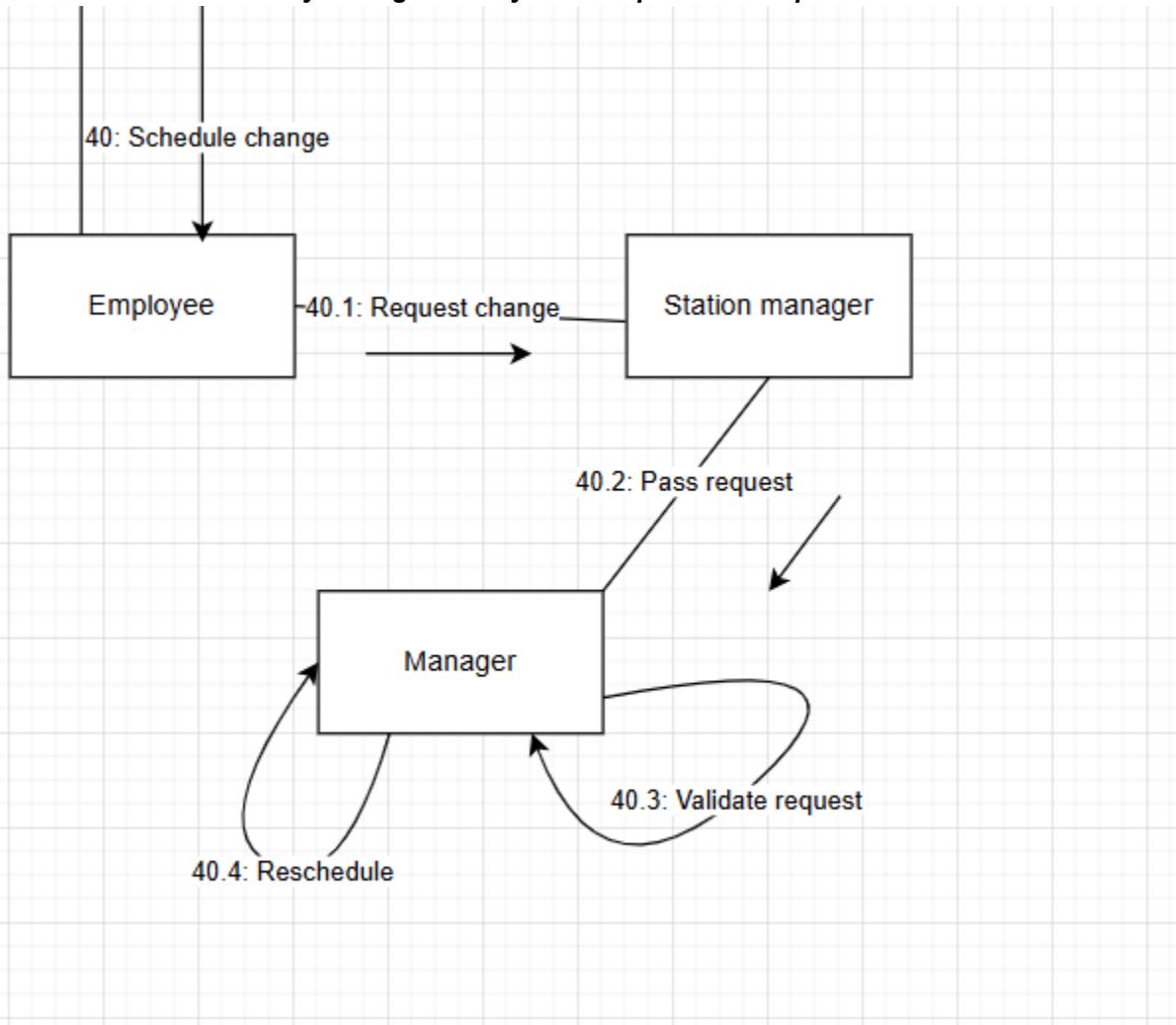
Railway Management System Requirements Specification



Railway Management System Requirements Specification



Railway Management System Requirements Specification



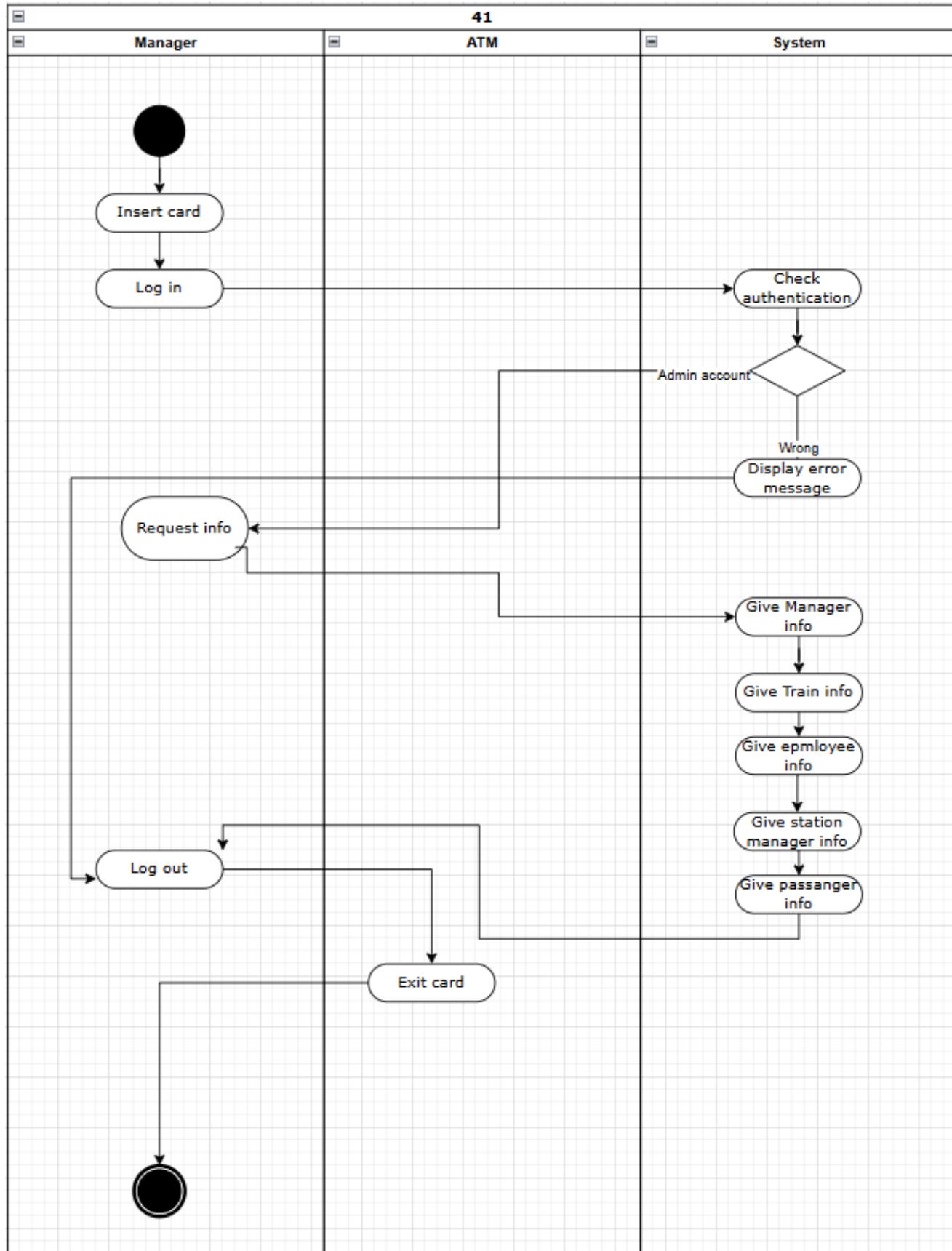
UC Name	A_VIW_38
Summary	An Manager user is allowed to view all info on the system
Dependency	All
Actors	Manager, System
Preconditions	Manager must be logged in.
Description of the Main Sequence	<ol style="list-style-type: none"> 1. Manager accesses system overview. 2. System displays relevant data.
Description of the Alternative Sequence	System must ensure data confidentiality.

Railway Management System Requirements Specification

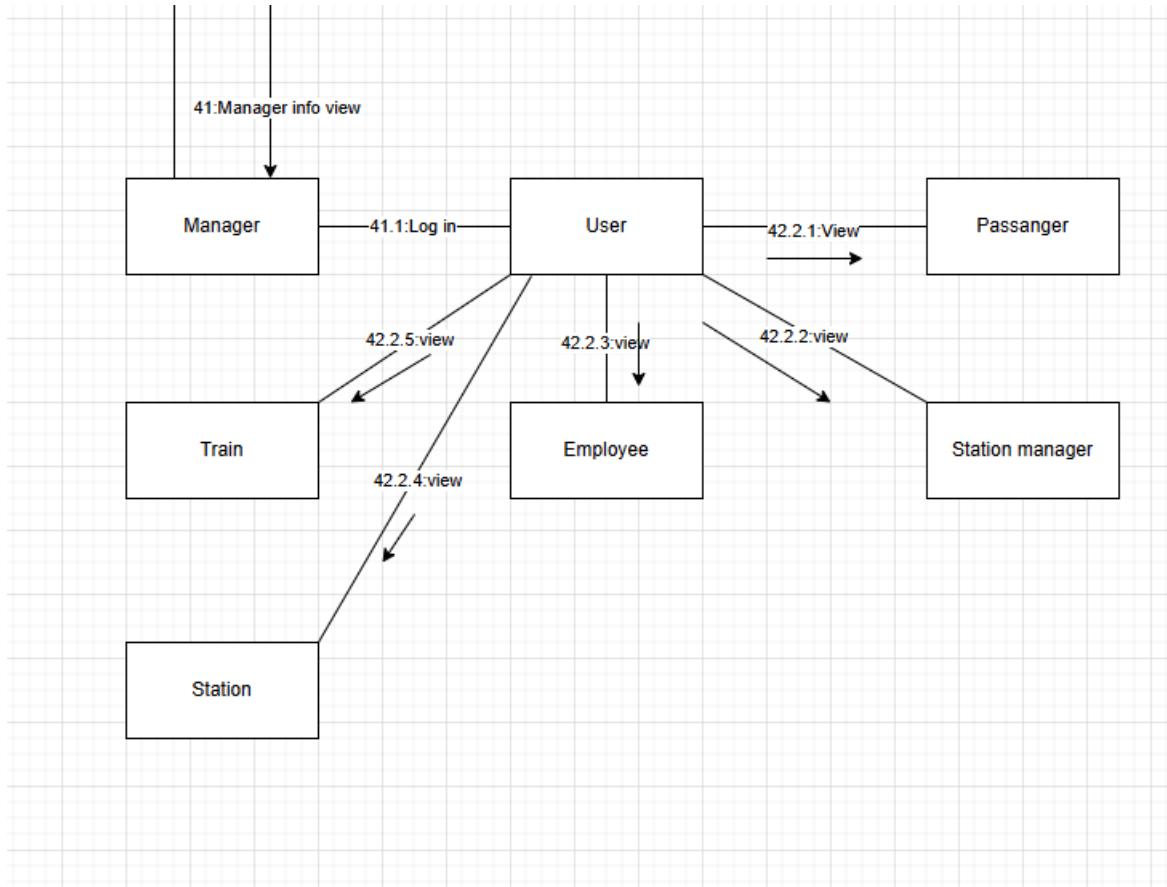
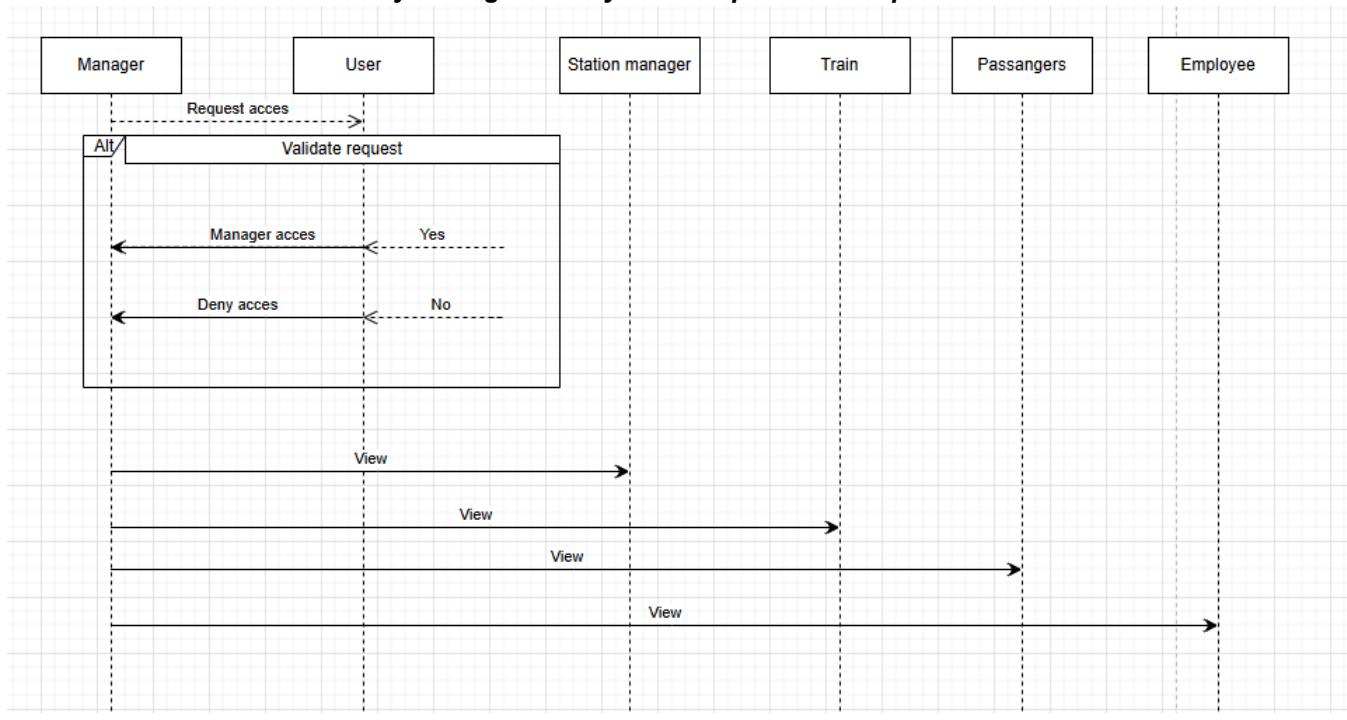
Non functional requirements	-
Postconditions	Manager successfully views system information.

Railway Management System Requirements Specification

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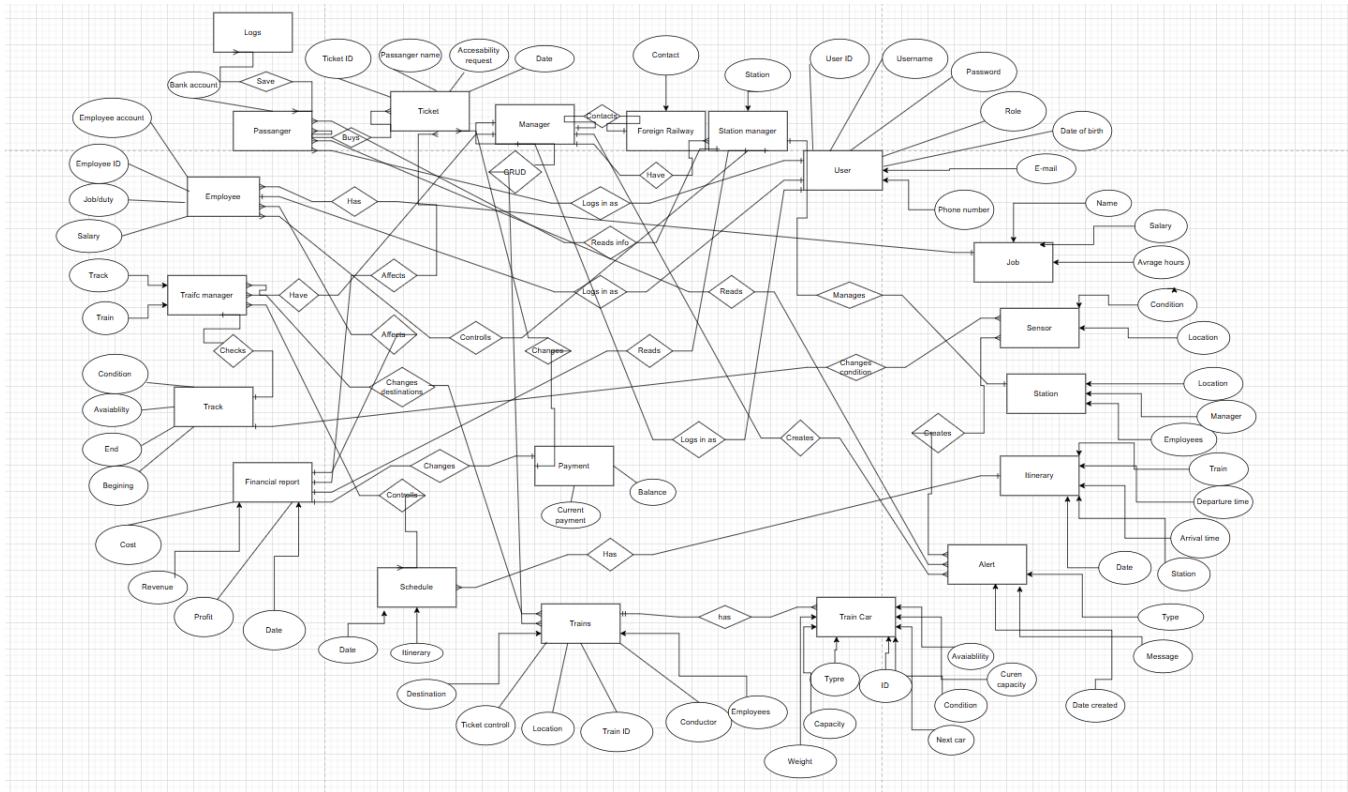
Railway Management System Requirements Specification



5. Diagrams

In this section you are going to place all of the diagrams that you build throughout the course, in following with the slides presented throughout the weeks.

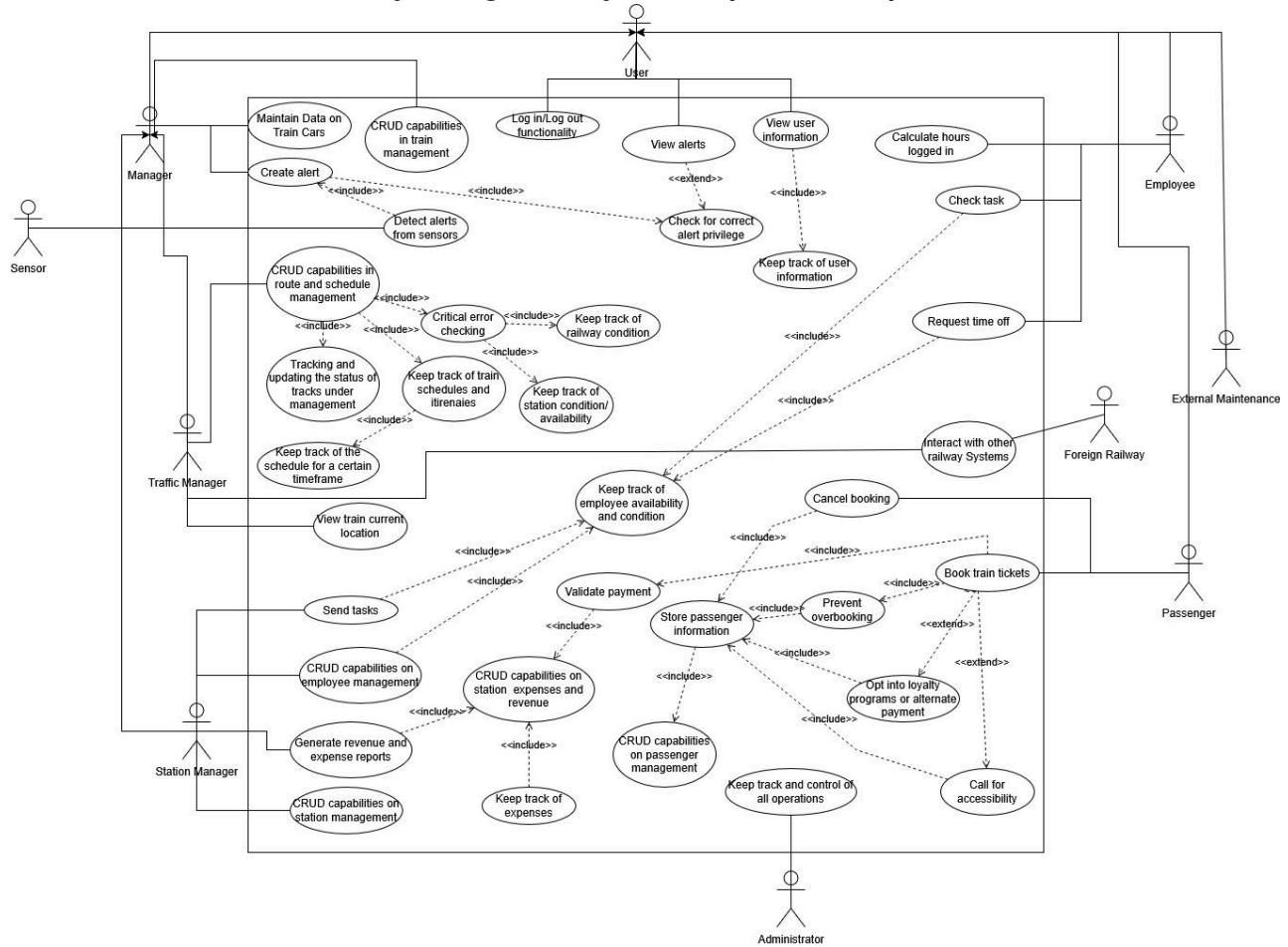
5.1 ER Diagram



5.2 Use Case Diagram (general)

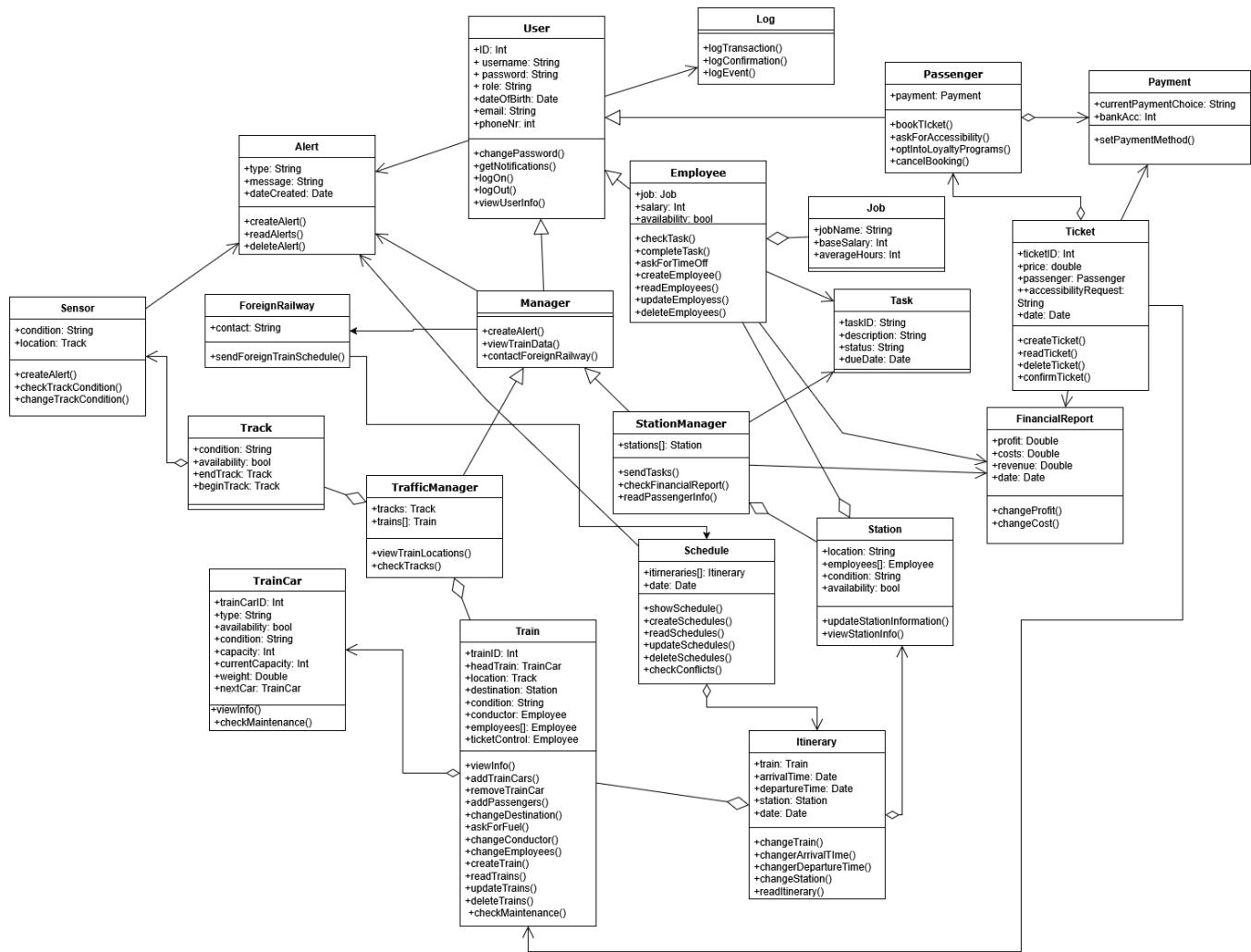
Use Case Diagram (only one, with all the use cases).

Railway Management System Requirements Specification



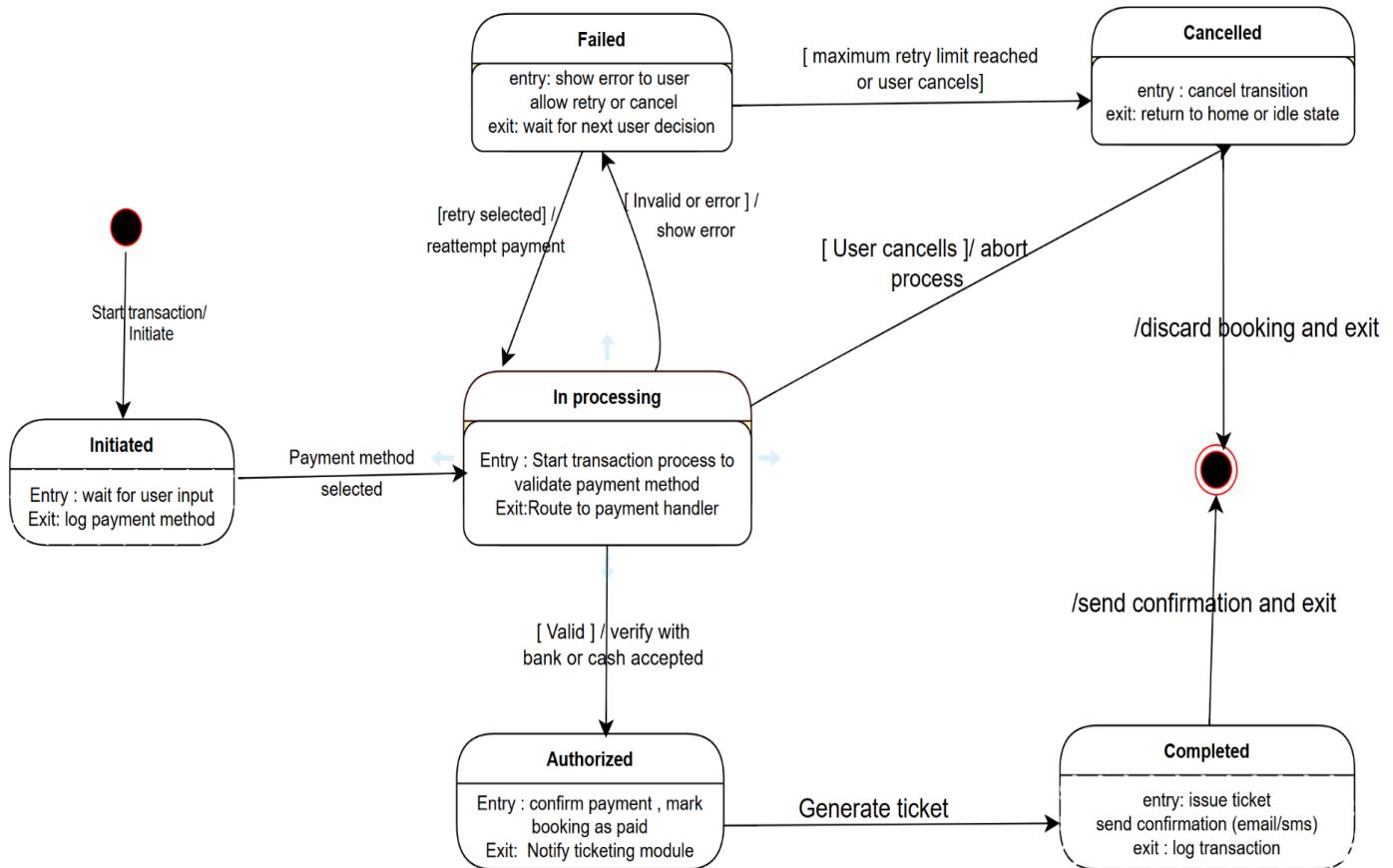
5.4. Class diagram.

Railway Management System Requirements Specification

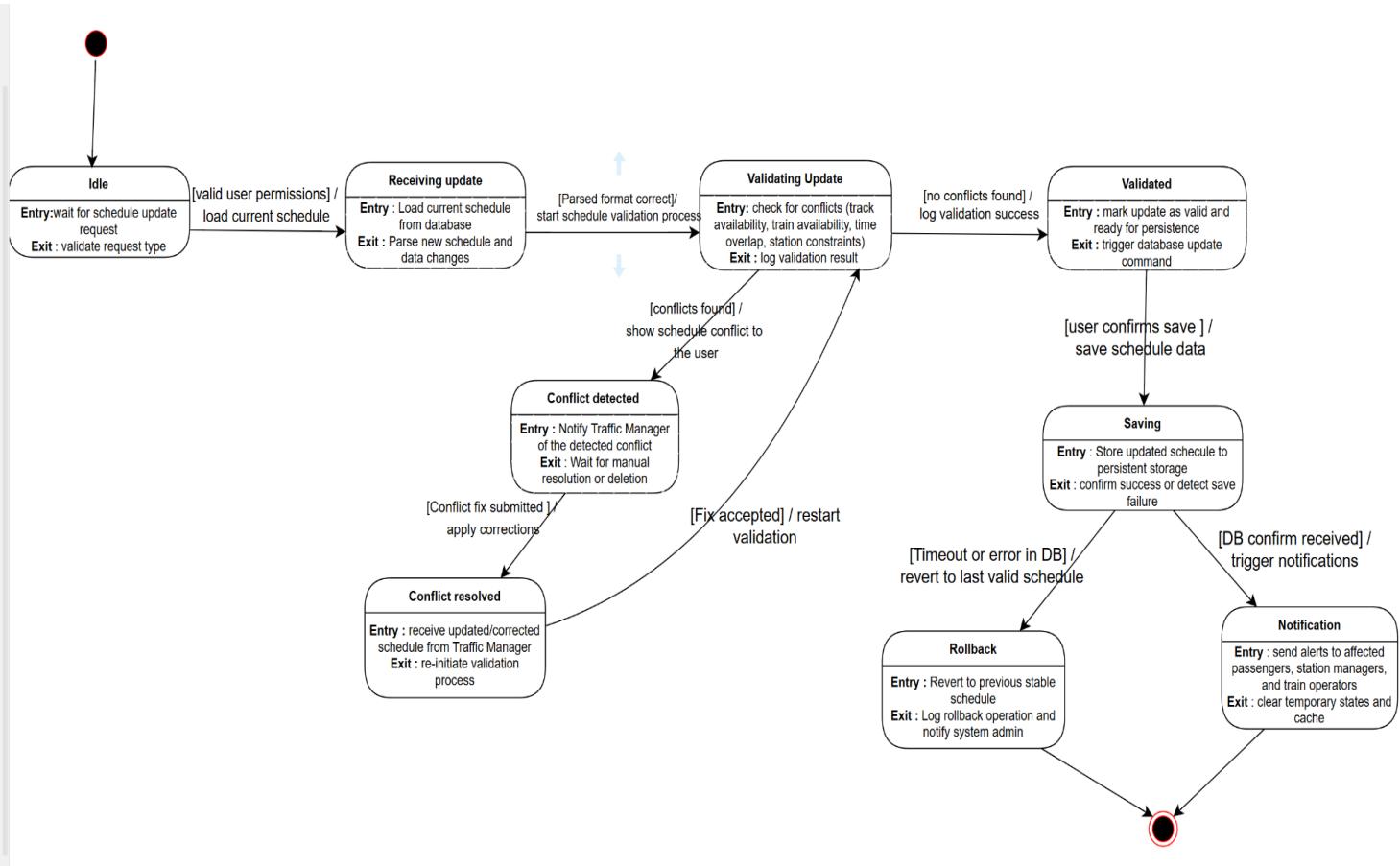


5.5 State diagram

Payment Transaction State Diagram

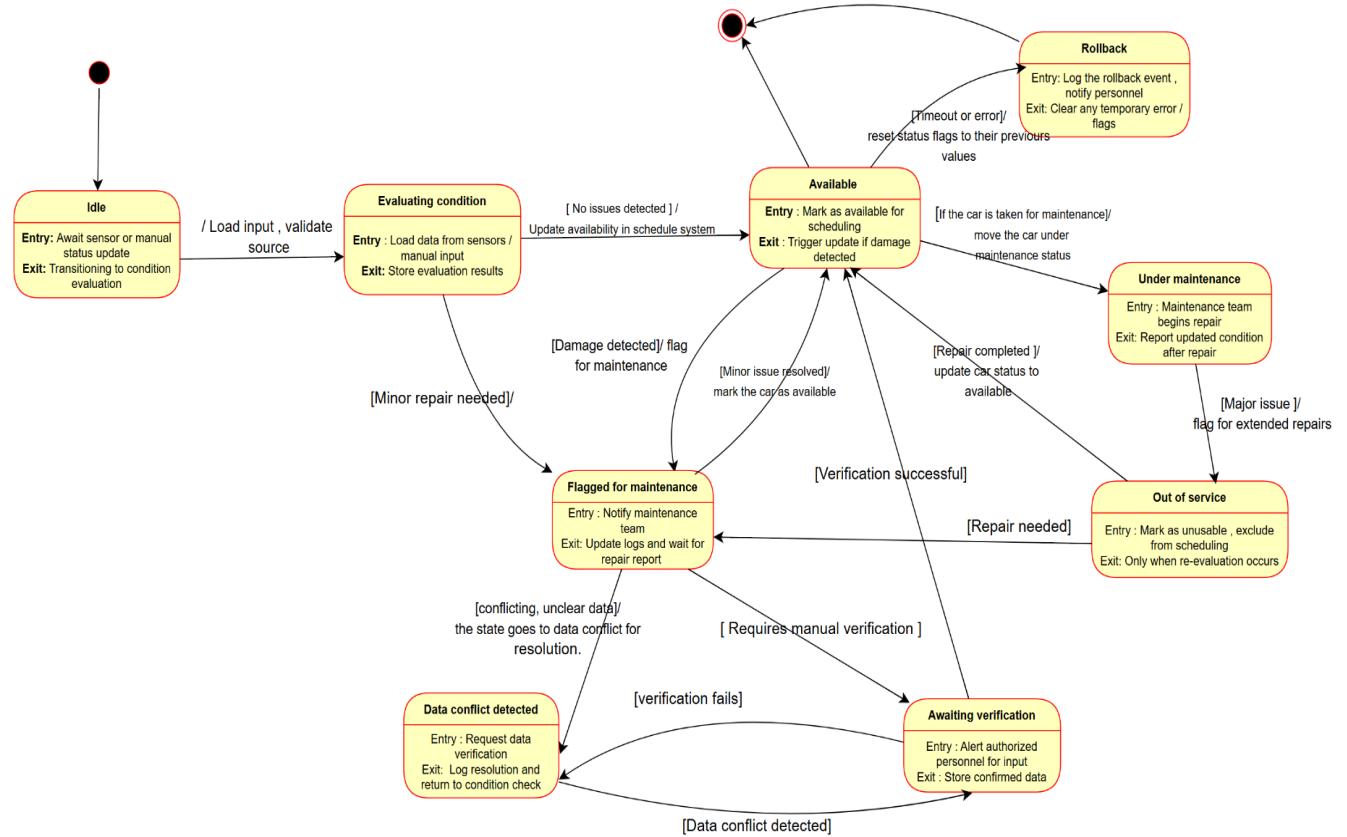


State diagram : Train schedule record

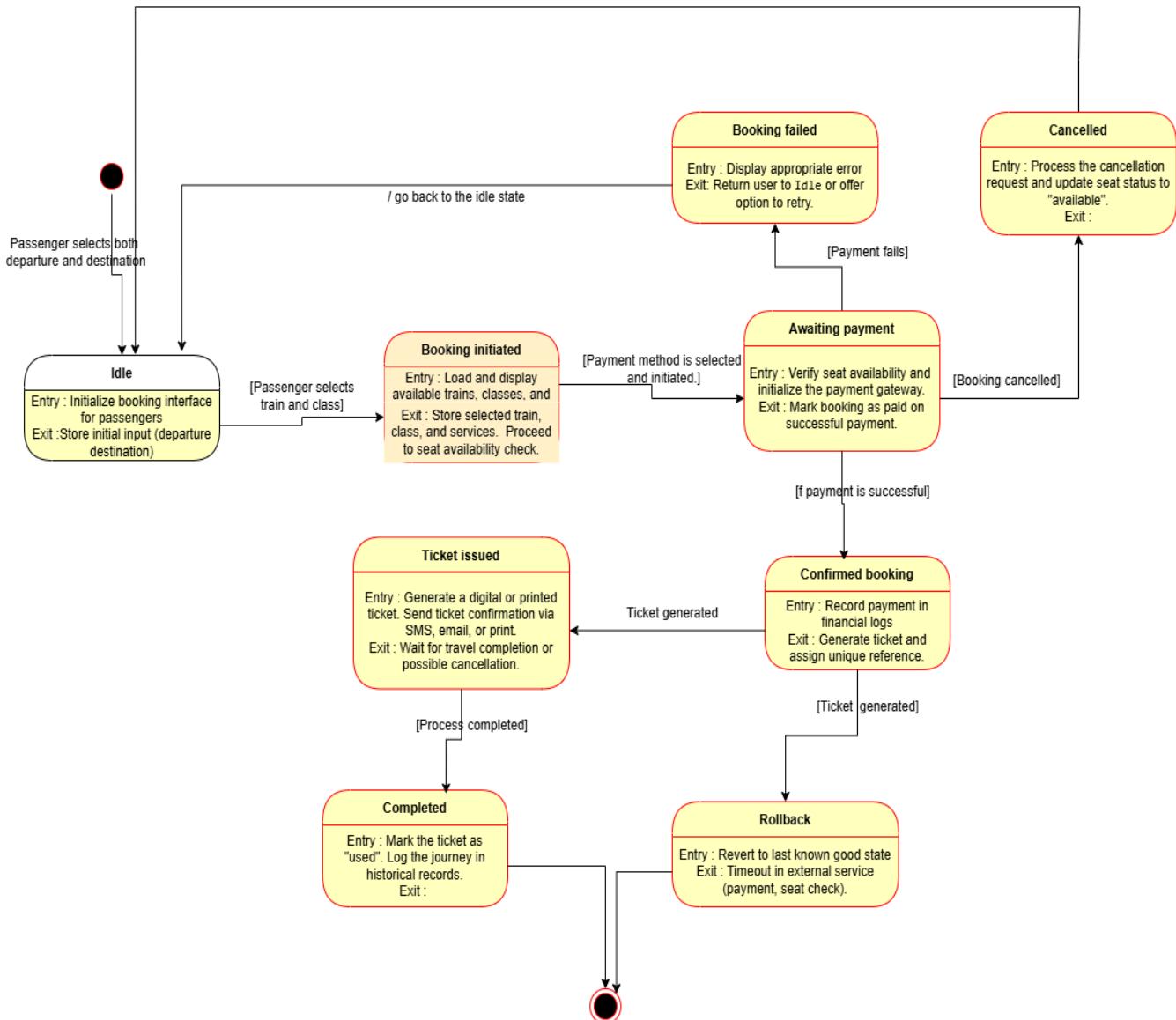


Note: **Rollback** is a process where the system undoes or reverts changes made during an operation due to an error or conflict. It ensures the system returns to its previous stable state, maintaining data integrity and preventing further issues.

Train car condition monitoring state diagram



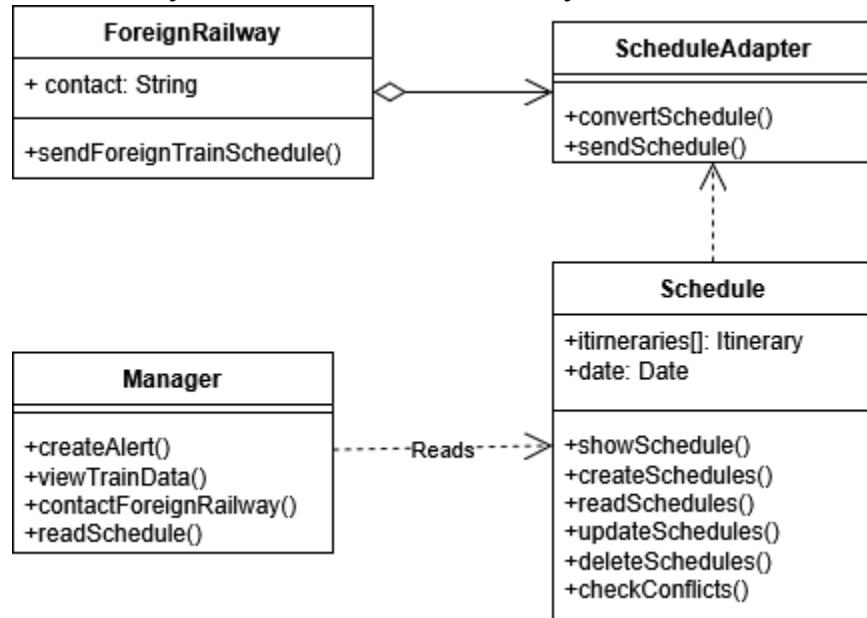
Railway Management System Requirements Specification
Ticket Booking State Diagram



6. Design Patterns

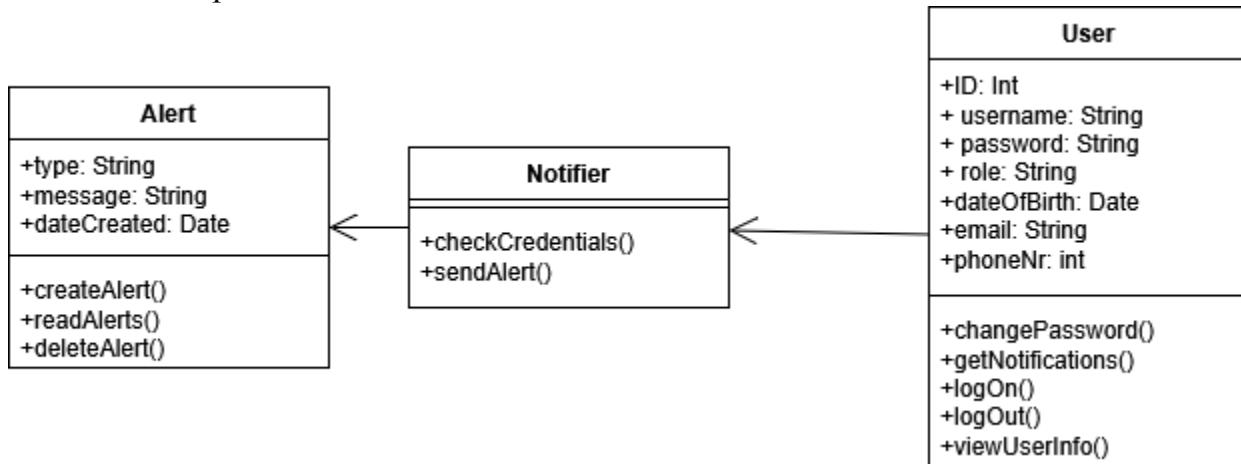
- Adapter Pattern

We want to ensure that Foreign Railways, that are outside of our system, are able to send their schedule in a way that can interact with our system, without causing bugs or errors.



- Proxy Pattern

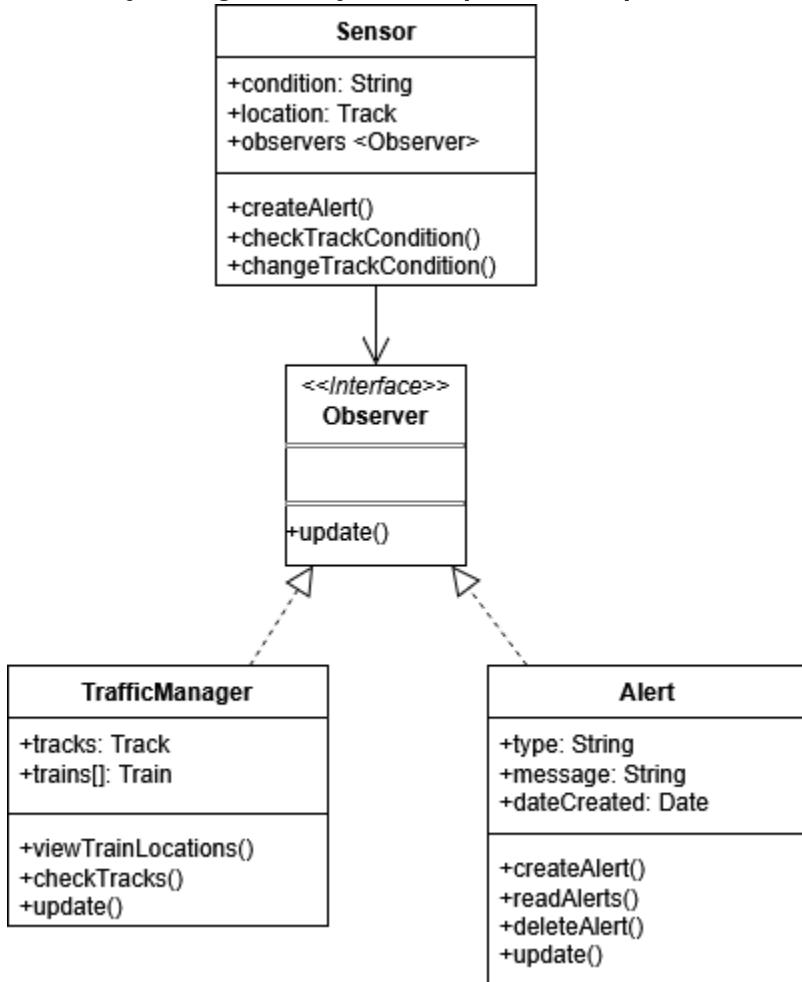
We use the proxy pattern to “decompose” the Alert class, while also keeping the way the Users actually receive information separate from the way that Alerts themselves are made and updated.



- Observer Pattern

Since we have multiple classes that have functionalities that depend on the state of a specific other class, and we want to make sure that they receive updates on the changes of said class, this is a textbook definition use for the Observer pattern. This also allows us to allot more computational power to this functionality as it is a critical component in the system.

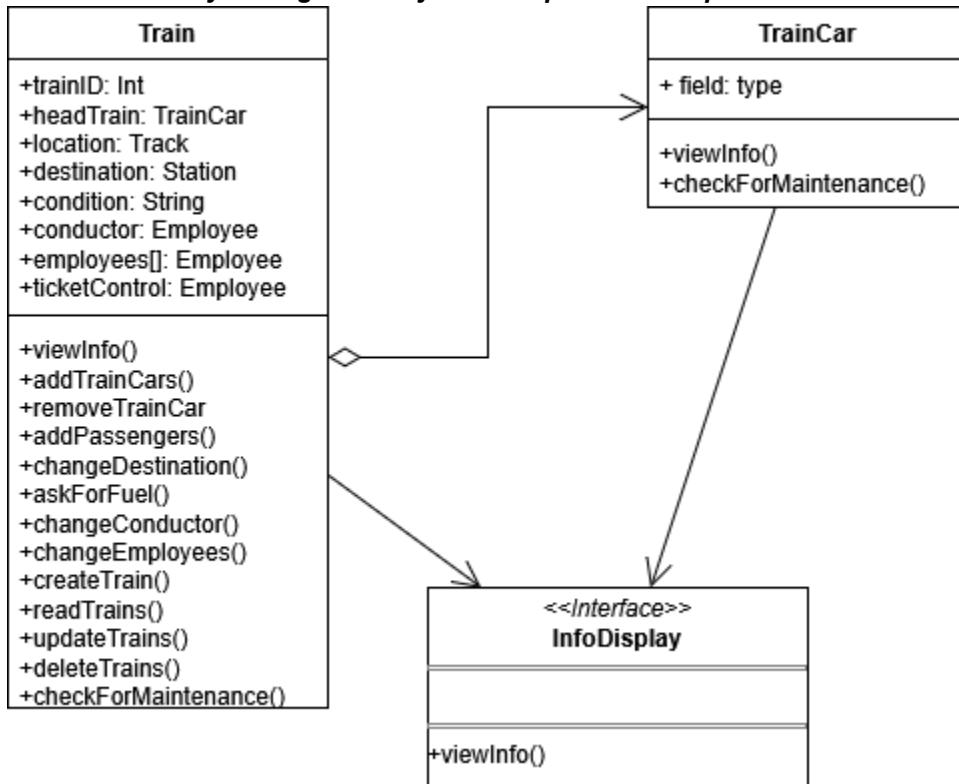
Railway Management System Requirements Specification



- Composite Pattern

Using the Composite pattern, we make sure that the classes in question, Train and TrainCar, respectively have different definitions and implementations of functions that they share, specifically used due to the fact that a Train is composed from a group of TrainCar objects.

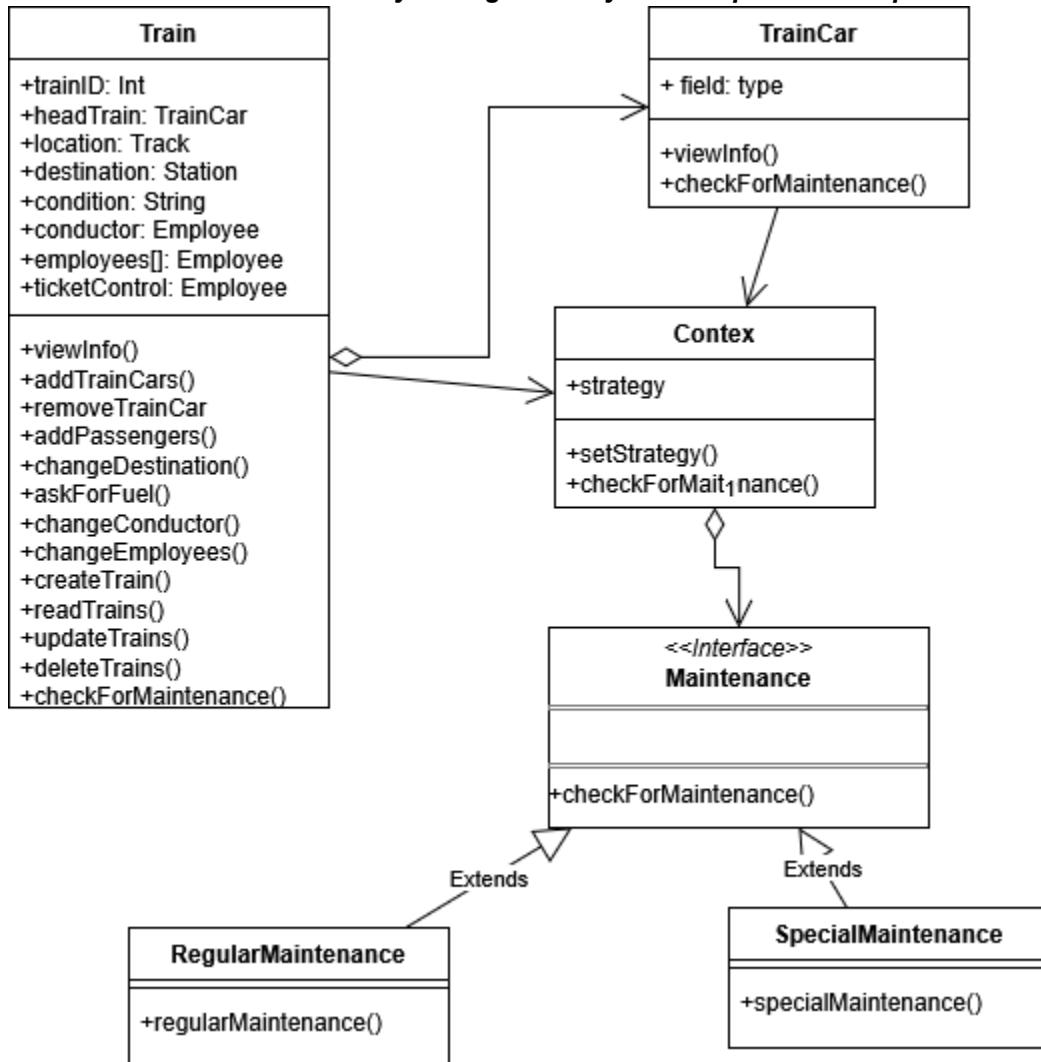
Railway Management System Requirements Specification



- **Strategy Pattern**

We have the same situation, in this case, the maintenance of the vehicles, which can happen in two different scenarios. One, either its a regular checkup maintenance, or its maintenance done after something has been broken or perhaps modifications are needed. Therefore, since we have this situation, we can use the Strategy pattern to make sure the code is implemented correctly, without affecting each other.

Railway Management System Requirements Specification



Work and Task Allocation for the Project

Group Members	Work Done
Alijon Sina	Project Leader, System Architecture and Design, Requirement Creation, Class Diagram Creation, Design Patterns.
Arber Lilaj	Use Case 14, 17, 18, 20
Durim Ceka	Use Cases 22, 23, 26, 27, State Diagrams.
Endi Cikalleshi	Use Cases 24, 25, 26, 27
Endri Dika	Use Case 1 - 6, 15, 16, 19, State Diagrams
Endri Lika	Use Case 7 - 13
Geldi Salillari	Use Cases 29 - 38, ER Diagram.