

SOVEREIGN Online Course on

## “Blockchain: Fundamentals and Security”

Tuesday 18<sup>th</sup> – Wednesday 19<sup>th</sup> of February 2025

### Organized by



#### MSCA-SE-SOVEREIGN (G.A. 101131481)

distributed ledger technologies and user-driven automation towards self-SOVEREIGN mobile data access in beyond 5G networks



#### MSCA-DN-ELIXIRION (G.A. 101120135)

Realizing healthcare 4.0 exploiting the 6G network evolution

### Technical Coordination by

*Dr. Dionysis Xenakis, Assistant Professor NKUA, Department of Digital Industry Technologies  
Project Coordinator, MSCA-SE-SOVEREIGN programme*

### The Course is under the auspices of



The Master's Program of the National and Kapodistrian University of Athens in "[Business Administration](#)"



The Master's Program of the National and Kapodistrian University of Athens in "[Financial Technology/ FINTECH](#)"

### Technically co-sponsored by the following EU-funded actions:

The logo for the NGI TRUST CHAIN project, featuring the letters "NGI" in a colorful gradient and "TRUST CHAIN" in blue.	The logo for the CHRIS project, featuring the word "CHRIS" in a stylized font with a blue and green gradient.	The logo for the AIAS project, featuring a shield with a blue and white pattern and the letters "AIAS" below it.	The logo for the ERATOSTHENES project, featuring a shield with a blue and white pattern and the word "ERATOSTHENES" below it.
<a href="#">Fostering a Human-Centered, Trustworthy and Sustainable Internet</a>	<a href="#">Critical infrastructure High accuracy and Robustness increase Integrated Synchronization Solutions</a>	<a href="#">AI-ASsisted cybersecurity platform empowering SMEs to defend against adversarial AI attacks</a>	<a href="#">Secure management of IoT devices lifecycle through identities, trust and distributed ledgers</a>
<a href="#">GA 101093274</a>	<a href="#">GA 101082440</a>	<a href="#">GA 101131292</a>	<a href="#">GA 101020416</a>

## 1<sup>st</sup> Day: Tuesday 18th of February 2025

Time	Speaker	Title	Syllabus
8:30 - 10:15	<p style="text-align: center;"><b>NKUA</b> Prof. Thanasis Papaioannou</p> <p>Sponsoring Project: NGI TrustChain</p>	Blockchain Fundamentals (1/2)	<ul style="list-style-type: none"> <li>• Introduction to Blockchain Technology</li> <li>• Definition, key characteristics (decentralization, transparency, immutability).</li> <li>• Historical evolution (from Bitcoin to modern systems).</li> <li>• Components of a Blockchain</li> <li>• Nodes, transactions, blocks, consensus mechanisms.</li> <li>• Public vs. Private Blockchains</li> <li>• Differences, examples, and use cases.</li> <li>• Blockchain trilemma</li> </ul>
10:15 - 10:45	<b>Coffee Break</b>		
10:45 - 12:30	<p style="text-align: center;"><b>NKUA</b> Prof. Thanasis Papaioannou</p>	Blockchain Platforms and Ecosystems	<ul style="list-style-type: none"> <li>• Bitcoin <ul style="list-style-type: none"> <li>- Key features, scripting language.</li> </ul> </li> <li>• Ethereum <ul style="list-style-type: none"> <li>- Smart contracts, ERC standards, Ethereum Virtual Machine (EVM).</li> </ul> </li> <li>• Other Platforms <ul style="list-style-type: none"> <li>- Hyperledger Fabric, Solana, Cardano.</li> </ul> </li> <li>• Blockchain Interoperability <ul style="list-style-type: none"> <li>- Cross-chain solutions and bridges.</li> </ul> </li> <li>• Advanced operations</li> <li>• Sharding, state channels, oracles</li> </ul>
12:30 - 13:30	<b>Lunch Break</b>		
13:30 - 15:15	<p style="text-align: center;"><b>University of Piraeus</b> Mr. Aggelos Sideris</p> <p>Sponsoring Project CHRISS</p>	Blockchain Fundamentals (2/2)	<ul style="list-style-type: none"> <li>• Introduction to Blockchain Technology</li> <li>• Definition, key characteristics (decentralization, transparency, immutability).</li> <li>• Historical evolution (from Bitcoin to modern systems).</li> <li>• Components of a Blockchain</li> <li>• Nodes, transactions, blocks, consensus mechanisms.</li> <li>• Public vs. Private Blockchains <ul style="list-style-type: none"> <li>- Differences, examples, and use cases. <ul style="list-style-type: none"> <li>o Blockchain trilemma</li> </ul> </li> </ul> </li> </ul>
15:15 - 15:45	<b>Coffee Break</b>		
15:45 - 17:30	<p style="text-align: center;"><b>University of Piraeus</b> Mr. Anastasios Voudouris</p> <p>Sponsoring Project ERATOSTHENES</p>	Cryptographic Foundations	<ul style="list-style-type: none"> <li>• Core Cryptographic Concepts <ul style="list-style-type: none"> <li>- Hashing</li> <li>- Public and private key cryptography.</li> <li>- Digital signatures.</li> </ul> </li> <li>• Merkle Trees <ul style="list-style-type: none"> <li>- Structure, purpose in blockchains.</li> <li>- Security Challenges</li> </ul> </li> </ul>

2<sup>nd</sup> Day: Wednesday 19th of February 2025

Time	Speaker	Title	Syllabus
8:30 - 10:15	<b>NKUA</b> Prof. Thanasis Papaioannou & Prof. Dionysis Xenakis	Consensus Mechanisms	<ul style="list-style-type: none"> <li>• Proof of Work (PoW) <ul style="list-style-type: none"> <li>- Mechanism, energy concerns, and mining.</li> </ul> </li> <li>• Proof of Stake (PoS) and Variants <ul style="list-style-type: none"> <li>- Staking mechanics,</li> <li>- Delegated PoS, Practical Byzantine Fault Tolerance (PBFT).</li> </ul> </li> <li>• Emerging Consensus Mechanisms <ul style="list-style-type: none"> <li>- Proof of Authority (PoA), Proof of Space and Time, etc.</li> </ul> </li> <li>• Comparative Analysis <ul style="list-style-type: none"> <li>- Strengths, weaknesses, and use-case suitability.</li> </ul> </li> </ul>
10:15 - 10:45	<b>Coffee Break</b>		
10:45 - 12:30	<b>NKUA</b> Prof. Thanasis Papaioannou	Smart Contracts (1/2)	<ul style="list-style-type: none"> <li>• What are Smart Contracts? <ul style="list-style-type: none"> <li>- Definition, characteristics, execution.</li> </ul> </li> <li>• Smart Contract Development <ul style="list-style-type: none"> <li>- Tools: Solidity.</li> <li>- Hands-on: Write and deploy a basic contract.</li> </ul> </li> <li>• Common Vulnerabilities <ul style="list-style-type: none"> <li>- Reentrancy, integer overflow, gas limit issues</li> </ul> </li> </ul>
12:30 - 13:30	<b>Lunch Break</b>		
13:30 - 15:15	<b>University of Piraeus</b> Mr. Aggelos Sideris  Sponsoring Project: CHRISS	Smart Contracts (2/2)	<ul style="list-style-type: none"> <li>• What are Smart Contracts? <ul style="list-style-type: none"> <li>- Definition, characteristics, execution.</li> </ul> </li> <li>• Smart Contract Development <ul style="list-style-type: none"> <li>- Tools: Solidity.</li> <li>- Hands-on: Write and deploy a basic contract.</li> </ul> </li> <li>• Common Vulnerabilities <ul style="list-style-type: none"> <li>- Reentrancy, integer overflow, gas limit issues</li> </ul> </li> </ul>
15:15 - 15:45	<b>Coffee Break</b>		
15:45 - 17:30	<b>NKUA</b> Prof. Thanasis Papaioannou & Prof. Dionysis Xenakis	Blockchain Applications	<ul style="list-style-type: none"> <li>• Healthcare</li> <li>• Supply Chain</li> <li>• Decentralized Finance</li> <li>• Telecoms / Content Sharing</li> <li>• Other applications</li> </ul>
17:45 - 18:15	<b>Coffee Break</b>		
18:15 - 19:30	<b>University of Piraeus</b> Mr. Anastasios Voudouris  Sponsoring Project: AIAS	Blockchain and Research	<ul style="list-style-type: none"> <li>• State-of-the-Art Research Topics <ul style="list-style-type: none"> <li>- Privacy-preserving technologies (zk-SNARKs, zk-STARKs).</li> <li>- Multiparty computation</li> <li>- Game theory</li> </ul> </li> <li>• Open Challenges</li> <li>• Opportunities for Innovation <ul style="list-style-type: none"> <li>• Identifying gaps for academic contributions</li> </ul> </li> </ul>

**Need further details | Having connectivity issues? Please mail to: [nio@uoa.gr](mailto:nio@uoa.gr)**

# SOVEREIGN: distributed ledger technologies and user-driven automation towards self-SOVEREIGN mobile data access in beyond 5G networks

**SOVEREIGN**  
Grant agreement ID: 101131481

DOI: [10.3030/101131481](https://doi.org/10.3030/101131481)

EC signature date: 24 August 2023

Start date: 1 January 2024 | End date: 31 December 2027

Funded under: Marie Skłodowska-Curie Actions (MSCA)

Total cost: € 0,00

EU contribution: € 1 656 000,00

Coordinated by: ETHNIKO KAI KAPODISTRIAKO PANEPISTIMIO ATHINON, Greece

<https://cordis.europa.eu/project/id/101131481>

SOVEREIGN aims to fuel artificial intelligence (AI) with DLT-backed data in order to innovate the B5G service chain and the B5G protocol stack towards the support of fully decentralized, instantaneous, and anonymous resource trading across the B5G network ecosystem (end terminals, infrastructure, OTT service providers, etc.). SOVEREIGN aims to empower intelligent end points in B5G networks, to gain full control of their identities, connectivity, sessions, service terms, and shared data upon accessing B5G spectrum, antennas, network slices and services.

**Self-sovereign identity (SSI)** is a model for managing digital identities in which individuals or businesses have sole ownership over the ability to control their accounts and personal data.

8 Partners  
6 Countries

## Research and Innovation Objectives (RIOs)

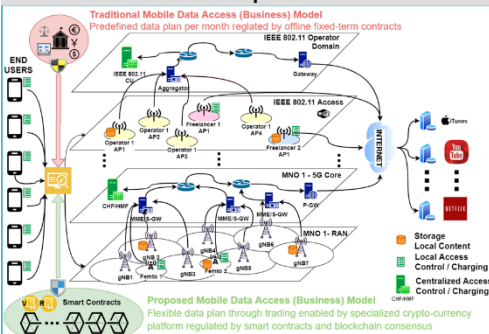
- RIO1.** Conceptualize and develop a modular end-to-end service architecture integrating DLT-empowered service provisioning towards self-sovereign mobile data access in B5G networks
- RIO2.** Design and implement a fully decentralized DLT-backed authentication, authorization, and accounting (AAA) platform tailored to self-sovereign connected intelligence in B5G networks
- RIO3.** Design and implement forward-thinking protocols for self-sovereign identity management and anonymity/data privacy preservation over joint DLT/B5G system infrastructures
- RIO4.** Design, implement, and assess the performance of user-controlled AI-enabled service discovery, pairing, mobility management and resource provisioning for the B5G network protocol stack

WHITE PAPER: D. Xenakis, C. Koulis, A. Tsiota, N. Passas, C. Xenakis, «Contract-less Mobile Data Access Beyond 5G: Fully-decentralized, high-throughput and anonymous asset trading over the Blockchain», *IEEE Access*, vol. 9, pp. 73963-74016, 2021, <https://doi.org/10.1109/ACCESS.2021.3079625>.

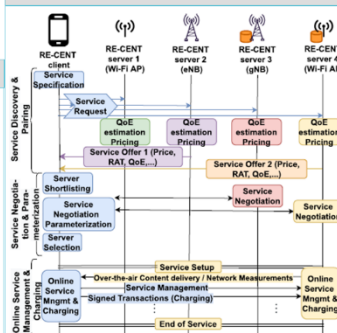
## Measurable Performance Objectives (MPOs)

- MPO1.** Setup new mobile data services and negotiate new service terms in sub-minute scales
- MPO2.** Self-sovereign mobile data access of 20B peers using the DLT-backed B5G service platform
- MPO3.** Design a DLT-backed B5G service platform supporting 20M transactions per second
- MPO4.** Sustain 99.99999% availability of the SOVEREIGN anonymity services in B5G systems
- MPO5.** Demonstrate 99.99% service reliability with partial network-assistance and 99.99999% service reliability with full network-assistance

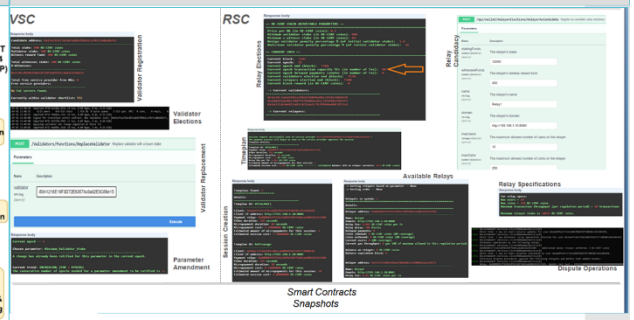
## SOVEREIGN Conceptual Architecture



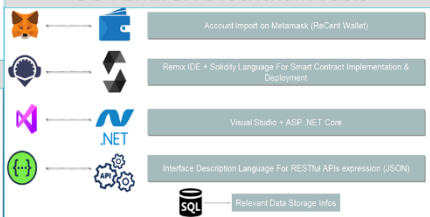
## SOVEREIGN Service Flow



## Back-end Infrastructure



## SOVEREIGN Blockchain Tools

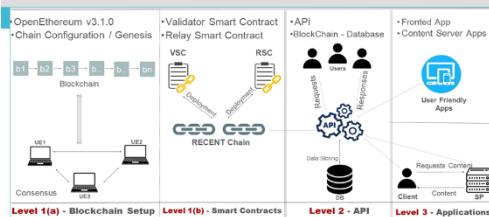


**4. Fixations**  
Presents all the necessary functionalities and information about the Re-Cent Blockchain and related tasks, such as Validator/Relay elections blockchain info, etc.

**FrontEnd Part (ReCent's Webpage) contains:**

- Home - Initial Webpage
- My Wallet - Validator/Relay/Client/Server Account & Balance Overview
- Blockchain Information - Validator/Relay & Adjustable Parameters
- Election Hub - Validator/Relay Elections Information
- Advanced Statistics - Chain's Statistics & Data
- "About" Section - Information about Re-Cent
- "Buy Re-Cent" Section - "TED"

## SOVEREIGN Blockchain Platform



**Project Coordinator:** Prof. Dionysis Xenakis, National and Kapodistrian University of Athens  
**Emails:** Prof. Dionysis Xenakis ([nio@uoa.gr](mailto:nio@uoa.gr))  
**WWW:** <https://cordis.europa.eu/project/id/101131481>



## ELIXIRION: rEaLizing healthcare 4.0 eXploiting the 6G netwoRk evolutiON

### Project Information

#### ELIXIRION

Grant agreement ID: 101120135

#### DOI

[10.3030/101120135](https://doi.org/10.3030/101120135)

#### EC signature date

6 July 2023

#### Start date

1 November 2023

#### End date

31 October 2027

#### Funded under

Marie Skłodowska-Curie Actions (MSCA)

#### Total cost

€ 0,00

EU contribution  
€ 2 536 970,40



Coordinated by  
ARISTOTELIO PANEPISTIMIO 1  
Greece

<https://cordis.europa.eu/project/id/101120135>

ELIXIRION aims to set the foundations of the emerging Healthcare 4.0 paradigm by leveraging 6G technologies targeting to: i) provide all citizens/patients with a wide range of services of different requirements, such as ultra-low latency for latency-critical applications, high speed for data hungry services and ubiquitous secure access to healthcare resources, anytime, anywhere, respecting all privacy aspects, and ii) ensure a secure, efficient, and profitable healthcare ecosystem to all involved stakeholders, while creating a sustainable open market easing access to new players

8 Countries



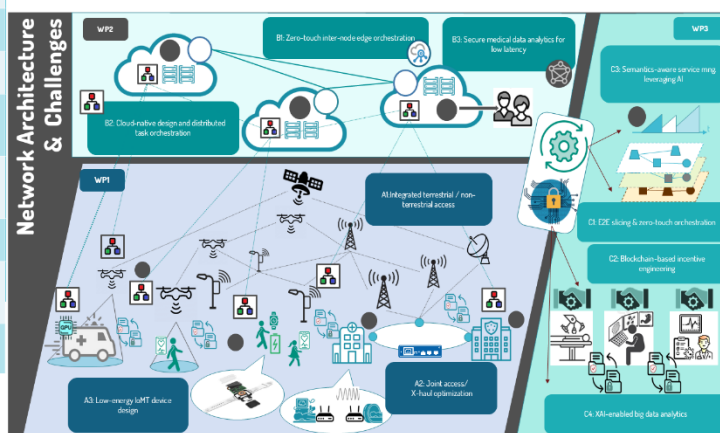
**Healthcare 4.0** promotes the digitization of healthcare through the use of advanced technologies. Such technologies provide patients with greater reliability, convenience, satisfaction, and transparency.

14 Partners



Ind.	Target KPIs	W P	DCs
A1	Reliability: up to 99.99999%, 100% Coverage	1	LU-1
A2	Capacity: up to 1 Tbps, Energy/Cost-efficiency: 75% higher than SoA	1	AUT H-1
A3	Increased 6x battery lifetime/energy efficiency compared to SoA	1	MCS-1
B1	Service placement latency: down to sub-ms, Service continuity: 99.99999%	2	NBC-1
B2	30% develop./deploy. Time reduction, 30% workflow exec. time reduction	2	BSC-1
B3	50% more info shown to patients on EMR access, 50% manual work decrease for data collection	3	AMC-1
C1	E2E latency: down to sub-ms, Energy/Costefficiency: 50% higher than SoA	3	ORA N-1
C2	Transaction throughput: 100k transactions per second (TPS)	3	FOG-1
C3	>75% higher energy/cost-efficiency, 100% uninformative information reduction	3	LIU-1
C4	20% increased analytics performance, 80% increased output understanding	2	SUIT-1

Project Coordinator: Prof. Amalia Miliou (AUTH)  
 UOA PI: Prof. Dionysis Xenakis ([nio@uoa.gr](mailto:nio@uoa.gr))  
 WWW: <https://elixirion-mc.eu/>



**Research Area 1:** High reliability and high capacity green 6G infrastructures, focusing on technologies such as i) **NTNs** (Unmanned Aerial Vehicles (UAVs), satellites and High Altitude Platform Stations (HAPS)), ii) **joint access and X-haul**, and iii) **multi-GHz bands** (mmWave, sub-THz, THz), to complement the TN services.

**Research Area 2:** Fully-distributed compute continuum for low latency healthcare applications.

**Research Area 3:** AI-driven E2E Healthcare service provisioning over 6G.