3rd party identity card

Project acronym/name	**Experimentation: SCDT** *Experimentation: Smart Contract-based Digital Twins for the IoT*
Logo (if any)	
Organisation name(s)	**Athens University of Economics and Business**

Objective, goal, use case

The goal of the SCDT project is to assess the feasibility and evaluate the performance of a novel form of decentralized, transparent, auditable, interoperable, and secure smart contract-based digital twins for IoT devices in next generation networks (5G and beyond). Our design aims to address the fragmentation and interoperability challenges of IoT ecosystems, while enhancing the security of IoT services, which often demand complex security solutions. Therefore, in the SCDT project, we designed and implemented the smart contract-based digital twins and evaluated their performance against defined KPIs using the 6G-SANDBOX testbed.

Concept, approach

The main activities of the SCDT project centered on the design, implementation, and evaluation of smart contract-based digital twins. We began with a conceptual design of the digital twins, followed by the development of a complete IoT system that demonstrated the use of smart contract-based digital twins as an indirection mechanism between IoT devices and end users. The system was implemented in a modular fashion and deployed on a Kubernetes cluster, which served as the foundation for our experimentation in the 6G-SANDBOX testbed. Subsequently, we defined our experimentation and testing methodology, including some high-level KPIs with their respective targets that we defined. Finally, the experimentation was conducted in two phases. Initially, the Kubernetes cluster was deployed on a single node local testbed at our site on AUEB. In the second phase, the system was deployed, tested, and evaluated at scale on the 6G-SANDBOX tested in Oulu.

Results (testing, validation) and Impact

During the experimentation phase, we conducted a variety of experiments and tests to assess the feasibility and evaluate the performance of smart contract-based digital twins. Most of the experiments relied on time-based test runs and the blockchain benchmarking tool, Hyperledger Caliper, which enabled us to measure system performance under varying levels of demand with different levels of parallelization. Experiments on the single node local testbed helped us to identify areas for optimization, refine system configurations, and establish baseline expectations for system performance and behaviour. Testing on the 6G-SANDBOX testbed at Oulu demonstrated that our system is feasible and performs well, with sensing operations showing a latency of **0.02 seconds** and actuation operations at **0.38 seconds.** We achieved a throughput of **31.77 Transactions per Second (TPS)** for sensing and **646.76 TPS** for actuation. In terms of scalability, throughput remained stable as the number of network nodes increased, confirming that the system is scalable.

Our findings demonstrate that the proposed design is feasible and offers acceptable performance for a wide range of real-world use cases and applications. We now aim to foster collaboration and promote adoption of our solution among researchers and developers. Furthermore, the outcomes of the project offer meaningful benefits beyond our team, providing valuable insights for third parties interested into real-world deployments of blockchain-based solutions. Additionally, the gathered results and lessons learned can be used for further research and development in both the digital twin and blockchain domains, potentially contributing to smarter, more secure, and sustainable IoT infrastructures.