# Functional Requirement

1. Functional Requirements  
  
1.1 Vehicle Registration Function   
 Function ID: FR-01   
 Description: Administrators can register new vehicles, update existing registrations, or remove outdated vehicle records. This function ensures data integrity by validating input and checking for duplicate entries in the Data Source.   
 Input: Vehicle details (e.g., make, model, license plate, vehicle identification number (VIN), and registration status).   
 Output: Updated or newly added vehicle data stored in the Data Cache and Data Archive. The Map Display and Icon Layer are updated to reflect the new or modified vehicle location.   
  
1.2 Manage Vehicle Data Function   
 Function ID: FR-02   
 Description: Administrators can add, update, or remove vehicle data from the system. The function ensures that all changes are validated and stored in the Data Cache and Data Archive.   
 Input: Vehicle data (e.g., VIN, license plate, location, speed, or registration status) and an action (Add, Update, Remove).   
 Output: Updated vehicle data stored in the Data Cache and Data Archive. The Map Display and Icon Layer are refreshed to reflect the current state of vehicle data.   
  
1.3 Read Vehicle Information Function   
 Function ID: FR-03   
 Description: Administrators can retrieve and view detailed information about a specific vehicle, including its location and status. The retrieved data is stored in the Data Cache for quick access.   
 Input: Vehicle identifier (e.g., VIN or license plate).   
 Output: Retrieved vehicle data displayed in the User Interface. The Map Display and Icon Layer are updated to show the vehicle's location and current status.   
  
1.4 Delete Vehicle Record Function   
 Function ID: FR-04   
 Description: Administrators can delete a vehicle record from the system. The function ensures that the deletion is validated and that the Data Cache and Data Archive are updated accordingly.   
 Input: Vehicle identifier (e.g., VIN or license plate).   
 Output: Deleted vehicle data removed from the Data Cache and Data Archive. The Map Display and Icon Layer are updated to remove the deleted vehicle’s representation.   
  
1.5 Traffic Data Collection Function   
 Function ID: FR-05   
 Description: The system collects real-time traffic data from various Data Sources and stores it in the Data Cache and Data Archive for immediate and long-term use.   
 Input: Traffic data (e.g., vehicle speed, traffic volume, and occupancy) from external Data Sources.   
 Output: Collected and validated traffic data stored in the Data Cache and Data Archive. The Map Display and Icon Layer are updated to reflect current traffic conditions.   
  
1.6 Analyze Traffic Metrics Function   
 Function ID: FR-06   
 Description: The system analyzes traffic data to derive key metrics such as congestion levels, travel times, and queue lengths using predefined Algorithms.   
 Input: Traffic data (e.g., vehicle speed, traffic volume, and occupancy) and analysis parameters (e.g., geographic area and time frame).   
 Output: Traffic metrics (e.g., congestion level, travel time, queue length) stored in the Data Cache and Data Archive. The Map Display and Icon Layer are updated to reflect the analysis results.   
  
1.7 Update Traffic Status Function   
 Function ID: FR-07   
 Description: The system updates the traffic status based on the latest data collected from the Data Source. This function ensures that the updated status is stored and visualized on the Map Display.   
 Input: Traffic data (e.g., vehicle speed, congestion level, and incident status) and update parameters (e.g., geographic area and time frame).   
 Output: Updated traffic status stored in the Data Cache and Data Archive. The Map Display and Icon Layer are refreshed to reflect the current traffic conditions.   
  
1.8 View Traffic Congestion Function   
 Function ID: FR-08   
 Description: The system retrieves and displays current traffic congestion levels, based on vehicle speed and density, using the Michigan Geographic Framework for spatial representation.   
 Input: Geographic area and time frame for congestion analysis.   
 Output: Traffic congestion level visualization on the Map Display. The results are stored in the Data Cache for quick access in future sessions.   
  
1.9 Weather Data Integration Function   
 Function ID: FR-09   
 Description: The system integrates real-time weather data with traffic and road condition data to improve incident detection and road surface condition inference.   
 Input: Weather data (e.g., temperature, precipitation, visibility) and integration parameters (e.g., geographic area and time frame).   
 Output: Integrated weather and traffic data stored in the Data Cache and Data Archive. The Map Display and Icon Layer are updated to reflect weather-related traffic impacts.   
  
1.10 Process Weather Observations Function   
 Function ID: FR-10   
 Description: The system processes and normalizes weather observation data, aligning it with traffic and road condition data for analysis and visualization.   
 Input: Weather observation data (e.g., temperature, wind speed, and precipitation) and processing parameters (e.g., geographic area and time frame).   
 Output: Processed weather data stored in the Data Cache and Data Archive. The Map Display and Icon Layer are updated to reflect the weather conditions.   
  
1.11 Modify Weather Record Function   
 Function ID: FR-11   
 Description: Administrators can modify weather records in the system, including updating temperature, precipitation, or visibility data. The modified data is validated and stored for use in analysis.   
 Input: Weather record identifier (e.g., location and timestamp) and updated weather data (e.g., temperature, precipitation, visibility).   
 Output: Updated weather data stored in the Data Cache and Data Archive. The Map Display and Icon Layer are refreshed to reflect the new weather conditions.   
  
1.12 Road Condition Monitoring Function   
 Function ID: FR-12   
 Description: The system monitors road conditions and visualizes them on the Map Display using the Michigan Geographic Framework.   
 Input: Road condition data (e.g., surface condition, visibility, and friction) and monitoring parameters (e.g., geographic area and time frame).   
 Output: Road condition visualization on the Map Display. The processed data is stored in the Data Cache and Data Archive.   
  
1.13 Infer Road Surface Status Function   
 Function ID: FR-13   
 Description: The system infers the current road surface status by analyzing Road Condition Data, Traffic Data, and Weather Data. This function is used to determine conditions such as icy, wet, or dry road surfaces.   
 Input: Road condition data, traffic data, and weather data.   
 Output: Inferred road surface status stored in the Data Cache and Data Archive. The Map Display and Icon Layer are updated to reflect the inferred road conditions.   
  
1.14 Update Road Condition Function   
 Function ID: FR-14   
 Description: Administrators can update road condition records in the system, including surface condition, visibility, or road closure status. The updated data is validated and stored for analysis and visualization.   
 Input: Road segment identifier (e.g., road name or segment ID) and updated road condition data (e.g., surface condition, visibility, or closure status).   
 Output: Updated road condition data stored in the Data Cache and Data Archive. The Map Display and Icon Layer are refreshed to reflect the changes.   
  
1.15 Incident Detection Function   
 Function ID: FR-15   
 Description: The system detects traffic incidents such as accidents, breakdowns, or road closures by analyzing Traffic Data, Road Condition Data, and Weather Data.   
 Input: Traffic data, road condition data, and weather data.   
 Output: Detected incident data stored in the Data Cache and Data Archive. The Map Display and Icon Layer are updated to reflect incident locations.   
  
1.16 Manage Incident Details Function   
 Function ID: FR-16   
 Description: Administrators can add, update, or remove incident details in the system. The function ensures that changes are validated and stored for use in alerts and visualization.   
 Input: Incident details (e.g., location, type, severity, and time of occurrence) and an action (Add, Update, Remove).   
 Output: Updated or newly added incident data stored in the Data Cache and Data Archive. The Map Display and Icon Layer are refreshed to reflect the new or modified incident status.   
  
1.17 Delete Incident Record Function   
 Function ID: FR-17   
 Description: Administrators can delete an incident record from the system. The function ensures that the deletion is validated and that the Data Cache and Data Archive are updated accordingly.   
 Input: Incident identifier (e.g., location and timestamp).   
 Output: Deleted incident data removed from the Data Cache and Data Archive. The Map Display and Icon Layer are updated to remove the incident’s visual representation.   
  
1.18 View Incident Information Function   
 Function ID: FR-18   
 Description: Administrators can retrieve and view detailed information about a specific incident, including its location, type, severity, and status. The retrieved data is stored in the Data Cache for quick access.   
 Input: Incident identifier (e.g., location, type, or timestamp).   
 Output: Retrieved incident data displayed in the User Interface. The Map Display and Icon Layer are updated to reflect the incident’s location and details.   
  
1.19 Data Caching Management Function   
 Function ID: FR-19   
 Description: Administrators can manage the Data Cache by adding, updating, or removing data. The function ensures that caching strategies are optimized and that the Data Cache and Data Archive are synchronized.   
 Input: Data type (e.g., vehicle, road, or incident data) and an action (Add, Update, Remove).   
 Output: Updated Data Cache and Data Archive. The Map Display and Icon Layer are refreshed to reflect any changes in data representation.   
  
1.20 Archive Historical Data Function   
 Function ID: FR-20   
 Description: Administrators can archive historical data from the Data Cache to the Data Archive for long-term storage. The function ensures that the data is validated and formatted for archival.   
 Input: Data type (e.g., traffic, weather, or incident data) and a time range for archiving.   
 Output: Archived data stored in the Data Archive. The Data Cache is cleared or updated as needed. The Map Display and Icon Layer remain unchanged unless affected by the data.   
  
1.21 Retrieve Archived Data Function   
 Function ID: FR-21   
 Description: Administrators can retrieve historical data from the Data Archive and store it in the Data Cache for quick access and visualization.   
 Input: Data type (e.g., vehicle, road condition, or incident data) and an identifier (e.g., vehicle ID or incident ID).   
 Output: Retrieved data stored in the Data Cache. The Map Display and Icon Layer are updated to reflect the archived data as needed.   
  
1.22 Data Quality Validation Function   
 Function ID: FR-22   
 Description: The system validates incoming data (e.g., traffic, weather, or road condition data) to ensure consistency, completeness, and accuracy. Invalid or corrupted data is flagged or corrected.   
 Input: Data type (e.g., traffic data, weather data, or road condition data) and a time range for validation.   
 Output: Valid data stored in the Data Cache and Data Archive. Invalid data is flagged and reported to the Administrator. The Map Display and Icon Layer are updated if the validation affects the data visualization.   
  
1.23 Modify Data Quality Rule Function   
 Function ID: FR-23   
 Description: Administrators can modify existing data quality rules to adapt to changing data standards or system requirements. The function ensures that the new rule is validated and stored.   
 Input: Rule identifier (e.g., rule name or ID) and updated rule parameters (e.g., validation thresholds, data formats, or error tolerances).   
 Output: Updated data quality rule stored in the Data Cache and Data Archive. The Algorithm is updated to reflect the new rule.   
  
1.24 Administrator Login Function   
 Function ID: FR-24   
 Description: Administrators can log in to the system using valid credentials. The function ensures that login attempts are validated and that session information is stored in the Data Cache.   
 Input: Username and password.   
 Output: Session information stored in the Data Cache. The Administrator is granted access to the system and receives a confirmation Alert.   
  
1.25 Access User Interface Function   
 Function ID: FR-25   
 Description: The system provides access to the User Interface after successful login. The function ensures that the session is recorded and that the Administrator is informed of the access.   
 Input: Valid login session.   
 Output: Access granted to the User Interface. Session details are stored in the Data Cache. An Alert is generated to confirm the access.   
  
1.26 Browse Traffic Information Function   
 Function ID: FR-26   
 Description: Administrators can browse and view real-time or historical traffic information. The function ensures that the data is retrieved, validated, and visualized on the Map Display.   
 Input: Geographic area and time frame for traffic data.   
 Output: Traffic information retrieved and displayed in the User Interface. The Map Display and Icon Layer are updated to reflect current traffic conditions.   
  
1.27 Display Map Overview Function   
 Function ID: FR-27   
 Description: The system displays a comprehensive map overview that integrates traffic, road condition, and weather data. The function ensures that the map is updated and that the data is formatted for visualization.   
 Input: Traffic data, road condition data, and weather data.   
 Output: Updated Map Display with visual representation of traffic, road, and weather conditions. The Data Cache is updated with the latest data for quick reference.   
  
1.28 Toggle Icon Layer Function   
 Function ID: FR-28   
 Description: Administrators can toggle the visibility of the Icon Layer to display or hide specific data visualizations on the Map Display.   
 Input: Action (Enable or Disable) and optional data layer to toggle.   
 Output: Updated visibility status of the Icon Layer stored in the Data Cache. The Map Display is refreshed to reflect the new visibility state.   
  
1.29 Declutter Map View Function   
 Function ID: FR-29   
 Description: Administrators can declutter the Map Display by hiding or prioritizing specific data layers to improve visual clarity.   
 Input: Data layers to hide or show.   
 Output: Updated Map Display with decluttered view. The new decluttering settings are stored in the Data Cache for future use.   
  
1.30 Add Data Source Function   
 Function ID: FR-30   
 Description: Administrators can add a new Data Source to the system, including its name, type, connection parameters, and data format. The function ensures that the Data Source is validated and stored.   
 Input: Data Source details (e.g., name, type, connection parameters, and data format).   
 Output: New Data Source metadata stored in the Data Cache and Data Archive. An Alert is generated to confirm the addition.   
  
1.31 Configure Algorithm Function   
 Function ID: FR-31   
 Description: Administrators can configure the parameters of an Algorithm to customize its behavior for data processing and analysis.   
 Input: Algorithm identifier (e.g., name or ID) and new configuration parameters (e.g., thresholds, weights, or data formats).   
 Output: Updated Algorithm configuration stored in the Data Cache and Data Archive. The Map Display and Icon Layer are refreshed if the configuration affects spatial data visualization.   
  
1.32 Update Algorithm Function   
 Function ID: FR-32   
 Description: Administrators can update an Algorithm with new settings or versions. The function ensures that the update is validated and that the Algorithm is synchronized with the Data Cache and Data Archive.   
 Input: Algorithm identifier (e.g., name or ID) and updated algorithm parameters or version.   
 Output: Updated Algorithm stored in the Data Cache and Data Archive. The Map Display and Icon Layer are refreshed if the update affects data visualization.   
  
1.33 Delete Algorithm Function   
 Function ID: FR-33   
 Description: Administrators can delete an Algorithm from the system. The function ensures that the deletion is validated and that the Data Cache and Data Archive are updated.   
 Input: Algorithm identifier (e.g., name or version).   
 Output: Algorithm removed from the Data Cache and Data Archive. The Map Display and Icon Layer are refreshed if the deletion affects data visualization.   
  
1.34 Format Data Output Function   
 Function ID: FR-34   
 Description: The system formats data into specified Output Formats (e.g., SAE J2354, TMDD, or custom format) for external use.   
 Input: Data type (e.g., traffic, weather, or incident data) and Output Format (e.g., SAE J2354 or TMDD).   
 Output: Formatted data stored in the Data Cache and Data Archive. The Map Display and Icon Layer are updated if the formatting affects spatial data.   
  
1.35 Modify Output Format Function   
 Function ID: FR-35   
 Description: Administrators can modify the Output Format configuration to align data with new or updated standards.   
 Input: Output Format identifier (e.g., format name or ID) and new format parameters (e.g., mapping rules or field definitions).   
 Output: Updated Output Format configuration stored in the Data Cache and Data Archive. The Algorithm is updated to reflect the new format.   
  
1.36 Publish Data to SAE J2354 Function   
 Function ID: FR-36   
 Description: The system publishes data in SAE J2354 format to external systems.   
 Input: Data type (e.g., traffic, road condition, or weather data) to be published.   
 Output: Data in SAE J2354 format published to the SAE J2354 interface. The Data Cache and Data Archive are updated to reflect the publication.   
  
1.37 Publish Data to TMDD Function   
 Function ID: FR-37   
 Description: The system publishes data in TMDD format to external systems.   
 Input: Data type (e.g., traffic, road condition, or weather data) to be published.   
 Output: Data in TMDD format published to the TMDD interface. The Data Cache and Data Archive are updated to reflect the publication.   
  
1.38 Generate Alert Function   
 Function ID: FR-38   
 Description: The system generates alerts based on specified criteria, such as traffic congestion, weather events, or asset conditions.   
 Input: Alert criteria (e.g., type, severity, geographic area, or time frame).   
 Output: Generated Alert stored in the Data Cache and Data Archive. The Map Display and Icon Layer are updated if the alert involves spatial data.   
  
1.39 Modify Alert Settings Function   
 Function ID: FR-39   
 Description: Administrators can modify alert settings, such as severity thresholds, notification frequency, or data types that trigger alerts.   
 Input: Alert identifier (e.g., name or ID) and new alert parameters (e.g., severity thresholds or notification channels).   
 Output: Updated alert settings stored in the Data Cache and Data Archive. The Map Display and Icon Layer are refreshed if the alert settings affect visualization.   
  
1.40 View Alert History Function   
 Function ID: FR-40   
 Description: Administrators can view historical alerts based on time range, severity, or alert type. The function ensures that the data is retrieved and displayed.   
 Input: Time range or filter criteria for alert history.   
 Output: Alert history retrieved and displayed in the User Interface. The Data Cache is updated with the retrieved data. The Map Display and Icon Layer are updated if the alerts involve spatial information.   
  
1.41 View AlgorithmExecutionLog Function   
 Function ID: FR-41   
 Description: Administrators can view the Algorithm Execution Log to track the execution history of Algorithms, including input parameters, execution time, and status.   
 Input: Time range, algorithm name, or execution status.   
 Output: Algorithm Execution Log retrieved and displayed in the User Interface. The Data Cache is updated with the retrieved log entries. The Map Display is updated if the logs involve spatial data execution.   
  
1.42 Format DataFormatMapping Function   
 Function ID: FR-42   
 Description: Administrators can define or modify how data fields are mapped to standardized formats (e.g., SAE J2354 or TMDD).   
 Input: Data type (e.g., traffic, weather, or incident data) and mapping rules (e.g., field definitions or format specifications).   
 Output: Updated DataFormatMapping stored in the Data Cache and Data Archive. The Algorithm is updated to use the new mapping rules.   
  
1.43 View Incident History Function   
 Function ID: FR-43   
 Description: Administrators can retrieve and view historical incident records based on time range, geographic area, or incident type.   
 Input: Time range, geographic area, or incident type.   
 Output: Incident history retrieved and displayed in the User Interface. The Data Cache is updated with the retrieved data. The Map Display and Icon Layer are refreshed to show the locations of historical incidents.   
  
1.44 Manage DataRule Function   
 Function ID: FR-44   
 Description: Administrators can manage Data Rules, including adding, updating, or removing rules for data validation and consistency.   
 Input: DataRule identifier (e.g., rule name or ID) and new or modified rule parameters (e.g., validation thresholds or error tolerances).   
 Output: Updated DataRule stored in the Data Cache and Data Archive. The Algorithm is updated to use the new or modified rule in its processing.   
  
1.45 Configure Map Layer Setting Function   
 Function ID: FR-45   
 Description: Administrators can configure the visibility, styling, and priority of map layers in the Map Display.   
 Input: Layer settings (e.g., visibility status, color, or priority).   
 Output: Updated Map Layer Settings stored in the Data Cache. The Map Display and Icon Layer are refreshed to reflect the new settings.   
  
1.46 Michigan Geographic Framework Integration Function   
 Function ID: FR-46   
 Description: The system integrates data with the Michigan Geographic Framework to ensure accurate spatial representation on the Map Display.   
 Input: Data types (e.g., traffic, road condition, or weather data) to be integrated with geographic data.   
 Output: Data aligned with the Michigan Geographic Framework and stored in the Data Cache and Data Archive. The Map Display and Icon Layer are updated to reflect the geographic context.   
  
1.47 Modify Geo-referencing Settings Function   
 Function ID: FR-47   
 Description: Administrators can modify the geo-referencing parameters of the Michigan Geographic Framework, such as coordinate system or projection.   
 Input: Geo-referencing parameters (e.g., coordinate system, projection, or geographic scale).   
 Output: Updated geo-referencing settings stored in the Data Cache and Data Archive. The Map Display and Icon Layer are refreshed to reflect the new configuration.   
  
1.48 Travel Demand Analysis Function   
 Function ID: FR-48   
 Description: The system analyzes traffic and weather data to calculate travel demand in specific geographic areas and time frames.   
 Input: Geographic area and time frame for analysis.   
 Output: Travel demand data stored in the Data Cache and Data Archive. The Map Display is updated to show the travel demand distribution.   
  
1.49 Update Travel Demand Model Function   
 Function ID: FR-49   
 Description: Administrators can update the travel demand model with new or modified parameters (e.g., population growth or traffic influence factors).   
 Input: Travel demand model parameters (e.g., population growth, travel patterns, or traffic influence factors).   
 Output: Updated travel demand model stored in the Data Cache and Data Archive. The Map Display is refreshed to reflect the new demand distribution.   
  
1.50 Asset Condition Monitoring Function   
 Function ID: FR-50   
 Description: The system monitors asset conditions, such as infrastructure status, and visualizes them on the Map Display using the Icon Layer.   
 Input: Asset type and geographic area for monitoring.   
 Output: Asset condition data stored in the Data Cache and Data Archive. The Map Display and Icon Layer are updated to reflect asset status.   
  
1.51 Update Asset Status Function   
 Function ID: FR-51   
 Description: Administrators can update the status of an asset (e.g., operational, under maintenance, or decommissioned) in the system.   
 Input: Asset identifier (e.g., asset ID or location) and updated status.   
 Output: Updated asset status stored in the Data Cache and Data Archive. The Map Display and Icon Layer are refreshed to reflect the new asset condition.   
  
1.52 Manage AssetStatus Function   
 Function ID: FR-52   
 Description: Administrators can add, update, or remove asset status records. The function ensures that changes are validated and stored in the Data Cache and Data Archive.   
 Input: Asset identifier (e.g., asset ID or location) and an action (Add, Update, Remove).   
 Output: Updated or newly added asset status stored in the Data Cache and Data Archive. The Map Display and Icon Layer are refreshed to reflect the new or modified status.   
  
1.53 Delete Icon Layer Function   
 Function ID: FR-53   
 Description: Administrators can delete an Icon Layer from the Map Display. The function ensures that the deletion is validated and that the Data Cache is updated.   
 Input: Icon Layer identifier (e.g., layer name or ID).   
 Output: Icon Layer removed from the Map Display. The Data Cache is updated to reflect the removal.   
  
1.54 Manage Traveler Record Function   
 Function ID: FR-54   
 Description: Administrators can manage traveler records, including adding, updating, or removing information. The function ensures that all changes are validated and stored in the Data Cache and Data Archive.   
 Input: Traveler identifier (e.g., name or ID) and an action (Add, Update, Remove).   
 Output: Updated or newly added traveler record stored in the Data Cache and Data Archive. The Map Display and Icon Layer are refreshed if the traveler is associated with location data.   
  
1.55 MI Drive Presentation Support Function   
 Function ID: FR-55   
 Description: The system supports the presentation of traveler information for MI Drive, using the selected Output Format and Presentation Method.   
 Input: Traveler information type (e.g., traffic conditions, road closures, or weather impacts).   
 Output: Traveler information formatted and displayed in the selected Output Format. The Map Display is updated to reflect the presentation.   
  
1.56 View Traveler Information Function   
 Function ID: FR-56   
 Description: Administrators can retrieve and view traveler information, such as traffic, road conditions, or weather impacts. The function ensures that the data is validated and displayed.   
 Input: Geographic area and time frame for the query.   
 Output: Traveler information retrieved and displayed in the User Interface. The Map Display and Icon Layer are refreshed to reflect the data.   
  
1.57 Update Traveler Notification Function   
 Function ID: FR-57   
 Description: Administrators can update traveler notifications, including message text, severity, or display duration. The function ensures that the update is validated and stored.   
 Input: Notification identifier (e.g., location or message ID) and updated notification details.   
 Output: Updated notification stored in the Data Cache and Data Archive. The Map Display and Icon Layer are refreshed to reflect the new notification.   
  
1.58 Delete Traveler Record Function   
 Function ID: FR-58   
 Description: Administrators can delete a traveler record from the system. The function ensures that the deletion is validated and that the Data Cache and Data Archive are updated.   
 Input: Traveler identifier (e.g., user ID or traveler profile).   
 Output: Traveler data removed from the Data Cache and Data Archive. The Map Display and Icon Layer are updated to remove the traveler's representation.   
  
1.59 Manage Vehicle Registration Function   
 Function ID: FR-59   
 Description: Administrators can manage vehicle registration records, including adding, updating, or removing vehicle data. The function ensures that all changes are validated and stored in the Data Cache and Data Archive.   
 Input: Vehicle details (e.g., make, model, license plate, VIN) and an action (Add, Update, Remove).   
 Output: Updated or newly added vehicle registration stored in the Data Cache and Data Archive. The Map Display and Icon Layer are refreshed to reflect the changes.

# External Description

2. External Interfaces   
  
2.1 User Interface   
Description: The system provides a graphical User Interface (UI) for administrators to interact with and manage traffic, weather, and road condition data. The UI allows for data input, retrieval, visualization, and configuration.   
Interaction Method:   
- Administrators log in via the UI using valid credentials (FR-24).   
- The UI displays real-time and historical data, including traffic congestion, road conditions, weather impacts, and incident details (FR-08, FR-13, FR-15, FR-18, FR-26, FR-27, FR-28, FR-29).   
- Administrators can toggle the visibility of the Icon Layer and declutter the Map Display for better data visualization (FR-28, FR-29).   
- The UI also provides access to data management functions, such as adding, updating, or removing vehicle, incident, asset, or traveler records (FR-01, FR-04, FR-16, FR-17, FR-51, FR-58).   
- Alert settings, data quality rules, and algorithm configurations can be modified through the UI (FR-39, FR-44, FR-31).   
- The UI displays formatted data outputs and provides options for selecting output formats such as SAE J2354 or TMDD (FR-34, FR-35).   
- Traveler information, including traffic and weather conditions, can be viewed and managed through the UI (FR-56, FR-57).   
  
2.2 Hardware Interface   
Description: The system interacts with external hardware devices to collect real-time traffic and weather data. These devices may include sensors, cameras, radar systems, and other IoT-enabled infrastructure.   
Interaction Method:   
- Traffic data is collected from hardware devices such as vehicle sensors, traffic cameras, and radar systems. Inputs include vehicle speed, traffic volume, and occupancy (FR-05, FR-07, FR-48).   
- Weather data is collected from hardware devices such as weather stations, temperature sensors, and precipitation detectors. Inputs include temperature, wind speed, and visibility (FR-09, FR-10, FR-13).   
- Road condition data is collected from hardware devices that monitor road surface conditions, such as friction sensors and visibility meters. Inputs include surface condition, visibility, and friction (FR-12, FR-13).   
- Asset condition data is collected from hardware devices monitoring infrastructure, such as road signs, bridges, or tunnels. Inputs include asset status, maintenance needs, or decommissioning status (FR-50, FR-51).   
- These hardware devices communicate with the system via predefined communication protocols (e.g., MQTT, HTTP, or TCP/IP).   
  
2.3 Software Interface   
Description: The system interacts with various software components and databases to store, retrieve, and process data. These software interfaces include the Data Cache, Data Archive, Algorithm Engine, and external data formatting standards.   
Interaction Method:   
- Data Cache:   
 - Stores real-time data for quick access and visualization.   
 - Receives updates from functions such as vehicle registration (FR-01), traffic data collection (FR-05), and alert generation (FR-38).   
 - Provides data to the Map Display and Icon Layer for visualization (FR-03, FR-10, FR-13, FR-18, FR-22, FR-28, FR-29).   
  
- Data Archive:   
 - Stores historical data for long-term analysis and retrieval.   
 - Receives archived data from the Data Caching Management and Archive Historical Data functions (FR-19, FR-20).   
 - Provides data to the Retrieve Archived Data function (FR-21) and is updated with new data from various functional operations (FR-01, FR-05, FR-13, FR-16, etc.).   
  
- Algorithm Engine:   
 - Processes data using predefined algorithms to generate traffic metrics, infer road surface status, calculate travel demand, and detect incidents.   
 - Receives data from the Data Cache and Data Archive (FR-06, FR-13, FR-15, FR-48).   
 - Updates its configuration based on administrator inputs (FR-31, FR-32, FR-33).   
  
- Data Quality Rules:   
 - Stored in the Data Cache and Data Archive.   
 - Used to validate incoming data and ensure consistency, completeness, and accuracy (FR-22, FR-23).   
  
- Output Formats (e.g., SAE J2354, TMDD):   
 - Define the structure and format of data for external systems.   
 - Updated by administrators to align with new standards or data types (FR-34, FR-35, FR-42).   
 - Used to publish data in standardized formats (FR-36, FR-37).   
  
2.4 Communication Interface   
Description: The system communicates with external systems and services to exchange data and generate alerts. These interfaces ensure that data is shared in real-time and that administrators are informed of system events.   
Interaction Method:   
- Map Display:   
 - Visualizes traffic, road condition, weather, and asset data using the Michigan Geographic Framework.   
 - Updates in real-time based on data from the Data Cache and Data Archive (FR-08, FR-13, FR-15, FR-27, FR-46, FR-47).   
  
- Icon Layer:   
 - Provides visual indicators for vehicle, incident, asset, and traveler data on the Map Display.   
 - Updated dynamically based on data changes in the Data Cache and Data Archive (FR-03, FR-16, FR-18, FR-28, FR-50, FR-54).   
  
- Alert Notification:   
 - Sends alerts to administrators and external systems via predefined channels (e.g., email, SMS, or in-system notifications).   
 - Generated based on traffic, weather, or asset conditions (FR-38, FR-39, FR-40).   
 - Alert details are stored in the Data Cache and Data Archive for future reference (FR-38, FR-40).   
  
- Data Source Integration:   
 - Connects with external data sources (e.g., traffic sensors, weather APIs, road condition databases).   
 - Ensures data synchronization and validation between the system and these sources (FR-05, FR-09, FR-10, FR-12).   
  
- Algorithm Execution Log:   
 - Stores and retrieves logs of algorithm execution, including input parameters, execution time, and status.   
 - Used to monitor system performance and troubleshoot issues (FR-41).   
  
- Traveler Information Presentation:   
 - Supports data presentation for external platforms such as MI Drive.   
 - Formats and pushes traveler information (e.g., traffic conditions, road closures, weather impacts) using the selected Output Format (FR-55, FR-56).   
  
- Data Publication:   
 - Publishes data in SAE J2354 and TMDD formats to external systems for standardized data sharing.   
 - Updates the Data Cache and Data Archive with publication records (FR-36, FR-37).   
  
- Data Formatting and Mapping:   
 - Defines how data fields are mapped to standardized formats.   
 - Updated by administrators to reflect new or modified field definitions (FR-42).   
  
By clearly defining these external interfaces, the system ensures seamless data flow, real-time visualization, and effective communication with external systems and users.