

DECENTRALIZED AND AUTOMATED BUSINESS LOGIC IN A FUTURE MBSE BLOCKCHAIN ECOSYSTEM

ESA OSIP Project

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DISCLAIMER

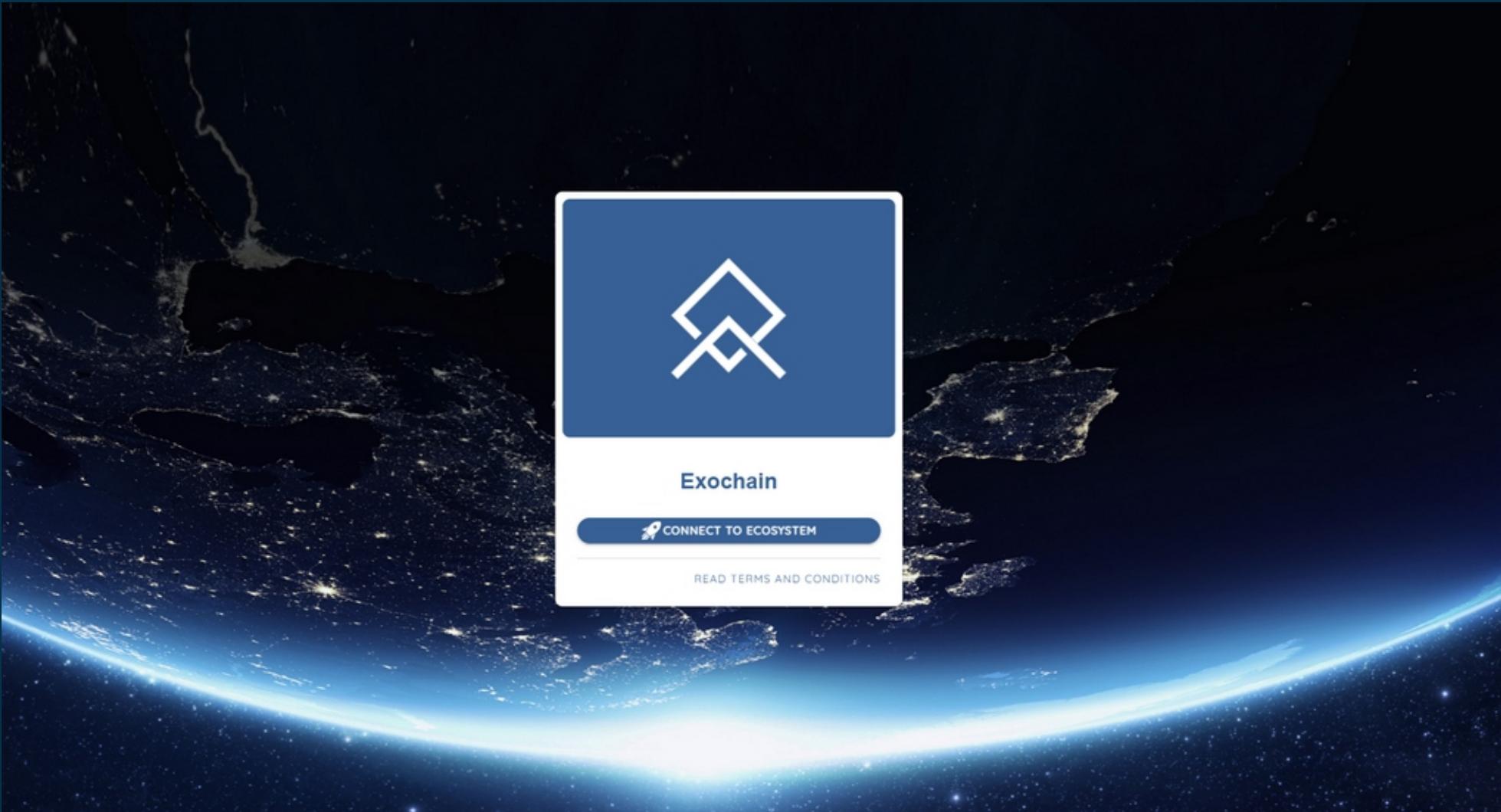
THIS IS NOT BITCOIN

THIS IS NOT A PUBLIC BLOCKCHAIN

THIS IS NOT ABOUT FINANCE

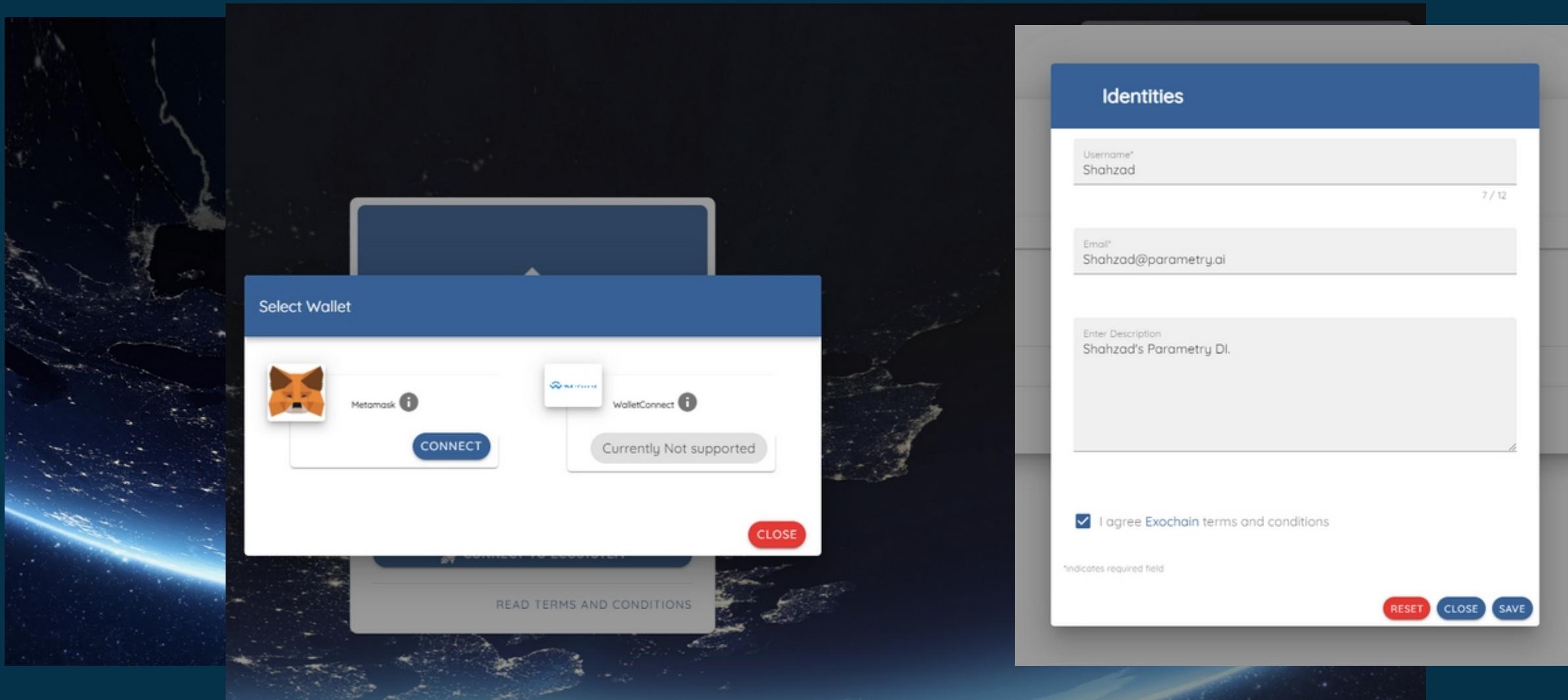
THIS IS ABOUT TRUST & COLLABORATION

Exochain: DApp – Web3 Prototype



ESA OSIP Project: Distributed Ledger Technology for MBSE

Exochain: Decentralized Identity



Exochain: Decentralized Assets Management

The image shows two forms overlaid on each other. The top form is titled 'Add new mission' and includes fields for Mission Name (Mission 1), Code Name (MSX), Launch date (08/10/2022 17:38), and Status (Preliminary Design). The bottom form is titled 'Add new spacecraft' and includes fields for Spacecraft Name (Craft), Code Name (SCE2), Launch date (09/10/2022 17:01), and Status (Preliminary Design). Both forms have a progress bar at the bottom right indicating 3/8 and 4/8 respectively.

This interface is titled 'Add component to spacecraft'. It has tabs for 'AUTOMATIC CONFIG' (selected) and 'MANUAL CONFIG'. A message states 'The following file are part of your COMET/CDP4 export'. Below this, there is a section for 'Iteration File(in json)' which shows '0 files (0 B in total)'. A note says 'Iteration.json file is in /(mission_name)/Iterations/(uuid).json'. At the bottom right is a blue 'LOAD' button.

**Automated Loading
and Tracking of Assets
And Identities**

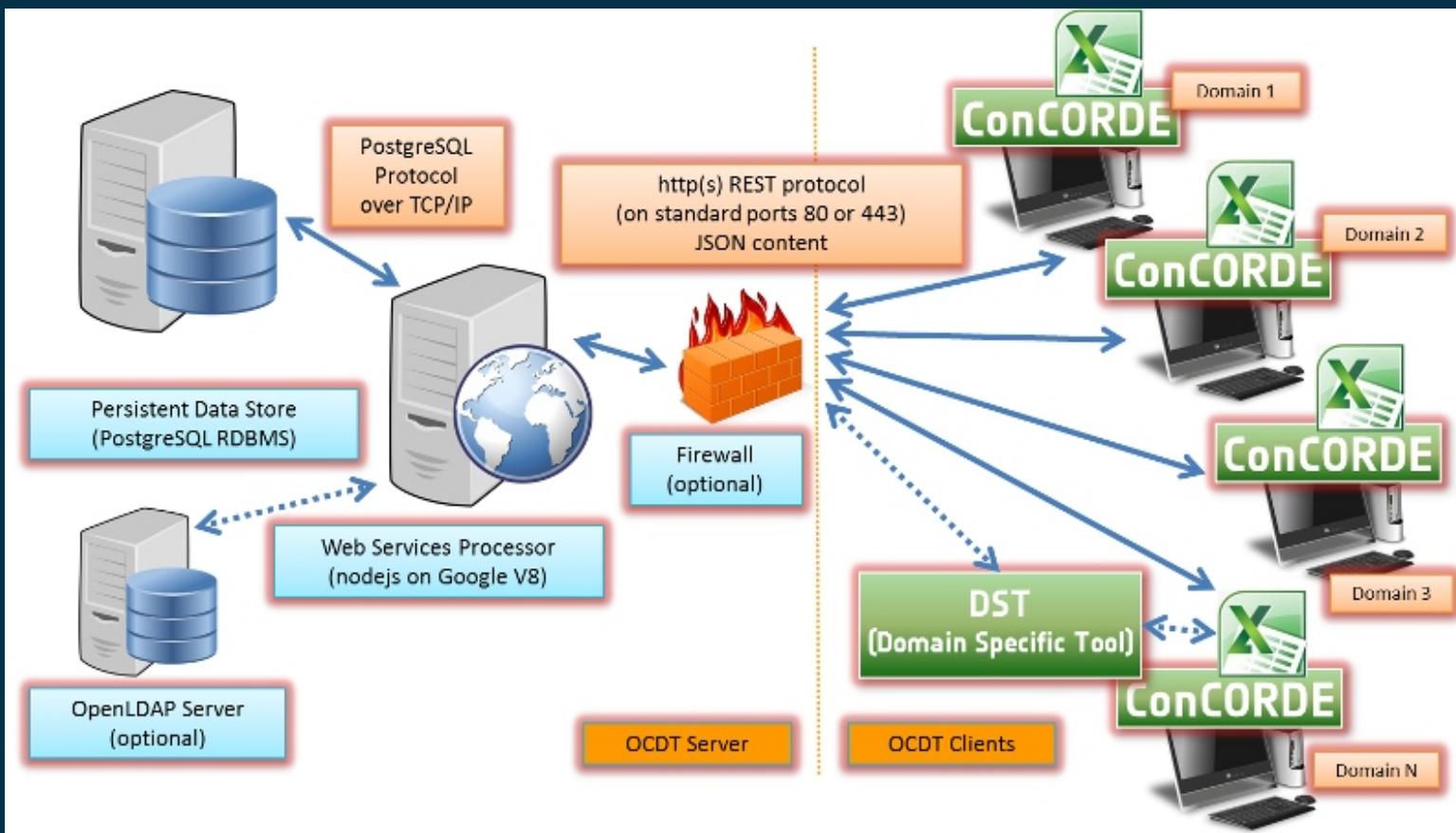
Need for decentralization & automation

- Complex project
- Lots of Interactions
- Lots of stakeholders
- Lots of domain of expertise
- Lots of private/secret information
- Overload in mundane tasks for:
 - permissions and authentication management
 - Tracking, verifying, monitoring, auditing...



**NEED FOR A decentralized trusted
partly-automated business network**

So we connected Excel sheets



So we kept centralizing, with good access control

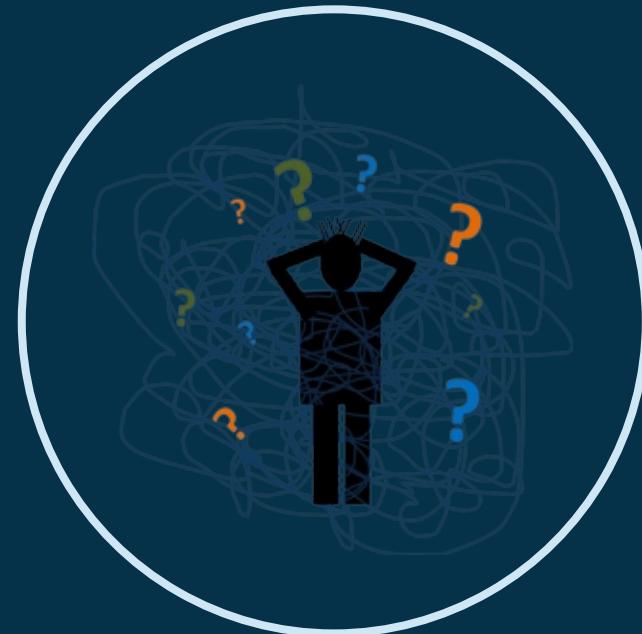
COMET IME - Community Edition

Model: LOFT Data-Source: https://cdf-dea.esa.int/
Iterations: 1 Person: The Administrator
Options: Default Option Domain Of Expertise: System Engineering [SYS]

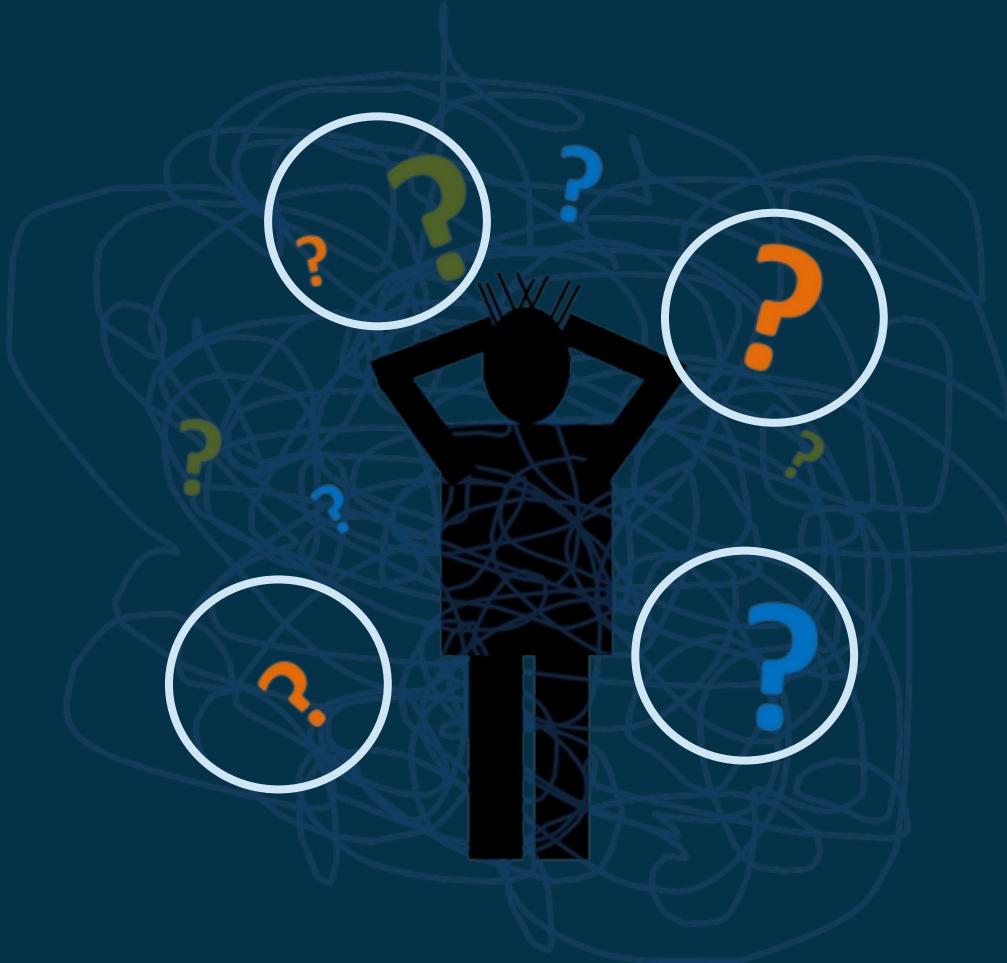
Name	Value	Owner	Switch	Description	Model Code	Row Type	Category
20 layers MLI on SVM ...		THE			Sata20_layers_MU_...	Element Usage	Element
20 layers MLI on top b...		THE			Sata20_layers_MLU_...	Element Usage	Element
20N Thruster : 20N Thr...		PRO			Sat.Thruster_20N	Element Usage	Element
400N Thruster : 400N T...		PRO			Sat.Thruster_400N	Element Usage	Element
diameter	- [m]	PRO	REFERENCE		Thruster_400N.d	Parameter	Element
height	- [m]	PRO	REFERENCE		Thruster_400N.h	Parameter	Element
length	- [m]	PRO	REFERENCE		Thruster_400N.l	Parameter	Element
mass	2.7 [kg]	PRO	REFERENCE		Thruster_400N.m	Parameter	Element
mass margin	5 [%]	PRO	REFERENCE		Thruster_400N.mas...	Parameter	Element
width	- [m]	PRO	REFERENCE		Thruster_400N.wid	Parameter	Element
altitude and Orbit Con...		SYS			Sataoc_SS1	Element Usage	System
mass	74.2 [kg]	AOGNC	REFERENCE		AOGNCS.m	Parameter	System
mass margin	5.1 [%]	AOGNC	REFERENCE		AOGNCS.mass_mar...	Parameter	System
Battery : Battery		PWR			Sat.Bat	Element Usage	Element
diameter	- [m]	PWR	REFERENCE		Bat.d	Parameter	Element
height	- [m]	PWR	REFERENCE		Bat.h	Parameter	Element
length	- [m]	PWR	REFERENCE		Bat.l	Parameter	Element
mass	21.6 [kg]	PWR	REFERENCE		Bat.m	Parameter	Element
mass margin	5 [%]	PWR	REFERENCE		Bat.mass_margin	Parameter	Element
number of items	- [-]	PWR	REFERENCE		Bat.n_items	Parameter	Element
width	- [m]	PWR	REFERENCE		Bat.wid	Parameter	Element
Battery 2 : Battery		PWR			Sat.Bat2	Element Usage	Element

Details

Info: Open ProductTreeViewModel took 00:00:00.4722435

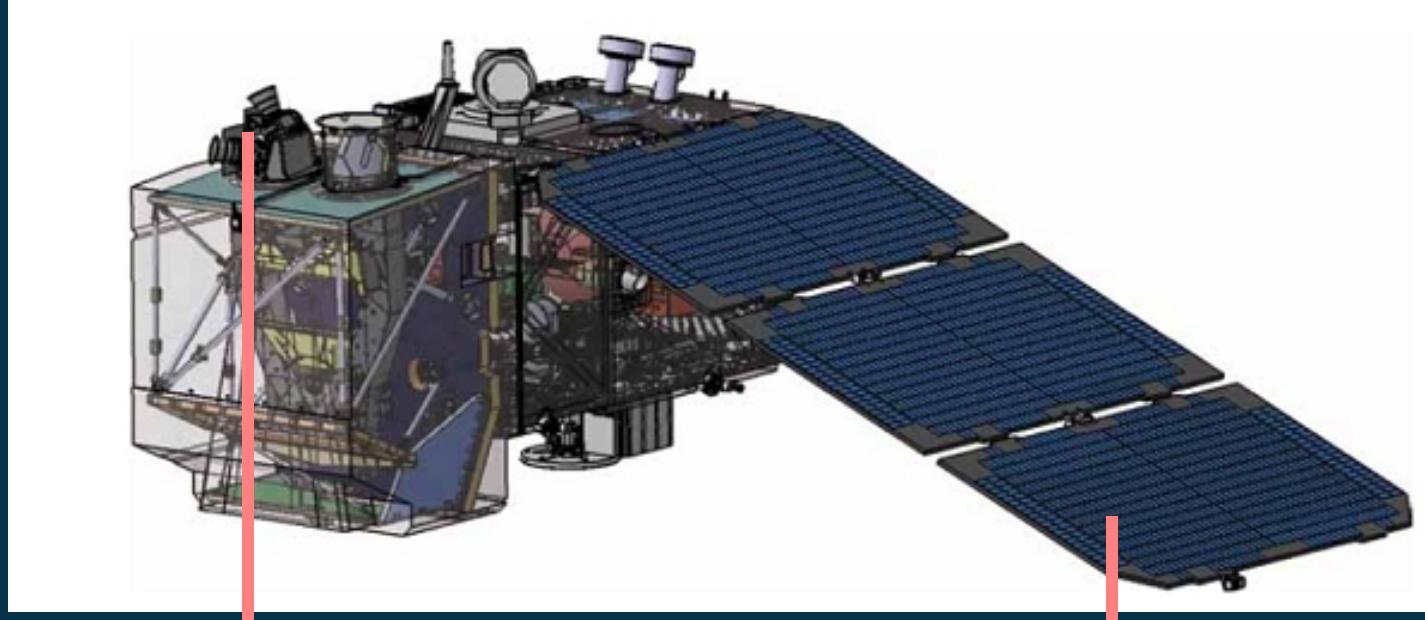


Exochain proposition



Exochain: event-based smart objects

1 Smart Object
=
1 Small Program
Implementation



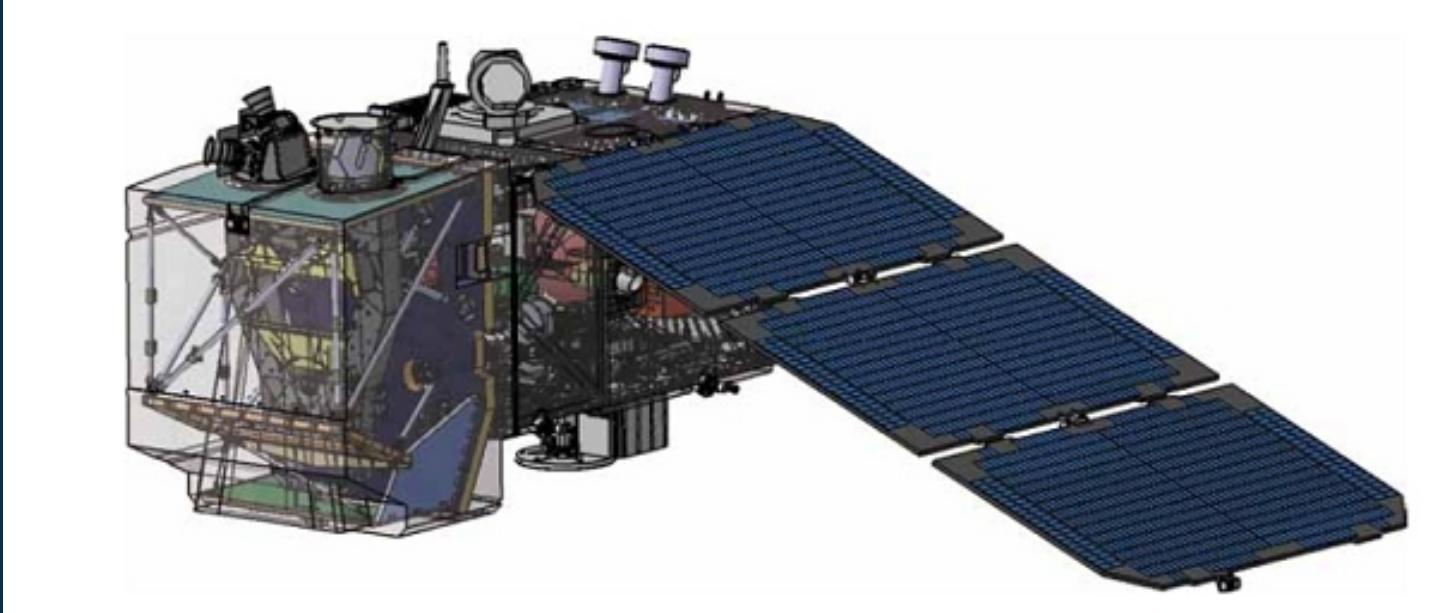
Star Tracker

- connects()
- estimates_attitude()
- takes_energy()

Solar Panel

- connects()
- collects_sun_rays()
- gives_energy()

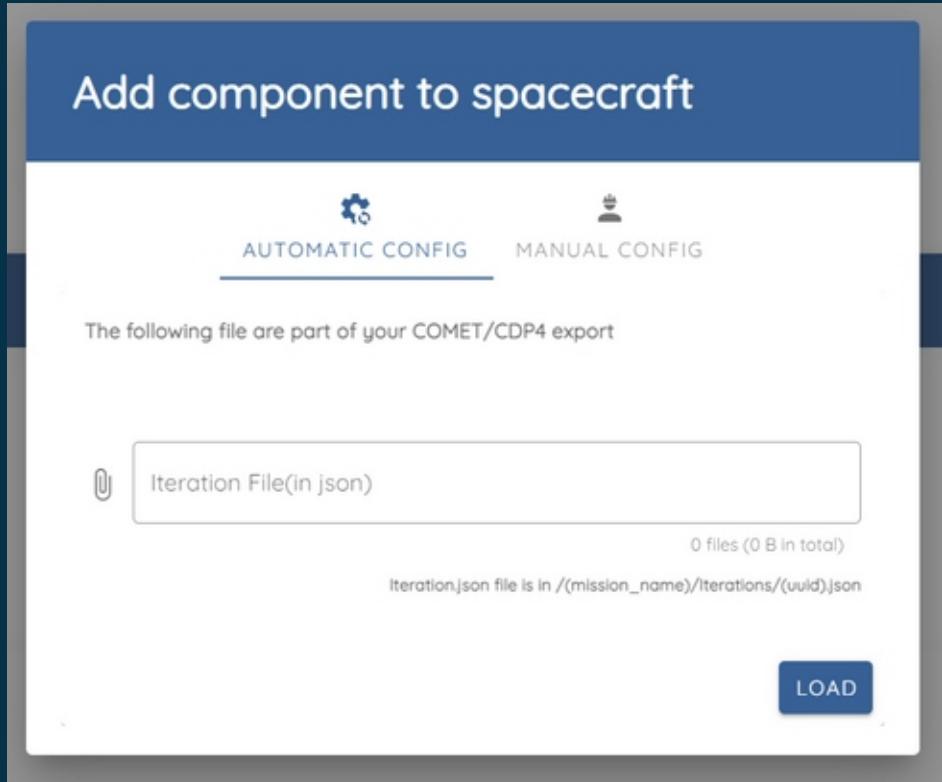
Exochain: event-based smart objects



smart objects ↔ **external data sources**

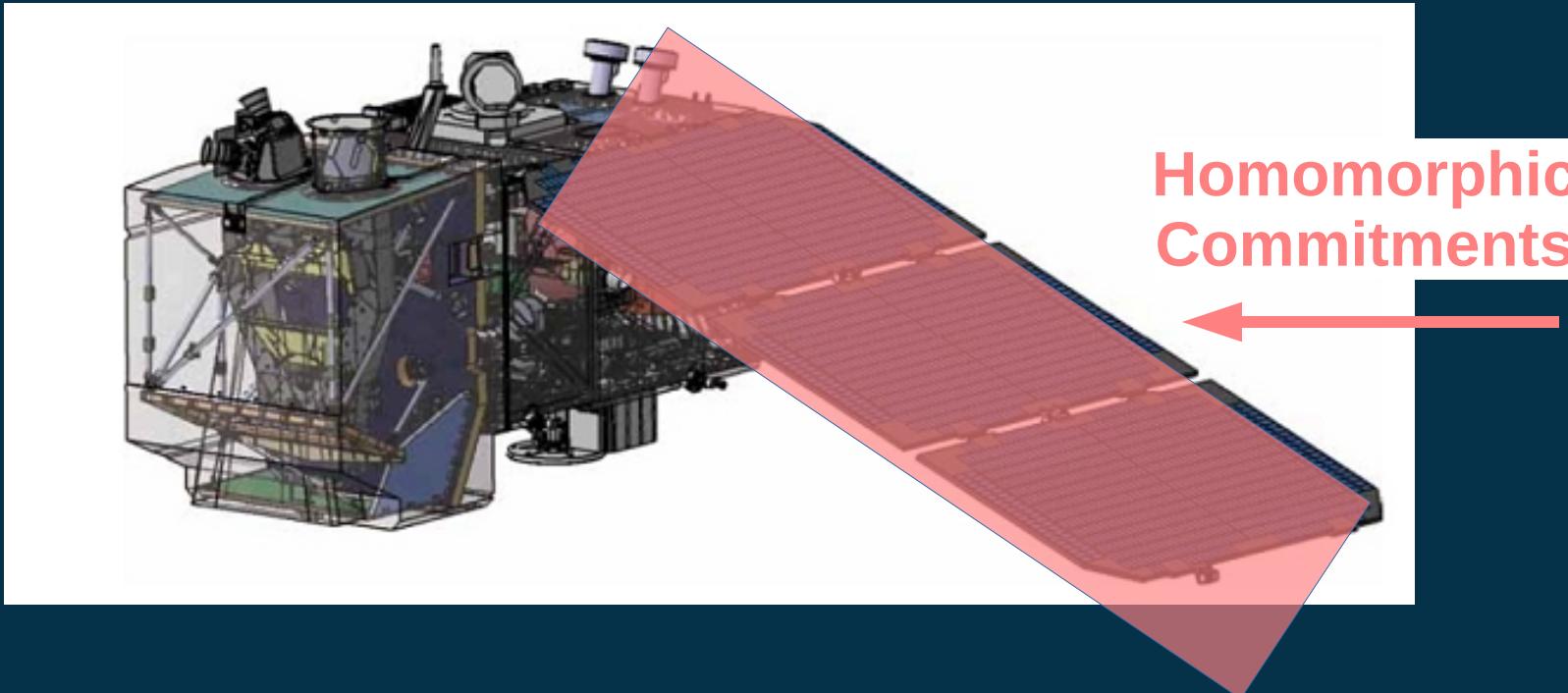
First Steps to Digital Twin

Exochain: Collaborating with Confidential Information



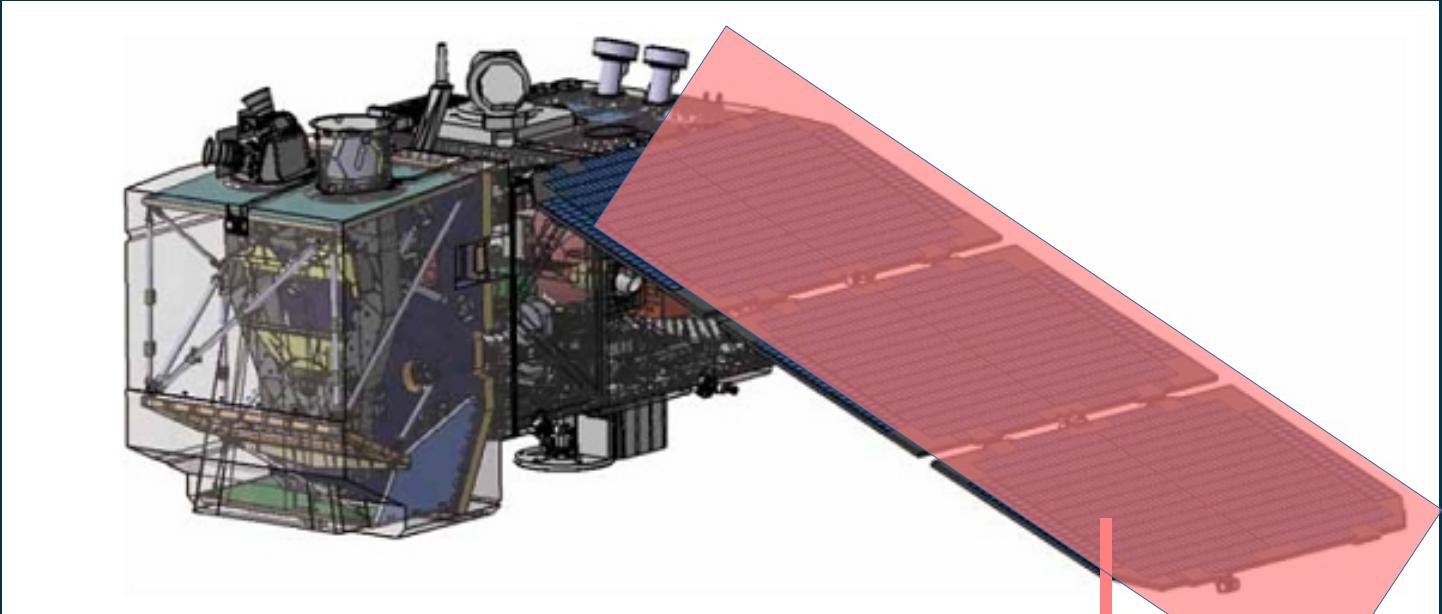
ZK-PROOF
Zero-
Knowledge
Proofs

Exochain: Collaborating with Confidential Information



ZK-PROOF
Zero-
Knowledge
Proofs

Exochain: Collaborating with Confidential Information

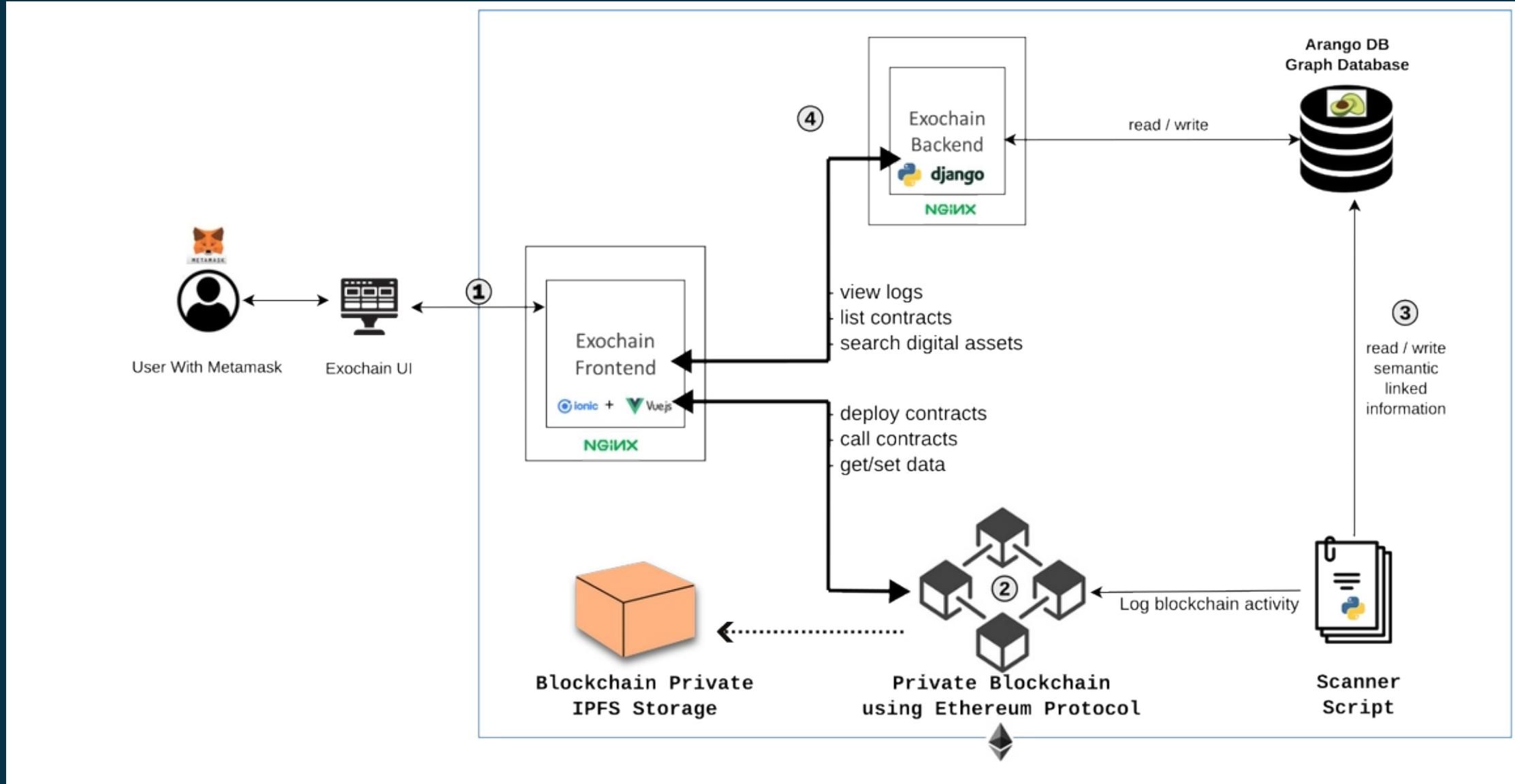


ZK-PROOF
Zero-
Knowledge
Proofs

Solar Panel

- connects()
- collects_sun_rays()
- proves_it_can_give_enough_energy()

Exochain: Architecture



Conclusion

- **Split by smart objects** forces decentralization
- **Decentralization** is haven to maintain **trust**
- **Smart Contracts** interactions and **ZK-Proof** permits automated interactions on **confidential/secret information**

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Conclusion

From a Technical Perspective

Blockchain is rarely easier or cheaper to set-up than modifying a traditional system

From a Trust Perspective

Blockchain can be easier and cheaper to set-up than a traditional system

Blockchain is a middleware to efficiently describe business logic

Composition of Blockchain Technology

Encryption

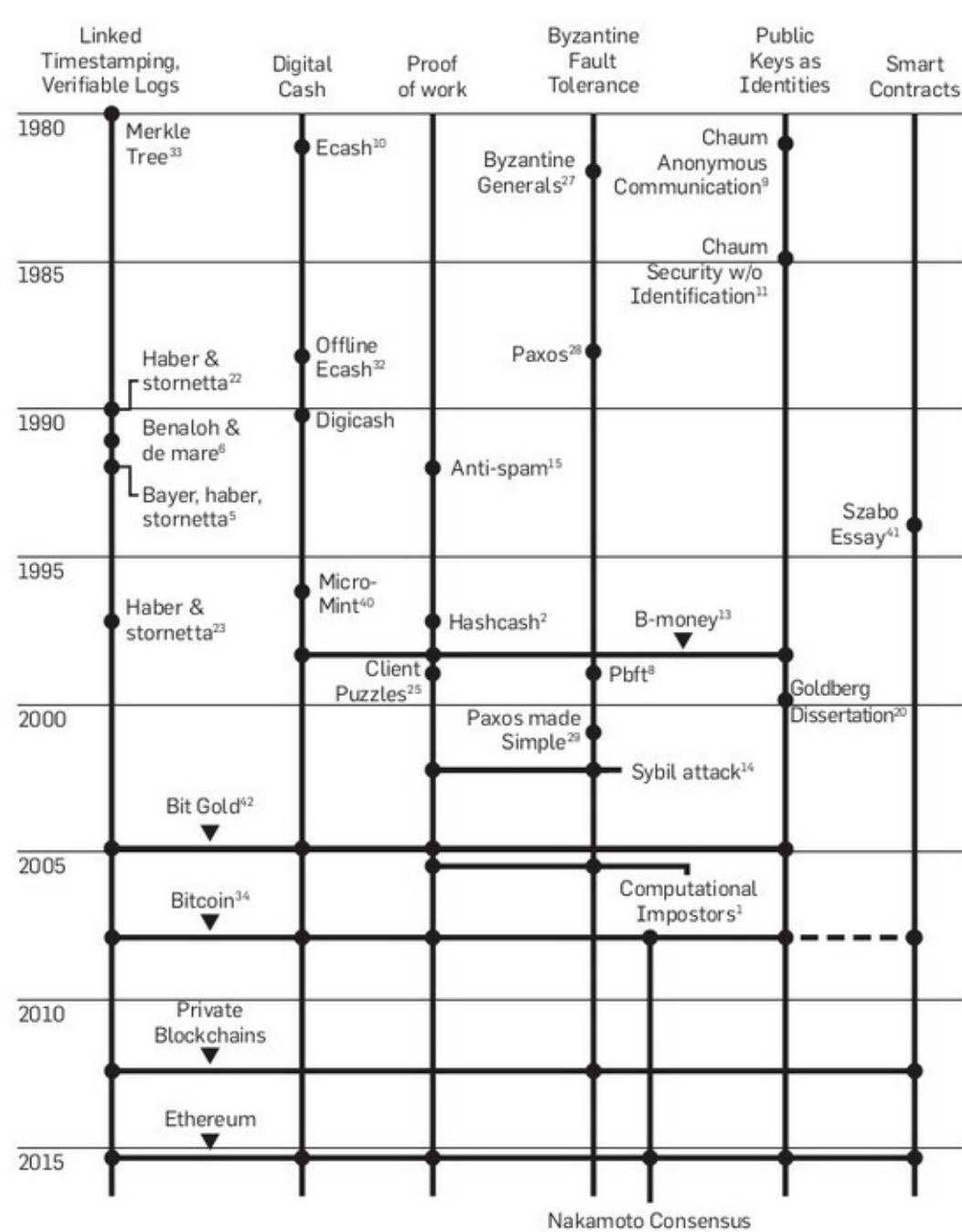
Signing who is making the claim
Assertion of the origin

Distributed Ledger

Transparent Information
Consensus on state of the whole system
Fault tolerance in distributed exchange

Chain history

Authenticity of history
Non-repudiation



Academic Pedigree of Blockchain Technology

"Bitcoin's academic pedigree", 2017

Narayanan & Clark

<https://dl.acm.org/doi/10.1145/3132259>