# Functional Requirement

2. Functional Requirements  
2.1 Data Collection and Ingestion  
FR-DCI-001: The system shall accept real-time data inputs from probe vehicles, traffic sensors, weather stations, and traveler information systems.  
  
Inputs: GPS data, speed, location, road condition reports, temperature, precipitation, visibility.  
Outputs: Normalized data stored in a central database.  
FR-DCI-002: The system shall validate incoming data against predefined quality rules and reject invalid or malformed data.  
  
FR-DCI-003: The system shall allow for the configuration of new data source types without requiring major software changes.  
  
FR-DCI-004: The system shall support batch ingestion of historical data for backfilling archives and training models.  
  
2.2 Data Processing and Analysis  
FR-DPA-001: The system shall compute traffic metrics including congestion levels, travel times, queue lengths, and traffic flow patterns.  
  
FR-DPA-002: The system shall detect and classify incidents such as crashes, debris, stalled vehicles, and work zones.  
  
Inputs: Raw sensor and probe data.  
Outputs: Incident reports with time, location, type, and severity.  
FR-DPA-003: The system shall calculate road surface conditions based on weather data and sensor inputs.  
  
FR-DPA-004: The system shall perform automated data quality checks to flag anomalies and inconsistencies.  
  
FR-DPA-005: The system shall support machine learning models for predictive analysis of traffic trends and incident likelihood.  
  
FR-DPA-006: The system shall generate statistical summaries of daily, weekly, and monthly traffic patterns.  
  
2.3 Data Storage and Archiving  
FR-DSA-001: The system shall maintain a long-term archive of all processed data using Oracle 10G.  
  
FR-DSA-002: The system shall implement dynamic caching for frequently accessed data to improve performance.  
  
FR-DSA-003: The system shall allow users to query archived data via SQL-based tools.  
  
FR-DSA-004: The system shall support automated data purging policies to manage storage limits.  
  
2.4 Data Publication and Output  
FR-DPO-001: The system shall publish processed data in standardized formats (SAE J2354, TMDD).  
  
FR-DPO-002: The system shall provide real-time data feeds to MDOT’s MI Drive system.  
  
FR-DPO-003: The system shall generate alerts for traffic incidents, severe weather events, and asset failures.  
  
FR-DPO-004: The system shall support exporting data in CSV, JSON, XML, and KML formats for third-party use.  
  
FR-DPO-005: The system shall provide an API for external applications to consume traffic and weather data in real time.  
  
2.5 User Interface and Presentation  
FR-UIP-001: The system shall provide a web-based interface for viewing traffic, incident, traveler, and weather data.  
  
FR-UIP-002: The interface shall include map displays with icon layers representing traffic, incidents, and road closures.  
  
FR-UIP-003: The system shall support de-cluttering features to reduce visual complexity during high-volume data display.  
  
FR-UIP-004: Users shall be able to filter and search data by location, time, event type, and other relevant criteria.  
  
FR-UIP-005: The system shall support multi-language UI options to accommodate diverse user groups.  
  
FR-UIP-006: The system shall allow users to create custom dashboards for frequent data views.  
  
2.6 System Administration and Configuration  
FR-SAC-001: The system shall allow administrators to configure data sources, algorithms, and output formats.  
  
FR-SAC-002: The system shall log all administrative actions and errors for audit and troubleshooting purposes.  
  
FR-SAC-003: The system shall support role-based access control for different user types (e.g., field operator, analyst, admin).  
  
FR-SAC-004: The system shall provide backup and restore capabilities for the database and configuration settings.  
  
2.7 Reporting and Analytics  
FR-REP-001: The system shall generate pre-defined reports on traffic volume, incident frequency, and road condition trends.  
  
FR-REP-002: The system shall allow users to schedule automatic report generation and email delivery.  
  
FR-REP-003: The system shall provide ad-hoc reporting tools for querying and visualizing data.  
  
FR-REP-004: Reports must be exportable in PDF, Excel, and HTML formats.  
2.8 Security and Compliance  
FR-SEC-001: The system shall enforce secure authentication and authorization for all users.  
  
FR-SEC-002: All data transmissions must be encrypted using TLS 1.2 or higher.  
  
FR-SEC-003: The system shall comply with MDIT security standards and FIPS 140-2 encryption requirements.  
  
FR-SEC-004: The system shall support audit logging of all user activities and system events.

# External Description

3. External Interfaces (Updated)  
3.1 Hardware Interfaces  
Oracle 10G Database Server  
Java Application Server  
GIS Servers (for map rendering)  
Data Source Gateways (probe vehicles, weather stations)  
3.2 Software Interfaces  
JDBC for database connectivity  
TMDD for external system data exchange  
SAE J2354 for vehicle-to-infrastructure data  
MI Drive API for data publishing  
Third-party APIs for weather and mapping services  
3.3 Communication Interfaces  
TCP/IP for network communication  
RESTful APIs for internal and external system integration  
MQTT/CoAP for IoT device communication  
3.4 User Interfaces  
Web Browser-Based UI (HTML5, CSS3, JavaScript)  
Map Display API (Leaflet, OpenLayers, or equivalent)  
Administrative Console (Java-based web application)