Design Document

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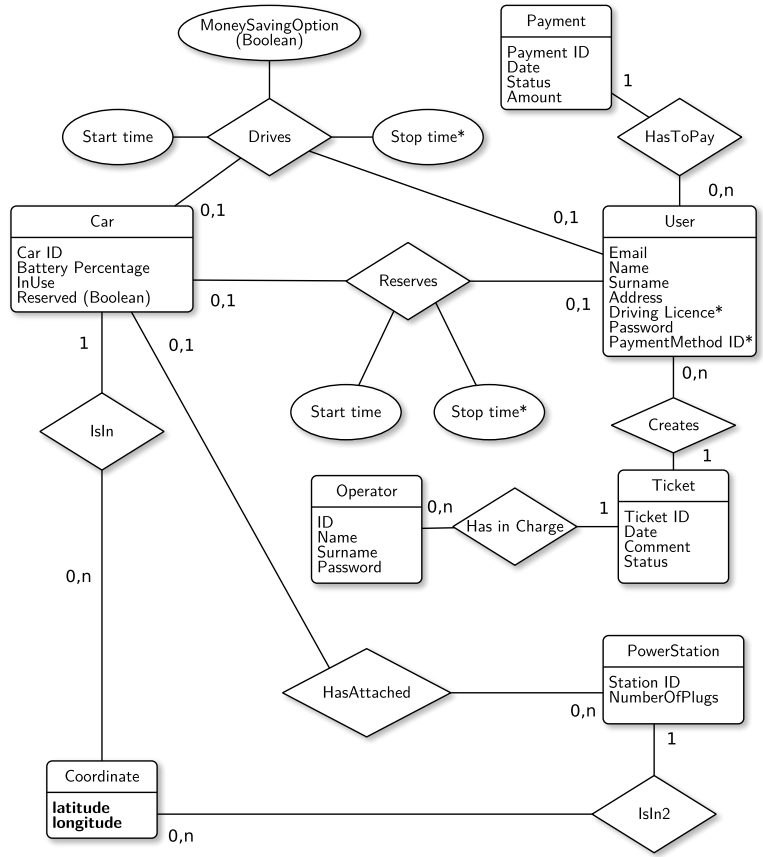
Data management

- We opted for a **centralized approach** since our **data model** is very small and interconnected and we do not need different types of data models (eg. SQL and noSQL).
- We chose a **SQL approach** because it offers an easy and **standardized language** for queries, and grants **ACID** properties.



Algorithmic decisions

- All **algorithms** needed in the project are trivial but the one dealing with uniform repartition of cars in the city.
- This problem has been studied a lot and there are in literature various algorithms that solve it.
- They are mainly based on **mixed integer linear programming** techniques and in particular [1] presented a complete **model**. In [2] is presented a **greedy algorithm** that achieves almost the same result.

The mixed integer linear programming formulation for the problem is:

$$\text{Min} \quad Z = c_0 \left(\sum_{(i,j)\in A_1} \sum_{k\in K} u^k_{i,j,s_{ij}} + \sum_{(i,j)\in A_2} \sum_{k\in K} v^k_{i,j,s_{ij}} \right) + c_2 \sum_{k\in L} x^k + c_d \sum_{i\in V} d'_i + c_t \sum_{i\in V} s'_i \qquad (1)$$

subject to

$$\sum_{i\in N} y^k_{0i} + \sum_{i\in N} z^k_{0,s_{0i}} + \sum_{\substack{i,j\in N \\ (i\neq j)}} u^k_{i,j,s_{ij}} + \sum_{\substack{i,j\in N \\ (i\neq j)}} v^k_{i,j,s_{ij}} = x^k \qquad \forall k \in \boldsymbol{L} \qquad (2)$$

$$\begin{aligned} & y^k_{i,t_i} + z^k_{(i,s_{ij}-d_i),s_{ij}} + \sum_{(i,j)\in A_1} u^k_{i,j,t_i} + \sum_{(i,j)\in A_2} v^k_{i,j,t_i} \\ & - y^k_{i,t_i+1} - z^k_{i,t_i,s_{ij}} - \sum_{(i,j)\in A_1} u^k_{i,j,s_{ij}} - \sum_{(i,j)\in A_2} v^k_{i,j,s_{ij}} = 0 \end{aligned} \qquad \forall i_t \in \boldsymbol{V}, k \in \boldsymbol{L}, t > 1 \qquad (3)$$

$$\begin{aligned} & r_{i_t} = r_{i_{t-1}} + \sum_{(j,i)\in A_1} \sum_{k\in L} v^k_{j,i,t_i} - \sum_{(i,j)\in A_1} \sum_{k\in L} v^k_{i,j,s_{ij}} \\ & + \sum_{\substack{(i,s_{ij}-d_i)\in A_2 \\ k\in L}} z^k_{i,s_{ij},t_i} + (s_{i_t} - s'_i) - (d_{i_t} - d'_i) - m_{i_t} \end{aligned} \qquad \forall i_t \in V \qquad (4)$$

$$\overline{r}_{i_t} = \overline{r}_{i_{t-1}} - \sum_{k\in L} z^k_{i,s_{ij}} + m_{i_t} \qquad \forall i_t \in V \qquad (5)$$

$$r_{i_t} + \overline{r}_{i_t} \leq p_i \qquad \forall i_t \in V \qquad (6)$$

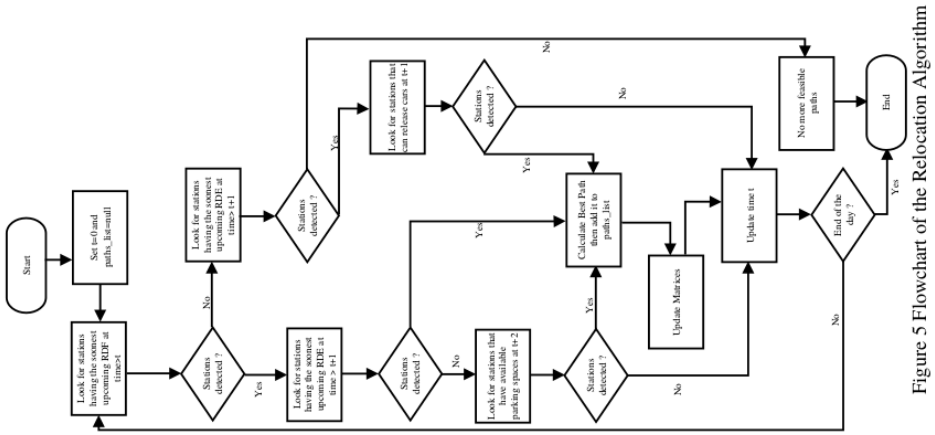
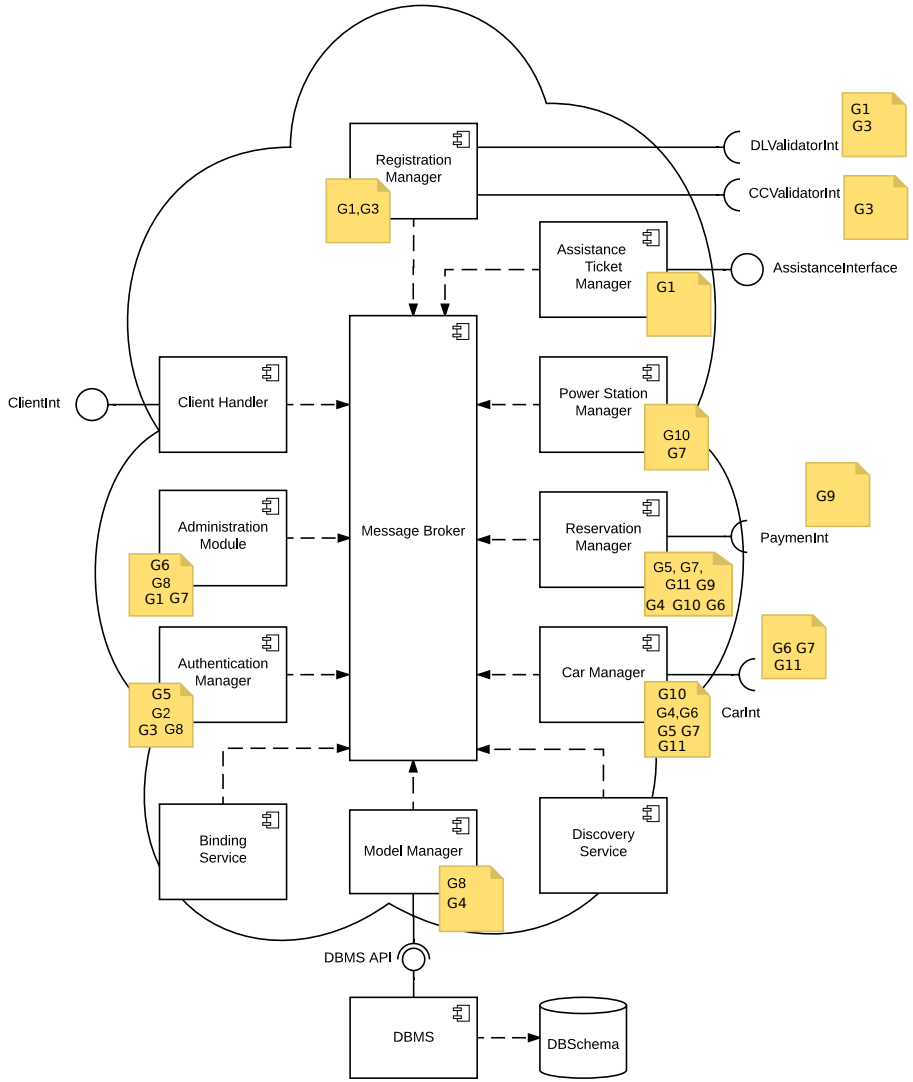


Figure 5 Flowchart of the Relocation Algorithm

Requirements traceability

1. Allow visitors to sign up.
2. Allow visitors to log in.
3. Allow Users and Active Users to update or modify their profile's information.
4. Show updated information on available cars.
5. Allow Active Users to reserve a car.
6. Allow Active Users to unlock the car reserved
7. Compute the fare.
8. Allow System Administrator(s) to update system's information.
9. Ensure that the fare is paid.
10. Allow the driver to choose the money saving option and get near their destionation.
11. Allow the user to park the rented car in safe zone.



UX Diagram

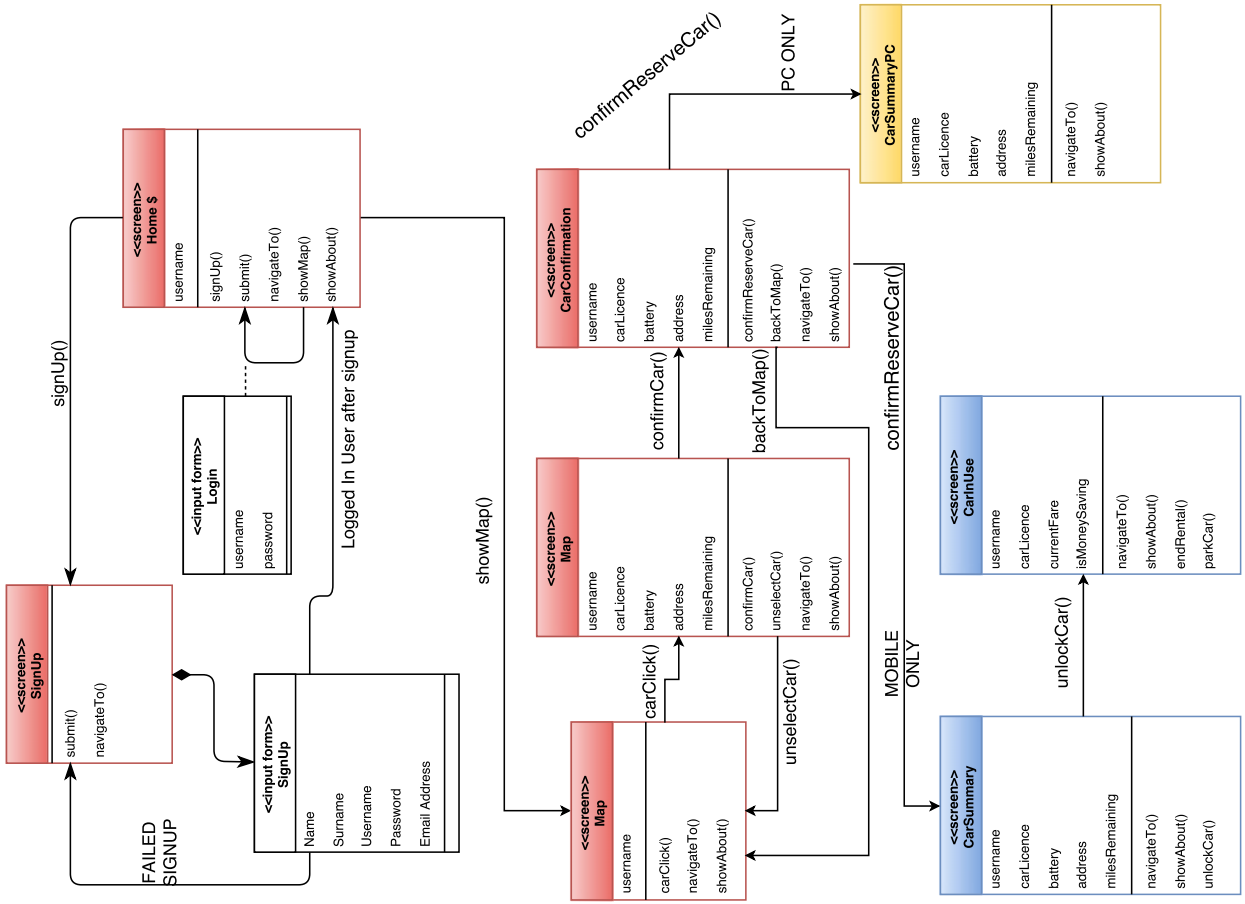
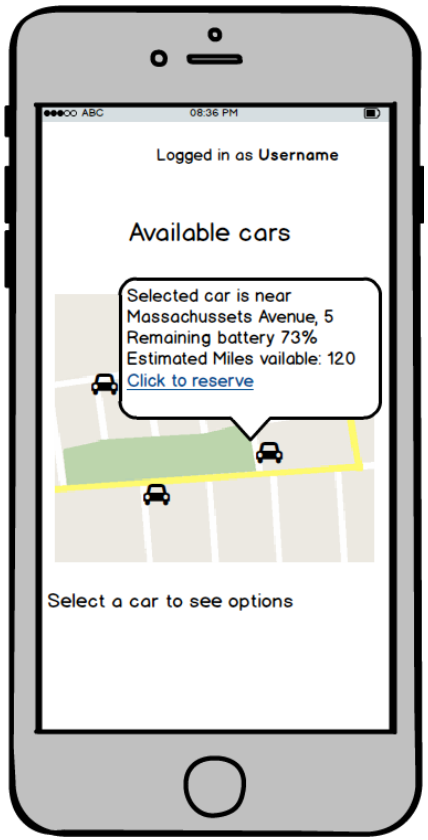


Figure: AAA

Sample Mockups



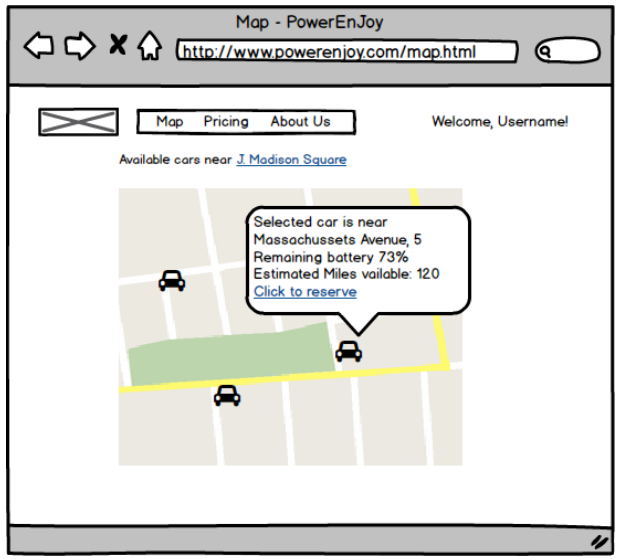


Figure: Mockup 1