Project #1: A Stateful Digital Twin for Pharmaceutical Traceability on a Permissioned Blockchain

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- ➔ **In Pilot context**: modeling the pharmaceutical digital twin lifecycle

Research focus

Exploring the lifecycle of a medicine pack by modeling it as a state machine, enforced by a smart contract on the blockchain. The research **must** propose a formal model for this digital twin, analyze how a permissioned blockchain/DLT can guarantee traceability and prevent counterfeit entries in this supply chain. Exploring the anchoring of a digital twin to its physical counterpart is also an extra option.

Primary research question

How can the states and state transitions of a pharmaceutical product be formally modeled and enforced with smart contracts?

What is expected

- ➔ State of the art on this exact topic.
  1/ A review of existing standards for pharmaceutical traceability (e.g., GS1 standards, EMVS).
  2/ An analysis of academic and industry proposals for blockchain in supply chain management.
  3/ Identification of research gaps in modeling stateful assets on DLT.
- ➔ Demonstrate the creation and management of a digital twin of a single medicine pack. This requires a full scenario definition and simulation, introducing different possibilities and conditions.
- ➔ Design a state machine for the digital twin (Manufactured, Shipped, Dispensed, etc.)
- ➔ Implement a smart contract (chaincode) that manages the state machine of the digital twin. It creates states and manages their transitions under different conditions by providing smart contract functions.
- ➔ Collaborate with 2nd team working on **Project 2** to help establish an immutable privacy preserving link between the digital twins and the medical prescriptions that were used to acquire these medicine products. **[optional]**

Technologies

Hyperledger Fabric (infrastructure), Chaincodes (Node.js, python, Go..), Node-Red.

Node-Red is a powerful visual flow simulation programming tool. It enables us to create a flow that visually represents the supply chain and the triggers, conditions and scenarios of a medicine pack lifecycle.

Node-Red also provides **node-red-contrib-hyperledger-fabric** which allows for integration between the visual flow and the blockchain, it can invoke smart contract functions to simulate the whole lifecycle and states.

Deliverables

- The code under git for the MVP or small PoC to be later integrated into the bigger pilot defined as " ***A Decentralized Platform for Pharmaceutical Traceability and Prescription Management***"
- The report detailing all the ideas and achievement