

Connected Vehicle Management

Group 16

Business Problems Addressed by the Database:

Connected vehicle Management addresses various problems by leveraging real world data by use of Internet of Things(IOT) devices, sensors and advanced analytics. These analyses can be used in providing solutions for various areas of business like logistics, automotive and mobility services.

Saves critical Information:

This database holds essential details about accidents, such as location and date/time, which can be utilized for insurance claims. It also aids in tracking incidents and providing necessary assistance during emergencies.

Enhanced Data-Driven Decision Making:

These management systems provide real world data which can be used to make data driven decisions and improve numerous industries related to automobiles.

Cost Management and Operation:

The system enables monitoring of vehicle usage and service expenses, helping to enhance vehicle management, reduce operational costs, and identify inefficiencies in operations.

One Place for all data related to vehicle:

This database serves as a central repository for all vehicle-related information. From vehicle onboarding to accident management, everything can be found in a single place.

Business Rules:

SIM:

1. A SIM card should have a mandatory IMEI Number.
2. A SIM card cannot be activated unless it has a valid phone number and network provider.
3. A SIM card is linked with only one device.

IOT Device:

1. Each device has its own unique DeviceID.
2. Only one IOT device can be installed in a vehicle at a time.
3. The IOT device connects to only one sim card.
4. Hardware version and manufacturer code is provided when a new IOT device is installed.

Insurance:

1. Each vehicle has mandatory insurance at any given time.
2. Insurance policies must have a start and end date.
3. Insurance must have a Unique InsuranceNumber.

Dealership:

1. Each Dealership must have a unique DealerID.
2. A Dealership can sell multiple vehicles, but a vehicle is sold by only one dealership

Vehicle:

1. Each Vehicle must have a unique VIN.
2. A vehicle must have a valid insurance policy associated with it.
3. A vehicle must have data like color, Model, make and year of Manufactured.

User:

1. Each User has a unique UserId and a license number.
2. A user can own multiple vehicles.
3. Users must provide valid phone numbers and insurance information if available.

ServiceHistory:

1. Each vehicle can have a recorded service history associated with it. It is uniquely identified by ServiceID.
2. Each record in Service History must have fields like Service Date, Cost, Description, and Service Provider name.

Incident:

1. Each Incident is uniquely identified by IncidentID.
2. Depending on the type of incident, it is classified as either Roadside Assistance or Accident.
3. Each incident can have Severity level of the incident.
4. A vehicle has multiple incidents but a list of incidents are linked with a single vehicle.

Roadside Assistance and Accident:

1. Each roadside assistance(RSA) and accident must be linked with an incident.
2. A vehicle can request multiple RSA but it should be recorded in multiple entries.
3. Each accident is identified by a Collision Type and must include a PoliceReportNumber.
4. If an accident results in fatalities, the Fatalities count, and Cause of the accident must be recorded.

Entities and Their Relationships:

1. IOT Device:

- Attributes: DeviceID, HardwareVersion, Manufacturer, InstallationDate, AverageSpeed.
- Purpose: IoT devices installed in cars offer better connectivity, safety, and efficiency through an integrated system wherein vehicles would communicate with external systems that include cloud servers or mobile apps.
- Relationships:

One-to-One with Sim: A user requires only one sim for one IOT device for a vehicle.

One-to-One with Vehicle: Only a single IOT device can be installed in a vehicle.

2. ServiceHistory:

- Attributes: ServiceID, ServiceDate, Cost, Description, ServiceProvider.
- Purpose: Because It allows vehicle owners and the service centers to keep track of all maintenance and repairs performed, ensuring timely servicing and reducing the risk of breakdowns.
- Relationships:

Optional-Many-to-One with Vehicle: A vehicle can have no service history or can have ample of service history depending upon the time the purchase of the vehicle.

3. User:

- Attributes: UserID, Name, DOB, LicenseNumber, PhoneNumber, InsuranceNumber
- Purpose: The User entity represents individuals who own or interact with vehicles. This entity is crucial for tracking personal information, such as the user's identity, license details, and insurance data. It is connected to various entities in the system either directly or indirectly.
- Relationships:

Optional-Many-to-Many with Vehicle : relationship between the User and Vehicle entities indicates that a user can own multiple vehicles and a Vehicle can be controlled by multiple Users.

4. Incidents:

- Attributes: IncidentID, Type, Location, Date/TimeOfIncident, Description, ResponseTime, Status, SeverityLevel
- Purpose: The INCIDENTS table typically stores general information about any notable occurrences involving a vehicle. An incident might refer to anything that impacts the vehicle's normal operation, such as breakdowns, traffic violations, mechanical failures and accidents.
- Relationships:

One-to-Many with VEHICLE: A vehicle can have many incidents. Each incident, however, belongs to only one vehicle.

5. RoadSideAssistance:

- Attributes: AssistanceType, CompletionTime, ServiceRating
- Purpose: The ROADSIDE Assistance table is focused specifically on roadside assistance events. A vehicle may require roadside help for various reasons, including flat tires, dead batteries, or towing after an accident.
- Relationships:

Subtype of INCIDENTS: ROADSIDE shares common attributes but has its unique attributes such as AssistanceType. Respecting the specific service provided after the incident.

6. Accidents:

- Attributes: CollisionType, PoliceReportNumber, Fatalities, Cause
- Purpose: The ACCIDENT table is essential for tracking events where the vehicle was involved in a collision or crash.
- Relationships:

Subtype of INCIDENTS: ACCIDENTS stores extra information for details of INCIDENT such as CollisionType.

7. DealerShip:

- Attributes: DealerID, Name, Address.
- Purpose: The Dealership entity captures data about car dealerships where users purchase vehicles. It serves as the service point for vehicles that are sold by the dealer or accountability for warranty claims.
- Relationships:

One-To-many with Vehicle:: A relationship exists between the Dealership and Vehicle entities, implying that a dealership sells vehicles. A vehicle may be associated with a specific dealership for purchase and other services.

8. Vehicle:

- Attributes: VIN: Vehicle Identification Number, LicenseNumber, Model, Year, Colour, Make, FuelType.
- Purpose: The Vehicle entity is the main entity of the system, representing the vehicle itself. It holds crucial information such as the vehicle's unique VIN (Vehicle Identification Number), model, make, year, and other technical details. To uniquely identify and track vehicles in the system. Links to the User entity to determine ownership. Serves as the basis for managing various data like insurance policies, incidents, services, and dealership details.
- Relationships:

Many-to-Many with User: A vehicle is managed by multiple users, with the relationship indicating that one user can manage multiple vehicles.

one-to-One with Insurance: The vehicle is connected to the insurance policy, suggesting that one insurance policy covers a vehicle.

Many-to-One with Dealership: This shows that a vehicle may be sold or maintained by a single dealership and a dealership can sell multiple cars.

One-to-One IOT Device: The vehicle can have an associated IoT device, which tracks or monitors the vehicle's performance, possibly for insurance or maintenance purposes.

9.SIM:

- Attributes: IMEI, NetworkProvider, IMSI, Status, PhoneNumber, ActivationDate.
- Purpose:

The SIM entity contains details on the sim card in the IOT device inside a given vehicle. The IMSI number is another unique 15 digit code, similar to IMEI, that is used to identify the mobile subscriber on the network. We have added this attribute along with IMEI for two reasons:

 - a) To ensure that there is no single point of failure in retrieving data on a given sim card entry as it is the most crucial component when it comes to responding to incidents.
 - b) While the IMSI tracks the person associated with the cellular network, the IMEI number instead tracks the IOT device connected to the sim card.

PhoneNumber attribute relates to the number of the sim. ActivationDate attribute is static and holds the first day the sim was activated. This gives us an easy operation in checking the subscription plans of the sims and when they are to be renewed with minimum modifications made to the database.
- Relationships:

One-to-One with IOT Device: The Sim entity is connected to the IOT DEVICE entity by a mandatory 1:1 relationship as every Data communication module within a given car has a singular sim that is responsible for sending out information on its respective registered cellular network in times of incidents reported.

10. Insurance:

- Attributes: InsuranceNumber, PolicyNumber, ProviderName, Status, StartDate, EndDate.
- Purpose:

The policy number attribute refers to a single value among a set of number-coded insurance policies that a user can opt for. The ProviderName is a string attribute that stores the name of the insurance providing company. Status attribute is a boolean value that switches to active or inactive based on the start and end date attributes of the insurance plan. Start date and end date are kept as separate attributes to enhance interoperability with other systems that may have to query details on different insurance periods to estimate cost as per its associated policy. The INSURANCE entity stores insurance details about the vehicle that can be crucial during claiming insurance and estimating incident costs that can be covered as per the policy that the user has opted for his or her vehicle.

- Relationships:

One-to-One with Vehicle: The INSURANCE entity is connected to the VEHICLE entity by a mandatory 1:1 as it is usually not recommended for vehicles to be registered under separate insurance plans issued by different providers even if technically allowed. Hence, One vehicle can have a single insurance plan and vice versa.

Conceptual ERD Diagram:



