Integrated Services for Passenger Transportation in Smart Cities Based on Blockchain Technology

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Outline

- Objectives & introduction
- Introduction
- Functionalities overview
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- Performances analysis
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Objectives

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- Define a solution based on **blockchain technology** (Hyperledger Fabric) with application in **multi-modal passenger transportation systems**
- Definition of a **data model** for multi-modal passenger transportation
- **Evaluate performances** of the proposed solution in a test environment

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Project facts

DELPHI

Full Title: Federated Network of Platforms for Passenger and Freight Intermobility
Project ID: 101104263
Funded under: Horizon Europe
Funding scheme: RIA – Research and Innovation Action
Duration: 36 months, 01 July 2023 – 30 June 2026
Total cost – EU contribution: EUR 4,999,561.50
Topic: HORIZON-CL5-2022-D6-02-05
Coordinator: Institute of Communication & Computer Systems (ICCS)

Consortium

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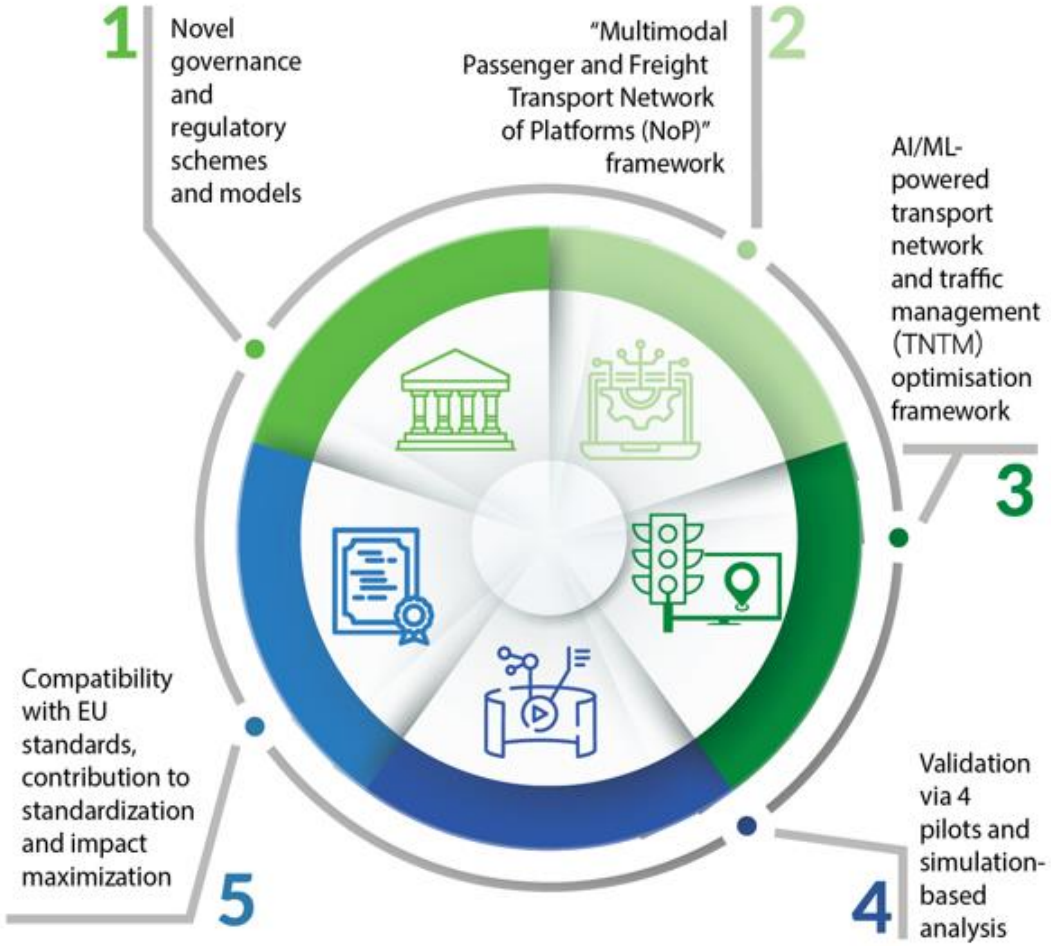
Objectives

Towards the overall project's concept and mission, the following five interdisciplinary implementation objectives have been defined:



USE CASE #1
Multimodal transport for a Sustainable LMD supported by blockchain for sharing economy in the e-commerce Channel in Madrid (Spain)

USE CASE #2
Integrated freight and passengers' models and data sharing framework in urban environment in the Attica region (Greece)

USE CASE #3
Integrated freight and passengers' models and data sharing framework in suburban/rural environment in the island of Mykonos (Greece)

USE CASE #4
Integrated passengers' models and data sharing governance framework in the Cluj-Napoca Metropolitan Area (Romania)

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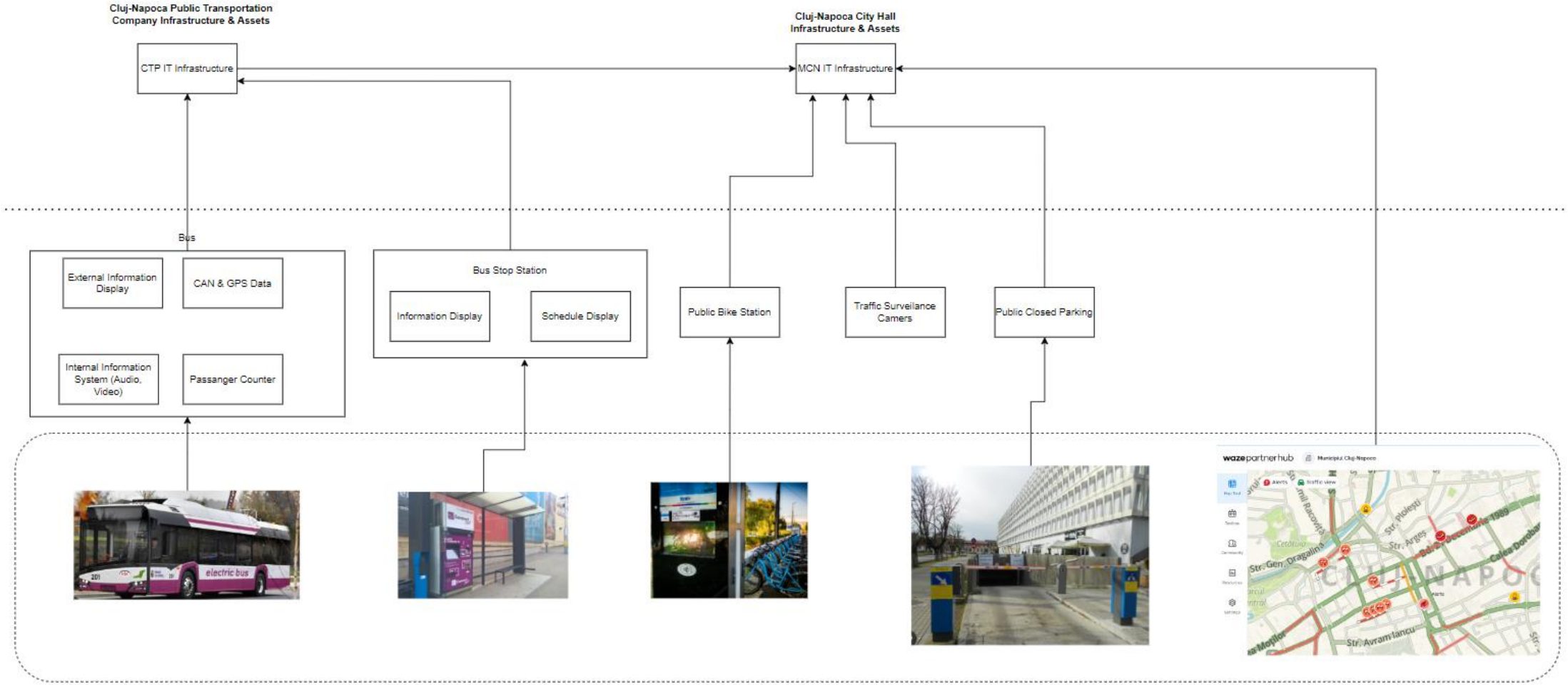
Cluj-Napoca Use Case



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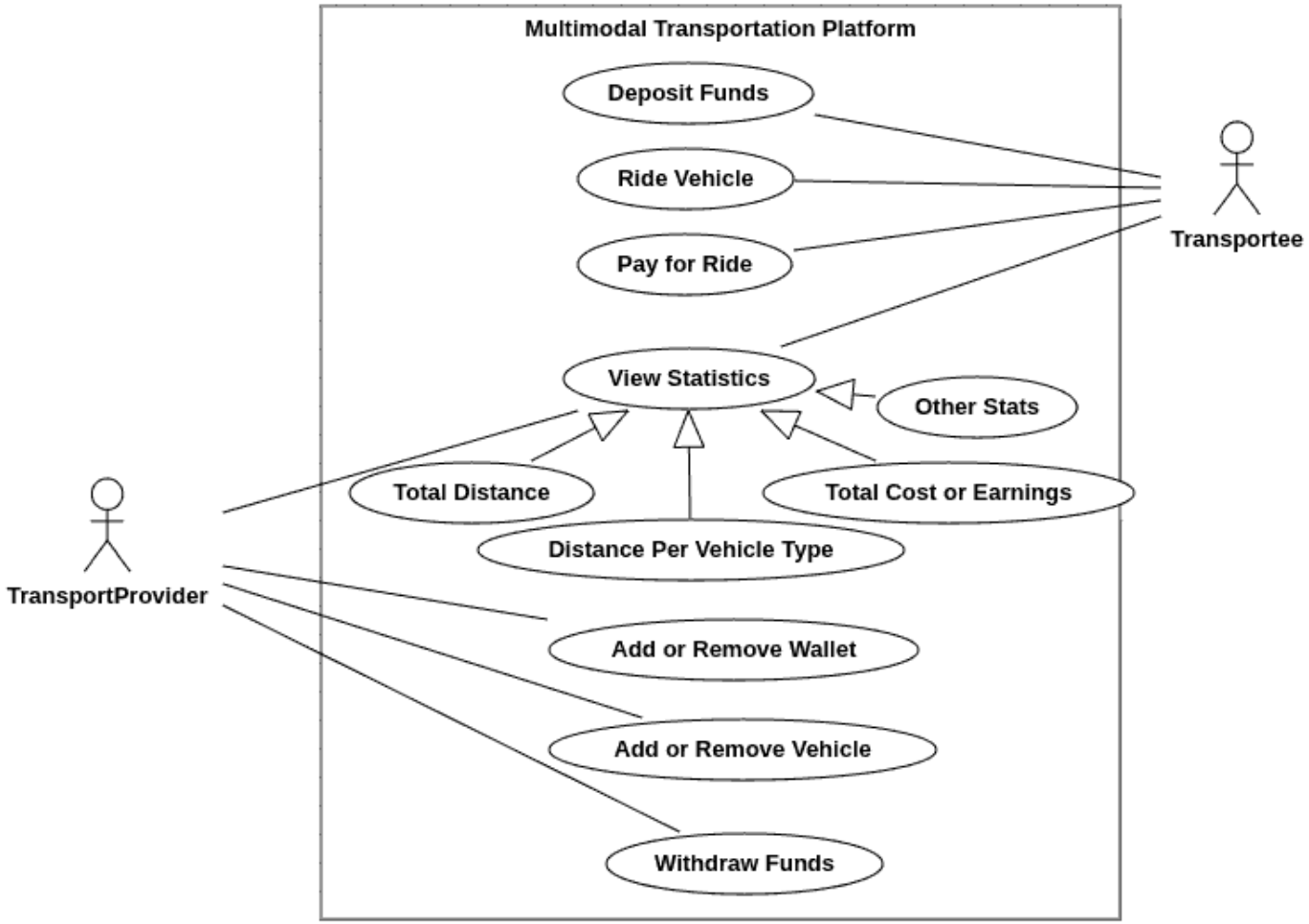
Functionality Overview



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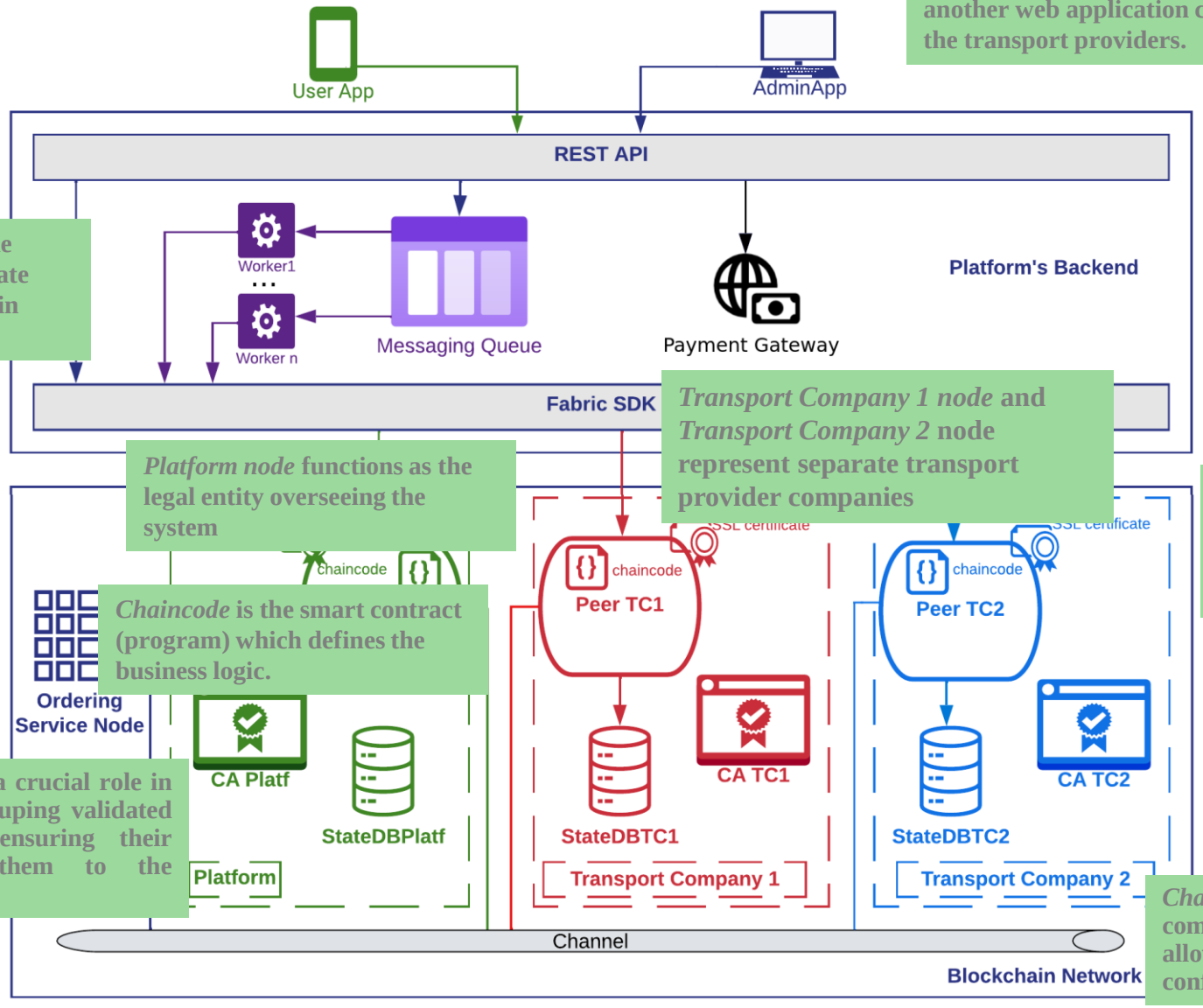
Solutions Architecture

There are two client applications utilized to access the system. One mobile application is designed for the transportation users, while another web application caters to the transport providers.

Backend services handle de communication and mediate interaction with blockchain platform



Platform node functions as the legal entity overseeing the system

Transport Company 1 node and *Transport Company 2* node represent separate transport provider companies

Chaincode is the smart contract (program) which defines the business logic.

Distributed blockchain network based on Hyperledger Fabrics technology which is a permissionless based blockchain.

Ordering Service Node plays a crucial role in managing the process of grouping validated transactions into blocks, ensuring their consensus, and adding them to the distributed ledger.

Channel. A channel is a private and confidential line of communication between specific network members, allowing for the segregation of transaction data and confidential communication within a subset of the network.

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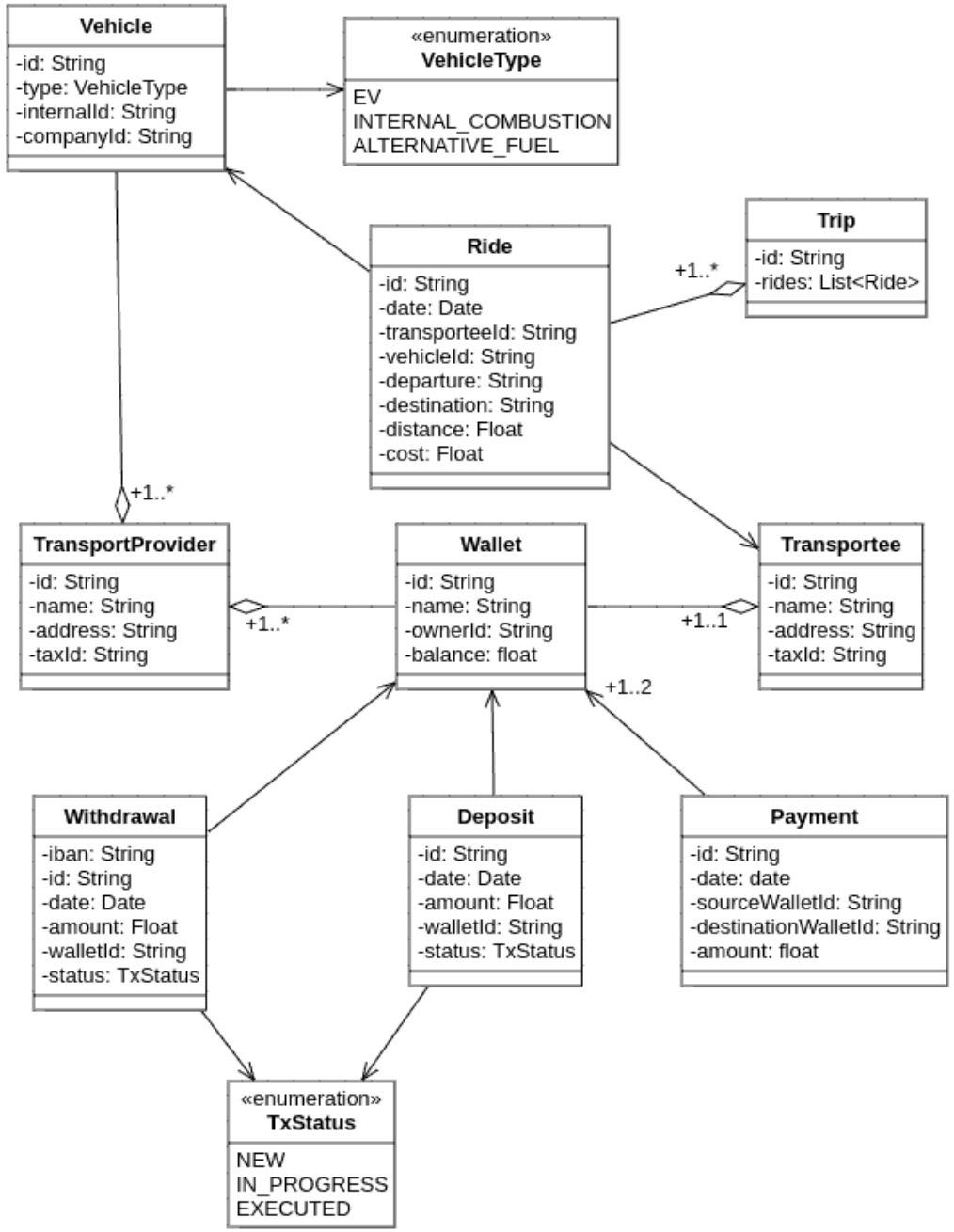
Data Model



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Performances analysis

- Test 2 operations:
  - Get wallet by ID
  - Get total costs\month
- Blockchain populated with up to 1.000.000 records
- Response time does not depends on number of records
- 400 requests in parallel the response error rate (timeout) was around 10%, on average for both operations
  - Can be used as a reference for tuning the number of workers for the messaging queue

No. of requests	Get wallet by ID time [ms]	Total cost per month time [ms]
1	6	11
10	14	28
50	67	100
100	134	158
150	205	292
200	363	403
250	399	521
300	501	633
400	713	833

Average response time of the blockchain per number of parallel requests

The test environment was deployed on the following configuration: Intel® Core™ i7-8565U CPU @ 1.80GHz × 8, 16 GB RAM, Ubuntu 20.04 LTS. The tool used for conducting the load tests was Apache JMeter 5.6.2.

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Conclusions

- **Explore application of blockchain technology** in passenger transportation within smart cities
  - Blockchain technology can effectively address the complex challenges of integrating various transportation modes and stakeholders
- **Proposed technical infrastructure based on Hyperledger Fabric** has demonstrated feasibility and the capacity to handle high loads and requests
- **Proposed a data model** to allow storing **multimodal transportation** data
- **Evaluation of the performances** on a base hardware infrastructure – results to be used for tuning and optimization of a production ready infrastructure

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