Autonomous Vehicle System

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CS 250: Introduction to Software Systems

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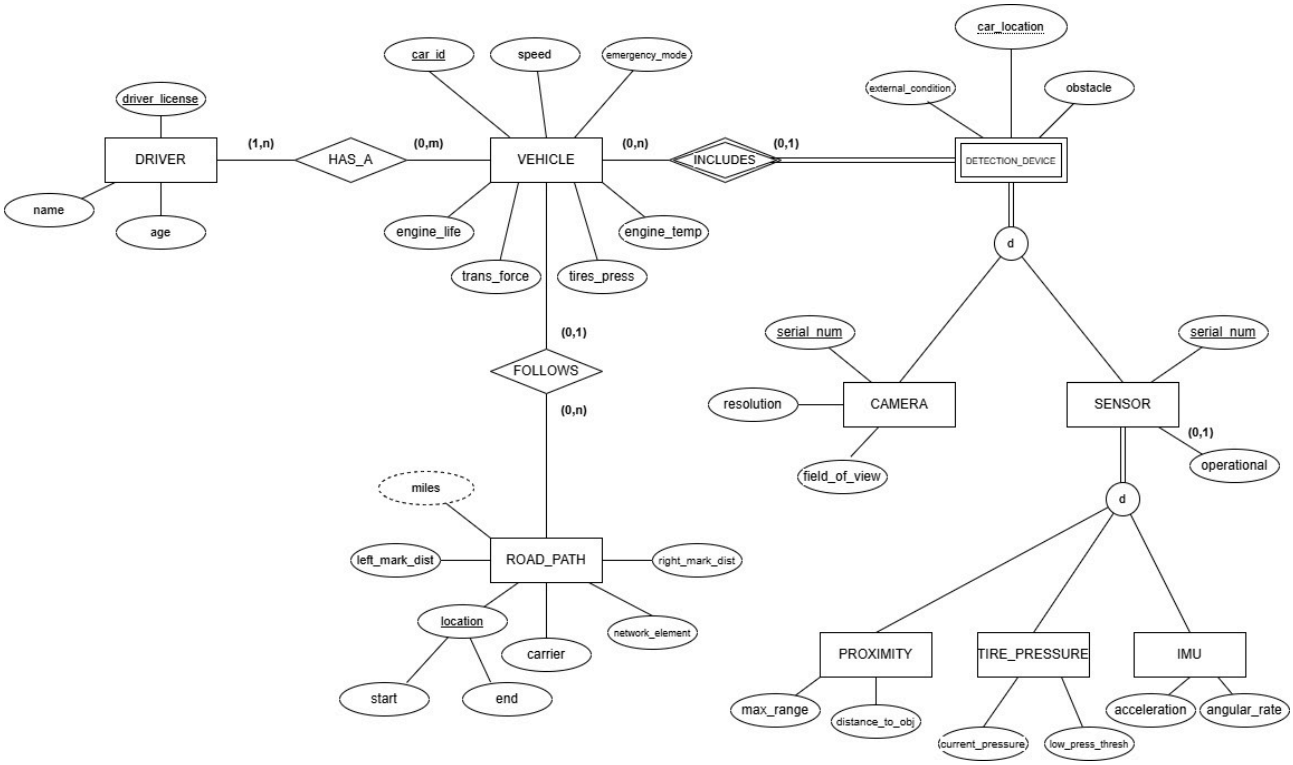
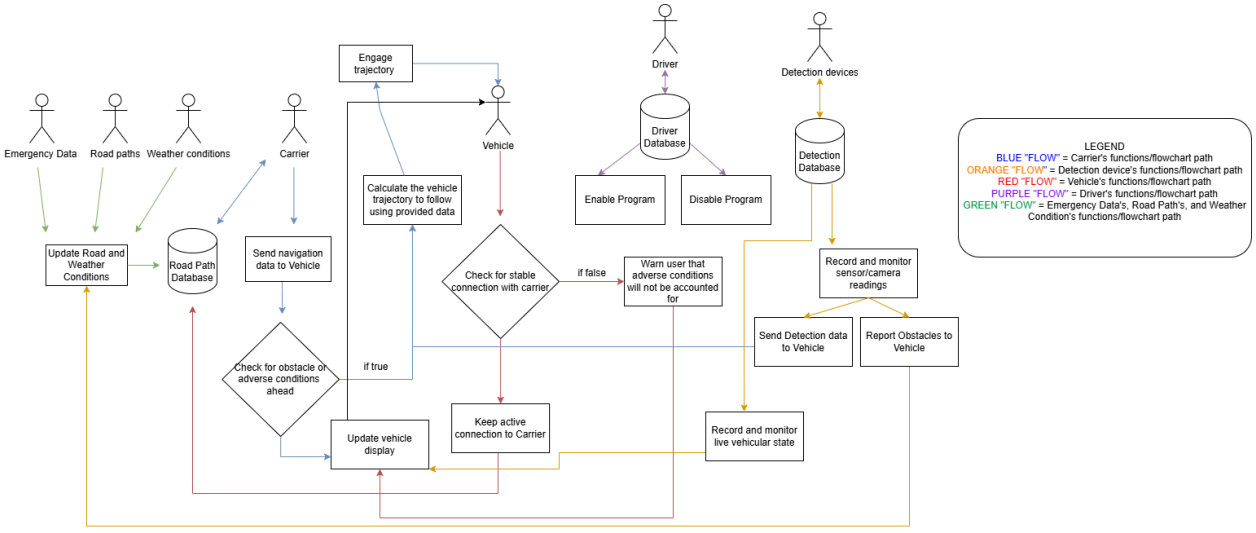
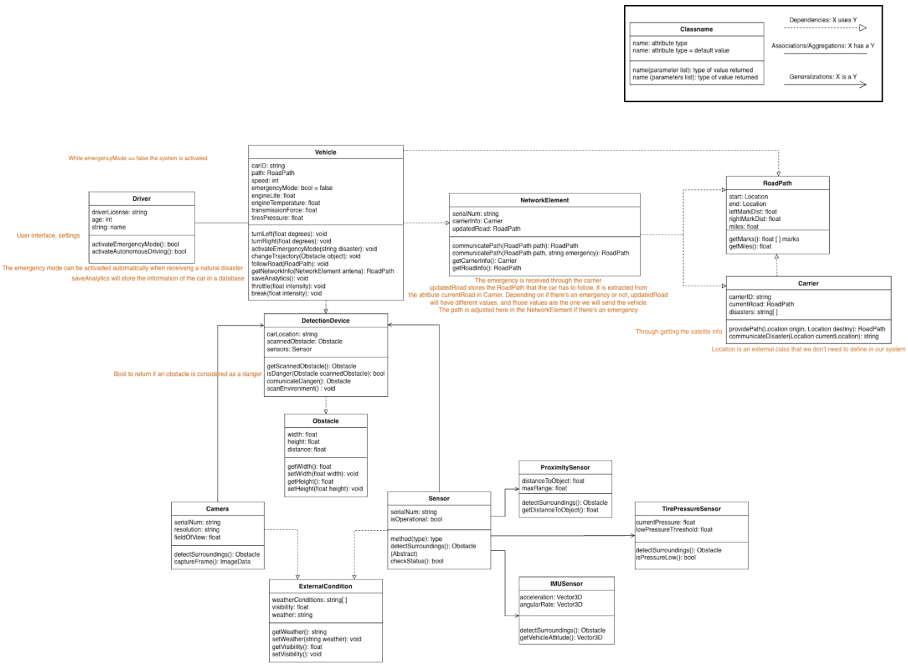
Database Diagram:



Updated SWA Diagram:



Updated UML Diagram:



Design Specification With Modifications:

Following our past versions of the model we've made edits to reflect now how we will store and manage all our data to have a functional and efficient program. We've rendered this new diagram that reflects our databases after revising our past design and deciding that our "Navigation Database" was too abstract and vague which left a lot of confusion. Now our databases include the "DRIVER", "DETECTION_DEVICE" and "ROAD_PATH". These communicate with each other using an SQL approach in the relational database and store different information that is nicely organized. For example the "VEHICLE" database follows the "ROAD_PATH" database and is able to retrieve information from it without the queries overloading "ROAD_PATH". Also "VEHICLE" includes "DETECTION_DEVICE" meaning it similarly uses the information from the database to operate since without it our program wouldn't be able to navigate. This is a conscious decision since we've decided that not only does

breaking the database down into separate ones allow for more abstraction that's easier to understand and follow. Additionally these changes are also reflected in our UML diagram and SWA diagram. These new changes on top of all of our previous designs get us one step closer to implementing a program that will operate seamlessly and hit all the benchmarks we previously discussed in our design specification.

Data Management Strategy:

Description of Data Management:

The Autonomous Vehicle System relies on a single relational database (SQL) to manage all critical data. This centralized approach ensures data consistency and integrity across the tightly coupled entities essential for safe operation.

The database is structured around three primary tables/conceptual entities:

Entry	**Purpose**	**Key Data stored**	**Usage and Updated Frequency**
ROAD_PATH	Stores foundational, geo-spatial, and regulatory data for navigation.	Route segments, GPS coordinates, speed limits, lane geometry, intersection rules, pre-defined maps.	Primarily Read operations by the Vehicle Navigation Logic; updated infrequently by the mapping service.
DETECTION_DEVICE	Stores high-frequency, real-time data from all vehicle sensors.	LiDAR readings, camera object detection (type and position), radar velocity measurements, timestamped event logs.	Primarily Write/Update operations by the sensor fusion component (high volume); Read operations for immediate obstacle avoidance.
DRIVER	Stores persistent data related to the driver, vehicle configuration, and historical performance.	User preferences, emergency contact details, vehicle configuration settings, historical trip logs, maintenance records, authentication tokens.	Balanced Read/Write operations; used during startup, trip planning, and shutdown.

Data Flow Strategy:

1. Guidance: The VEHICLE system initiates a query to the ROAD_PATH table to retrieve the necessary path segments and regulatory information.

2. Perception: Simultaneously, the DETECTION_DEVICE entity is continuously updated with sensor data. The Vehicle Perception Component executes highly localized queries against this real-time data to determine immediate threats and safe movement vectors.

3. Logging and State: All system actions, errors, and trip metadata are persisted to the DRIVER table's log fields, ensuring an immutable record for post-trip analysis or diagnostics.

This relational structure allows for clear foreign key relationships (e.g., the sensor data in DETECTION_DEVICE references the specific vehicle/driver context), enforcing the required strong consistency crucial for safety-critical operations.

Tradeoffs And Discussion For Design Choices: The chosen data management strategy utilizes a single SQL database due to the system's core requirements for strong transactional consistency and handling of complex, tightly coupled relationships between entities like the “VEHICLE”, “DRIVER”, and various “DETECTION_DEVICE” components, as clearly shown in the diagrams. SQL is superior to NoSQL alternatives in this context because the integrity of safety-critical vehicle data is more crucial than massive, distributed scalability. The decision to use a single database over multiple, distributed databases simplifies operations, guarantees data integrity across related tables within a single transaction, and avoids the complexity and potential synchronization issues associated with distributed data and microservices, which are unnecessary for this system's defined scope.