Name: Multi-vehicle Parking Change -75 000 sq ft: 12 floors.

Author : Mohamed Akthar K

4.1. Introduction

This report is a report in the form of a High-Level Design (HLD) to retrofit and expand a cycle parking system into a multi-level car parking system that accommodates 75,000 sq ft on 12 stories as an engineer-focused work. The design still includes all the cycle-Linked functionalities and adds them to the multi-vehicle operations ability, area-to-area traffic, and combined CCTV and enterprise software administration system.

Audience : Architects, Developers, Infrastructure Engineers, Facility Managers and Project Stakeholders.

4.2. High Level(HLD) Design Overview

- Layered view
- Physical Layer Sensors and Cameras, EV chargers, Kiosks.
- Layer — Edge Gateway (MQTT broker, local preprocessing, ANPR inference offline) , local cache.
- Network Layer Network Layer between cloud/on-prem and edge services secure VPN / VLAN.

Platform Layer Message wastes and Databases Microservices Data services provide loosely coupled, address-transparent, stateless web-based services, primarily operating through simplex connections over TCP and similar protocols.<|human|>Platform Layer message wastes and Databases Microservice is a set of loosely coupled, address-

transparent, stateless web-based services (mostly based on simplex connections over TCP and related protocols).

- Application Layer - Mobile applications, Administration dashboard, operator console.
- Integration middleware -- payment gateways, 3rd party APIs (maps), police interfaces.

4.3. UML Diagrams

Class Diagram: Is the definition of the data model that displays the entities such as Vehicle, Slot, Reservation, and Billing. It points out the relationships that include a vehicle taking a slot, reservations that are related to slots and billing records identifying the relationship to the reservation.

Sequence Diagram: Helps to outline time-based interactions of particular workflows. The ANPR entry flow in particular demonstrates how a driver causes a camera input that processes at the edge and once checked by the Vehicle Auth Service, the gate opens.

4.4. Module Design the Car Parking Management Service.

Responsibilities: assign closest slot according to the priority (reserved, EV, accessible, general), floor balancing, and the size of the vehicle.

Interface: POST /allocate by including body { vehicletype, plate number, preferences } REST where slot id is returned together with ETA.

Algorithms: preserve priority queues by floor, (repeatedly) grab next free position in that floor with minimum congestion score, (possibly with local heuristic) try to match driver to nearest ramp.

Vehicle Auth Service

Role: authenticate ANPR, verify reservations, carry out anti-fraud checks, emit entry/exit events.

interface: POST /auth/entry and POST /auth/exit.

Reservation Service

Manages pre-booked slot; implements hold window; integrates with SAS one-side to allocation hold.

Billing Service

Semi-automatic calculates the fees, supports the Payment Gateway, adds invoices, provides Macrefunds.

4.5. References

- Draw.io diagrams URL Link:- (https://viewer.diagrams.net/tags=7B7D&lightbox=1&highlight=0000ff&edit=1&layers=1&nav=1&dark=autosmo -241-G1xgUNrvk2L-7uXfzsGDCUzE-AZNm5alv7).