System Design and Architecture

For the following architectural problems, describe the system architecture in the following form:

- Name one architectural pattern that you will use.
- Draw a diagram that describes your system architecture.
- Quickly explain in words how the system works.
- State the three most important advantages of using this architecture.
- State the two most important disadvantages of using this architecture.

1. Content Filtering System

A content filtering system for a corporate network is designed to manage and control the type of content employees can access on the internet. It uses a whitelist (allowing access to approved websites), a blacklist (blocking access to disallowed websites), and a third-party filtering tool to categorize and filter content based on company policies. The system is initially deployed on a single-core server but can be scaled to a multi-core server if network traffic increases significantly.

2. Smart Home Monitoring

A smart home monitoring system integrates various sensors throughout a house, including temperature, humidity, motion, and door/window status sensors. The system processes sensor data to perform automated tasks and alert homeowners. For example, if a motion sensor detects movement while the security system is armed, it sends an alert to the homeowner's phone. If smoke is detected, the system activates the alarm and notifies emergency services. The system runs on a multi-core home automation hub and processes sensor data in near real-time.

3. Ride-Sharing Dispatch System

A ride-sharing dispatch system allows customers to book rides through a mobile app. When a ride request is made, the system records the request details, including the pickup and drop-off locations, customer information, and the type of vehicle requested. The system then identifies the nearest available driver using a vehicle location service. The scheduler assigns the most suitable driver to the ride request, and a dispatcher component sends the ride details to the driver's app. The system logs all ride requests and dispatch information for future reference and analysis.

4. Hospital Management System

A hospital management system is developed to handle patient records, doctor schedules, and laboratory results. Doctors can access and update patient history online, especially in emergency situations, and add new information based on examinations and test results. Patients can also access their medical information through a secure portal. The system is designed to integrate with a National Health Information Management System for future data sharing. Security is a major concern, and the system must ensure quick response times in emergencies and a user-friendly interface for medical staff and patients.

5. Autonomous Vehicle Emergency Handling

An autonomous vehicle control system manages both normal and emergency operations. Under normal conditions, the system monitors the vehicle's speed, navigation, and environment sensors, adjusting speed and route as necessary. In case of an emergency, such as an obstacle detected in the vehicle's path, the system must react immediately by applying brakes and activating safety protocols. The system continuously processes data from multiple sensors and must operate reliably on a multi-core processing unit to ensure safety and quick response times.

6. Environmental Monitoring Drones

Drones equipped with environmental sensors collect data on air quality, temperature, humidity, and location. These drones are deployed in remote or hard-to-reach areas to gather real-time environmental data. Each drone broadcasts the collected data periodically and responds to specific data requests from the central monitoring station. In case of detecting hazardous conditions, the drone sends an immediate alert. The software ensures the drones maintain updated sensor data, perform periodic broadcasts, and prioritize emergency transmissions when necessary.

7. Desktop Environment Manager

A desktop environment manager allows users to effectively manage open applications and windows on their computer screens. It supports operations such as creating, moving, resizing, minimizing, and closing windows. Each window is associated with a specific application process and can be represented by an icon when minimized. The manager also handles cursor interactions and ensures that the screen space is used efficiently. The system is designed to be responsive and provide a seamless user experience while managing multiple windows and applications.

8. Online Learning Platform

An online learning platform enables students to access educational content and participate in virtual classes. The platform includes two main components: a student portal where users can view and enroll in courses, access course materials, and submit assignments; and an admin console for instructors and administrators to manage courses, track student progress, and handle enrollment and grading. The platform dynamically displays content based on the user's role and permissions, ensuring secure access to sensitive information and providing a user-friendly interface for both students and educators.