Investigating the use of blockchain to increase trust, security and transparency of our software supply chains

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Outline

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- How does it work
- Blockchain properties

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Blockchain overview

What is Blockchain?

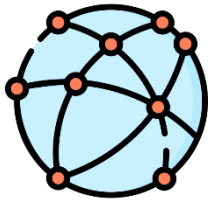
Definition

*Blockchain is a technology, a **decentralized digital ledger** that **securely stores records** across a **network** of computers in a way that is **transparent**, **immutable**, and **resistant to tampering**. Each "block" contains data are linked in a chronological "chain".*

Types of blockchain

	Public / Permissionless	Private / Permissioned
Examples	Bitcoin, Ethereum	Hyperledger Fabric, Corda, Quorum
Type	Trustless, nodes are anonymous	Trusted, nodes identities are certified
Consensus	Reached via proof of work, proof of stake	Governance set by policies / rules

How does Blockchain work?

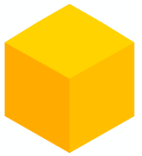


2 Validation

The request is broadcasted to a P2P network of nodes, validated (or not) through consensus decision

1 Transaction request

Someone request to register a new transaction: contracts, records or any other information

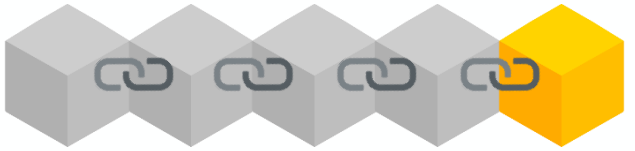


3 Block creation

Sets of validated transactions are stored in a block of data

5 Ledger is updated

Every nodes host a copy of the ledger storing all transactions



4 Addition to the blockchain

The new block is then added to the existing blockchain, in a permanent and unalterable way

Blockchain properties

Decentralized
A blockchain network is not controlled by a single entity. Data and operations are distributed across a network of peers

Distributed
Each node holds a copy of the shared ledger, providing redundancy and making the system more robust

Secure
Transactions and linked blocks are secured using cryptography and hashing algorithms

Immutable
Once data is happened to the blockchain, it is not possible to alter it. History of transactions is preserved

Transparent
Each node can access and verify the ledger of transactions increasing accountability and resistance to fraud

Consensus
Nodes follow a set of rules to agree on the validity of each new transaction to be added to the blockchain

Smart Contracts
Many blockchain supports self-executing programs based on certain conditions and agreed terms

Context

ESA Agenda

AGENCY

ESA Strategy 2040

Digital Revolution for Space
A coherent, interoperable digital thread facilitates formal traceability, analysis, data exchange and round-trip engineering across disciplines, lifecycle phases and supply chains.

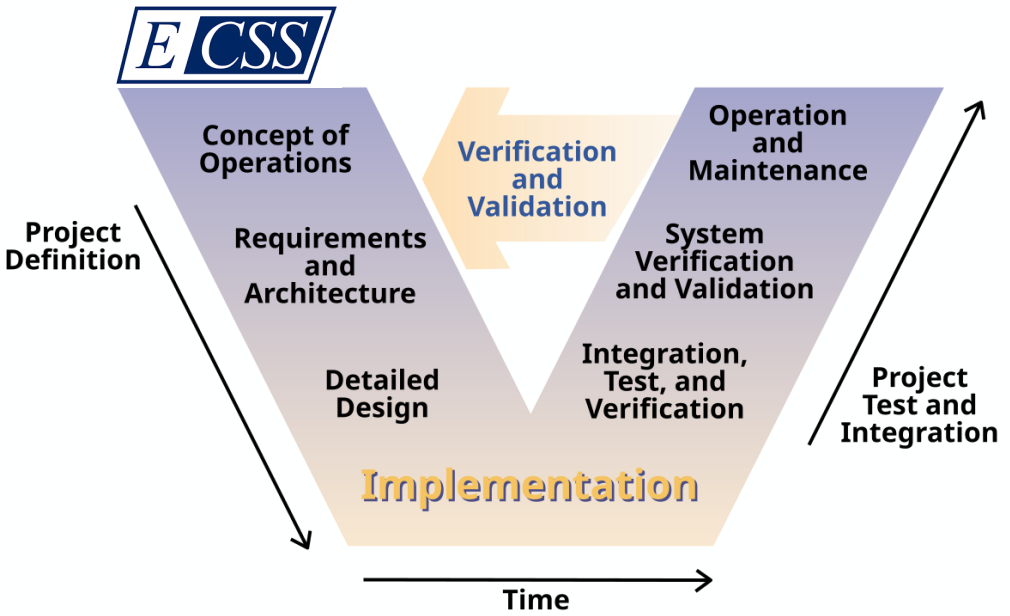
Security for Space Systems
Security protection mechanisms adapted to a dynamic environment of novel mission concepts and services, more complex space system architecture and evolving threat scenarios

More for Less: Technologies for Cost Reduction
Towards more capable virtual models, standardisation and automated series production to lower development, production and testing costs

Digital continuity (document to model-based)
Single point of truth (increasing communication)
Traceability (change impact analysis)
Interoperability (across disciplines)

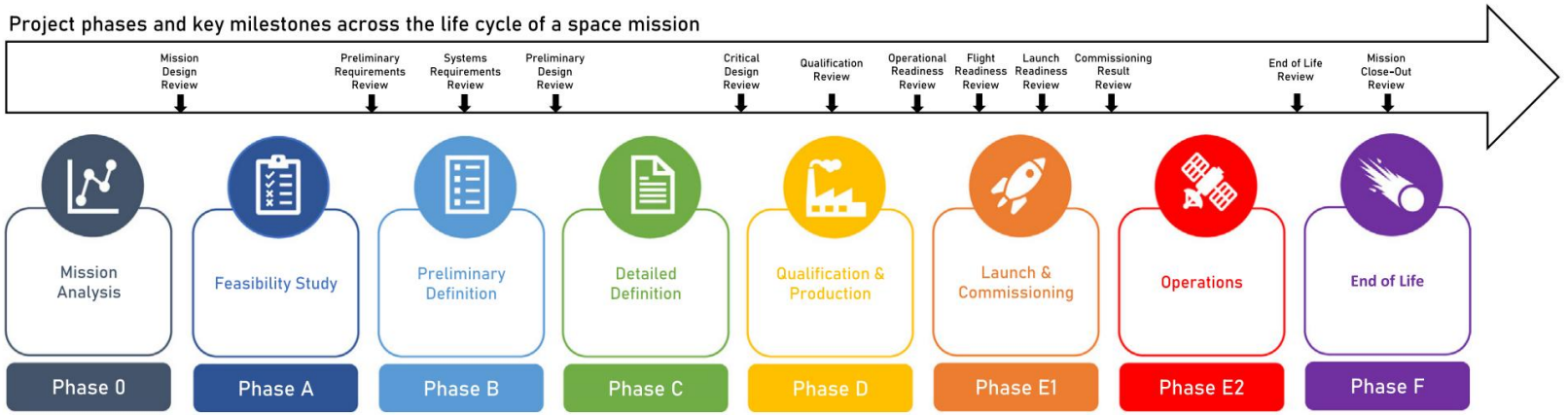
Continuous improvements
Adaptability & Flexibility
Increased transparency
Enhanced collaborations

Space Project Lifecycle



Current workflows

- Customers organize joint reviews with their suppliers throughout each project to assess their work
- Reviews (only) happen at major milestones in the project

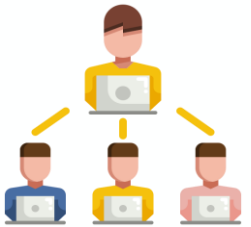


Review Challenges

As PA supporting projects, we participate to joint reviews with suppliers

Time constraints

Reviews are often short-timed, happening in parallel, giving little room for meticulous and complete analysis of work packages



Collaboration

Actors of a project are numerous. Trust is difficult to build. The culture is more in favor of sharing less than too much, and not in a continuous way

Inconsistencies

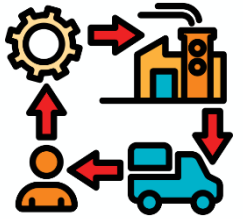
Data packs are often missing, incomplete. Information can be altered or lost over time

Large data packs

Data packs are often large containing many documents, requiring strong focus abilities to switch between projects

Lack of standardization

Data comes in non-ideal export format (pdf, excel), requiring tedious and manual analysis, preventing the digitalization of the review process



Long supply chains

Rigorous follow-up of all suppliers is challenging, opening doors to security issues and wrong reuse of building blocks

Applications

PABLO - Aims

PABLO stands for **P**roduct **A**ssurance based on **BLO**ckchain. Available as a **dashboard** built on top of **blockchain**

Similar objectives and properties

Digitalization of SW PA activities

Dashboards based on a single source of truth help quickly visualize the flow of information securely stored on the blockchain

Continuous monitoring

Shifting from static and intermittent project reviews to continuous monitoring. Updates can be followed in real-time.

Better assurance

Increasing the reliability of shared information, enabling better traceability & auditability during project lifecycle

Automation

Removing manual, repetitive and time-consuming work to let us focus on what really matters

PABLO - The SW PA Use Case

What is stored on the Blockchain?

Properties such as:

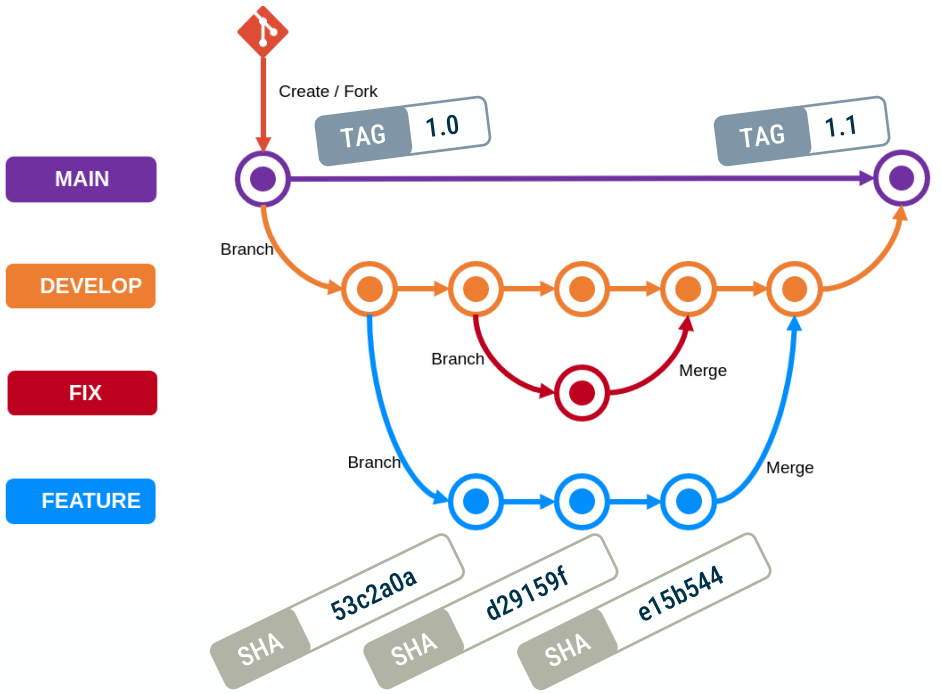
Date, Time, Company name, Author details,
Artefact type, ID (hash), artefact content (optional)

[Date: Time] Company OzoneCar created a SPAP
[Date: Time] Company OzoneCar updated a SPAP

[Date: Time] Company Pythagore opened an issue
[Date: Time] Company Pythagore pushed a commit
[Date: Time] Company Pythagore closed an issue

Example of information stored on the shared ledger

Continuous Development Traceability



Actions set up in CI/CD trigger smart contracts!

PABLO - Future Applications

- **PA / Project / Configuration Management, Domain specific (e.g. RAMS, system engineering)**

  Similar to handling software PA-related artefacts, we could support other disciplines, processes & their artefacts

- **Supply chain management**

  From sources to distribution, traceability helps organizations understand their supply chain & helps prevent supply chain attacks, ensuring what was done, when and by who

- **Auditability and Assessment**

  Increased visibility over one supplier projects could facilitates audits and assessment (S4S)

- **Procurement**

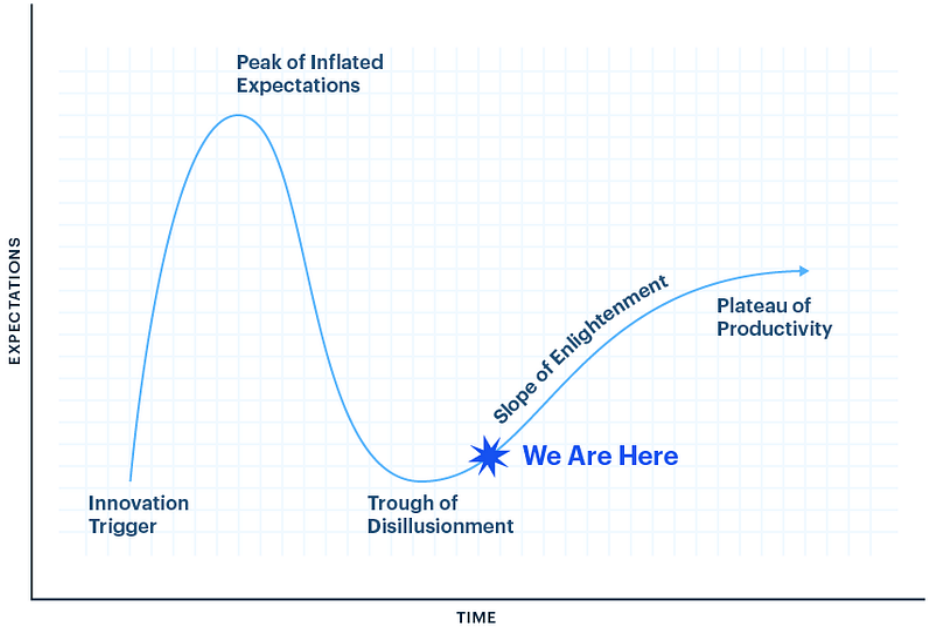
  Blockchain could help digitize procurement processes, reducing time-to-contract while maintaining security and trust

- ...

Wrapping up

Blockchain status in 2025

Gartner's Hype Cycle



Legal regulations coming into place

EU MICA, NIS2 directive, Cyber Resilience Act, AI Act, Data Act…

Blockchain technology & community growing

HyperLedger Fabric v2, Ethereum Virtual Machines…

Industry adopting the technology

Decentralized finance, food and transportation, railway…

Clouded maturation

The new Gen AI hype hides recent progress, but it's there!

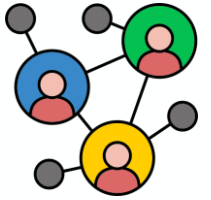
Feedback

Building a Blockchain Project

Points to consider

Technical challenges

Require coordination, efforts to setup the blockchain

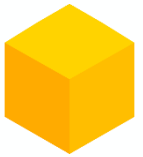


Adoption challenges

Early stakeholders onboarding is key

Must be business-driven

Key Take Away



Blockchain technology properties

Decentralized, secure, immutable, transparent, programmable

Digital transformation

ESA Strategy 2040 aims at reducing costs & time

Investigating applications

Software PA, development, supply chain & more…

Let's collaborate!

Discussing pros and cons, use cases…

Thank you!

Back Up Slides

Other Blockchain Use Cases at ESA

Application	Objective	Programme	Deliverable
Science	Ensuring reproducibility of scientific research	YGT	Proof-of-Concept
Science	Synergic use of blockchain and deep learning for space data		Feasibility study
Operations	Implementation of blockchain in ground segment operations	Estonian industry incentive scheme	Use case analysis
Operations	Advanced trust establishing methods in next generation spacecraft networks	NPI	Academic research
Telecom	Risk mitigation of farmland based on EO imagery	Business applications Kick Start Activity	Feasibility study
Telecom	Humanitarian goods supply chain	Business applications Kick Start Activity	Feasibility study
Telecom	Food safety and traceability supply chain	Business applications Kick Start Activity	Feasibility study
Telecom	Added value of blockchain on the spacecraft in satellite networks		Feasibility studies + demonstrator
Earth Observation	Blockchain 4 Space Activities: Integrity of EO data	GSTP	Feasibility study + use case analysis
Earth Observation	Identification of blockchain use cases in EO	Phi Week	Use case analysis
Commercialization	Blockchain for secure nano-satellite constellations with distributed authority	SME initiative	Feasibility study
Generic	End to end supply chain protection	GSTP	Prototype