MINE.IO
A Holistic Digital Mine 4.0 Ecosystem

A Distributed Automation Framework for Observable and Accountable Process Control in Ore Mining

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Hello! I am Angela-Maria!

Angela-Maria (Angelina) Despotopoulou is a software and systems engineer from Greece, currently involved in EU-funded R&D projects as an employee of the Frontier Innovation Centre.

Through her participation in the HU MINE.IO project, she bridges data, technologies, and people to make ore mining process management smarter and safer.

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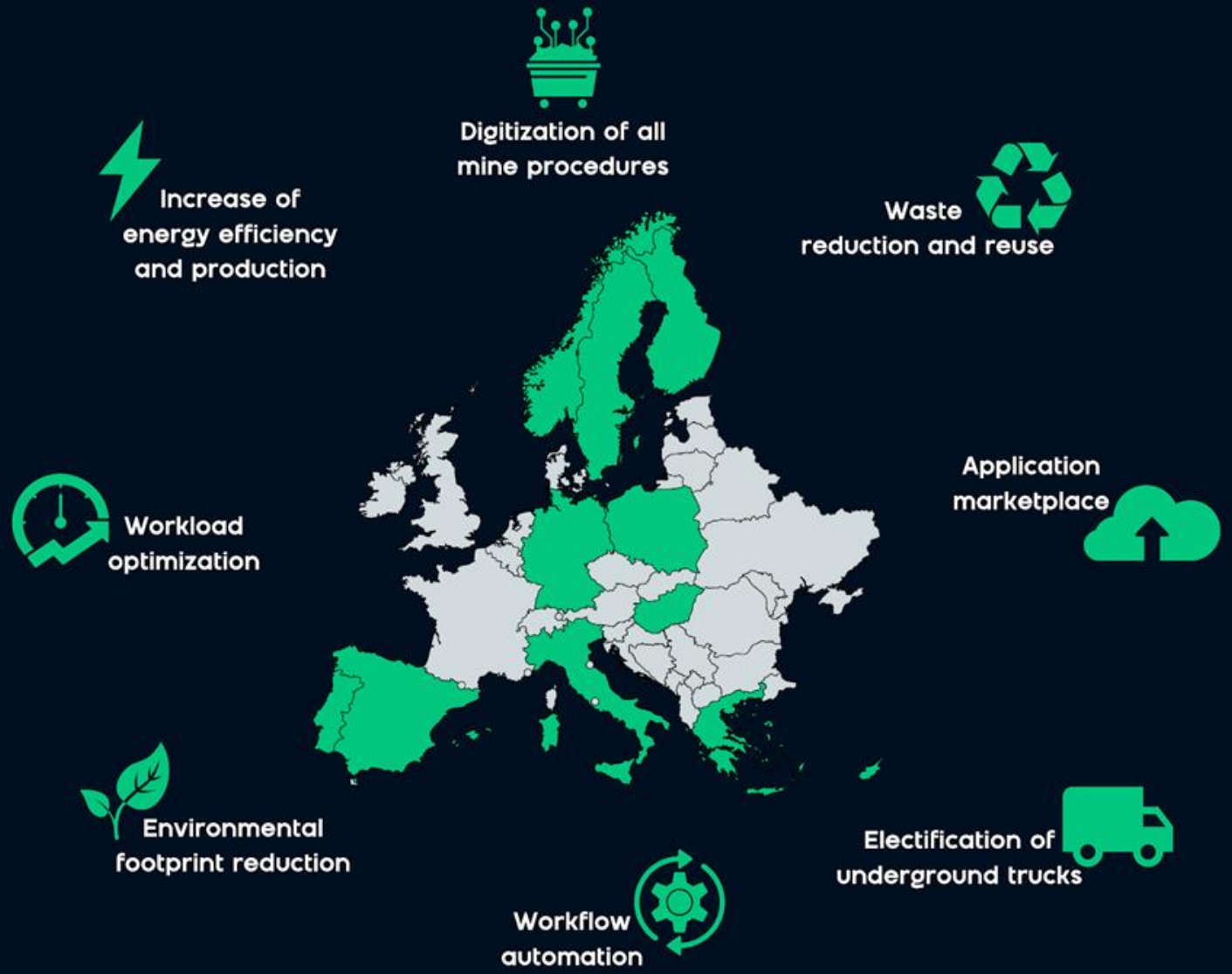
MINE.IO

Mine.io aims to provide solutions that will build a novel mining digital ecosystem and a systemic structure for the implementation of Industry 4.0 in mining industrial environments.

- 25 partners
- 7 pilot use cases
- €14M budget
- 42 months



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Systemic Barriers to Digital Transformation in Mining Operations

- **Lack of real-time visibility** → Decisions based on delayed or incomplete data; reduced coordination and oversight.
- **Data Silos and Fragmentation** → Isolated systems block integrated analysis and hinder optimisation.
- **Manual Compliance Processes** → Bureaucratic workflows slow approvals, increase non-compliance risk.
- **Workforce Resistance to Digital Tools** → Low adoption due to unfamiliarity and fear of job displacement.
- **Rising Cybersecurity Vulnerabilities** → Interconnected systems increase exposure and demand decentralised trust mechanisms.

Workflow Automation Engine

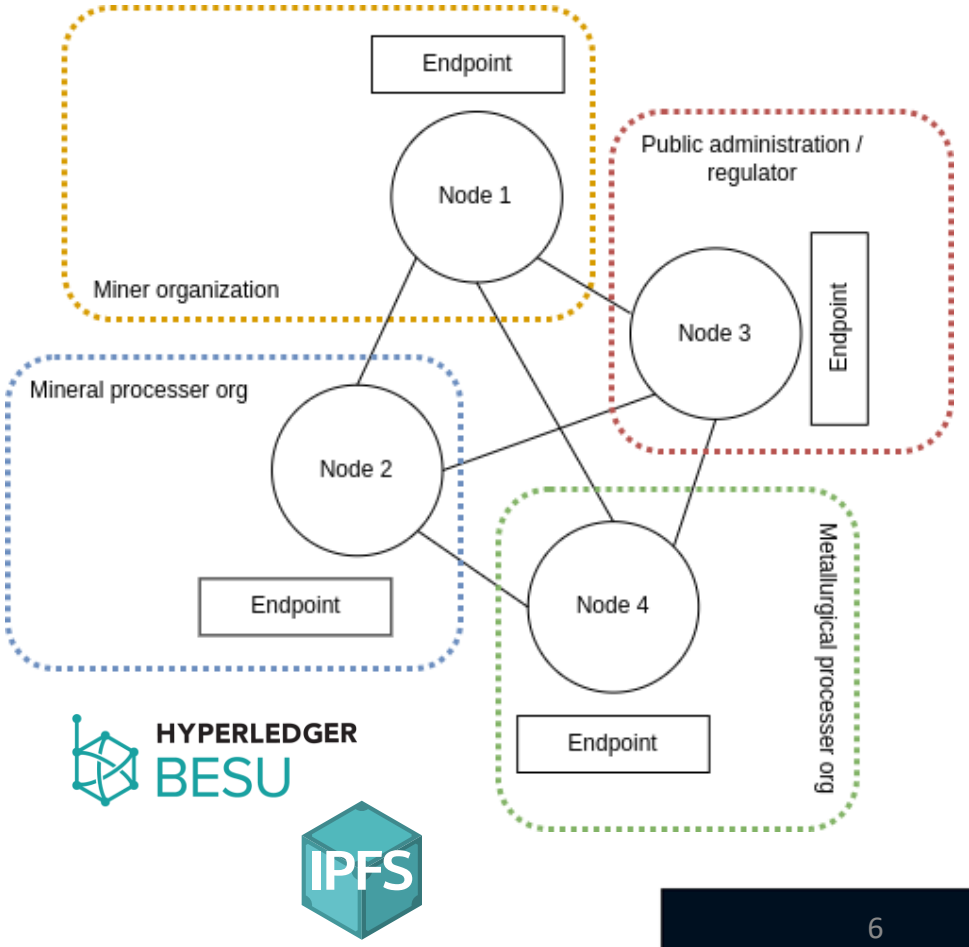
Official description: workflow automation engine for operational and business workflows covering Mines and Raw Material value chains

Decentralized Operations Governance

Distributed peer-to-peer operations leveraging private **Blockchain** accessible to parties with permission.

Each mining industry stakeholder maintains their proper ledger of business agreements and history of placements/verification of work orders.

Thanks to the blockchain they reach an agreement on a universally accepted and tamper-proof version of the events that transpired in the real world.

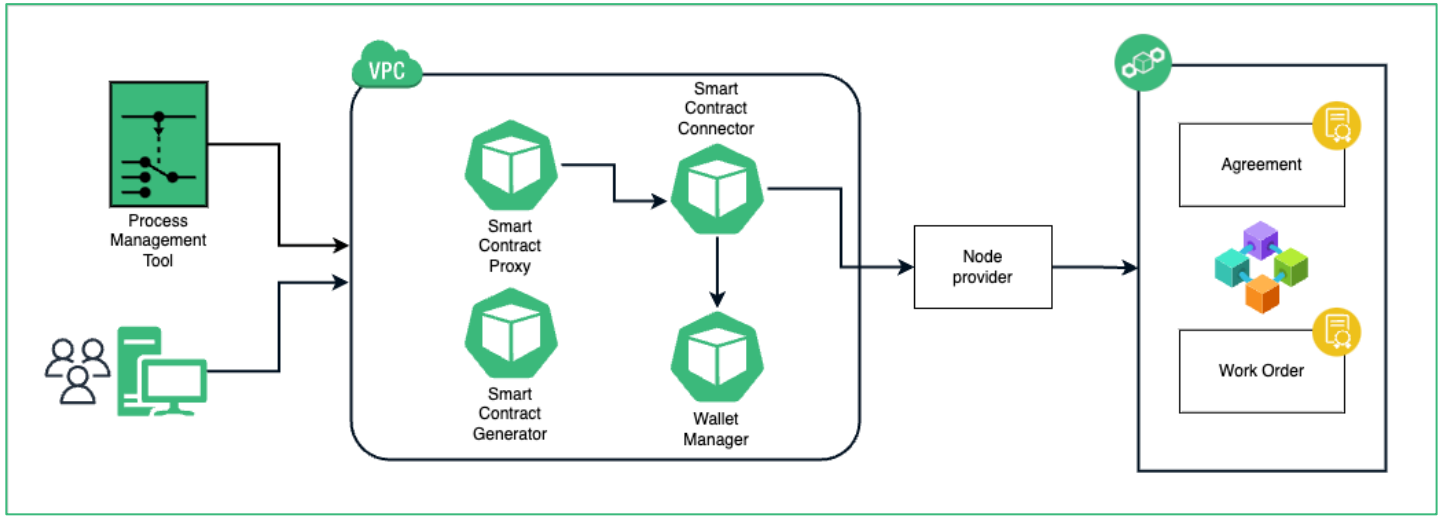


Automation of Business Operations' Code Lifecycle

Bridging the Workflow Automation Engine and the Blockchain Infrastructure stands the **Smart Contracts Manager**.

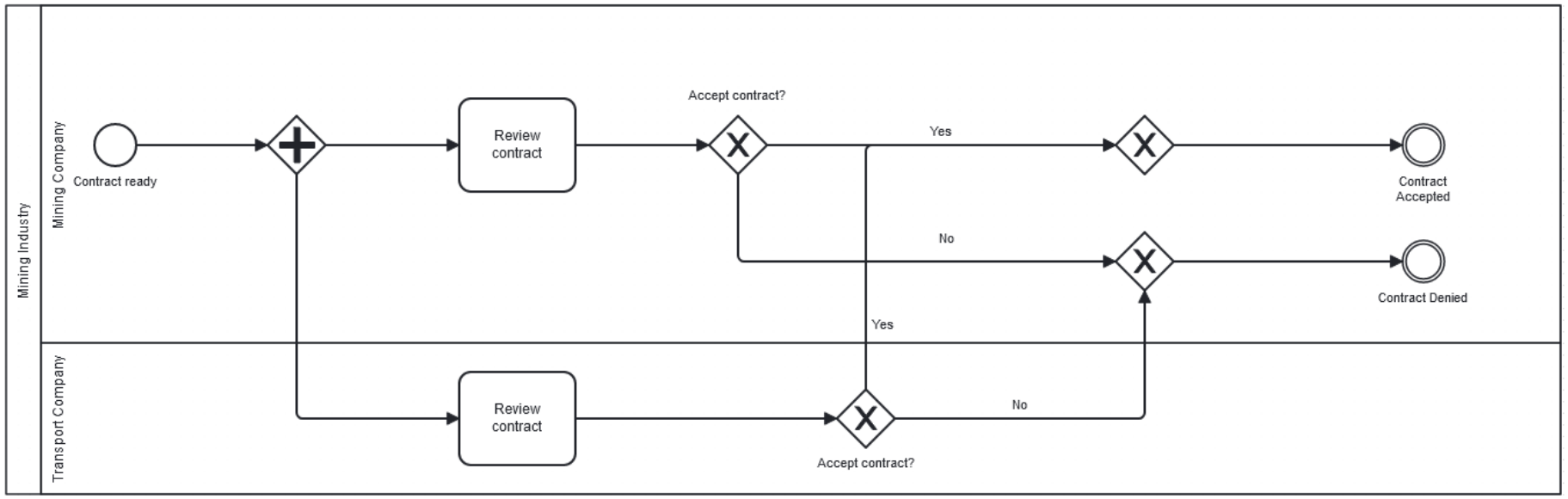
Its purpose is to help maintain the lifecycle of the implementation in code of the business logic (known as "smart contract" in the lingo of Blockchain).

It provides a layer of abstraction permitting other applications to deploy and use services on the blockchain infrastructure in a developer-friendly way.



The Microservices comprising the Smart Contracts Manager are deployed within a Virtual Private Cloud and managed as containers in a Kubernetes environment.

Business Process Modeling and Simulation



Mining industry stakeholders will be using the Workflow Automation Engine to design business processes using a very popular specification called Business Process Management Notation (BPMN 2.0).

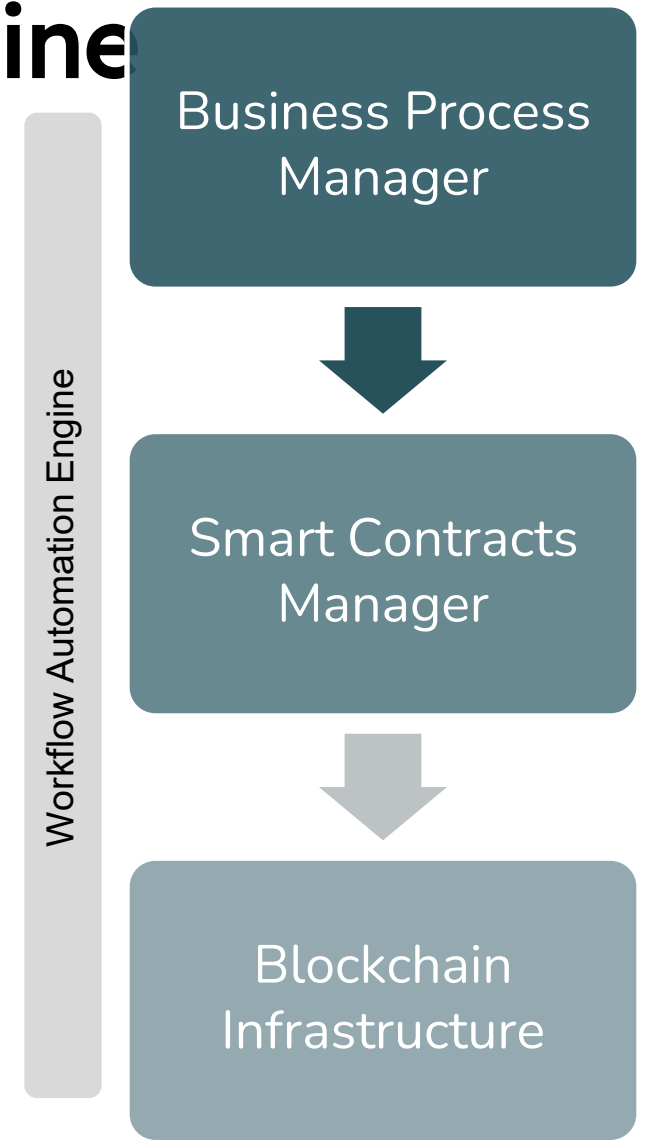
In the example above, a mining company models their process for signing an agreement with a company hiring trucks.

Then, the flow of events can be simulated by “executing” the scenario.

Workflow Automation Engine

By using the **Business Process Manager** as an application layer on top of the **Smart Contract Manager** and the **Blockchain Infrastructure**, one can automate business processes such as the peer-to-peer signing of business agreements and placement/validation of work orders.

This service can be offered as a “service block” to mining industry professionals using the Business Process Modeling user interface and dashboard (among the other capabilities of the BPM).



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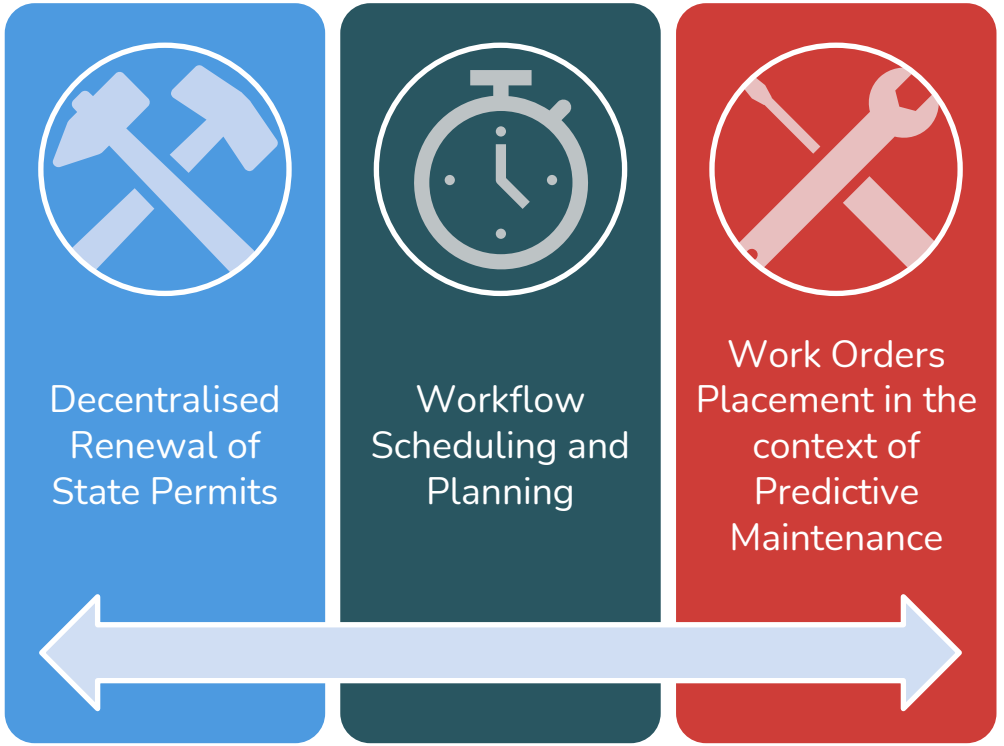
Validation use cases

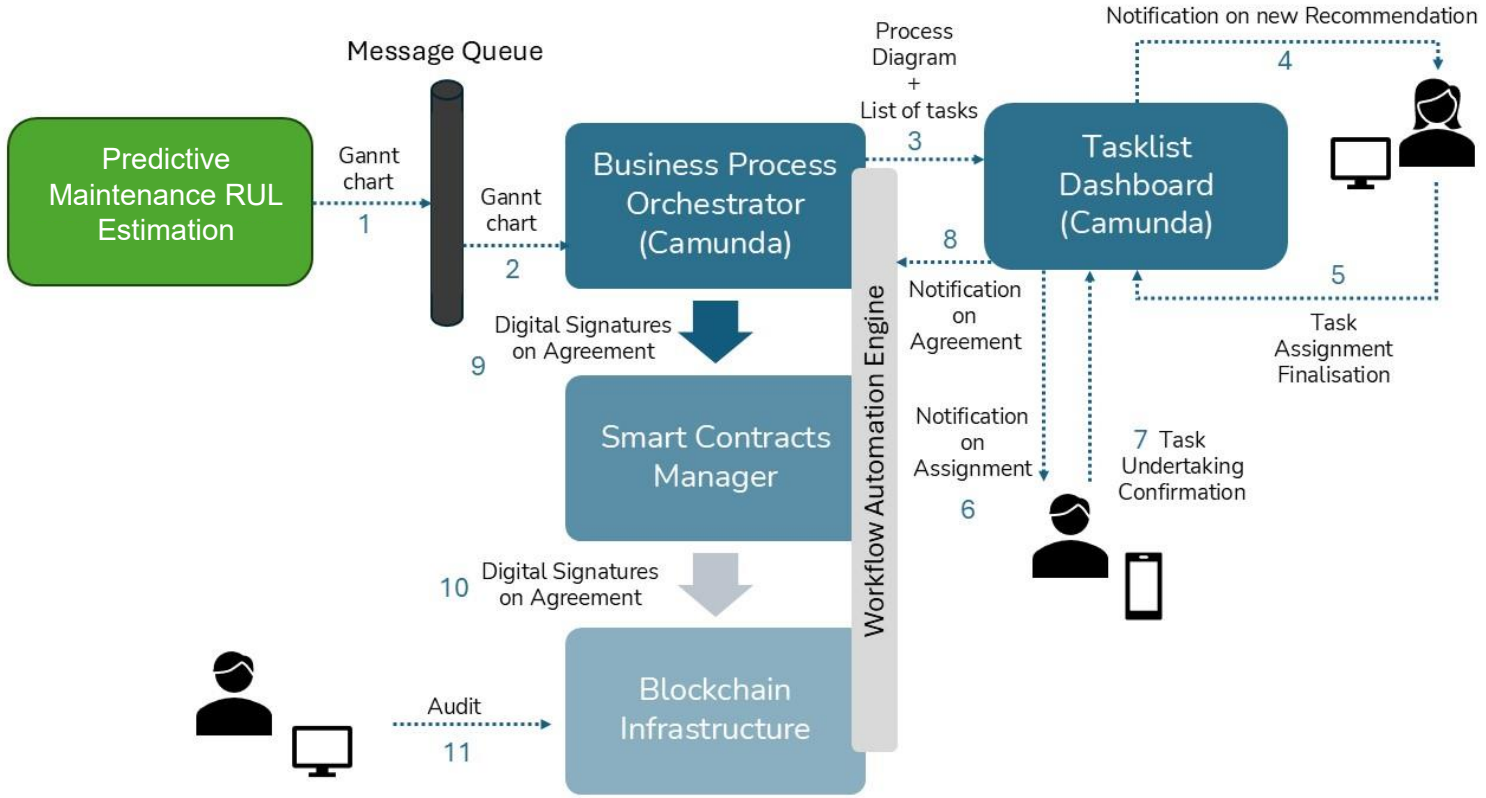
Lavrion, Greece



Freiberg, Germany

Björkdal, Sweden

Workflow example



WAE Business Value

Digitisation and automation of business provides real-time visibility. → Operational Transparency

Feedback loops and data analytics allow bottleneck tracking. → Continuous Process Refinement

Non-trusting business partners each retain ownership and control of their proper data. → Governance

Streamlined compliance tasks, reduced manual effort and administrative overhead. → Reduced Compliance Costs

History of business agreements is immutable and tamperproof → Transparency, Trust

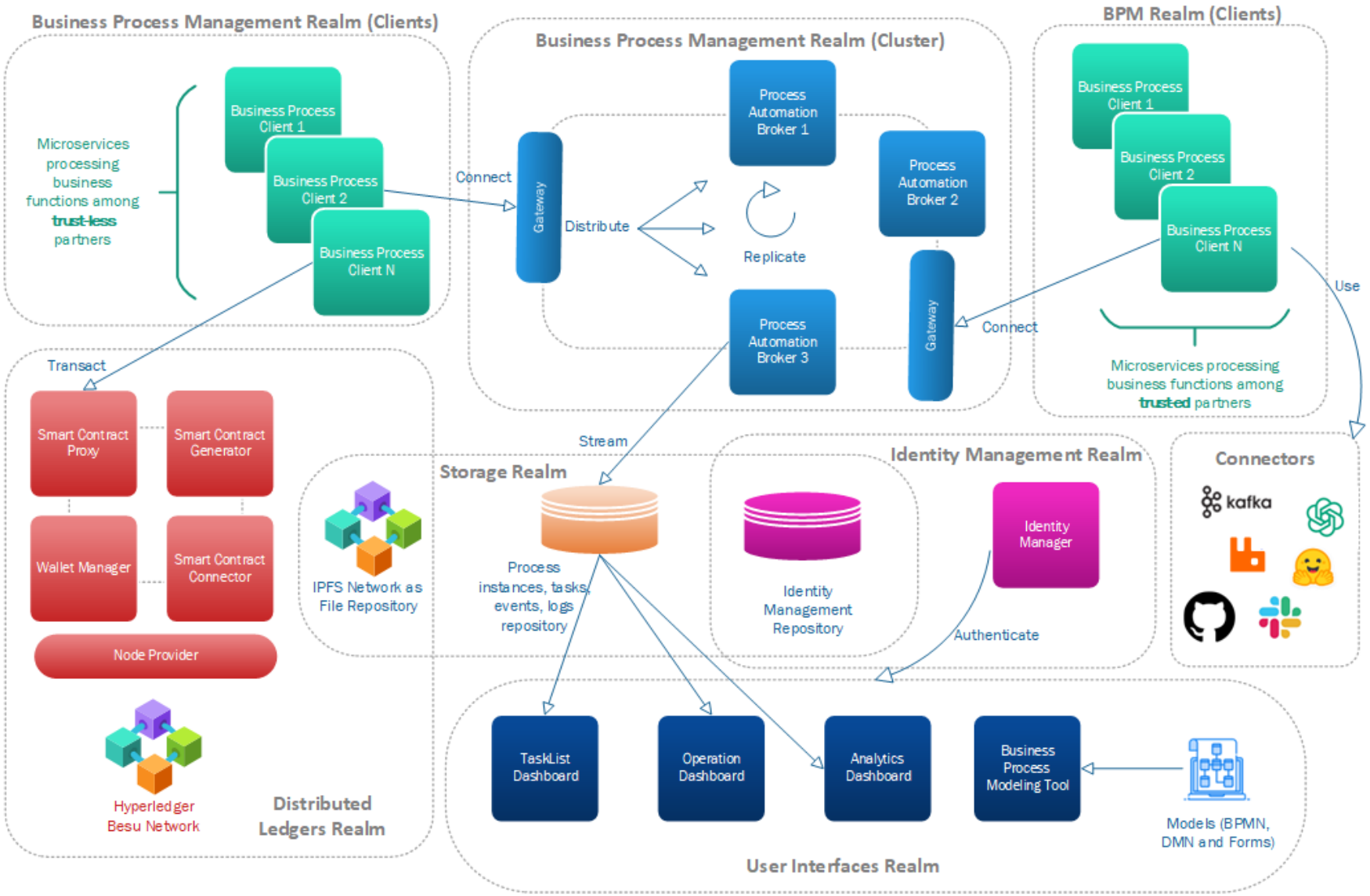
Achievements & Highlights

- Successful use of the Blockchain technology whose potential is **widely recognized** by the European Commission: within Horizon 2020, the EU has as of February 2022 funded several projects related to Blockchain and DLTs in various sectors for a total grant amount of €347 m (35.3% of projects related to Sustainability and 35.5% related to advanced manufacturing).
- Use of exclusively **open-source** technologies (non-proprietary, maintained by hundreds of developers, available free of charge).
- Enlistment of two well-established industrial **standards**: BPMN 2.0 (business process modelling) and MIMOSA OSA-CBM (predictive maintenance).

Stats source:
https://digital-strategy.ec.europa.eu/en/news/overview-eu-funded-blockchain-related-projects

Workflow Automation Engine

Architecture



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Thank you!

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Questions are welcome!

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