**High Level System Architecture**

**1. User Interaction Layer (Frontend)**

**Interfaces:**

* **Mobile App (Flutter)**
* **Web App (React.js)**
* **AI Chatbot (GenAI-powered Assistant)**

**User Inputs:**

* **Fault Code Search** → e.g., "P0301"
* **Symptom-Based Search** → e.g., "Car shakes when idling"
* **Spare Part Search** → e.g., "Denso Alternator"
* **Vehicle Model Search** → e.g., "Toyota Corolla 2018 brake pads"

**2. AI Pre-Processing (GenAI - GPT-4o)**

* Interprets user queries and structures them for search
* Maps symptoms to possible fault codes
* Expands & refines search queries for better accuracy
* Provides AI-powered debugging instructions

**3. Search & Data Processing**

1. **Technology:** Elasticsearch

**Purpose:** Full-text & structured search for fault codes, symptoms, and parts

1. **Technology:** PostgreSQL/MySQL

**Purpose:** Stores structured data (vehicles, inventory, pricing)

1. **Technology:** Django/FastAPI Backend

**Purpose:** Handles API requests, Business Logic, ML models, and database operations

**Workflow: How the System Works**

**User enters a query** (fault code, symptom, or part name).  
**GenAI pre-processes the query**:

1. Interprets **symptoms & maps them to fault codes**.
2. Expands the **query for better Elasticsearch results**.
3. **Ranks relevant spare parts** based on likelihood.
   * Optimized query is sent to Elasticsearch for fast search.
   * Elasticsearch fetches the best-matching spare parts.
   * PostgreSQL retrieves stock availability & pricing.
   * GenAI ranks parts & provides debugging steps.
   * The system returns AI-powered explanations & part recommendations.

**Example User Flow**

User Input:

"Car shakes when idling"

1. **GenAI Pre-Processing**

GenAI (GPT-4o) output is structured as JSON, but this is handled within the backend, not sent directly to Elasticsearch. The backend extracts relevant search terms from GenAI's response before querying Elasticsearch.

{ "processed\_query": { "symptoms": ["Car shakes when idling"], "possible\_fault\_codes": ["P0301", "P0300"], "likely\_causes": ["Misfiring spark plug", "Vacuum leak"] }, "optimized\_search\_query": "Misfire issue P0301 cylinder rough idling" }

* Converts symptoms into **fault codes**.
* Determines **likely causes**.
* Creates an **optimized search query**.

**Example:**

{ "query": { "bool": { "should": [ { "match": { "symptoms": "Misfire issue" } }, { "match": { "fault\_codes": "P0301" } } ] } } }

**Final System Output in JSON (AI-Powered Troubleshooting + Part Ranking):**

{ "issue\_analysis": "Your car shakes when idling, likely due to an engine misfire.", "most\_likely\_cause": "Faulty spark plug (P0301 detected)", "recommended\_parts": [ { "part\_name": "Bosch Spark Plug", "reason": "Misfiring spark plugs are the #1 cause.", "debugging\_steps": [ "Check if engine light is flashing.", "Inspect spark plugs for black soot.", "Replace spark plugs if over 30,000 miles old." ] }, { "part\_name": "Fuel Injector", "reason": "If spark plugs are fine, the injector may be clogged.", "debugging\_steps": [ "Check for engine hesitation.", "Run a fuel injector cleaner before replacing." ] } ] }