ASSIGNMENT 2: CASE STUDY

Subject: Implementation of SDLC in the "CityFlow" Smart Traffic Management System
Date: October 26, 2023

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1. Project Overview

Project Name: CityFlow Intelligent Traffic Control **Client:** Metropolitan Department of Transportation (DoT) **Objective:** To replace legacy timer-based traffic lights with an AI-driven system that adjusts signal timing in real-time based on traffic density, reducing city-wide congestion by 20%.

Engineering Challenge: This is a "Mission Critical" system. Software failure could result in gridlock or, worse, traffic accidents. Therefore, adherence to a structured SDLC was mandatory to ensure safety and reliability.

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2. Phase-by-Phase Analysis

Phase 1: Requirement Gathering & Analysis

The Process: The engineering team met with city planners, emergency response coordinators (police/ambulance), and traffic engineers. They gathered high-level goals and specific constraints.

- *Key Requirement 1:* The system must detect emergency vehicle sirens and turn lights green for them immediately.
- *Key Requirement 2:* The system must function locally even if the internet connection to the central server is lost.

Impact on Project Outcome: This phase was the **foundation of safety**. By identifying the "offline mode" requirement early, the team avoided a catastrophic failure scenario where the city's lights would go dark during an internet outage. The requirement to prioritize ambulances ensured the system provided social value beyond just convenience.

Phase 2: System Design

The Process: Architects designed a "Hybrid Edge-Cloud" architecture.

- **Edge (Local):** IoT sensors and controllers at every intersection to handle immediate signal changes.

- **Cloud (Central):** A central server to analyze long-term traffic patterns and push updates.
- **Database Schema:** designed to handle terabytes of video and sensor data.

Impact on Project Outcome: The design choice to use "Edge Computing" (processing data at the intersection rather than sending it all to a server) was critical. It ensured **low latency**—lights changed instantly when a car approached. A poor design (centralized only) would have caused lag, frustrating drivers and causing accidents.

Phase 3: Implementation (Development)

The Process: The coding was split into two modules:

1. **Embedded Systems Team:** Wrote highly efficient C++ code for the traffic light hardware (focusing on speed and reliability).
2. **AI/Algorithm Team:** Wrote Python code for the central machine learning models (focusing on prediction accuracy).

Impact on Project Outcome: Strict coding standards and modular development allowed the two teams to work in parallel without blocking each other. This **accelerated the timeline**, allowing the project to be delivered three weeks ahead of schedule.

Phase 4: Testing & Quality Assurance

The Process: Before installing a single light on the street, the code was tested in a **Digital Twin Simulation**. The engineers created a virtual replica of the city and ran millions of virtual cars through the system to see how the software reacted.

- *Critical Bug Found:* During simulation, the AI turned all lights green in a specific rare pattern of heavy rain.
- *Fix:* The bug was patched in the code before real-world deployment.

Impact on Project Outcome: This phase was the **guardian of public safety**. If this bug had been found after deployment, it could have caused multi-car pileups. Testing transformed a potential disaster into a routine software patch.

Phase 5: Deployment

The Process: The team utilized a **Phased Rollout (Canary Deployment)** strategy.

- *Week 1:* Deployed to only 5 intersections in a low-traffic industrial zone.
- *Week 4:* Deployed to the financial district.
- *Week 8:* City-wide activation.

Impact on Project Outcome: This approach **minimized risk**. When a minor sensor calibration issue appeared in Week 1, it only affected a few trucks in the industrial zone. The team fixed it immediately, ensuring the high-traffic financial district launch in Week 4 was flawless.

Phase 6: Maintenance

The Process: Post-launch, the system entered the "Operations & Maintenance" phase.

- *Adaptive Maintenance:* Six months later, the city added new bike lanes. The software was updated to account for bicycle speeds.
- *Corrective Maintenance:* Patching security vulnerabilities in the IoT sensors to prevent hacking.

Impact on Project Outcome: Maintenance ensured the **longevity and ROI (Return on Investment)** of the project. Without continuous updates, the system would have become obsolete within two years as traffic patterns changed. Instead, the system remains efficient and secure today.

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3. Conclusion: The Value of SDLC

The *CityFlow* project illustrates that SDLC is not just paperwork; it is a risk-management strategy.

1. **Requirements** prevented scope creep and defined safety boundaries.
2. **Design** ensured the system was fast enough to be safe.
3. **Implementation** delivered the product efficiently.
4. **Testing** saved lives by catching bugs in simulation.
5. **Deployment** protected the city from mass disruption.
6. **Maintenance** protected the investment.

Final Verdict: The disciplined application of SDLC phases transformed a complex, high-risk engineering concept into a reliable, functional utility that improved city life.