

# Study, design and implementation of a blockchain-based traceability system in the context of used cooking oil recycling



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Co-Advisor Valerio Goretti  
Adjunct Advisor Prof. Daniele De Sensi

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Department of Computer  
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23 January 2024

# Thesis context



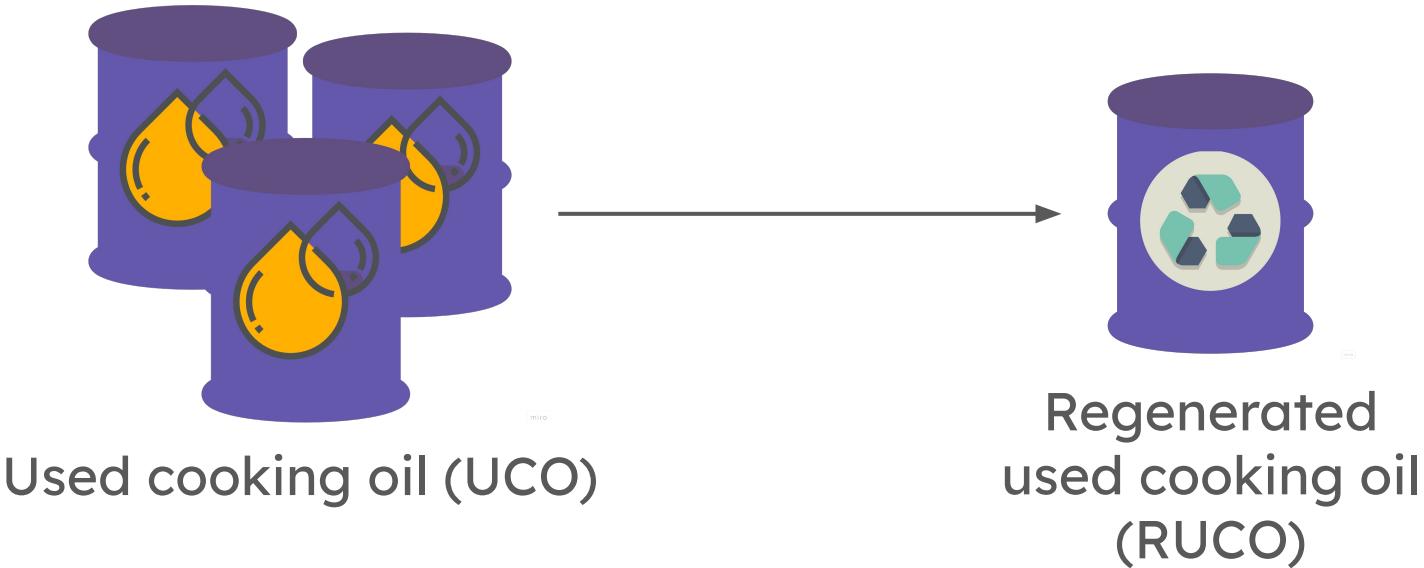
miro

Used cooking oil (UCO)

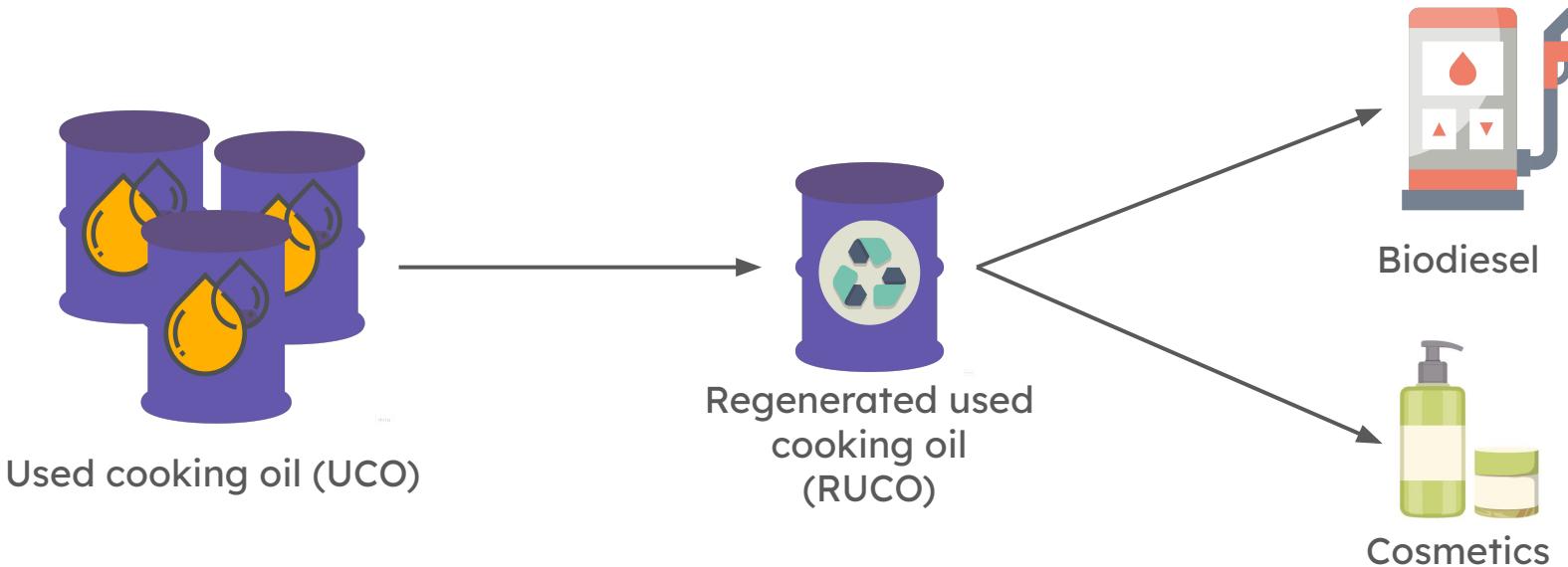


M. Raffaele – Study, design and implementation of a blockchain-based  
traceability system in the context of used cooking oil recycling

# Thesis context



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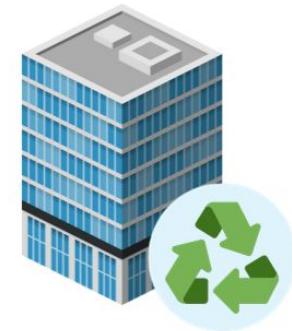


# Thesis context



National consortium for the collection and treatment of used vegetable and animal oils

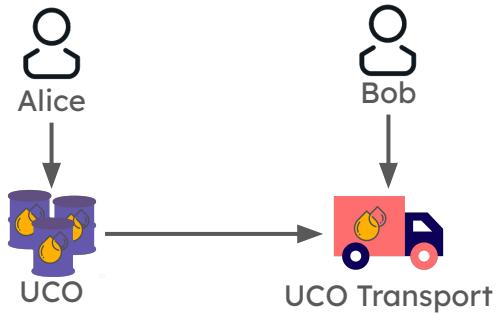
Research-oriented leading company in the field of bio-based material production from organic waste



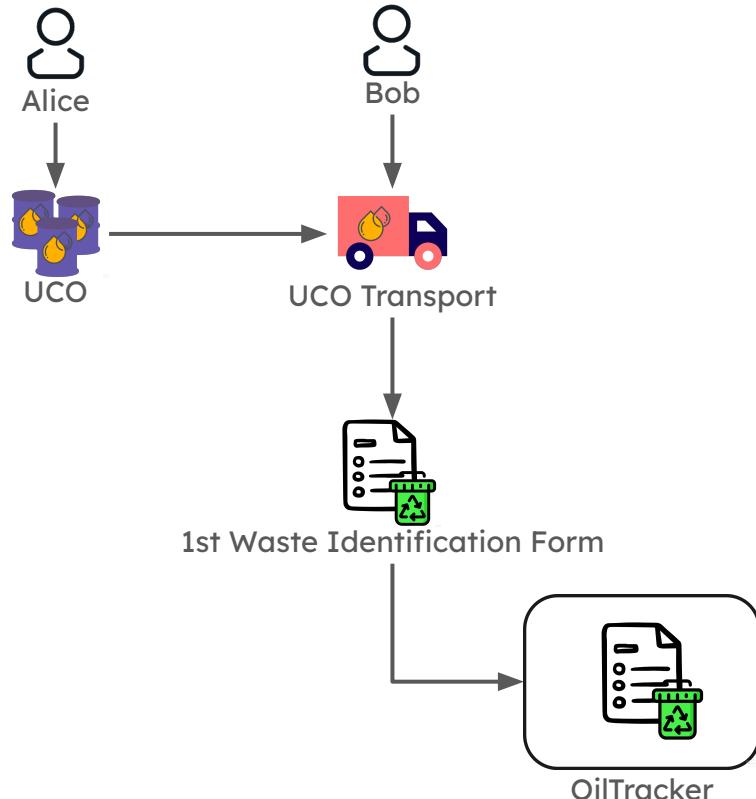
# Case study



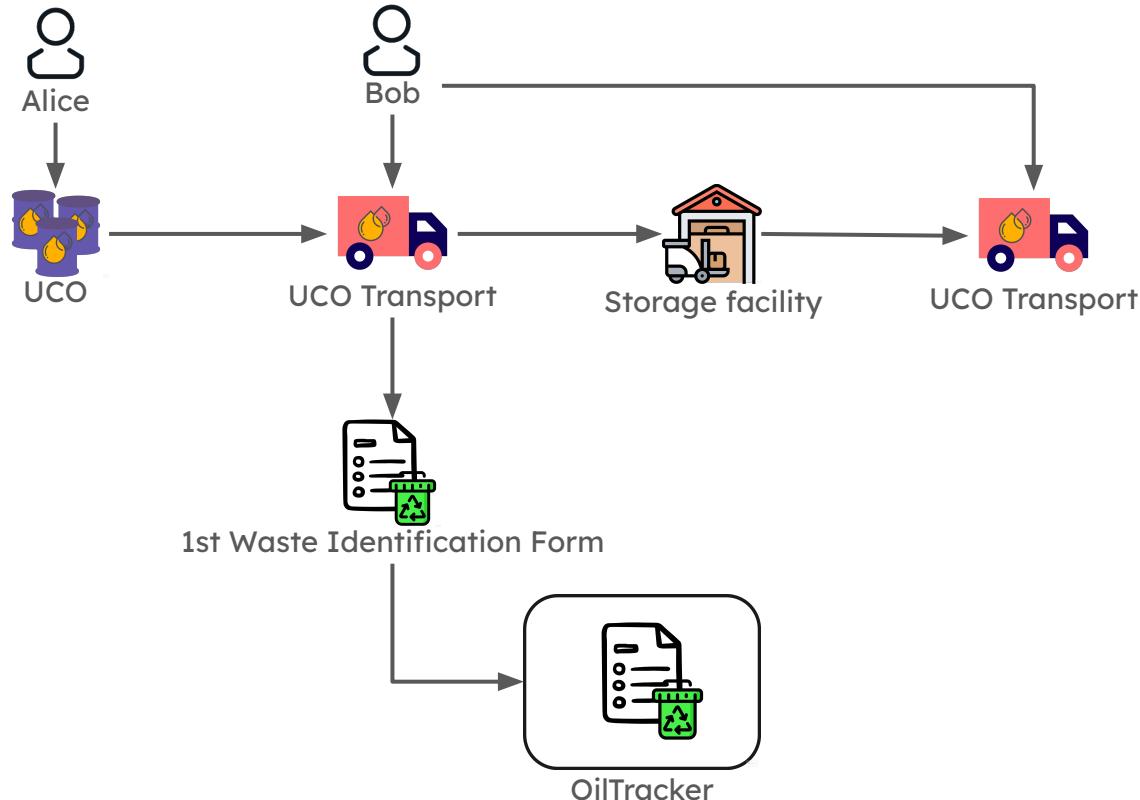
# Case study



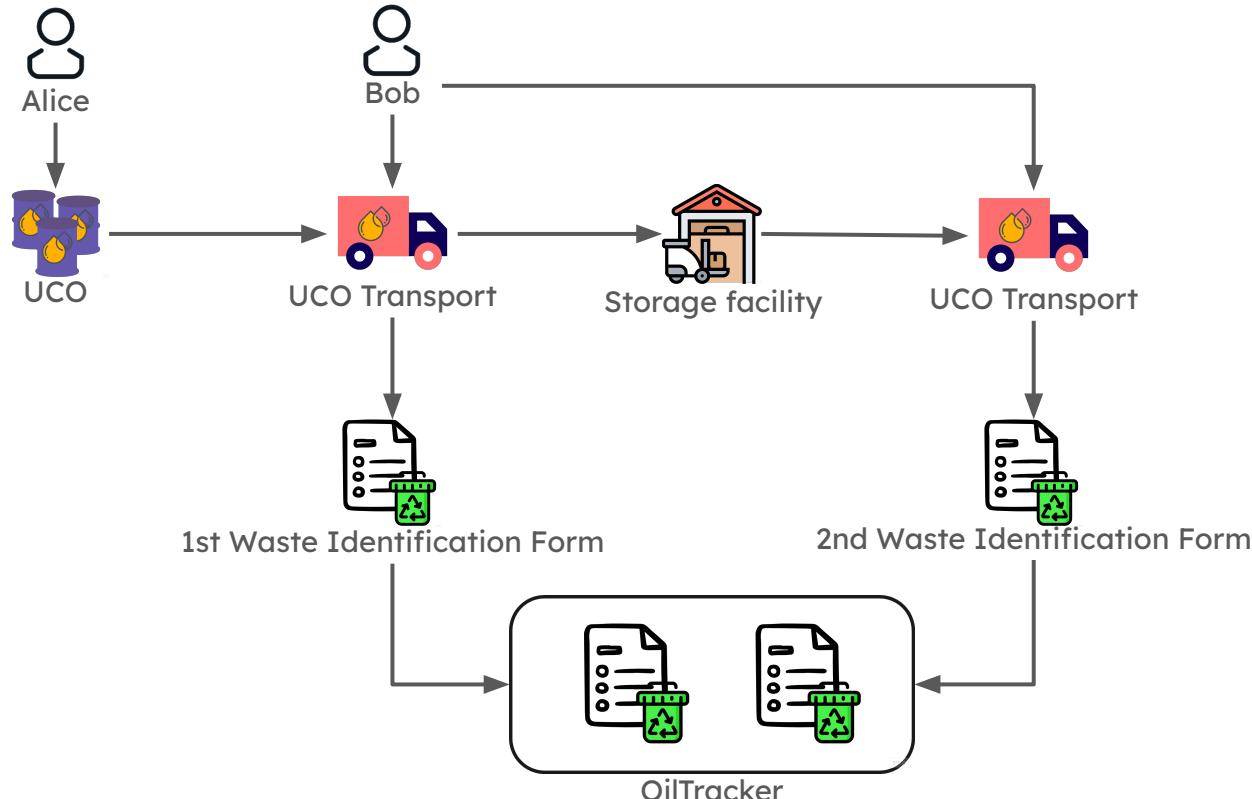
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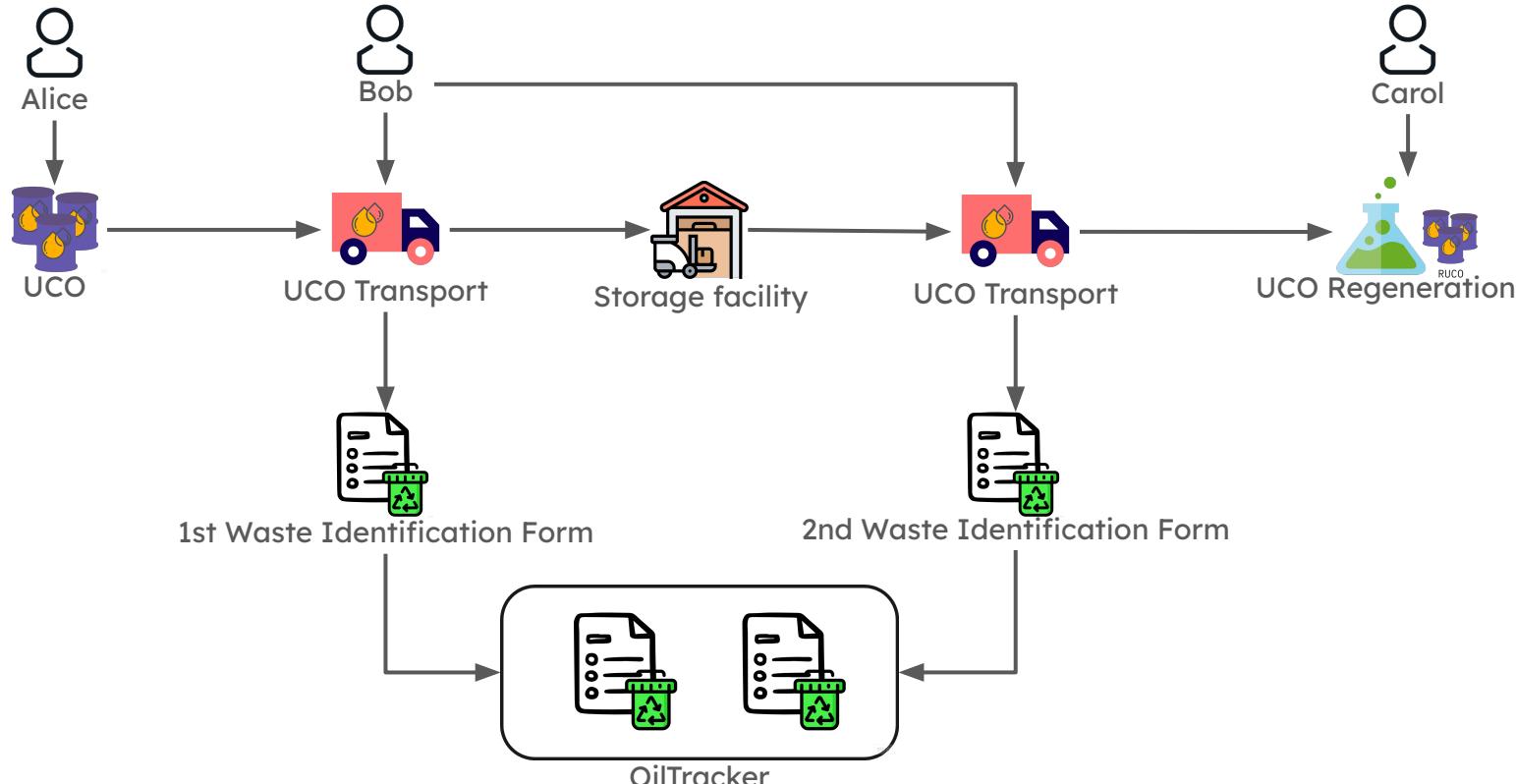
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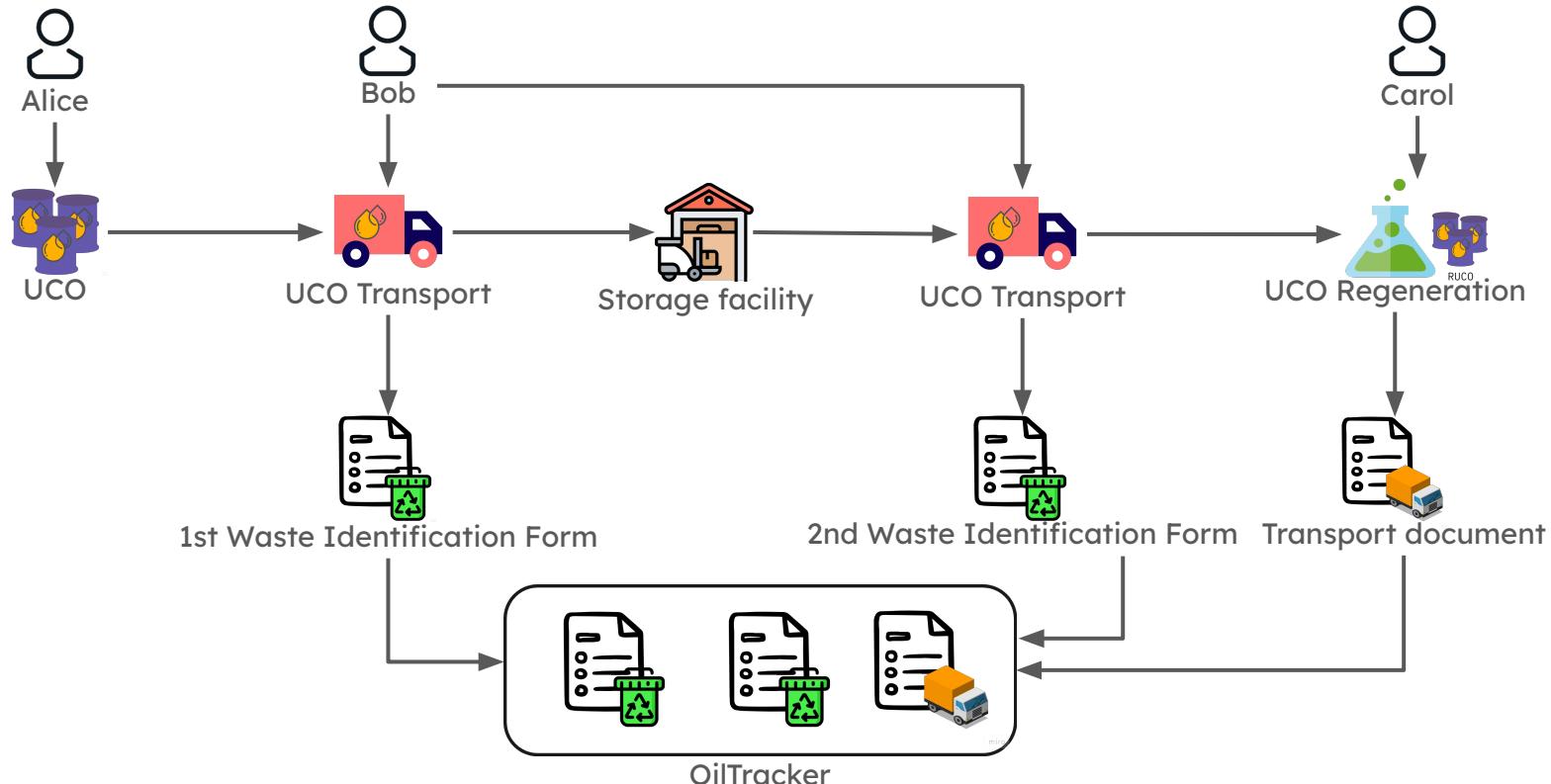
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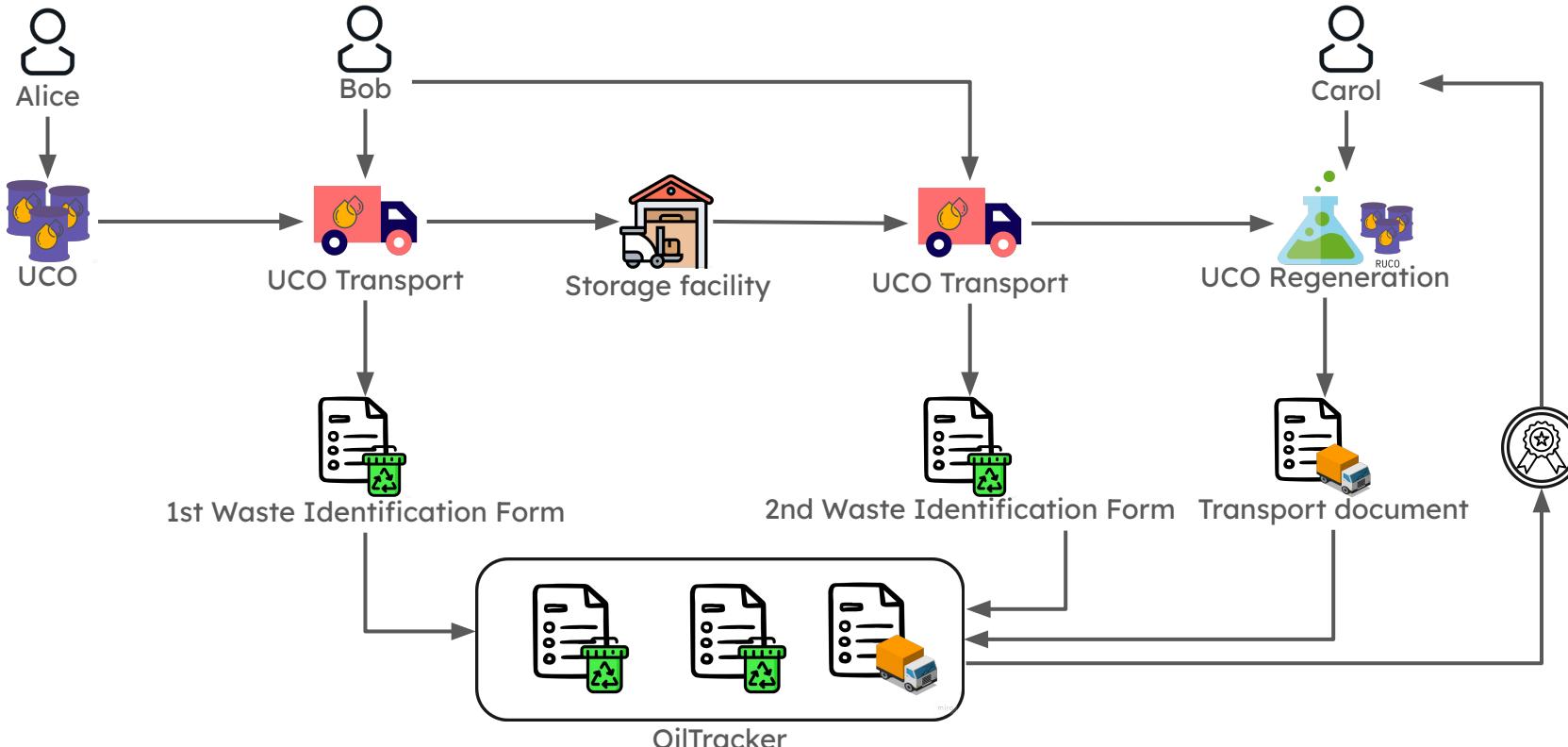
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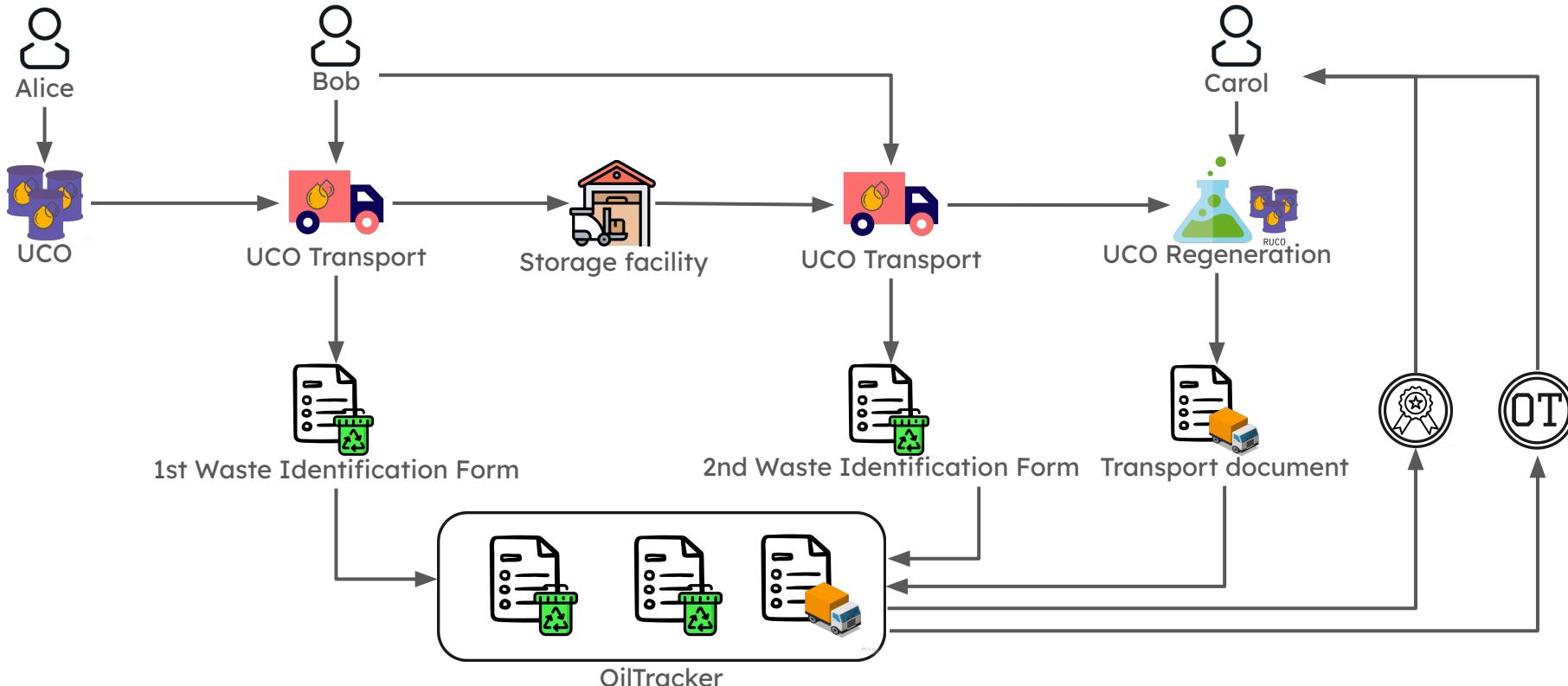
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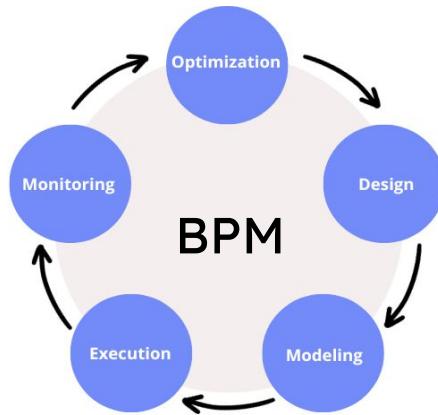
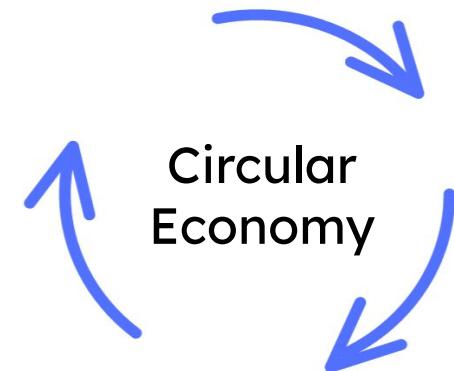


# Case study



# Background

Economic model based on continuous reuse of resources, elimination of waste, repair, and recycling

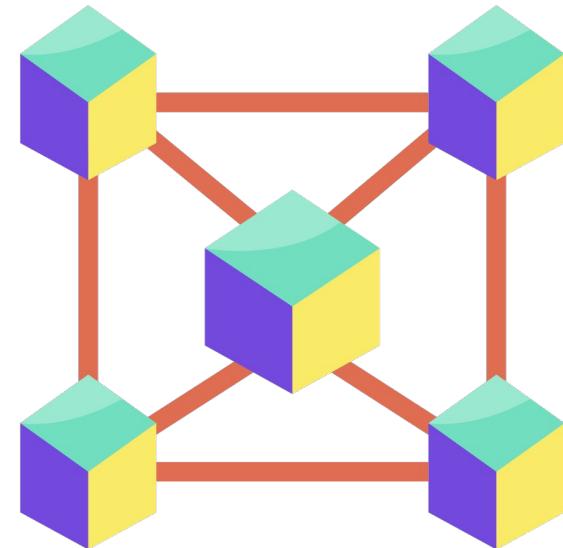


Approach that uses methodologies and technologies to improve efficiency and control of business processes



# Background

Technology that uses a network of nodes to store data and information in an open, shared and distributed ledger



miro



# Background



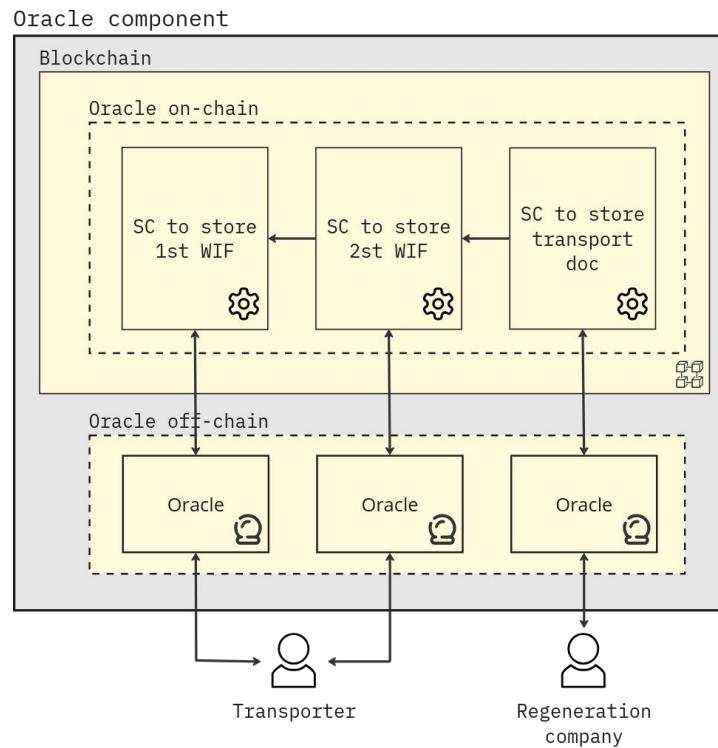
A smart contract is computer program, running on the blockchain, that implements contractual clauses and allows them to be verified automatically

# Background

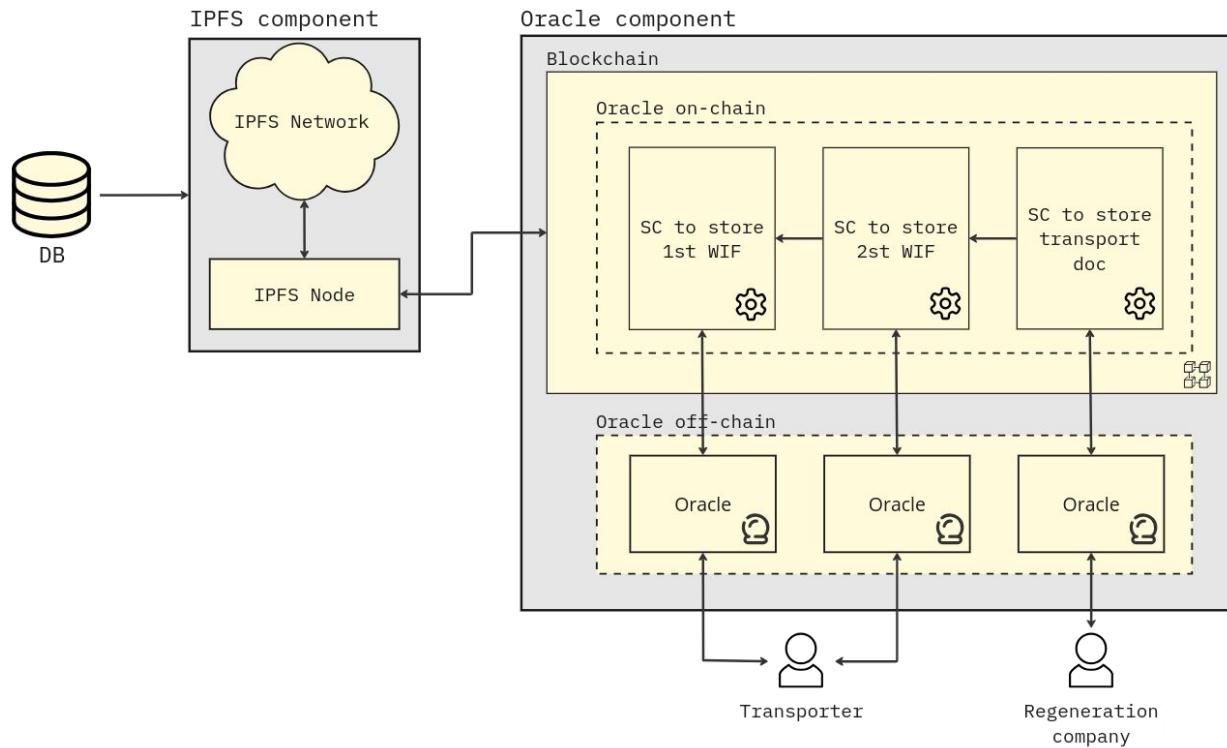
The InterPlanetary File System (IPFS) is a particular protocol designed to create a large global network of peer-to-peer nodes that allows each computer that takes part to upload and download files in a distributed way



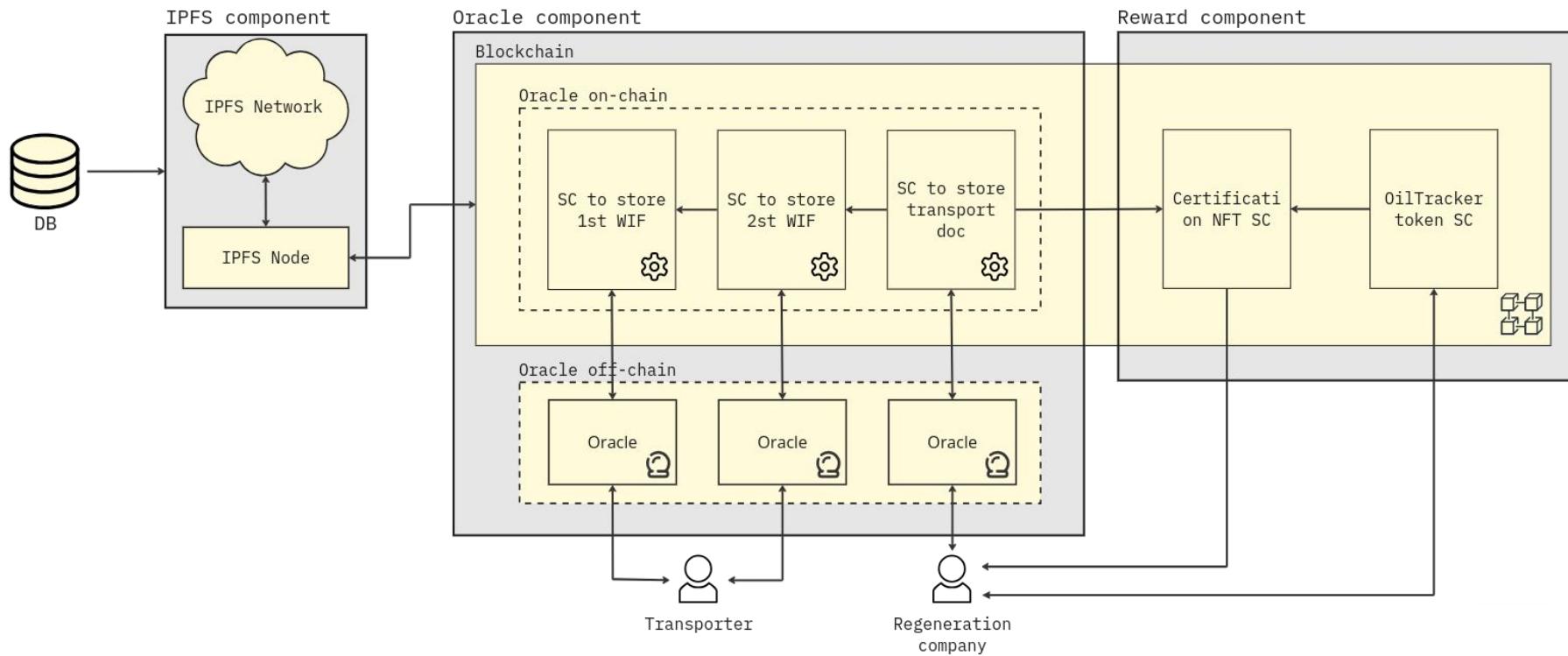
# System Design - Infrastructure



# System Design - Infrastructure



# System Design - Infrastructure



# System Design



Owner



Transporter



Regeneration  
company



# System Design



**Owner**



Transporter



Regeneration  
company



# System Design



Owner



**Transporter**



Regeneration  
company



# System Design



Owner



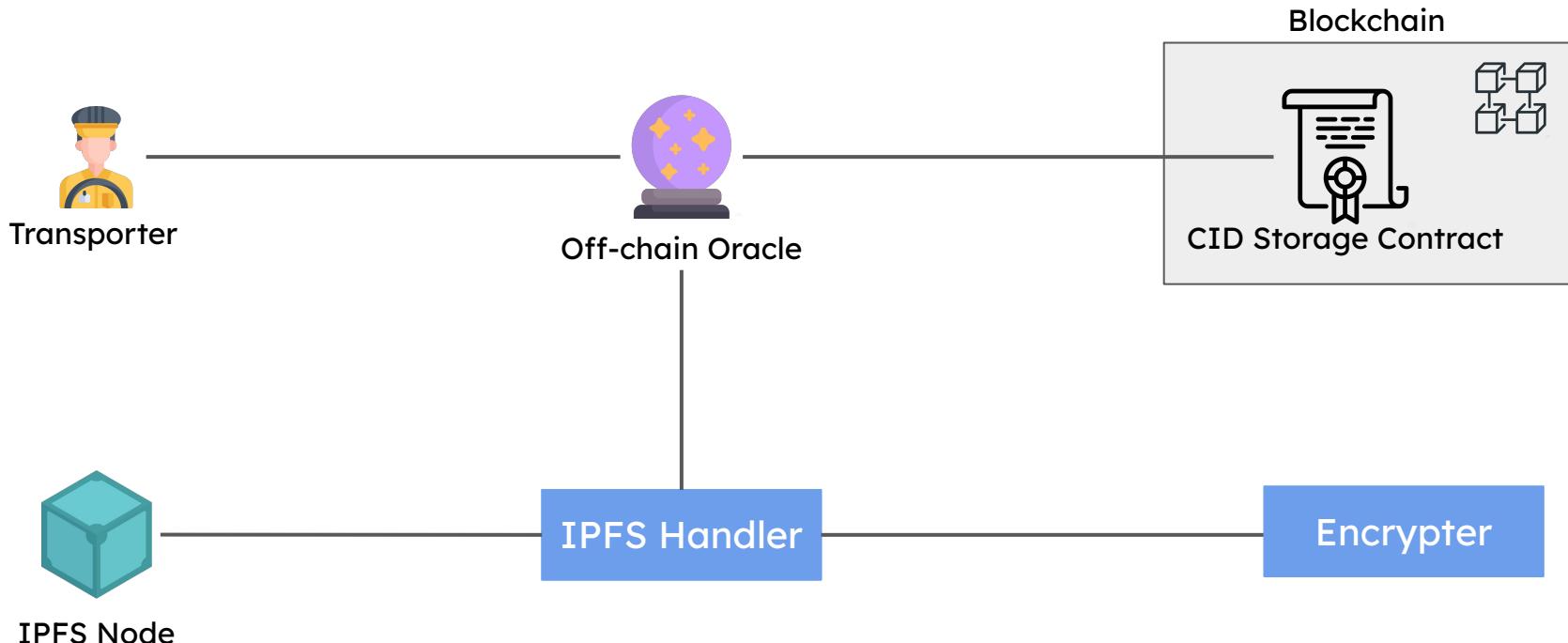
Transporter



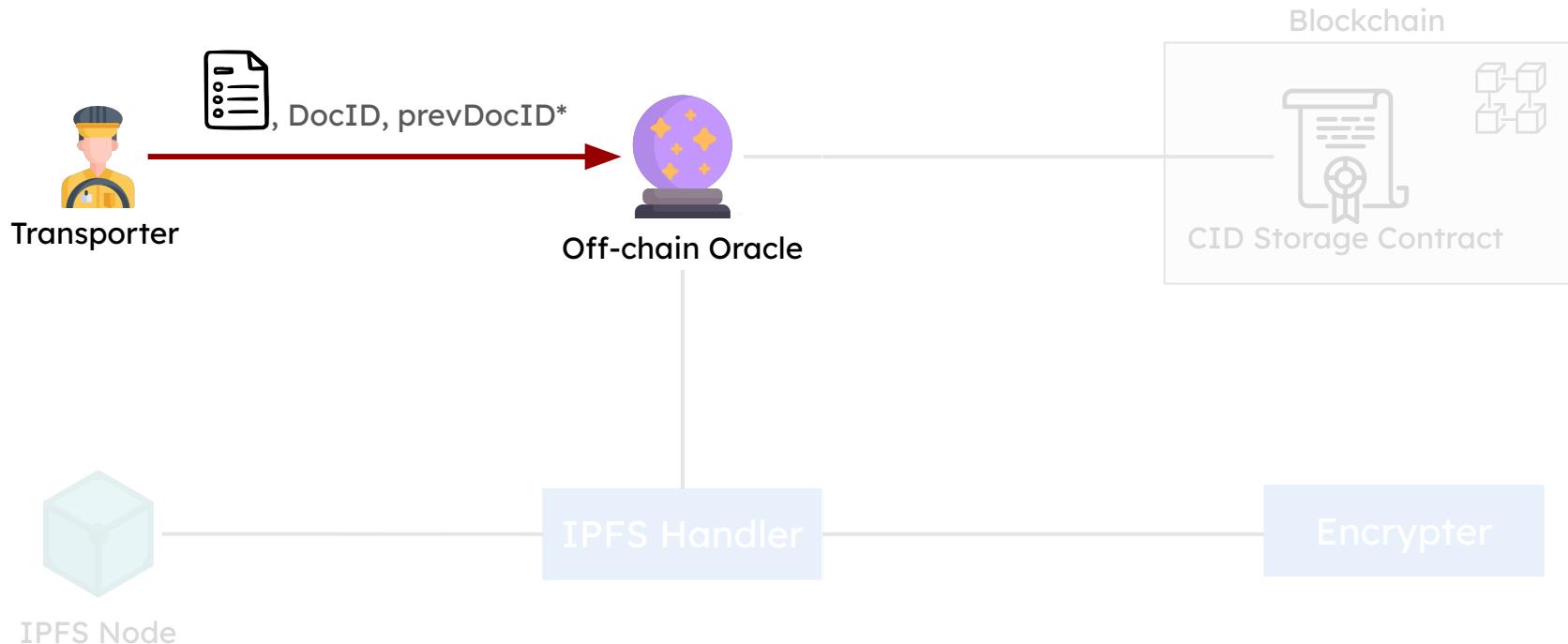
**Regeneration  
company**



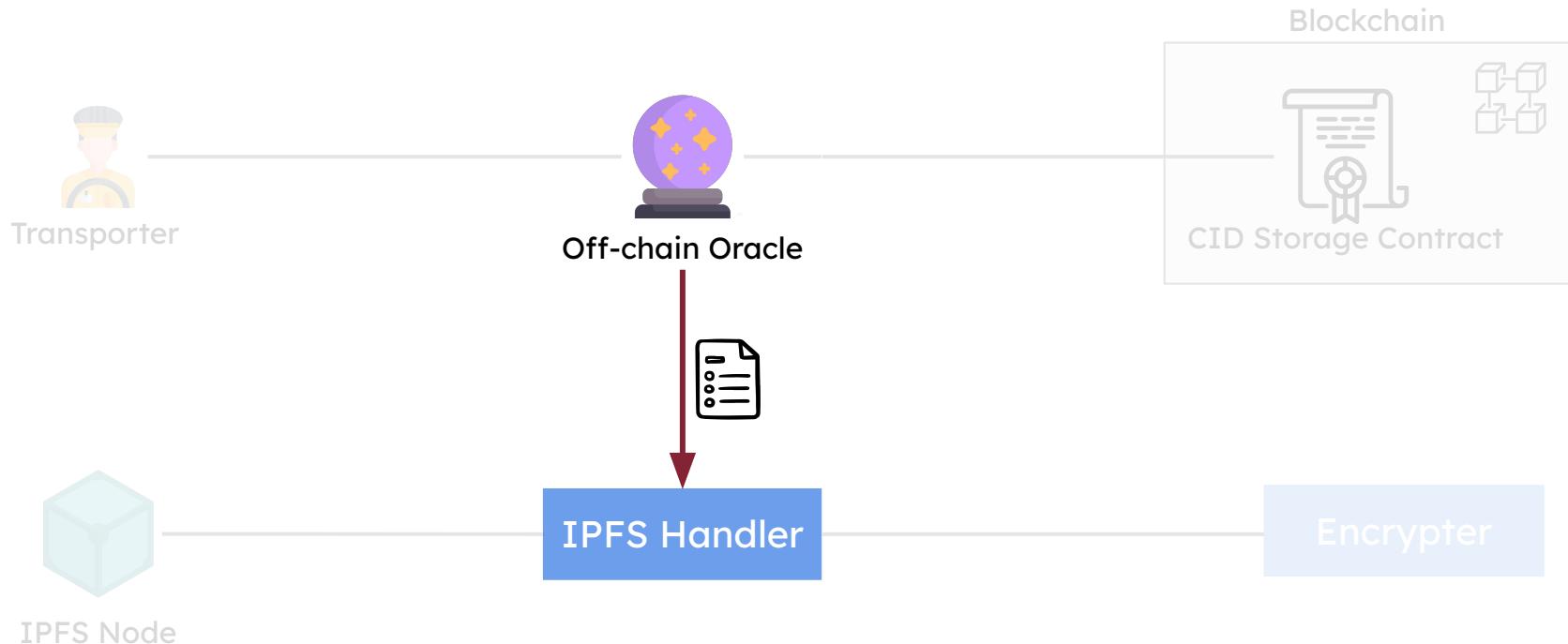
# System Design - Add tracking data



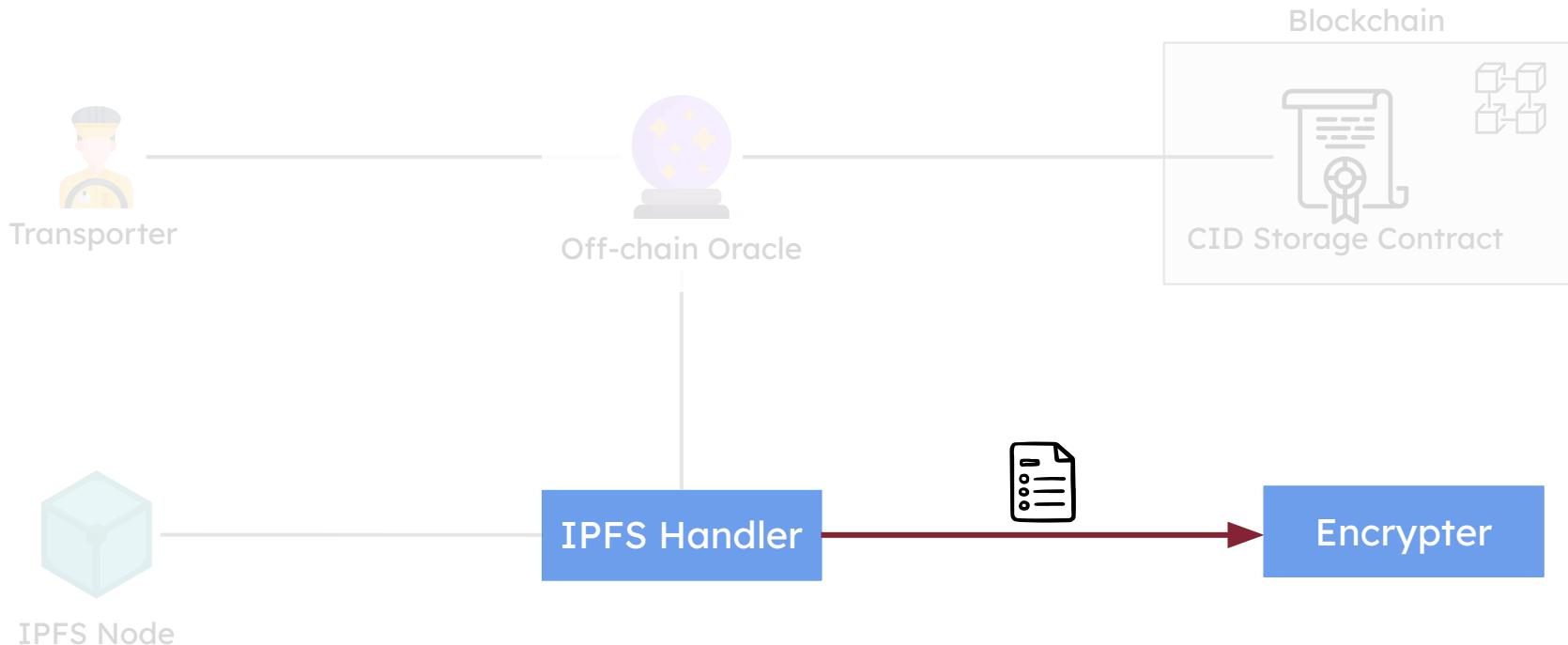
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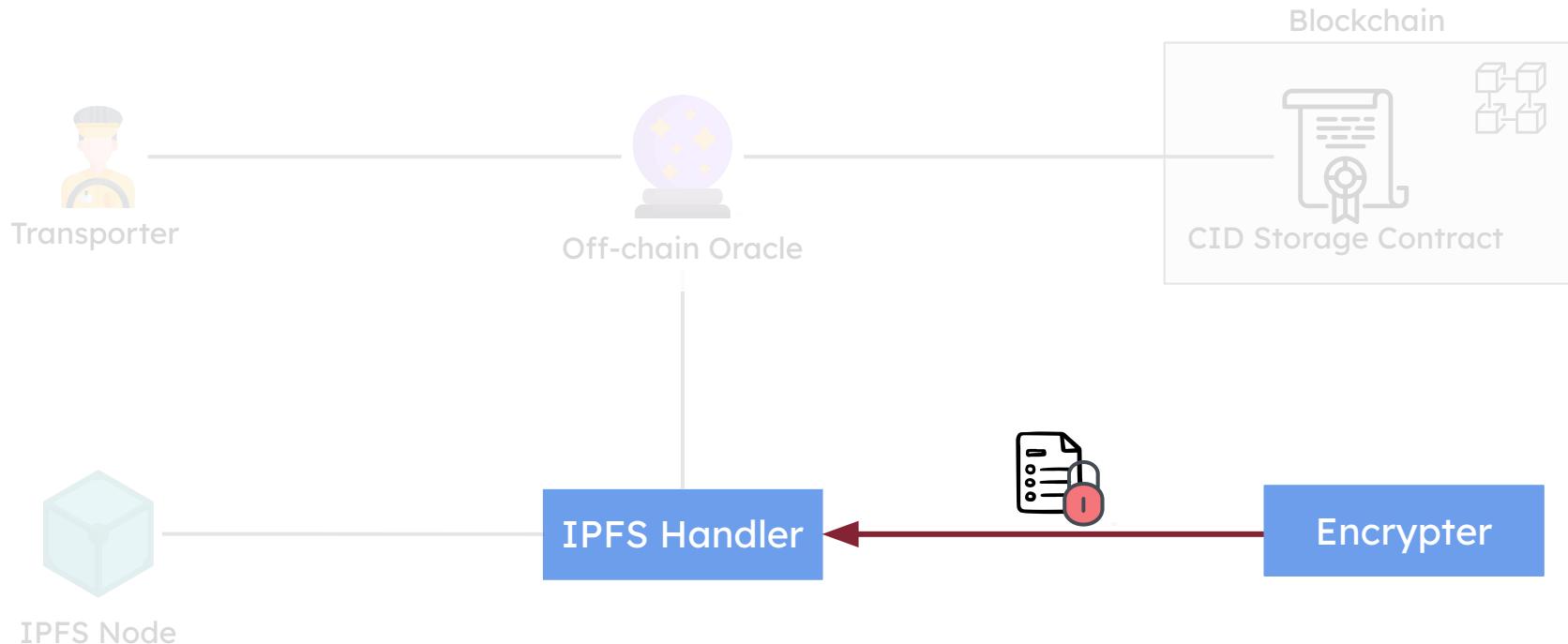
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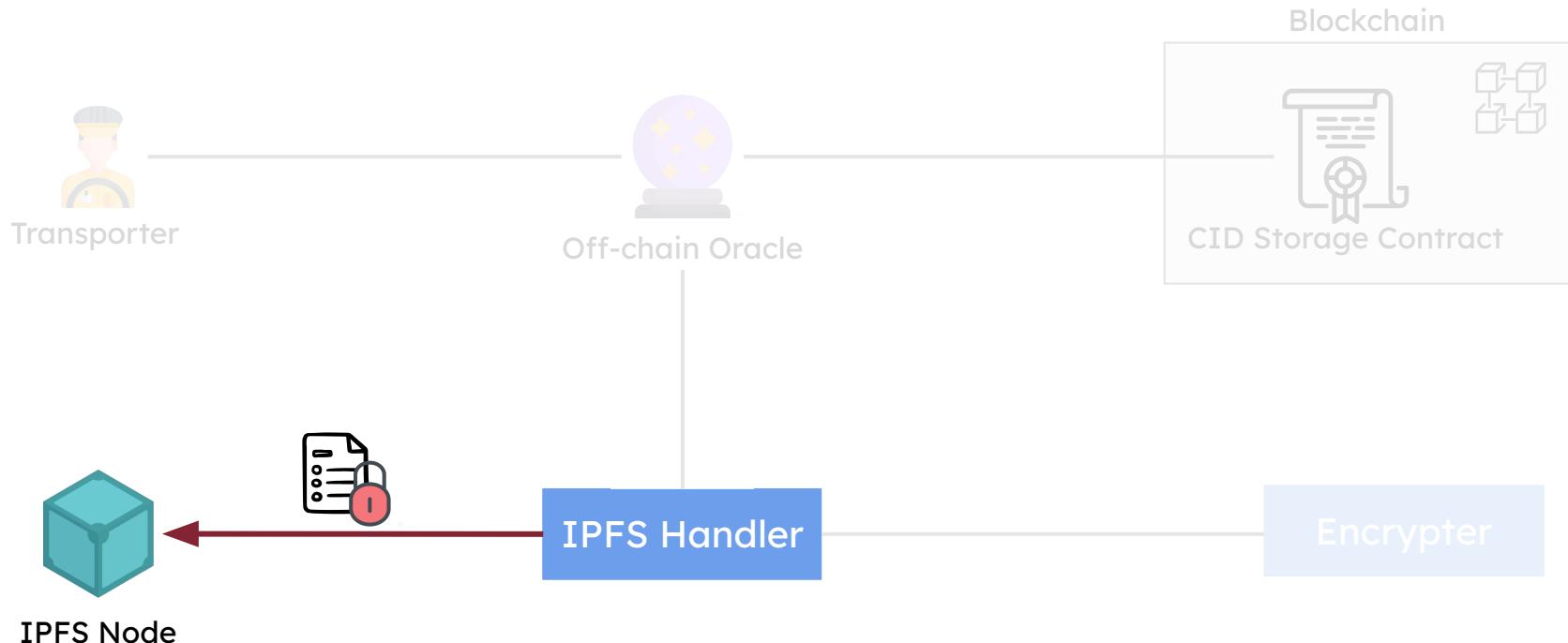
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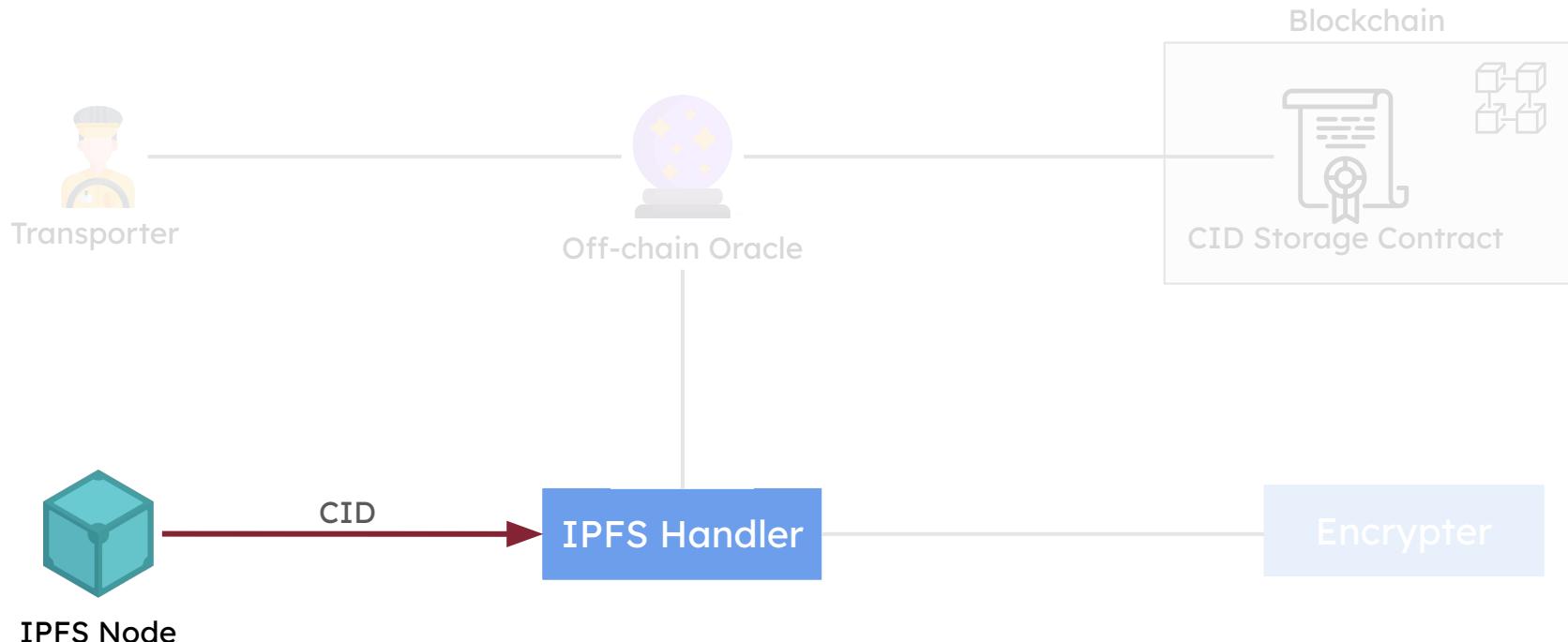
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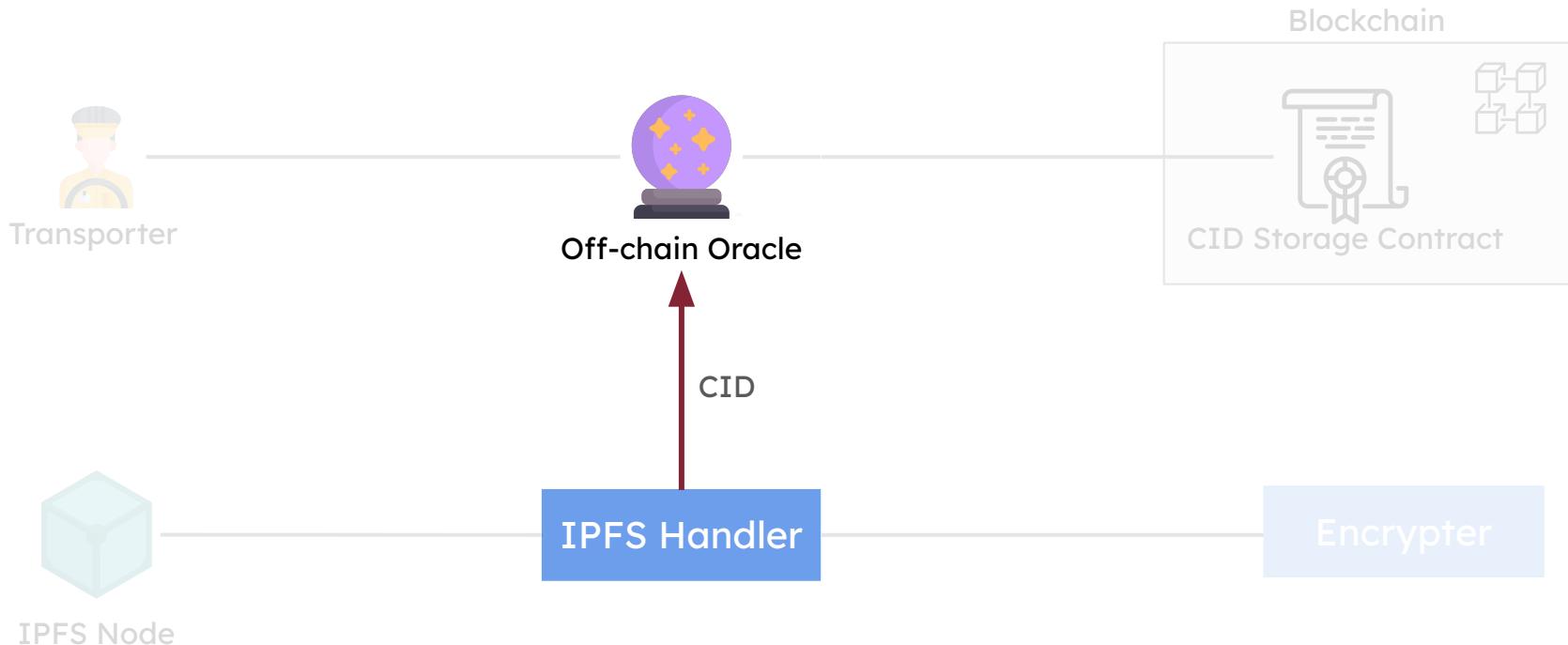
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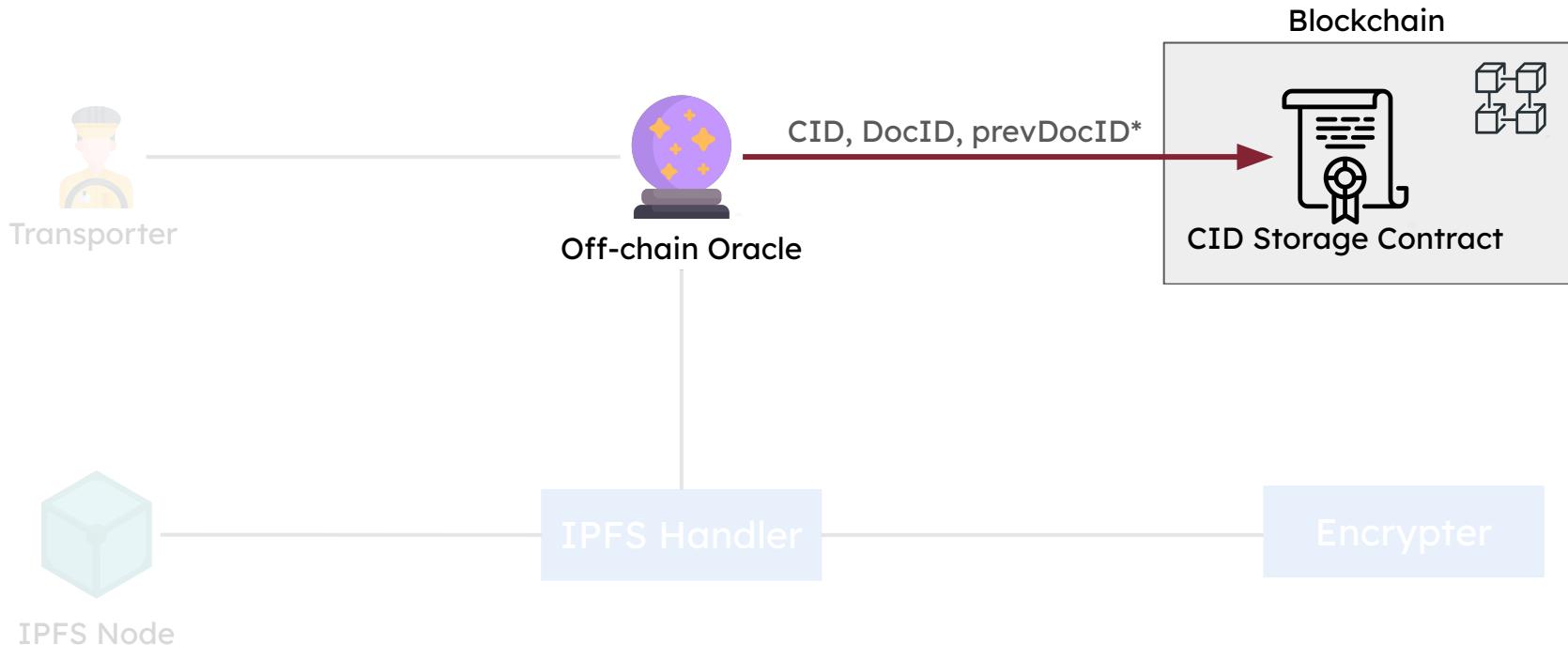
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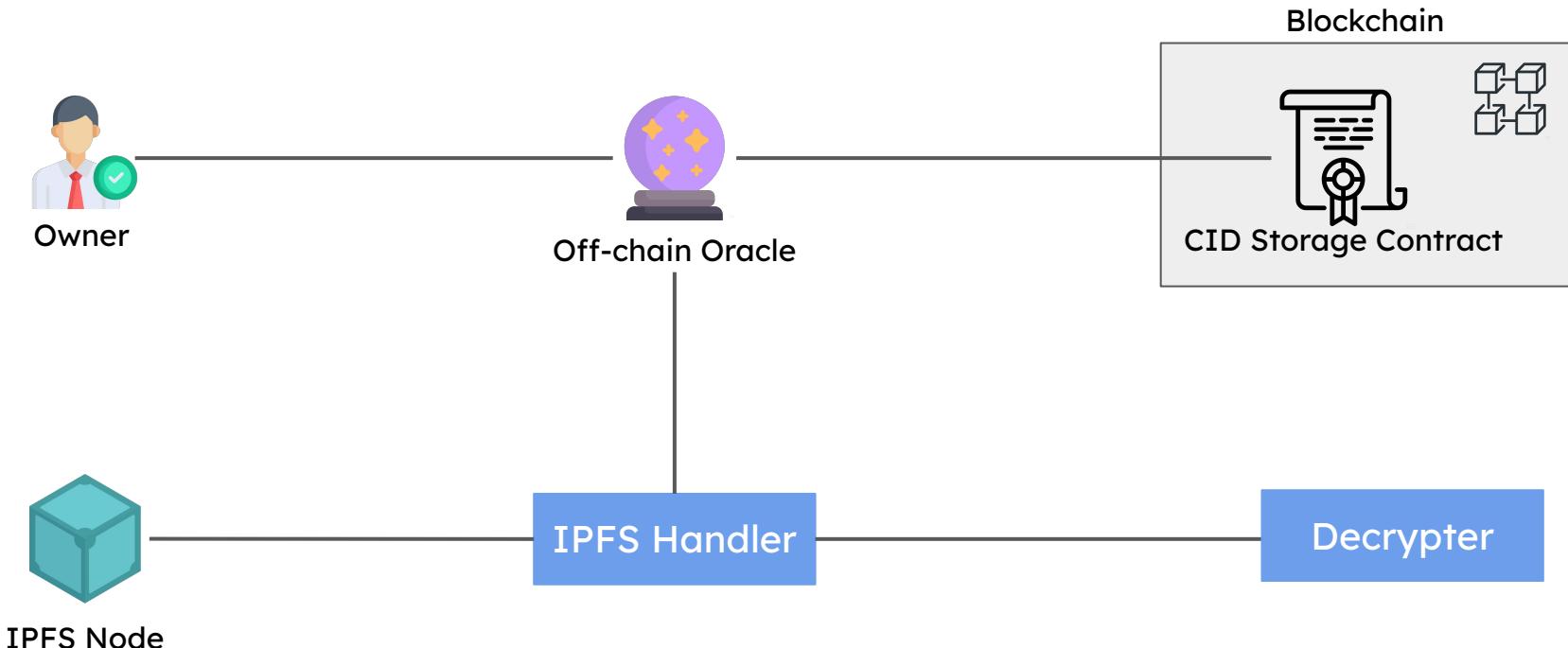
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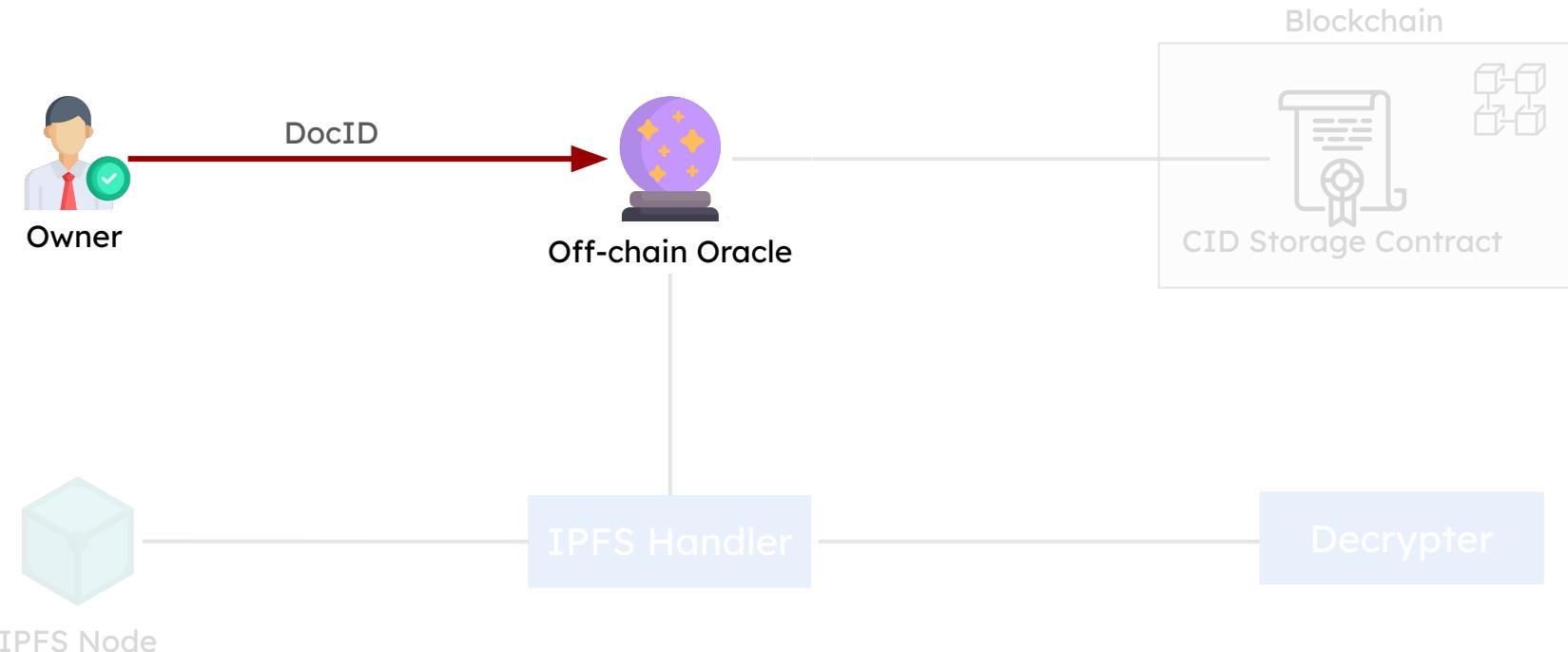
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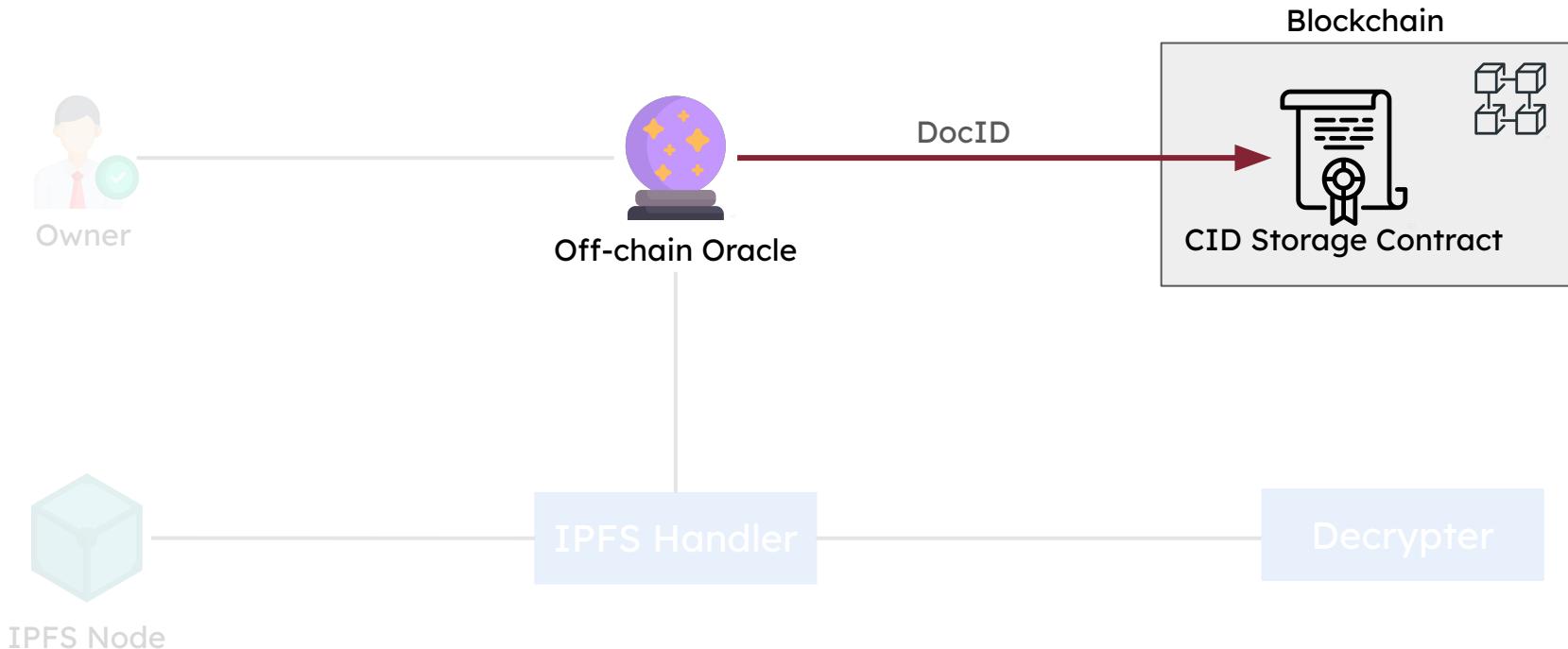
# System Design - Get tracking data



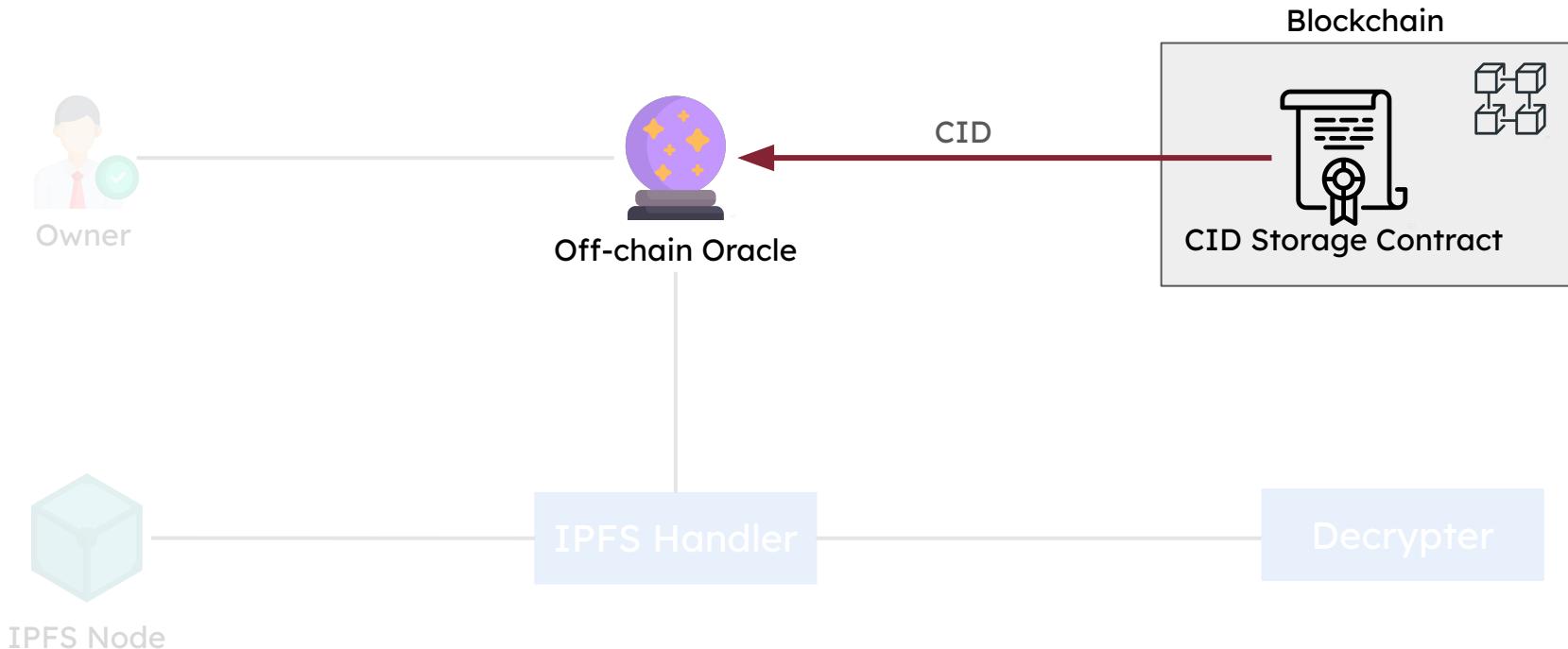
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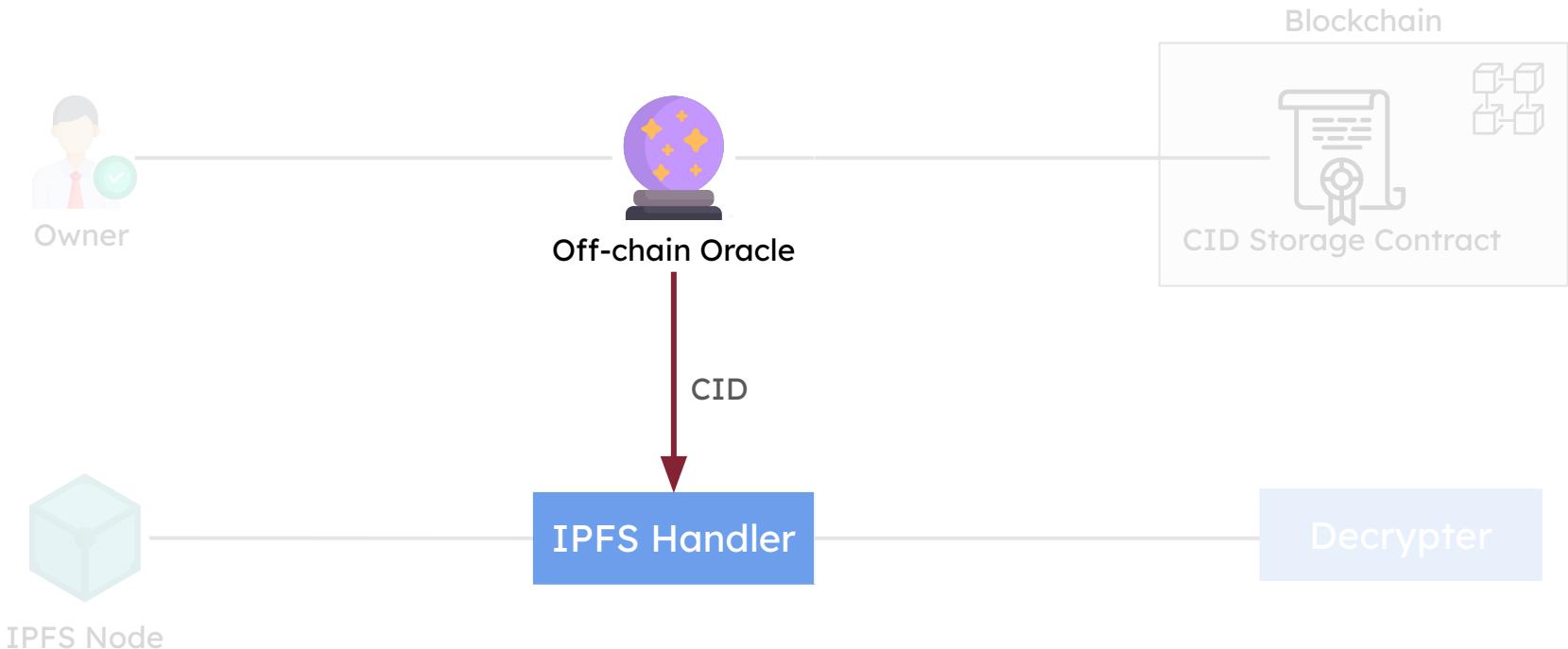
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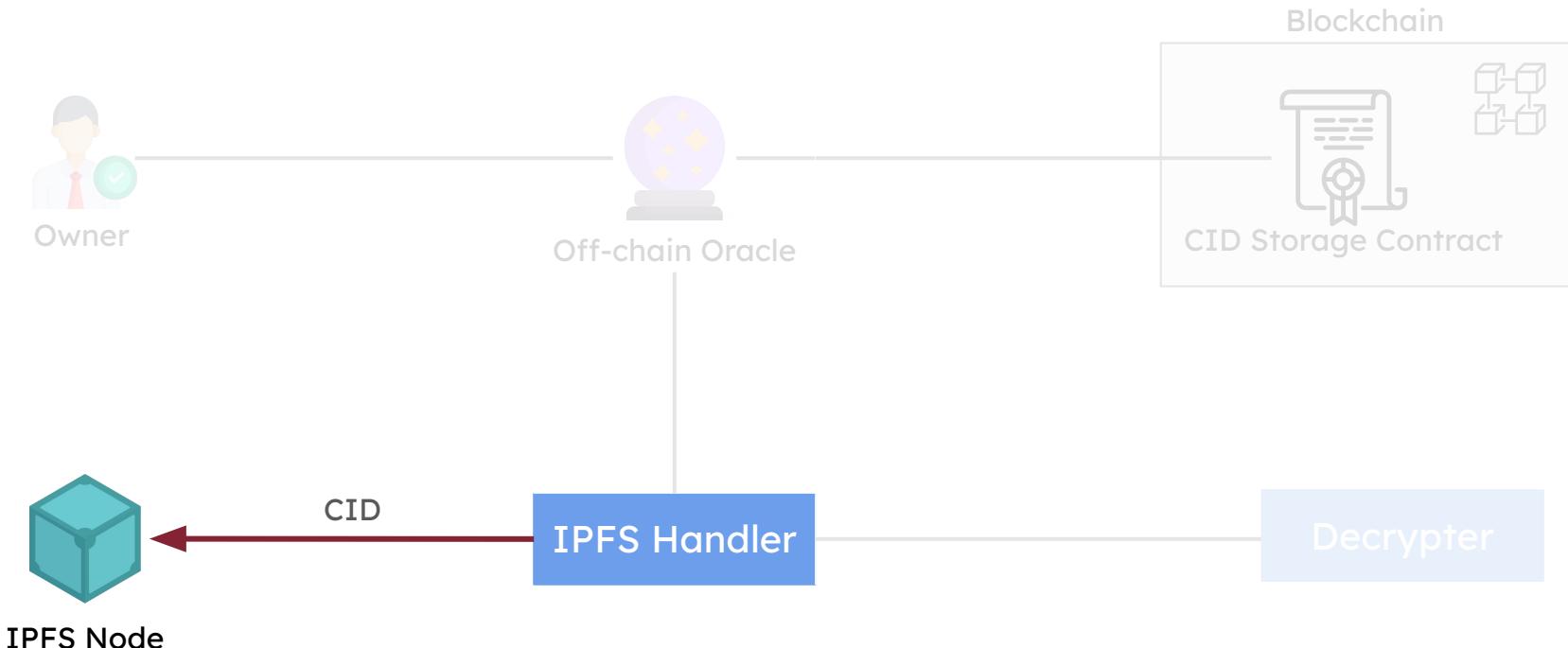
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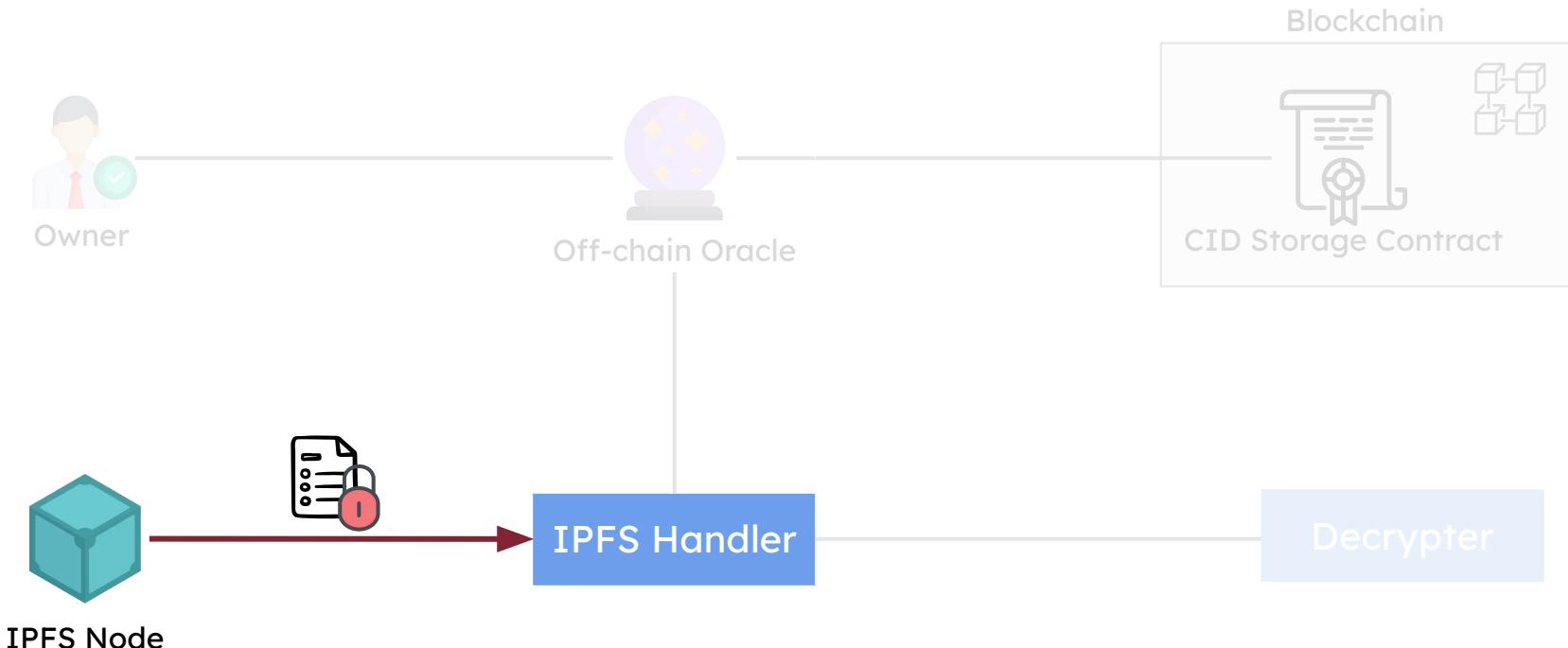
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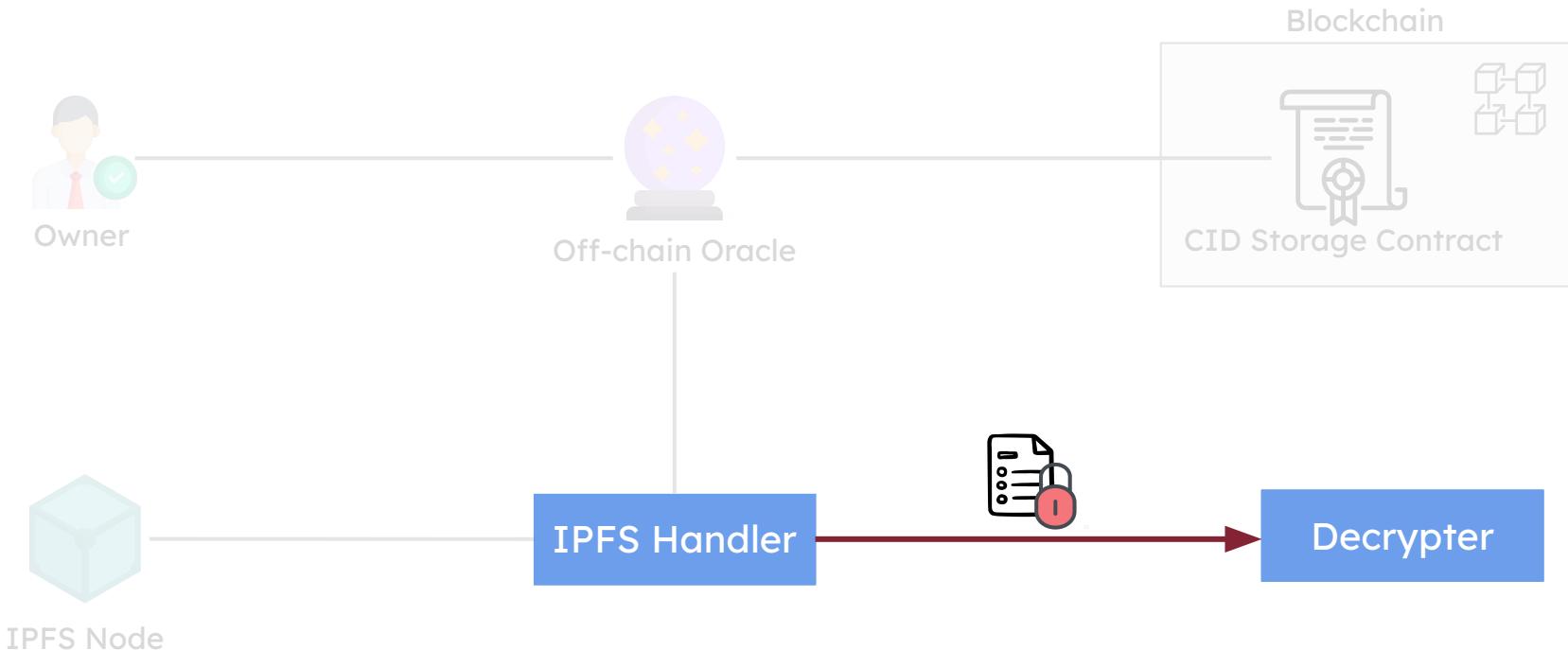
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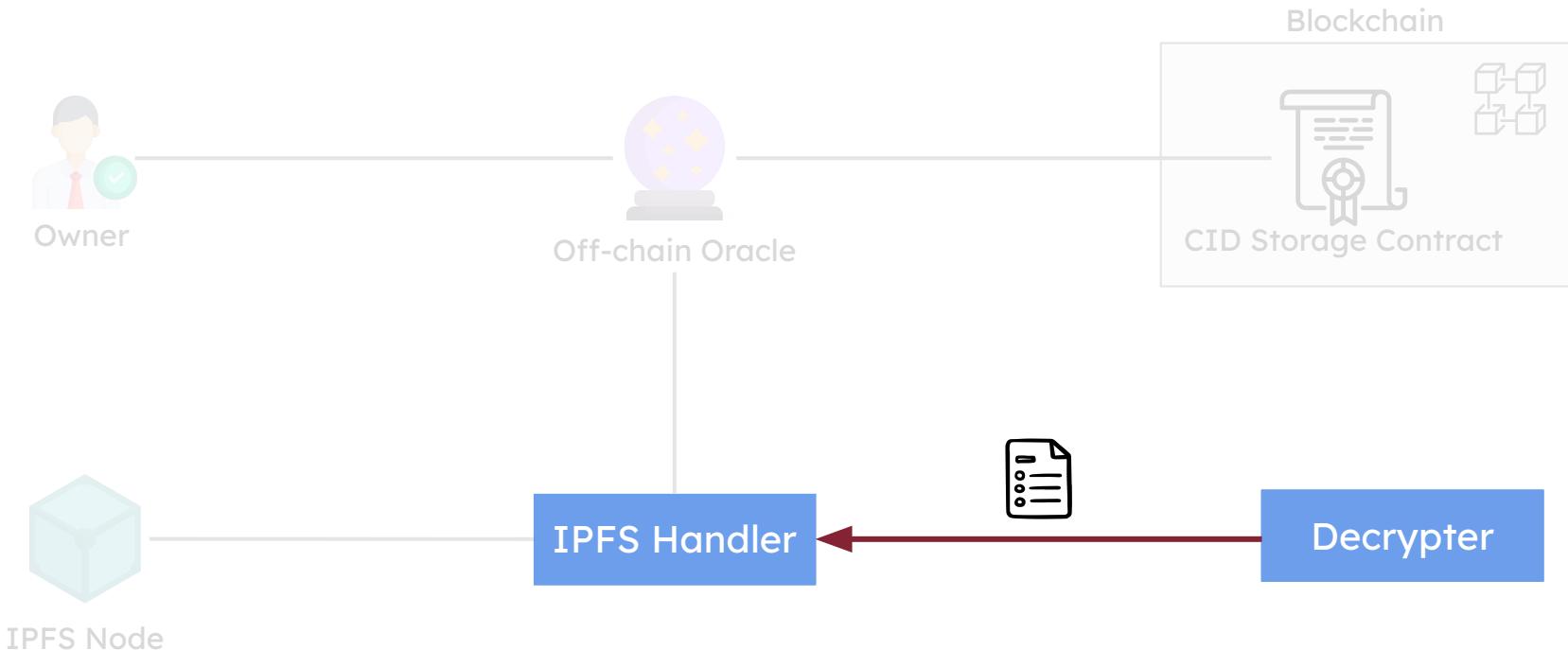
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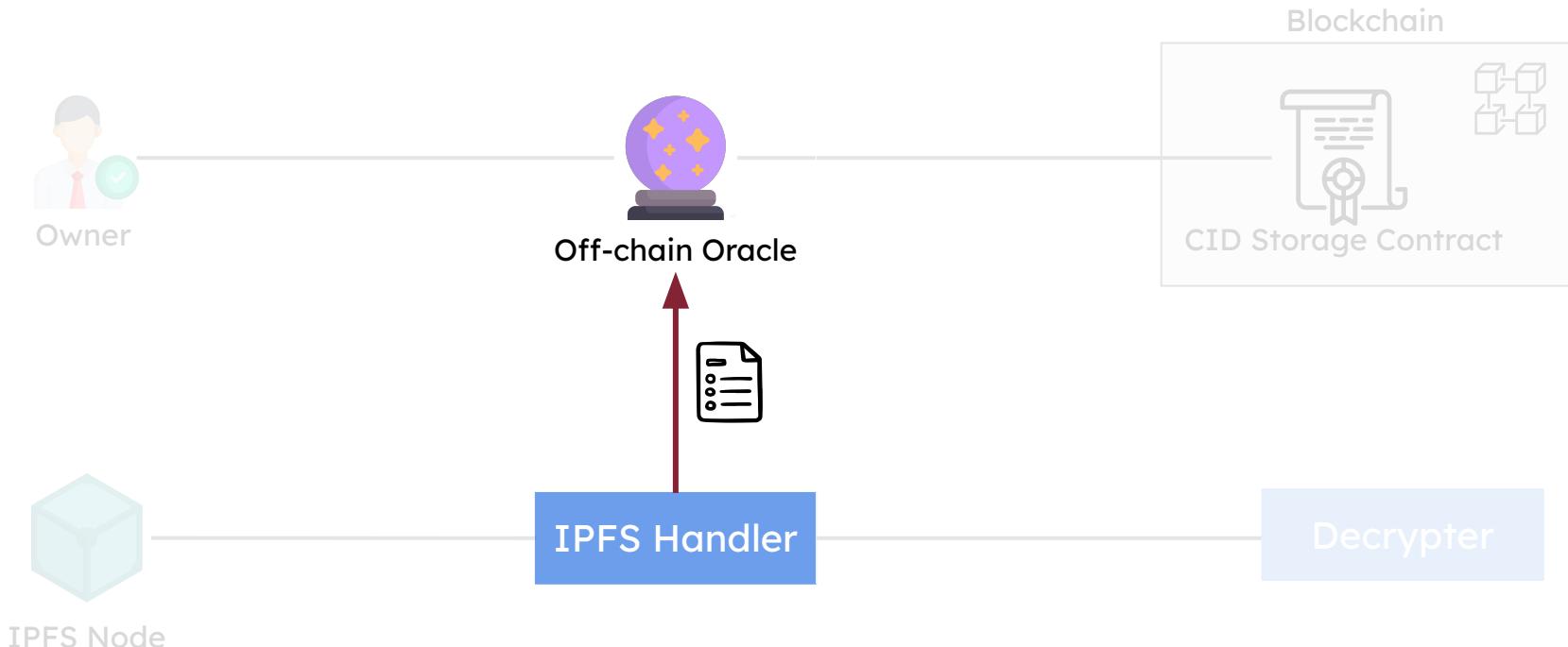
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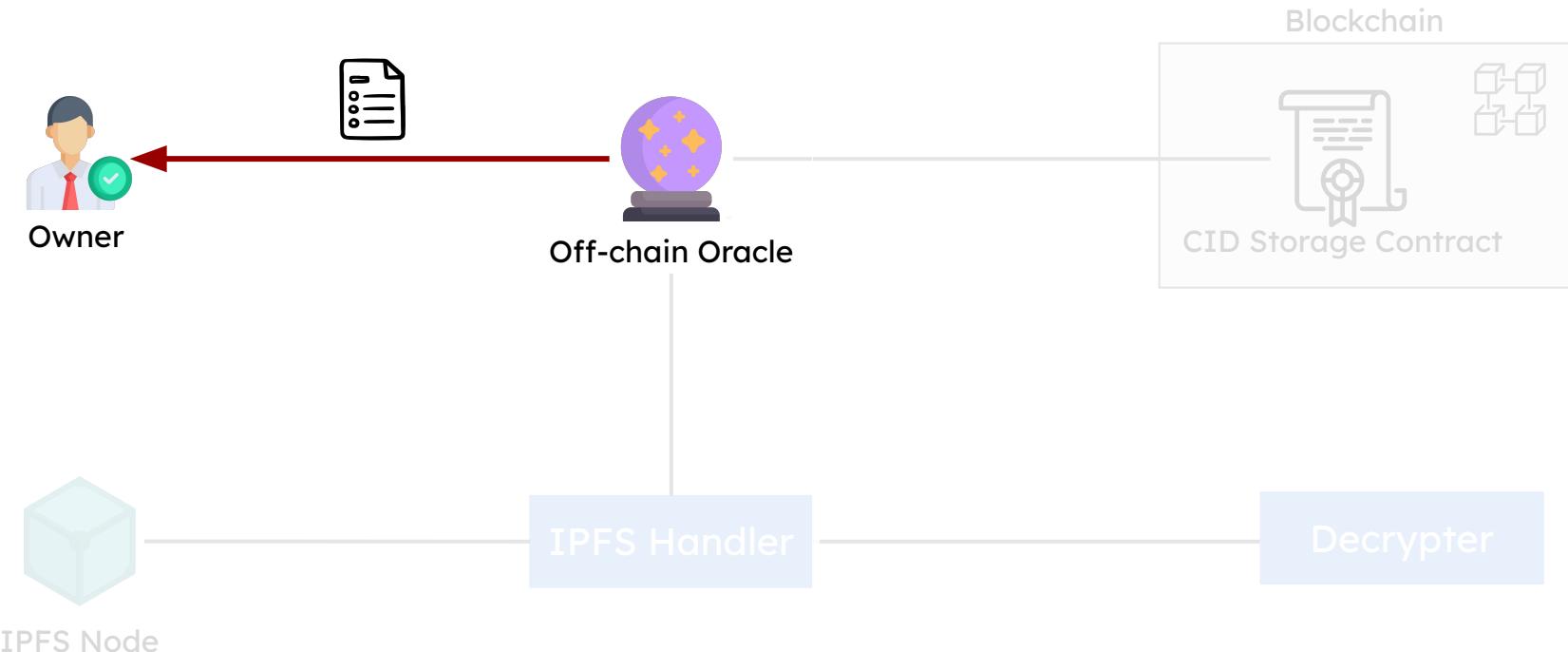
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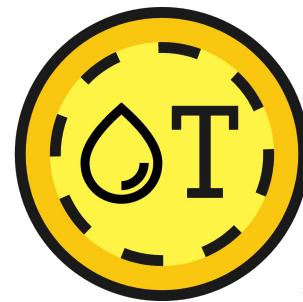
# System Design - Get tracking data



# System Design - Reward component



Certification NFT

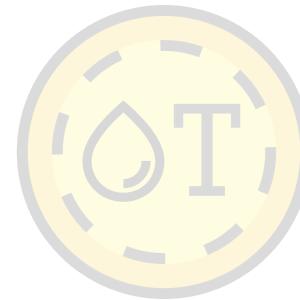


OilTracker Token

# System Design - Reward component



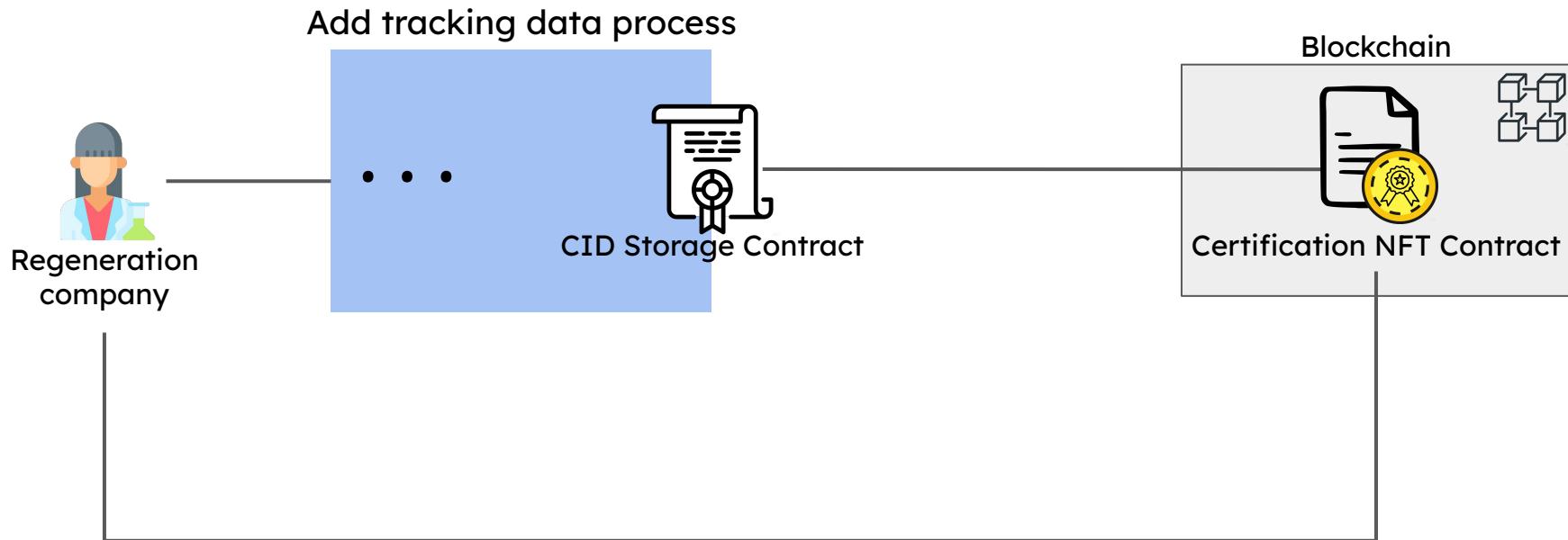
**Certification NFT**



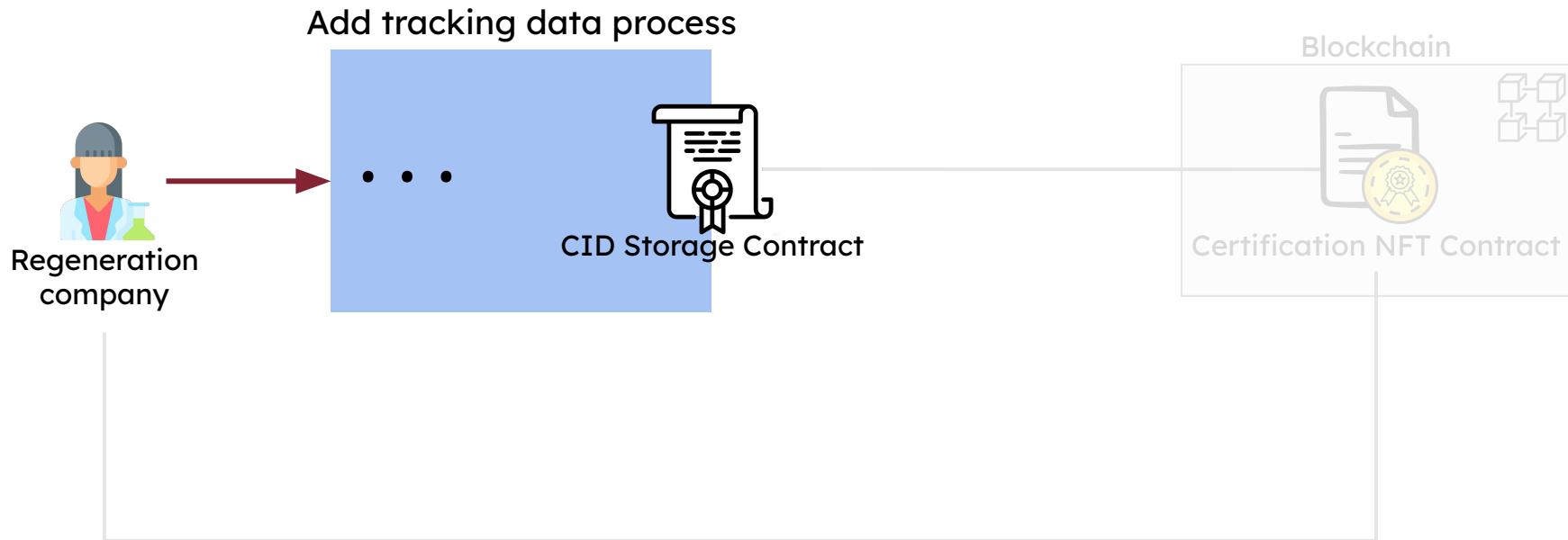
OilTracker Token



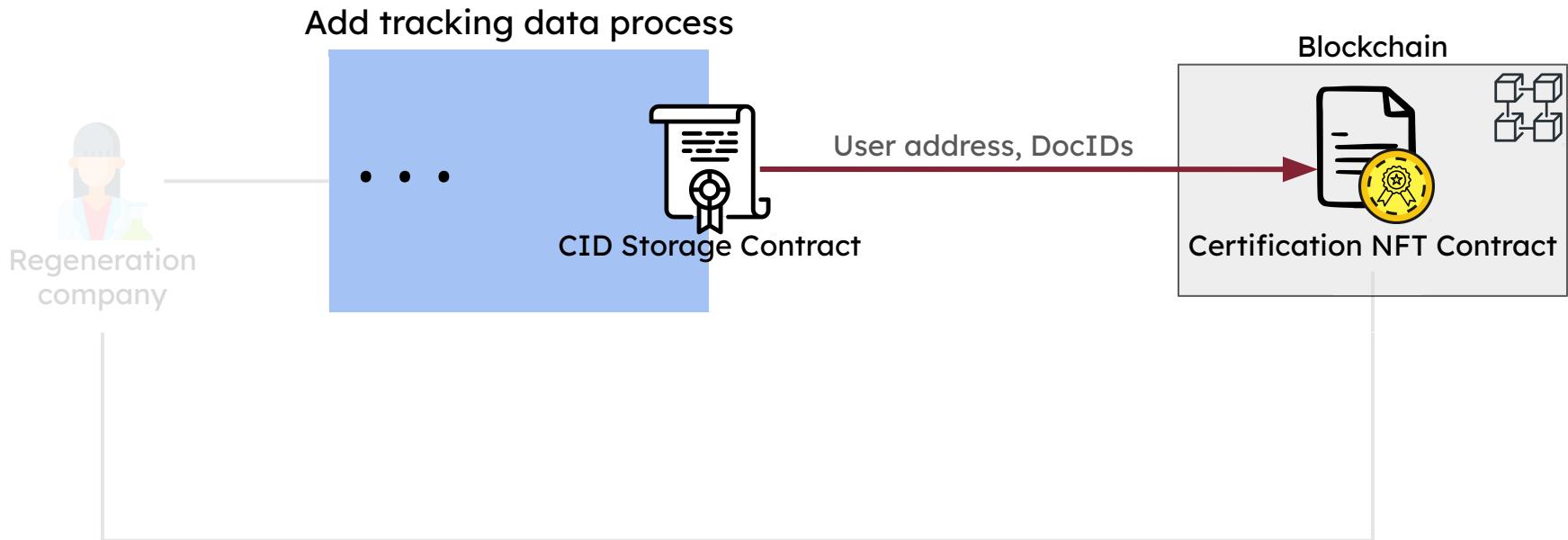
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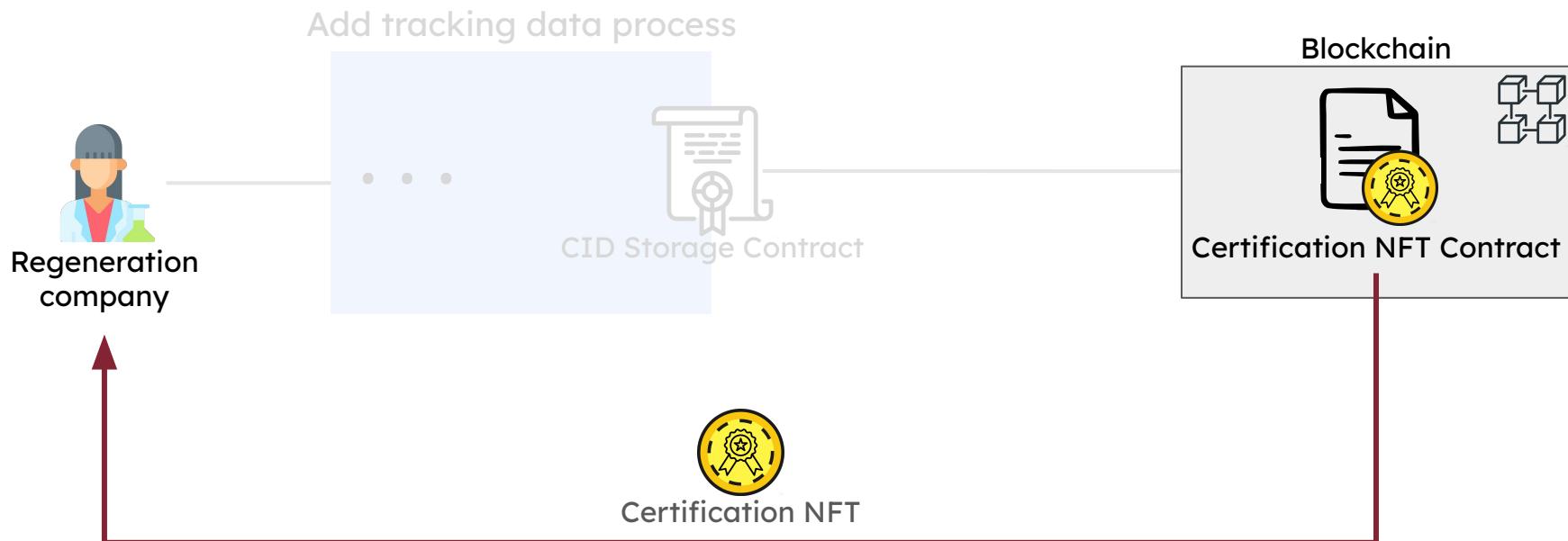
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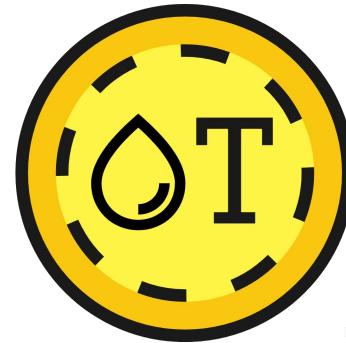
# System Design - Certification NFT



# System Design - Reward component



Certification NFT



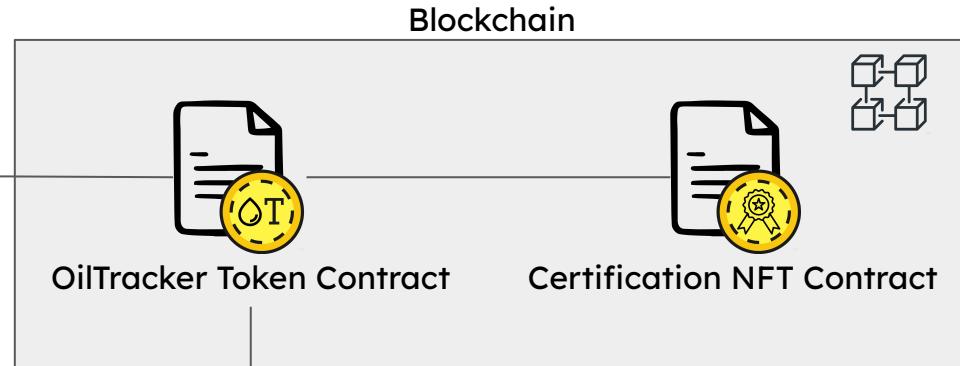
**OilTracker Token**



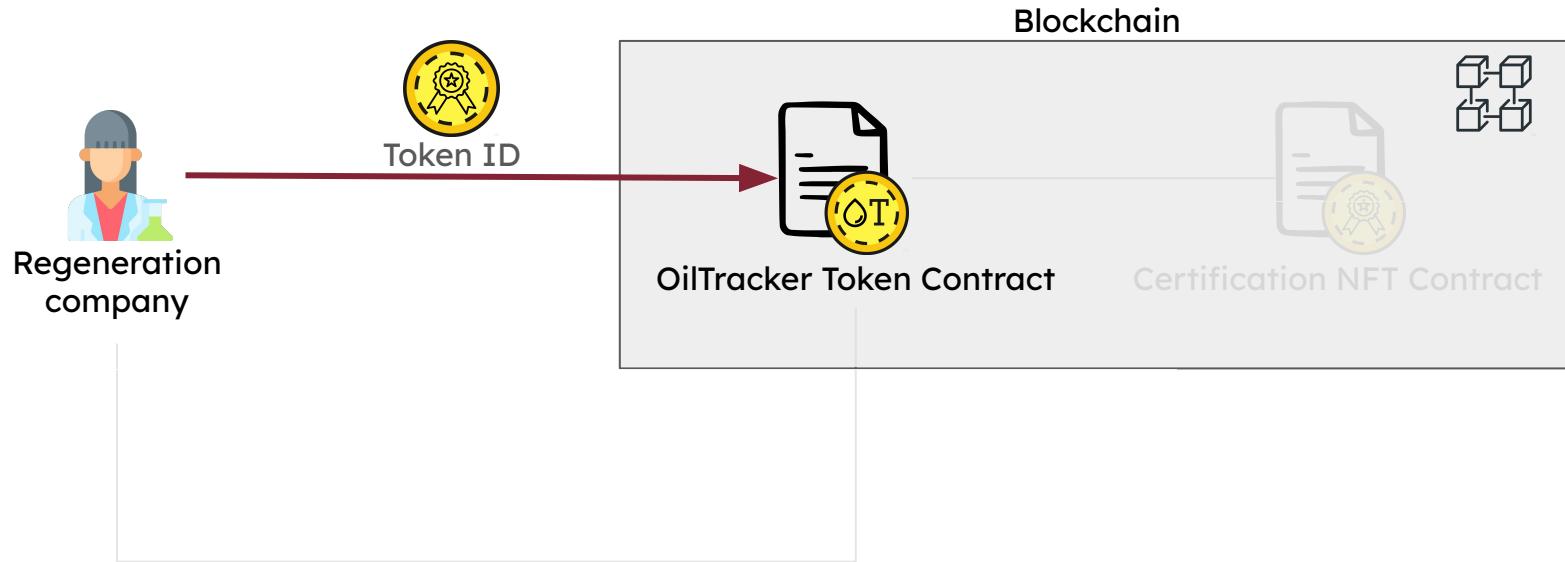
# System Design - OilTracker Token



Regeneration  
company



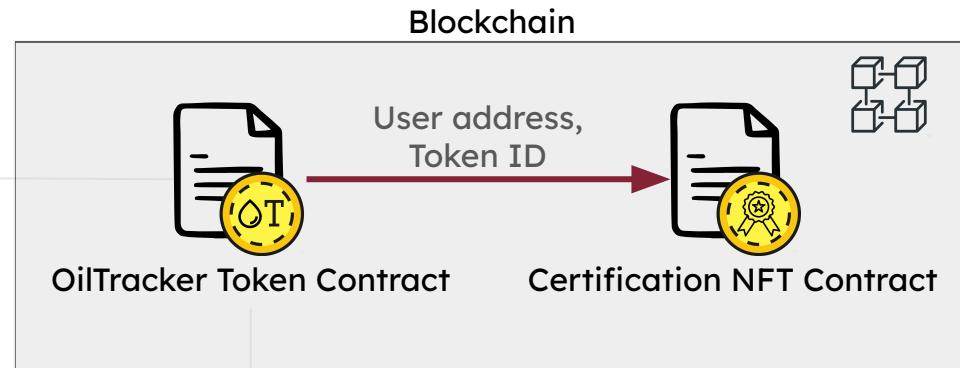
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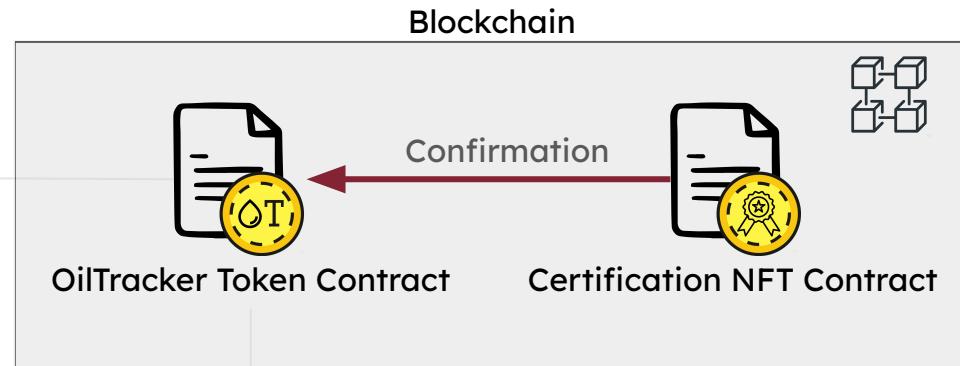
Regeneration  
company



# System Design - OilTracker Token



Regeneration  
company



# System Design - OilTracker Token



Regeneration  
company



OilTracker tokens



# Implementation - DApp

## File Upload

The screenshot shows the 'File Upload' page of the OilTracker DApp. At the top, there is a navigation bar with the 'OilTracker' logo, followed by links for 'Home', 'Transporter' (which is highlighted in green), 'Regeneration', and 'Admin'. On the right side of the navigation bar are language selection buttons ('En', 'It') and a user profile dropdown ('Hello Marco'). The main content area has a heading 'Enter the code from the previous document' above a text input field labeled 'Previous document id'. Below this is a section titled 'Upload WIF' with a dashed rectangular area for file upload, accompanied by the text 'Drag and drop the file or click to select'.



# Implementation - DApp

## File Generation

OilTracker

Home Transporter Regeneration Admin

En It Hello Marco ▾

Enter WIF data manually

### Producer/Holder

Fiscal Code Denomination

**Address**

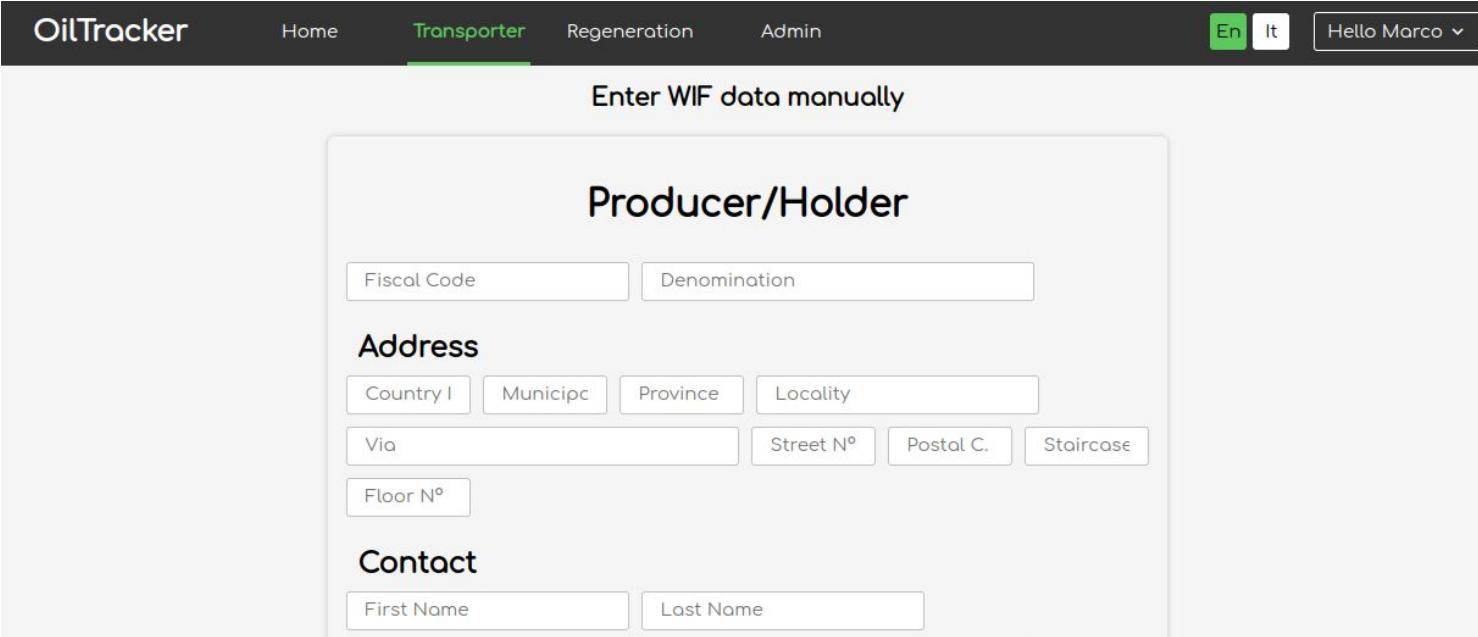
Country I Municip Province Locality

Via Street N° Postal C. Staircase

Floor N°

**Contact**

First Name Last Name



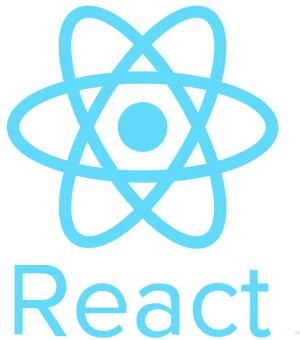
# Implementation - Technologies

- **Frontend**
  - ReactJs
  - Web3Js
- **Backend**
  - NodeJs
  - MongoDB
- **IPFS**
  - Infura
- **Blockchain**
  - Polygon
  - RemixIDE
  - Solidity
  - Metamask



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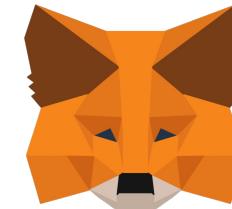
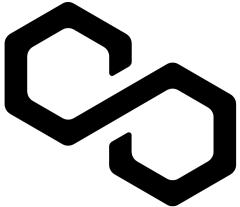
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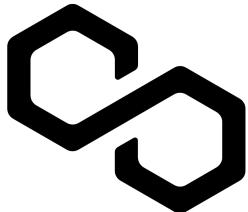
# Evaluation - Methodology

- The tests were run on three different platforms, based on the Ethereum Virtual Machine



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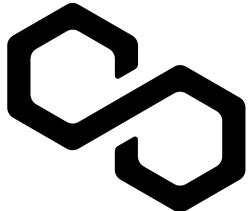


Polygon



# Evaluation - Methodology

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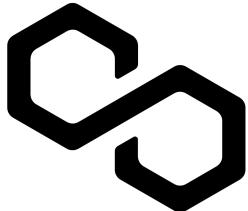
Polygon



Ethereum

# Evaluation - Methodology

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Polygon



Ethereum



Avalanche

# Evaluation - Methodology

- The evaluated value is the number of units of Gas used for the execution of smart contract functions, which was converted to GWei through this formula:

$$GasCost = GasPrice \times GasUsed$$



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- Two analyses were performed:
  - Smart contract deployment and configuration costs



# Evaluation - Methodology

- The evaluated value is the number of units of Gas used for the execution of smart contract functions, which was converted to GWei through this formula:

$$GasCost = GasPrice \times GasUsed$$

- Two analyses were performed:
  - Smart contract deployment and configuration costs
  - Costs related to the execution of a complete tracking process



# Evaluation - Results

## Set-up costs

	Polygon	Ethereum	Avalanche
<b>FirstWifCidStorage</b>	57968236.3	61658602.1	39703644.2
<b>SecondWifCidStorage</b>	75583561.3	80395246.9	51718614.2
<b>ThirdRegenerationCidStorage</b>	79648601.5	84774688.2	54447118
<b>CertificationNFT</b>	102298874.6	106795001.7	68630551
<b>OilTrackerToken</b>	57467768.8	61126194.4	39256618.5
<b>Total</b>	<b>372967042.5</b>	<b>394749733.3</b>	<b>253756545.9</b>



# Evaluation - Results

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# Evaluation - Results

## Data storage costs

	Polygon	Ethereum	Avalanche
<b>FirstWifCidStorage</b>	4101119.1	4320133.4	2798736.6
<b>SecondWifCidStorage</b>	6639535.5	7151875.1	4490674.1
<b>ThirdRegenerationCidStorage</b>	12430330.9	13108048.4	8293921.9
<b>CertificationNFT</b>	-	-	-
<b>OilTrackerToken</b>	2661280.7	2830699.1	1905520.1
<b>Total</b>	<b>25832266.2</b>	<b>27410756</b>	<b>17488852.7</b>



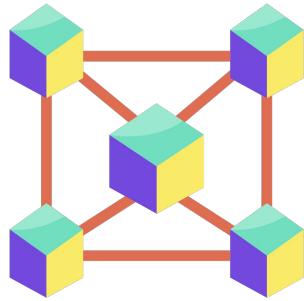
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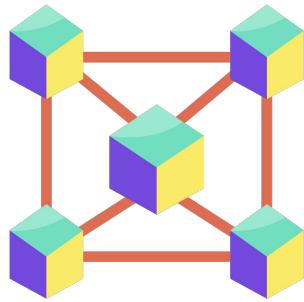
# Future Remarks



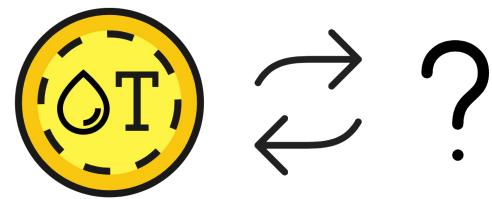
Different blockchain  
platforms



# Future Remarks

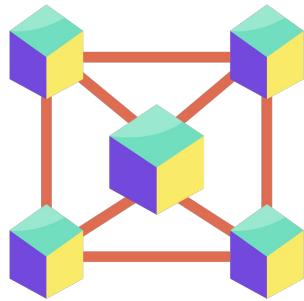


Different blockchain  
platforms

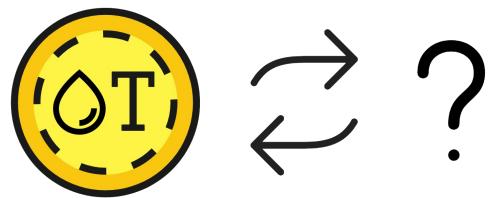


Future use of the OT  
token

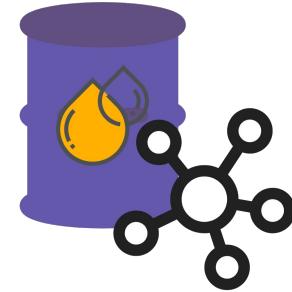
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Different blockchain platforms



Future use of the OT token



IoT Systems

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Marco Raffaele  
ID Number 1799912  
Department of Computer Science

23 January 2024

