



## Project Overview

This project aims to revolutionize water management in Greek smart cities through a permissioned blockchain network based on Hyperledger Fabric.

The initiative addresses key challenges in traditional water management systems, such as inefficiency, lack of security, and limited data transparency.

By integrating blockchain technology with IoT infrastructure, the project enhances the capabilities of Water Management Authorities, offering a secure, transparent, and efficient solution for monitoring, analyzing, and managing water resources.

### Main Contribution:

- Implement a secure, blockchain based IoT network for water management using encrypted communication technologies.
- Deploy a network with trusted entities and role permissions, reflecting our specified architecture and business logic.
- Deploying Chaincodes that are necessary to implement the functionalities.
- Develop Ricardian contracts for automated decision-making agreements.
- Develop a Hyperledger Fabric blockchain automated framework for initialization, monitor and management the network

## Marketing

The SUSANNA project, a collaborative effort between DOTSOFT SA and ATHENA RC, represents a groundbreaking initiative in the realm of water management and smart contracts. With a focus on security and privacy through innovative blockchain technologies, SUSANNA aims to revolutionize the way water utilization data is collected, shared, and analyzed. By leveraging the power of a permissioned Hyperledger Fabric blockchain network, the project seeks to transform traditional data collection methods into a secure and reliable framework, ensuring the integrity of transactions while safeguarding against malicious activities and identity theft.

SUSANNA's strength lies in its strategic integration with existing IoT infrastructure and sensors across Water Management Authorities in smart cities in Greece. The project's vision is to create a more efficient and tamper-proof system for managing water resources, mitigating risks associated with leaks, missing water meters, and exceeding limits. The implementation of smart data and trigger contracts within the permissioned blockchain architecture will enable the secure storage of critical information, such as water meter readings and utilization data. Each authorized node will have specific writing privileges, fostering a secure and transparent ecosystem, while anonymized data will be accessible to all nodes within the blockchain network.

The marketing and exploitation potential of SUSANNA is significant. As a state-of-the-art demo case for smart cities and smart home systems, the project showcases a cutting-edge blockchain network architecture that prioritizes data privacy, reliability, integrity, and accuracy. This innovation not only addresses current challenges in water management but also positions itself as a scalable solution with broader applications in diverse industries. SUSANNA has the potential to set new standards for secure data management, making it an attractive proposition for industries and municipalities looking to enhance the reliability and privacy of their data transactions. The outcomes of this project promise to contribute to the evolution of blockchain applications, particularly in the context of security and privacy, opening doors to novel opportunities and partnerships in the rapidly advancing field of smart technologies.

## SUSANNA

# Secure immUtable System based on blockchAiN for water management smart coNtrActs

### Organization, Channel, and Policies Architecture and Network Deployment

The SUSANNA ecosystem is designed to revolutionize water utility management through its transformation into a permissioned blockchain network. This sophisticated architecture enables secure and efficient communication via a "forwarding" gateway, where transactions are authenticated using private keys.

At the core of this system are the participating organizations within the Hyperledger network, categorized into three distinct levels based on their authorization and function:

**Water Management Organizations Entities:** Include Zagori, Zitsa Municipalities in Greece. These entities manage private channels for IoT water meter data, user information, dashboard analytics, and smart contracts.

**Control Level Entities:** Comprising governmental or independent authorities, which plays a pivotal role in governance and oversight.

**Research Entities:** A group consisting of NGOs, research centers, and universities such as ATHENA RC and CERTH, focusing on statistical analysis.

The architecture employs a hierarchical model, allowing each organization to access multiple channels tailored to their specific needs. DEYAs, for instance, not only handle their private channels but also collaborate with government agencies through dedicated channels for state inspections and regulatory compliance. A unique communication channel bridges all DEYAs and government public agencies, facilitating rule establishment and encrypted storage of user information.

### Chaincodes

Chaincodes, central to the project's functionality, were meticulously developed and deployed. These smart contracts, categorized into:

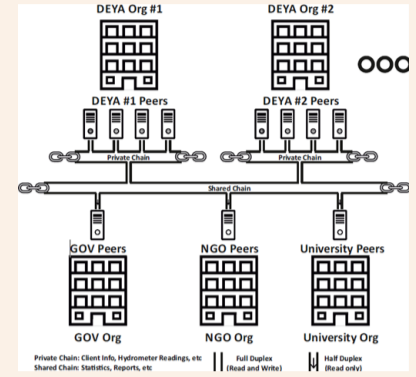
- **Data Contracts** are responsible for receiving and providing all the information needed (Asset, Info, Readings, Readings Bridge).
- **Trigger Contract** is responsible for automated or semi-automated actions and events like possible water leakages, missing water meters, warns if the water consumption exceeds, issuing bills, terminate the contract.
- **Ricardian Contract** incorporates functionalities to integrate Ricardian Contract templates and instances within the Hyperledger Fabric, and to subsequently trigger them as required.

Chaincodes played a pivotal role in managing water meter data, automating responses to specific triggers, and ensuring legal compliance within the blockchain ecosystem. This implementation not only streamlined water utilization data management but also fortified the system against unauthorized access and manipulation.

### Ricardian Smart Contract:

In our blockchain ecosystem, Ricardian contracts are crucial for embedding legal terms into Chaincodes, ensuring legal integrity and digital efficiency. These contracts, crafted in collaboration with the Water Management Organizations, are digitized and implemented using the Accord Project's tools.

The contracts that each customer signs are converted into computer-readable language, verified by the blockchain, and automatically activated for specific operations like managing



water leaks, faulty meters, consumption limits, billing services, and termination processes. Developed within the SUSANNA project's scope, these Ricardian contracts bridge the gap between legal language and blockchain technology, vital for the system's reliability and compliance.

### Blockchain Automated Framework and Management System

A core element of the SUSANNA is our Blockchain Automated Framework System, which was developed in-house. This framework serves as the foundation for the automated deployment, monitoring and maintenance of the blockchain network. Its main features are:

- **Automated Deployment:** Utilizing shell scripts, our system automates the setup process of a Hyperledger Fabric network. The end user can use it through a user-friendly web interface.
- **Real-Time Monitoring:** Incorporating advanced technologies like Prometheus and Grafana, the framework offers real-time monitoring, ensuring continuous oversight of network performance.
- **Management:** The framework's modular design allows for easy integration of updates and new components. In particular, the corresponding scripts have been developed as well as the appropriate web interface for the installation of new organizations, contracts as well as the invoke of the latter.

## Implementation

### Network Architecture and Organizational Participation

The project has successfully established a blockchain network encompassing five distinct organizations, each playing a crucial role. The cities of Zagori and Zitsa represent regional entities, while DOTSOFT functions as a controller, mirroring the role of the government. For research purposes, ATHENA RC and CERTH are integral participants. This network is structured around two primary channels: a shared communication channel for inter-organizational interaction and individual channels dedicated to each organization for handling private data.

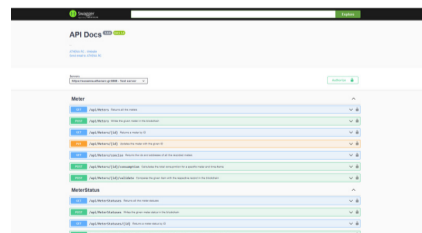


### Chaincode Development

More than six Chaincodes have been implemented to enhance the network's functionality:

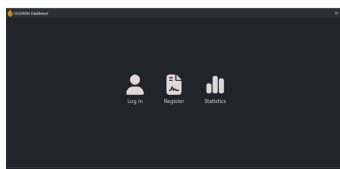
- **Data Contracts:** These include Asset, Info, Readings, and Readings Bridge contracts.
- **Trigger Contract:** This contract encompasses functions for Leak detection, Missing meter identification, Consumption Limit enforcement, Billing System management, and EndContract processes.
- **Ricardian Contract:** This contract facilitates the integration of Ricardian Contracts within the Hyperledger Fabric, ensuring legal compliance and clarity.

For external interfaces, APIs for the Chaincodes are available to allow third-party integrations. In each organization, API endpoints are established, accompanied by comprehensive Swagger documentation.

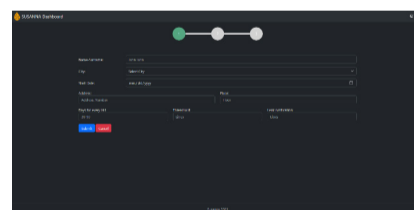


### User Interface and Contract Management

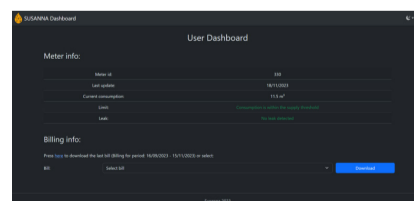
A dedicated website has been developed for users, offering functionalities such as contract creation, user personal page, and regional statistics viewing.



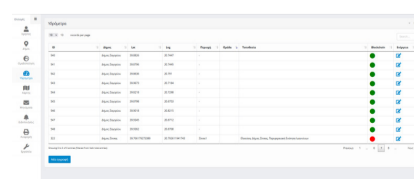
- System implementation is based on each user will have one contract with his provider. These contracts are digitally signed by the government, verified by the system, and confirmed by the blockchain.



- Users can access their personal pages with their signed contracts, where they can view details related to the five main Chaincode actions influenced by Ricardian smart contracts—Leak, Missing, Limit, Billing Service, Termination Contract—as well as their water consumption data.

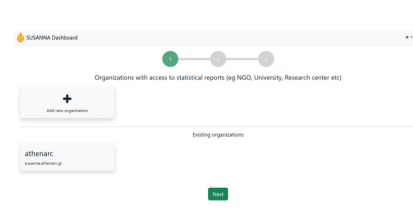
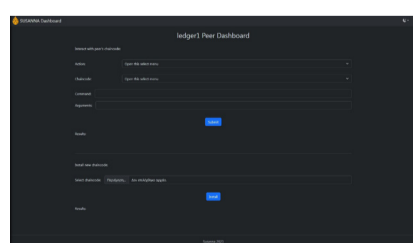
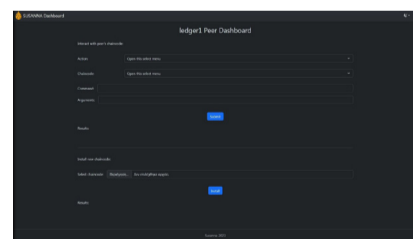
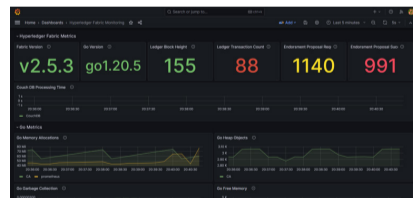


Additionally, DOTSOFT's existing platform interacts with the blockchain network, ensuring data validity and presenting user-specific information.



### Blockchain Automated Framework

A fully automated framework has been developed, which not only initiates and monitors each node within the network but also offers scalability. This scalability is evident in its capacity to integrate new organizations or contracts, ensuring the system's adaptability and future growth potential.



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