**1. Feature Requirements and Performance Targets**

**Feature Requirements**

* **Functional Requirements:**
  + Detect lane markings using camera-based systems or other sensors (e.g., LiDAR or RADAR).
  + Identify the vehicle's position relative to the lane boundaries.
  + Generate appropriate steering commands to keep the vehicle within the lane.

**Performance Targets**

* **Accuracy:**
  + Minimize deviation from the center of the lane (e.g., ±10 cm deviation on straight roads).
* **Response Time:**
  + Detect and respond to lane deviations within 100 milliseconds.
* **Reliability:**
  + Maintain lane-keeping functionality in 99.9% of operating conditions.

**2. Explanation of Feature-Specific Control and Adaptation of the Software Architecture**

**Feature-Specific Control**

* **Control Algorithm Design:**
  + Model Predictive Control (MPC) algorithms to calculate precise steering adjustments.
  + Incorporate real-time sensor fusion (e.g., camera and RADAR data) to enhance lane detection reliability.
* **Adaptive Steering Feedback:**
  + Adjust steering sensitivity based on vehicle speed and road curvature.
  + Switch to hands-off alerts if the driver disengages or overrides steering.

**Software Architecture Adaptation**

* **Modular Design:**
  + Divide the system into core components: perception, decision-making, and actuation.
  + Allow for independent upgrades or optimizations of modules (e.g., upgrading lane detection without affecting control logic).
* **Feature Integration:**
  + Integrate LKA with other Advanced Driver Assistance Systems (ADAS) such as Adaptive Cruise Control (ACC) for enhanced functionality.

**3. Dynamic Test Scenarios and Justification**

**Test Scenarios Considered**

1. **Straight Roads with Clear Lane Markings:**
   * Evaluate the system’s ability to maintain a steady lane position.
   * Measure response time and steering smoothness.
2. **Curved Roads:**
   * Assess the system’s ability to predict and follow varying road curvature.
   * Test limits for sharp turns and transitions between curves.
3. **Lane Splits and Merges:**
   * Test how the system adapts to diverging or converging lanes, especially on highways.
4. **Adverse Weather Conditions:**
   * Simulate rain, fog, or snow to test the robustness of lane detection algorithms.
5. **Partial or Faded Lane Markings:**
   * Test the system's behavior in environments with worn or obscured lane boundaries.
6. **Traffic and Obstacles:**
   * Evaluate the system’s response to lane changes caused by vehicles or debris.