

Semantic Web & Blockchain: Ready to Dance?

Vlado Stankovski

University of Ljubljana
Slovenia

IIT.SRC
Bratislava, April 28, 2022



THE INTERNET

- Its success has been based on **free expression, open innovation** and **interoperability**.
- However, there are growing concerns that **accessibility, privacy, security**, and **trustworthiness** are being sacrificed to achieve high performance and profit.
- The **Collingridge dilemma** is a methodological quandary in which efforts to influence or control the further development of technology face a double-bind problem:
 - An **information** problem: impacts cannot be easily predicted until the technology is extensively developed and widely used.
 - A **power** problem: control or change is difficult when the technology has become entrenched.

MORE SPECIFICALLY

In ***real-life scenarios*** of humans interacting with the internet, different problems have been detected, such as:

- *the **centralization of power*** i.e., information and knowledge being in the hands of just a few actors,
- *the **unknown provenance of information***, e.g., fake news,
- **anonymity** in favor of criminal activity,
- **personal privacy violations and personal data exploitation**, e.g., the Cambridge Analytica scandal,
- **biases in AI algorithms**, e.g., under-representation of certain social groups in training data can make AI algorithms discriminate against those social groups,
- **no fair rewards for quality contributions**, e.g., the provision of credible reviews,
- and more **threats to the fundamental rights of users**.

OBJECTIVE

The internet of the future should be more **resilient**, **trustworthy** and **sustainable**.



ONTOCHAIN answer

Develop **new** software technologies stack **at the meeting point** between **the Semantic Web** and **Blockchain**.

NEXT GENERATION INTERNET

ONTOCHAIN

Trustworthy information exchange

Trustworthy transactional content handling

Trustworthy service orchestration

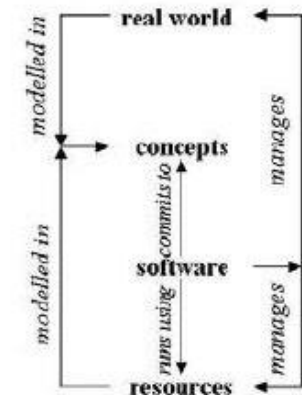
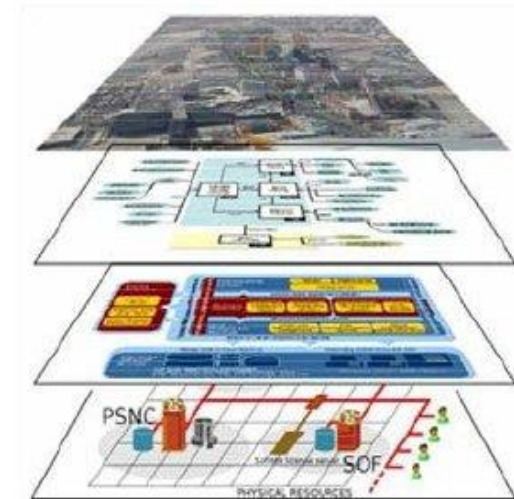
Decentralized social networks

SEMANTIC WEB

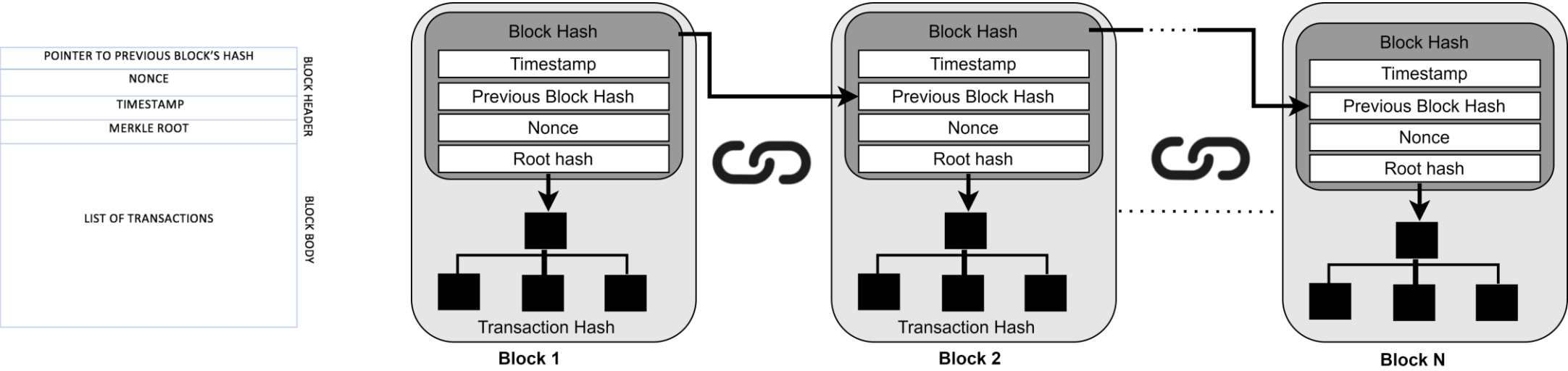
- **The Semantic Web is a vision** about **an extension of the existing World Wide Web**, which provides software programs with **machine-interpretable metadata** of the published information and data.
- In other words, we add **further data descriptors** to otherwise existing content and data on the Web.
- A **knowledge base (KB)** is a technology used to store complex structured and unstructured information used by a computer system. The initial use of the term was in connection with expert systems, which were the first knowledge-based systems.
- **Resource Description Framework (RDF), Web Ontology Language (OWL)** are **W3C** recommendations

ONTOLOGY

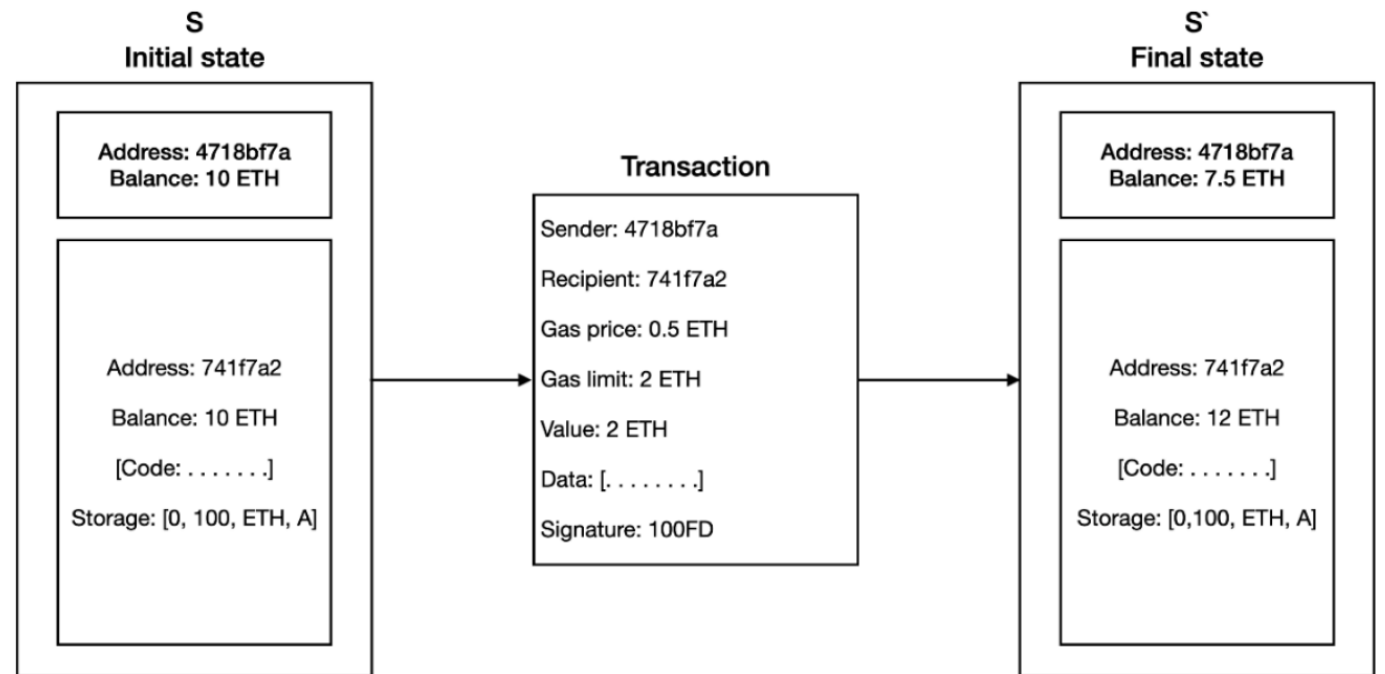
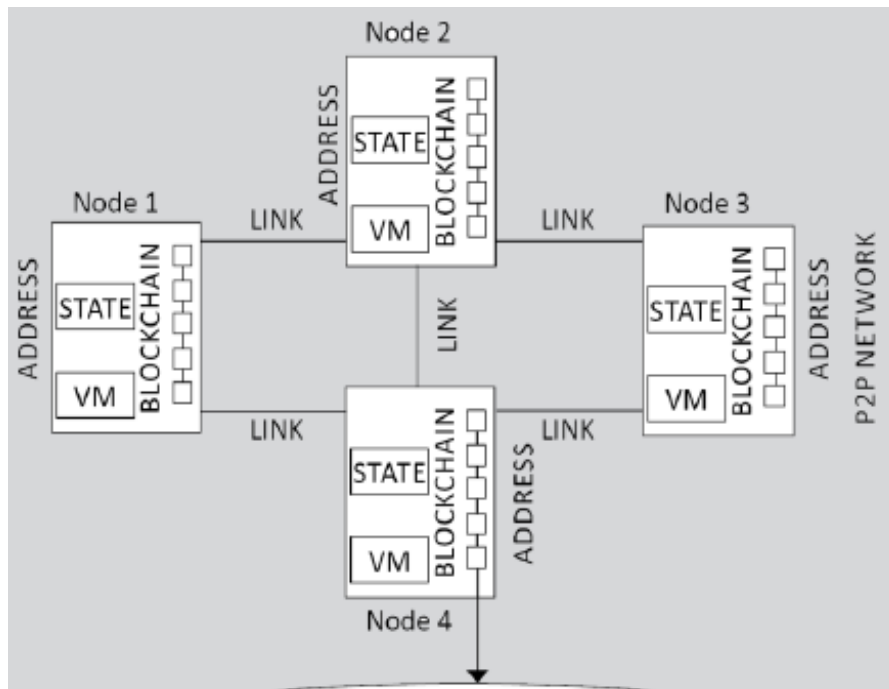
- **Ontology** is the branch of philosophy that studies concepts such as existence, being, becoming, and reality. It includes the questions of how entities are grouped into basic categories and which of these entities exist on the most fundamental level.
- **Aristotle's** ontology is the philosophical study of being in general, or of what applies neutrally to everything that is real.
- **Plato's** ontology is the theory of forms that are discovered by the exercise of reason.
- **Gruber's** ontology is an “explicit specification of a conceptualization.
- **Borst's** definition is a formal specification of a shared conceptualization.
- **W3C's Semantic Web** activity notably with RDF and the OWL2 Language species.



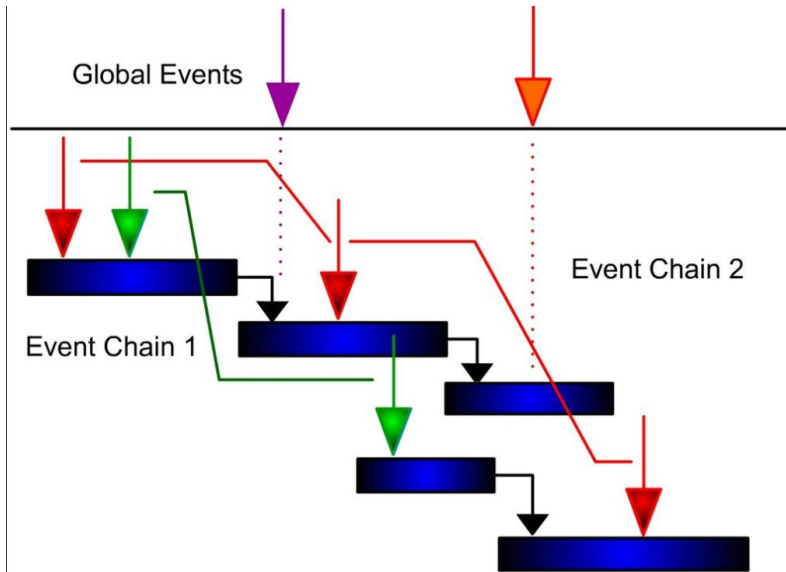
BLOCKCHAIN



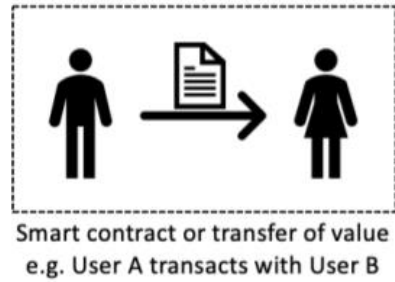
BLOCKCHAIN: THE VIRTUAL MACHINE



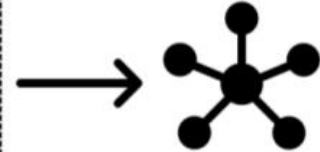
BLOCKCHAIN EVENTS



1- Transaction initiated



2- Transaction broadcast



3- Find new block (mining)

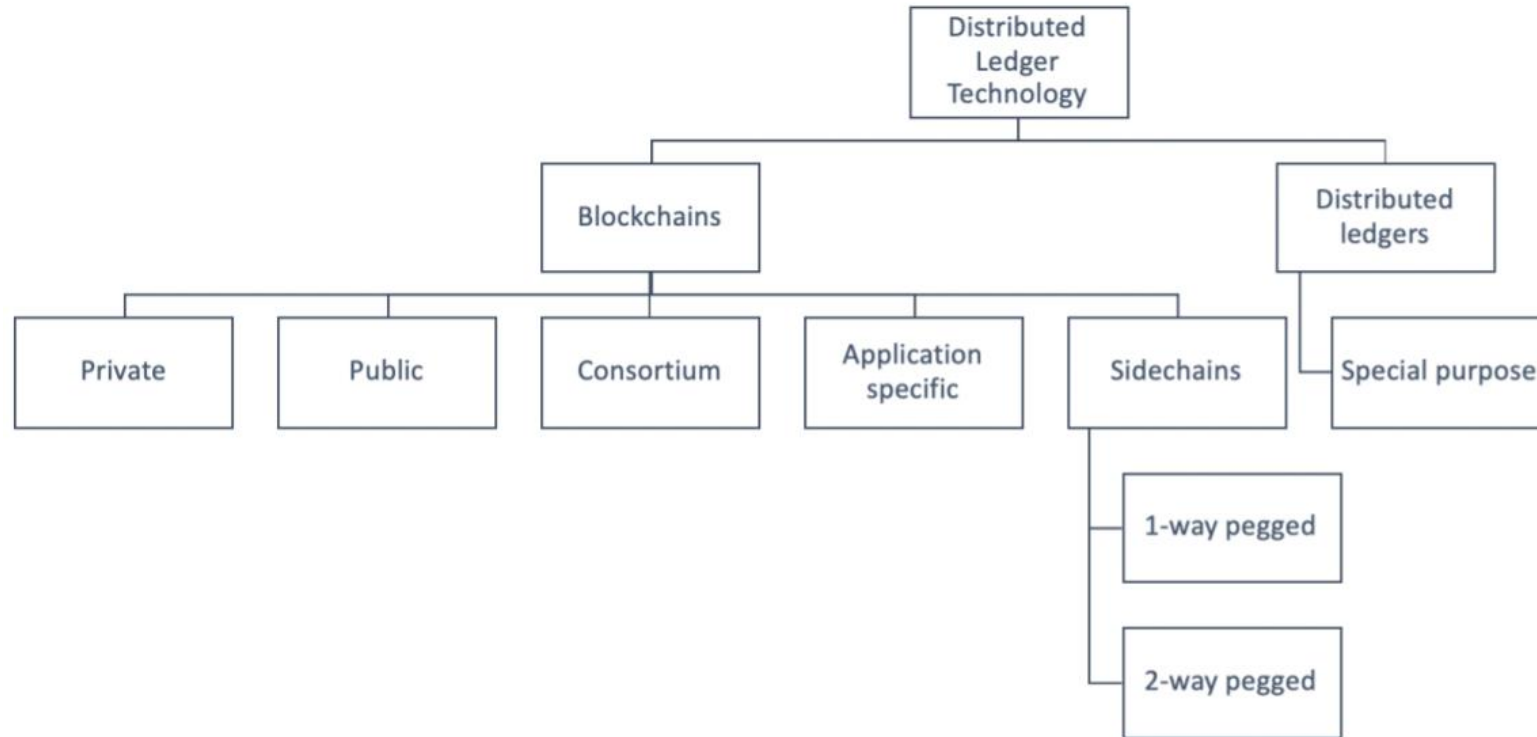


4- New block found (mined)

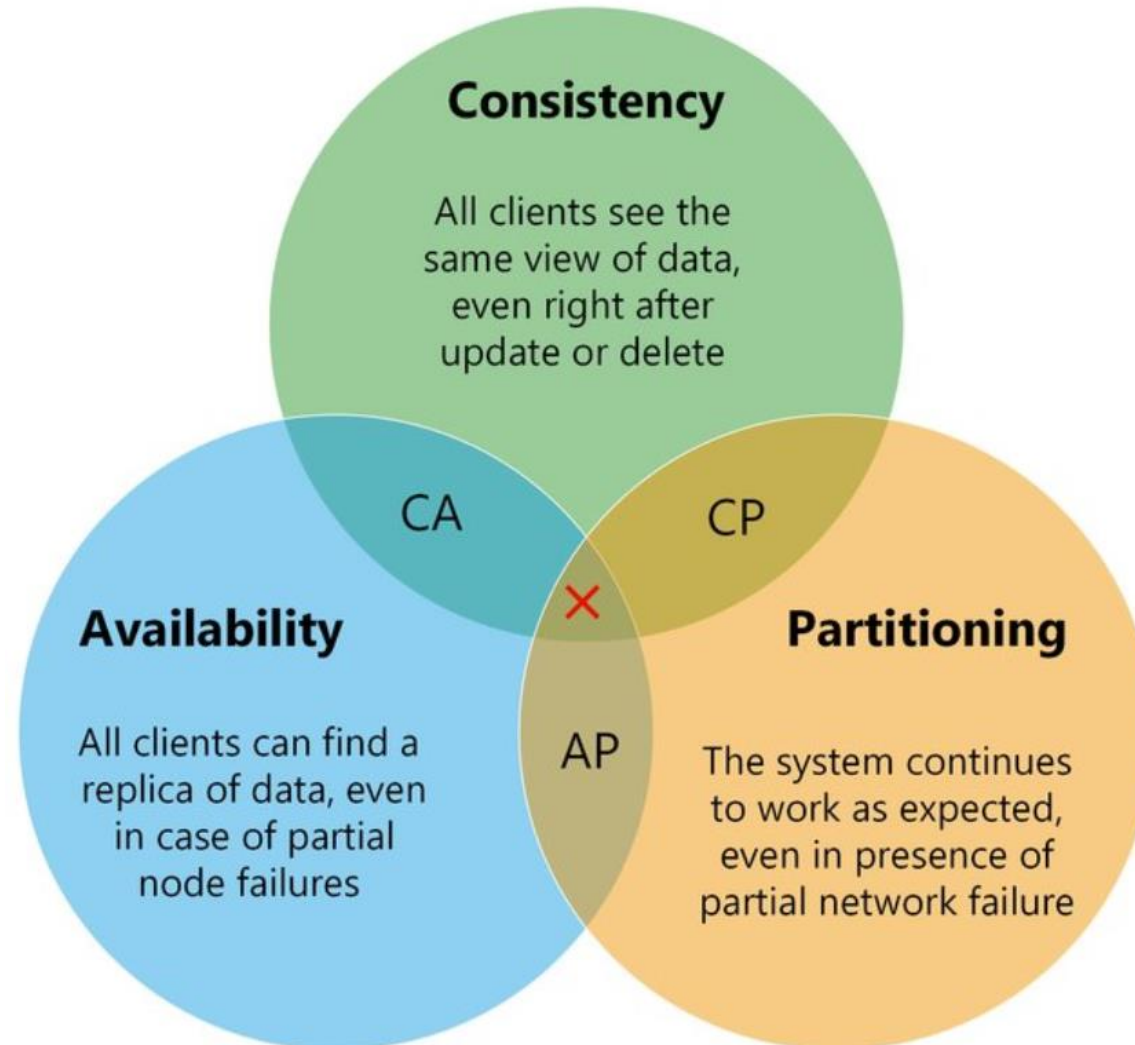


5- Add new block to the blockchain

BLOCKCHAIN: TAXONOMY



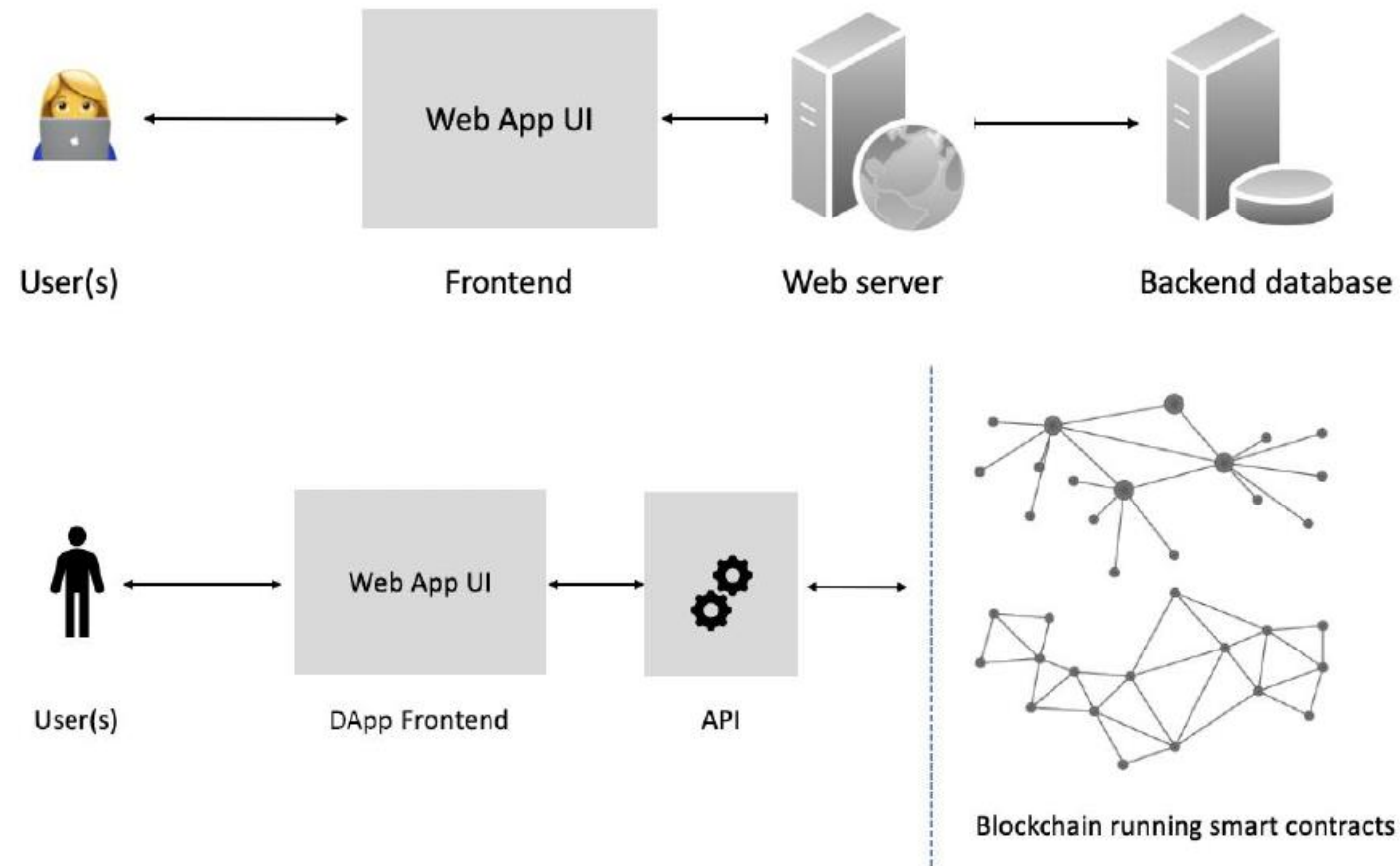
BLOCKCHAIN AND THE CAP THEOREM





SOME WELL-KNOWN DISTRIBUTED LEDGER TECHNOLOGIES

Decentralized Identity, Finance, Wealth, & Web
Blockchain Bitcoin, Ethereum, EOS, Tezos
Storage Filesystems (IPFS, Swarm, Storj), Database (BigChainDB)
Communication The Internet, Mesh networks, Whisper

DECENTRALISED APPLICATIONS




TOKENOMICS: ERC-20, ERC-1155, ERC-721



[Home](#) [What is an NFT?](#) [Help](#) [About](#)


[Setup your wallet](#)



SLOVENIA@EXPO2020....

Limited series
2000


SPIRIT



Lake Bled

Limited series
1000


SPIRIT



Postojna Cave

Limited series
1000

SPIRIT

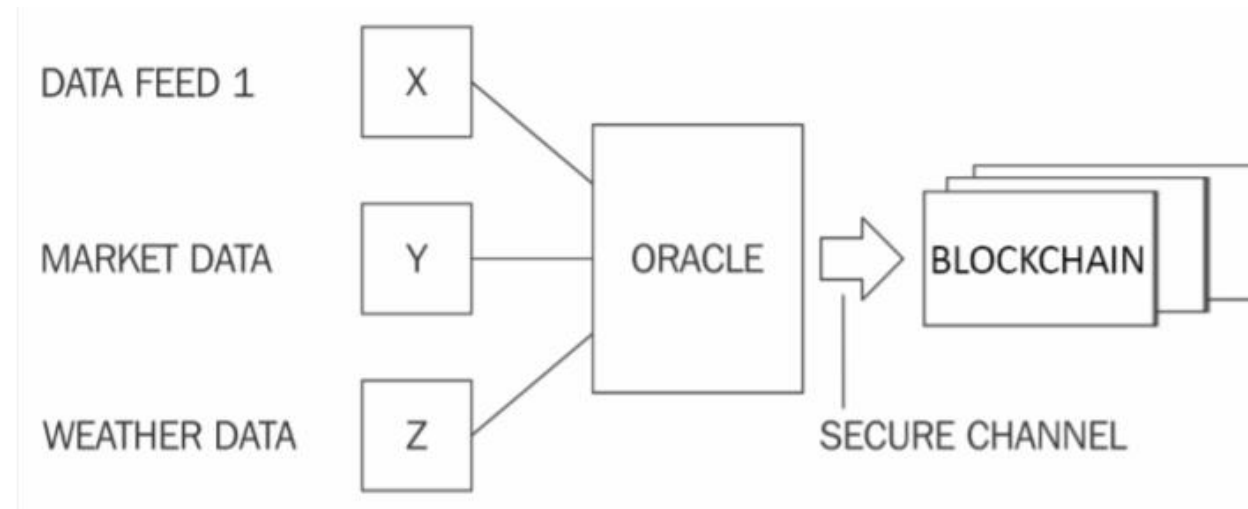


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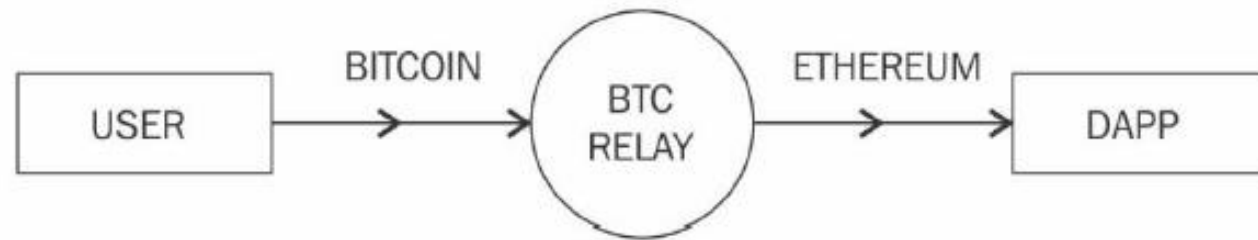
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1000

SPIRIT

ORACLES: OFF-CHAIN VS. ON-CHAIN DATA



INTERLEDGER: GATEWAYS



BLOCKCHAINS & SEMANTIC WEB

Blockchains & Semantic Web are all about building trust:

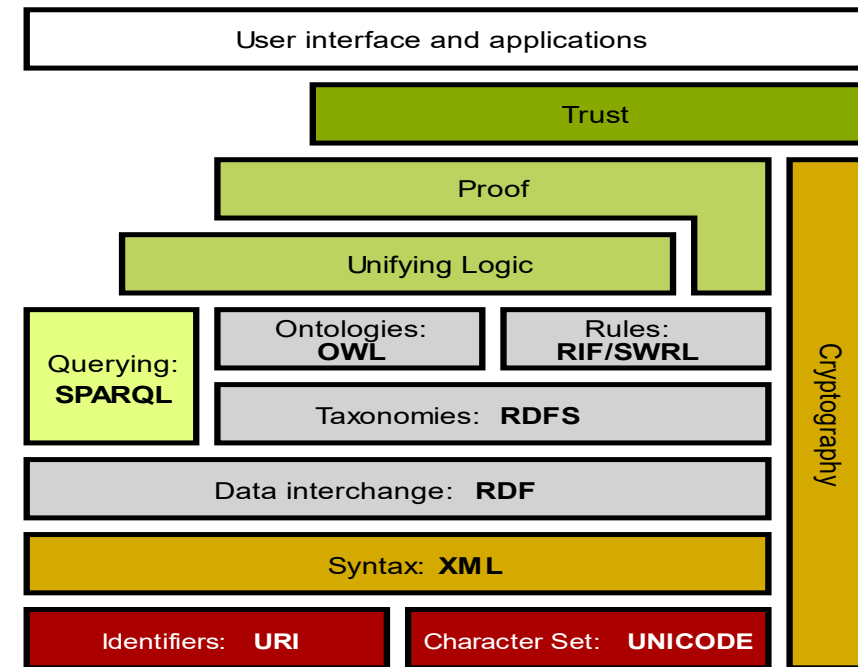
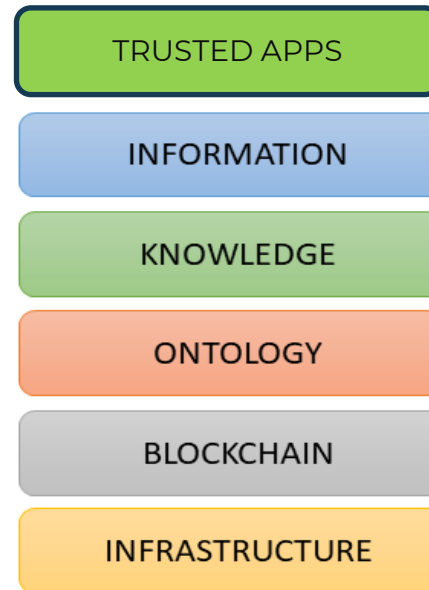
- Blockchain is a shared ledger
- Ontology is a shared conceptualisation (W3C Semantic Web)

Looking for a potentially new:

- ONTOCHAIN structure
- Ontologies and serialisation for Blockchains
- Consensus protocols
- Scalability mechanisms (e.g. using sidechains)
- Reputation and reasoning mechanisms
- Other

Focus on generic use case types (preliminary)

- Marketplace
- Part tracking
- IPR/copyright management
- Also see: European Blockchain Services Infrastruc



PRIMARY OBJECTIVE: QUALITY OF THE DATA, INFORMATION AND KNOWLEDGE

Author	Data	Information	Knowledge
Davies & Ledington (1991) p4	Data consists of many individual bits/pieces/items or facts that can be simultaneously, or sequentially, processed to support the learning process	Information is not some object that exists in the world – information is part of the learning process – information has meaning according to the interpretation which is happening	No actual reference to the term knowledge
Drucker (1989) p46	Data is relatively easy to capture and does not necessarily require analysis	Information is data endowed with relevance and purpose	Knowledge, by definition, is specialised
Checkland & Holwell (1998) p88,	Data are checkable facts, that can be agreed, disputed both of which allow supporting evidence to be brought forward	This is data – capta that then has been enriched. i.e. related to other things, seen as part of a larger whole – gains significance	Larger structures of related information – expected to have longevity
Chaffey & Wood (2005, p21)	Decrete, objective facts about events. Data are transformed into information by adding value through context, categorisation, calculations, corrections, and condensation	Organised data, meaningful and contextually relevant. Used for decision making	The combination of data and information to which is added expert opinion, skills and experience to result in a valuable asset which can be used to make decisions
Boddy, Boonstra and Kenndy (2002, p6, 15) Citing Martin et al, 1994, Turban, et al, 1999 &	Refers to recorded descriptions of things, events, activities and transactions	Information is data that has been processed so that it has meaning and value to the recipient	No clear definition is offered except to state certain information systems help people to make decisions by incorporating human knowledge into the system

Addressing needs of:

- ***Semantically complex, dynamic, trust-critical ecosystems***
- *Fostering diversity, plurality and democracy*
- *Human-rights, security and privacy*

DECENTER Fog Computing and Blockchain-based Brokerage Platform

The Big Data pipeline

The DECENTER's architecture: www.decenter-project.eu

Building Digital Twins



This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement no. 815141 (DECENTER: Decentralised technologies for orchestrated Cloud-to-Edge intelligence)

This work was supported by Institute for Information & communications Technology Promotion(IITP) grant funded by the Korea government(MSIT) (No. 1711075689, Decentralised cloud technologies for edge/IoT integration in support of AI applications)

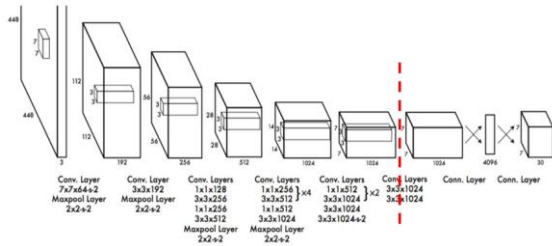


DECENTER

DECENTER Fog Computing and Brokerage Platform



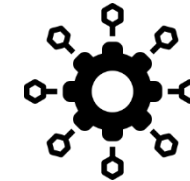
AI Model preparation



Model repository



AI into microservices



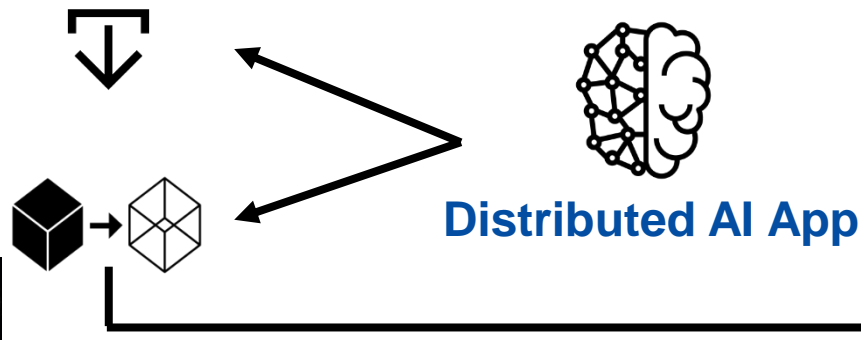
DECENTER base container
(deliver AI Service)

AI preparation

AI delivery

AI App Output

Digital twin



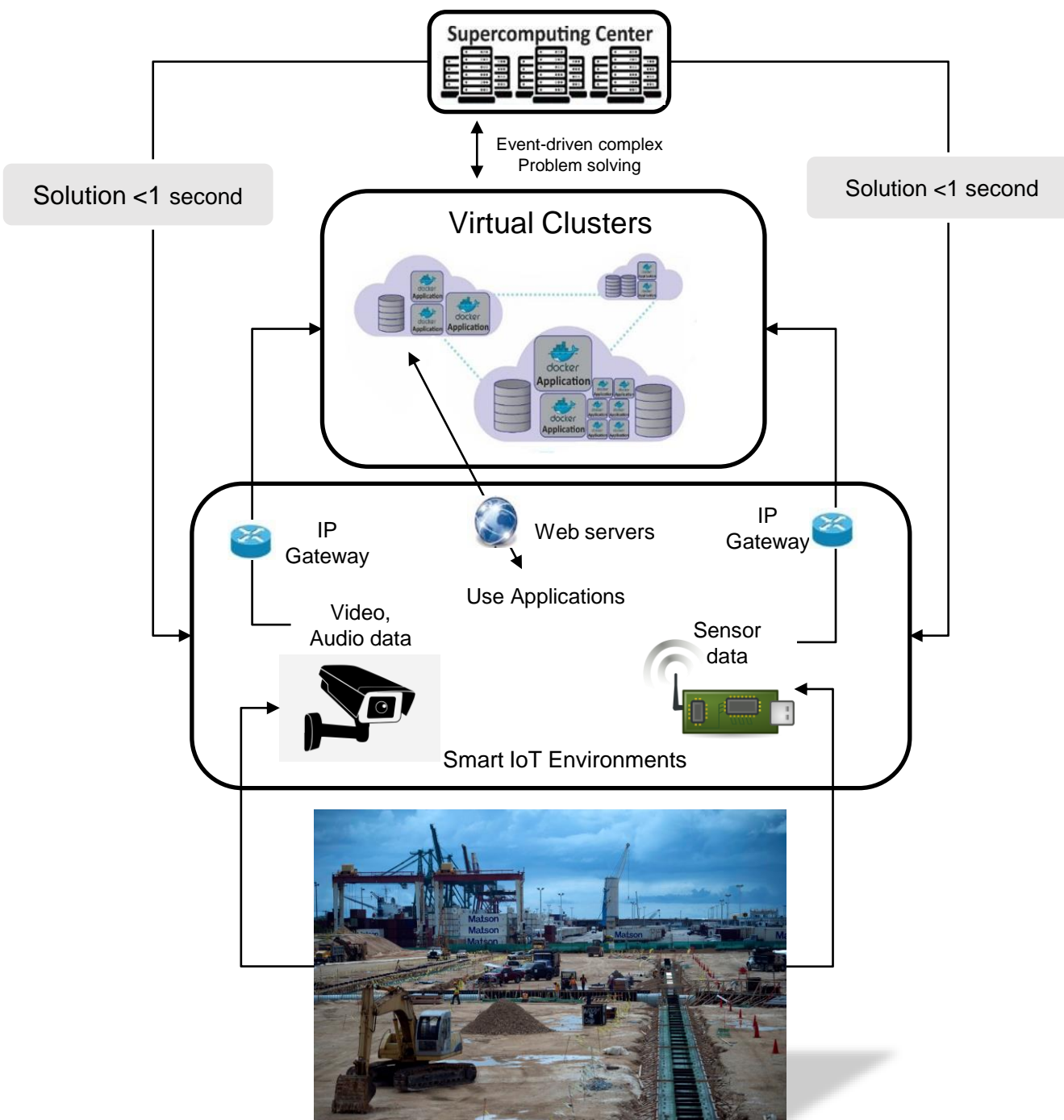
- Blockchain based AI Method/Model Exchange



DECENTER
Platform



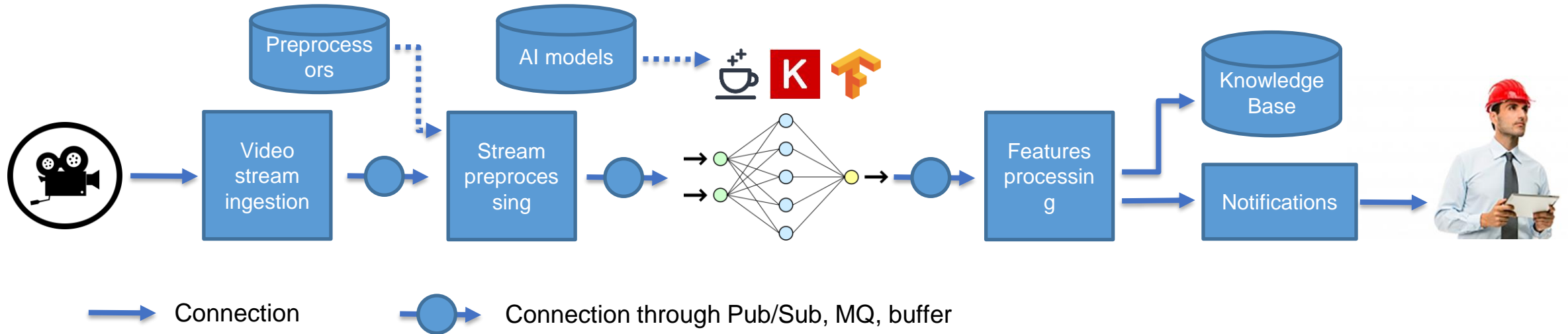
DECENTER 21



Semantically Complex, Dynamic, Trust Critical Ecosystems

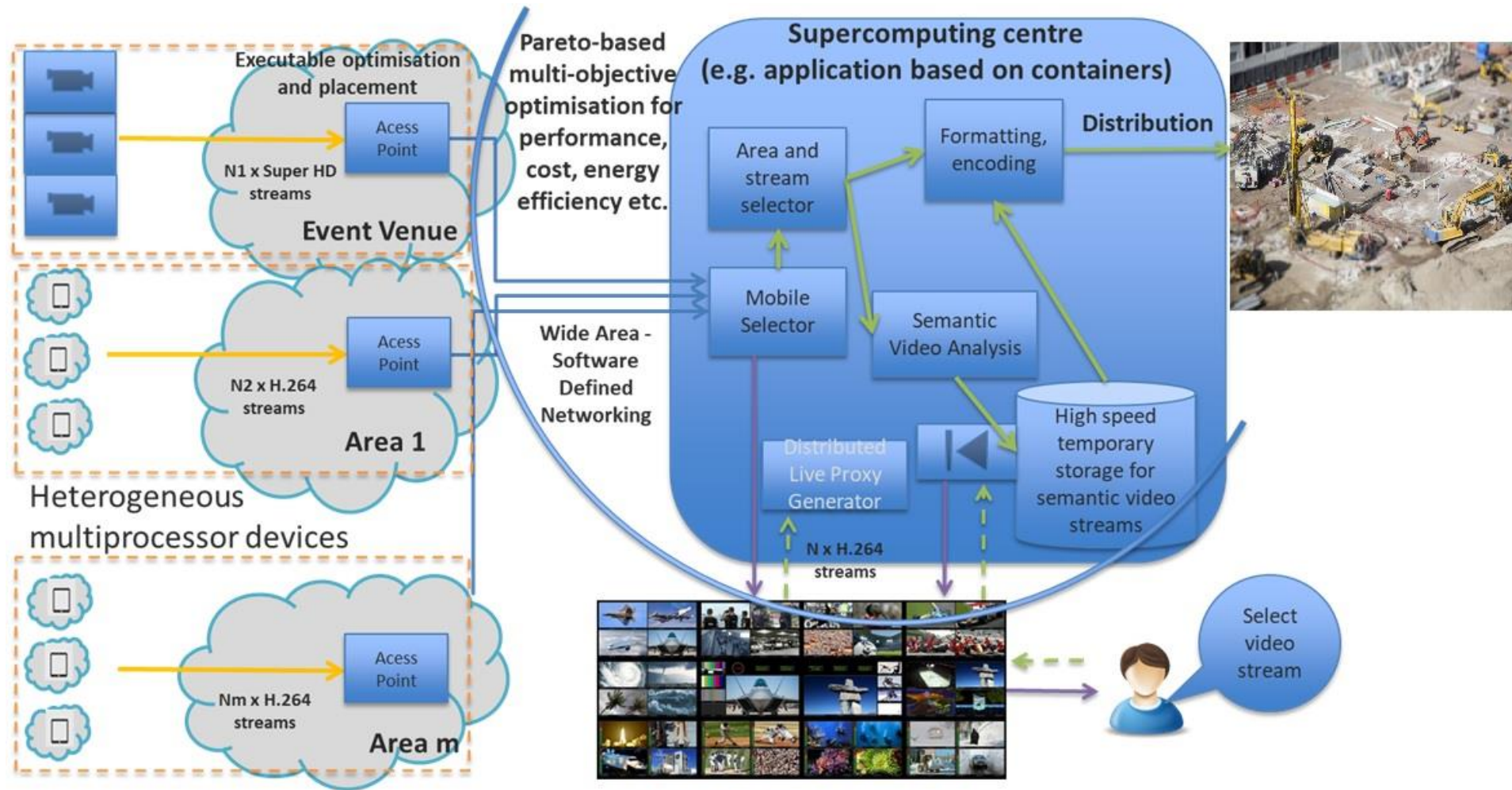
- Virtualisation & Containers
- Heterogeneous Resources
- Multi-tier: Cloud-to-Things
- Static and Dynamic Things
- Cyber-Physical: Events and Triggers
- Distributed Artificial Intelligence

Video Stream AI Processing Pipeline

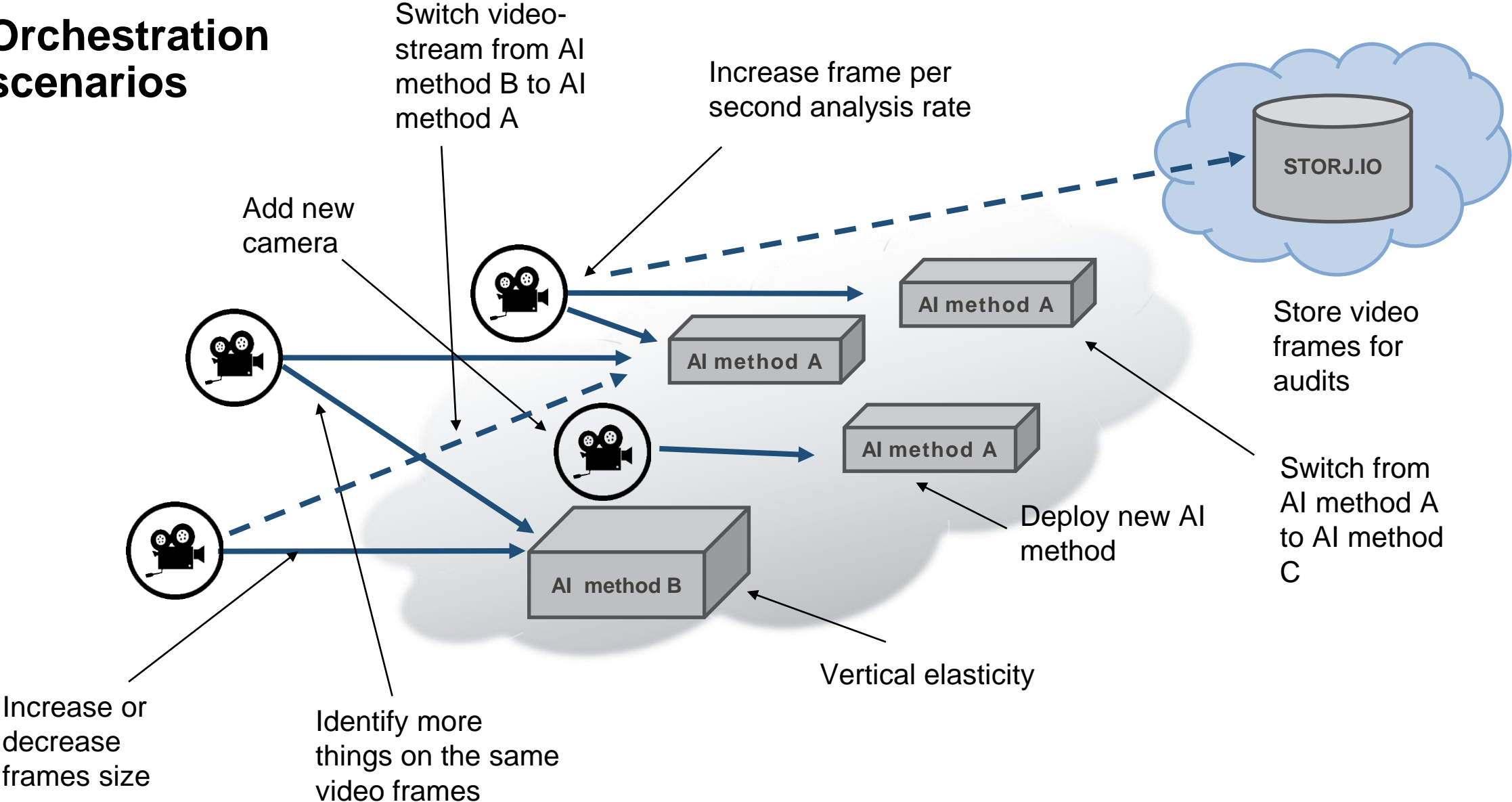


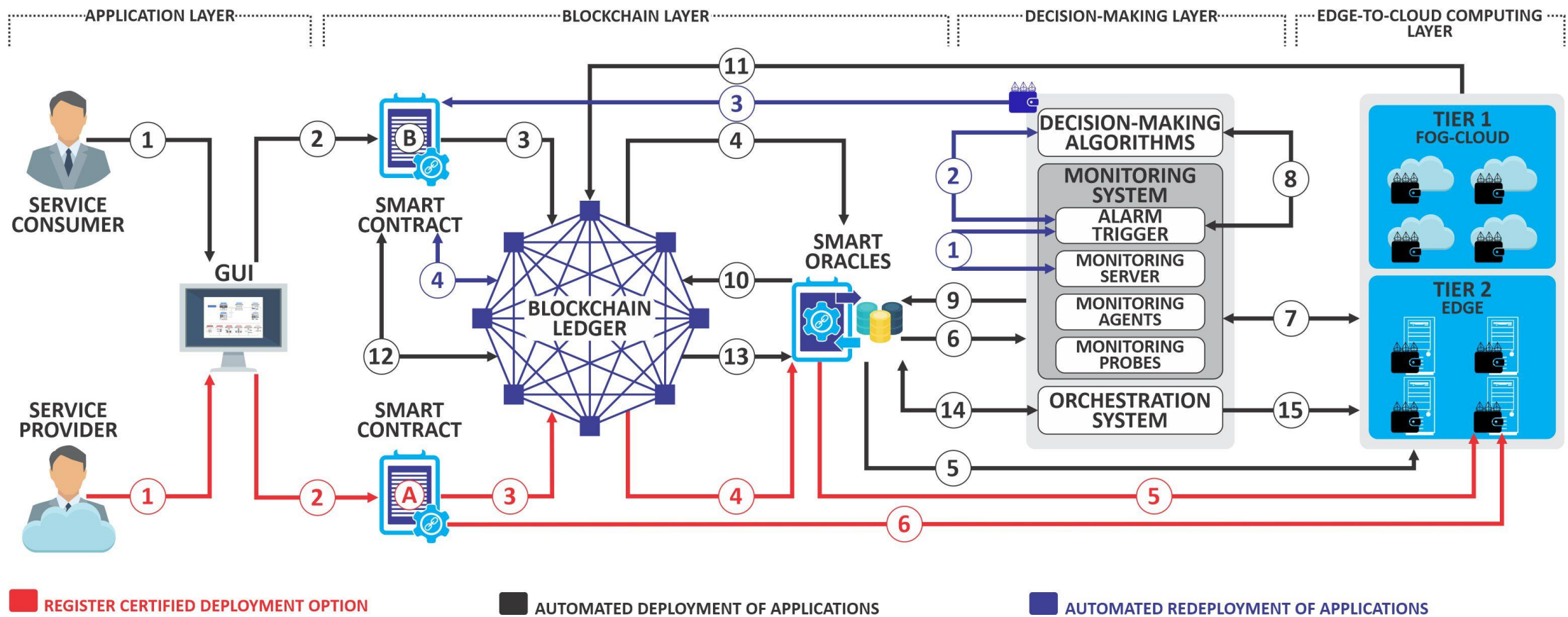
- Many video cameras
- Video streams are analysed
- AI libraries with pre-trained models are applied on video streams

Smart Application Design



Orchestration scenarios

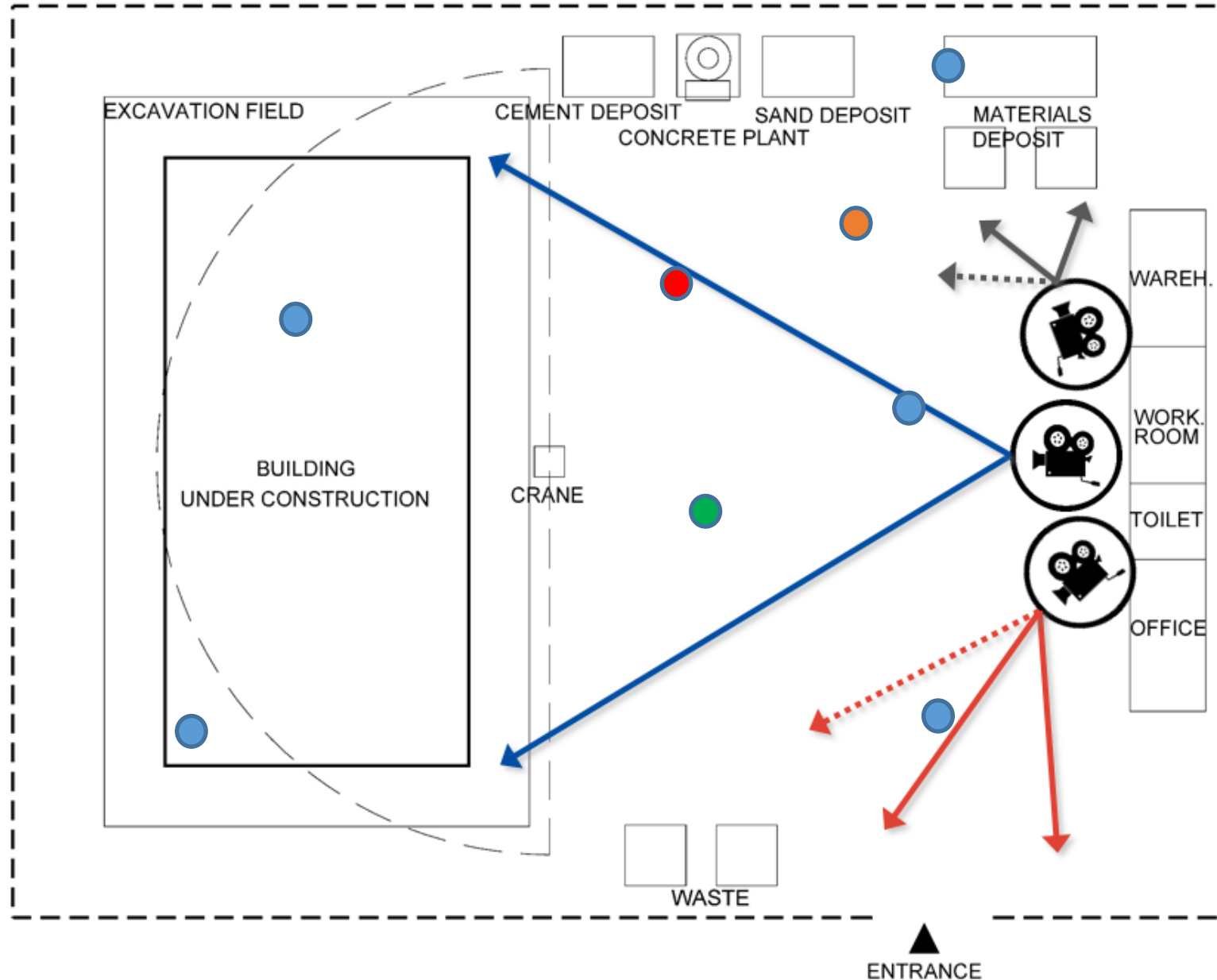




Use Case: Application for Smart & Safe Construction

- Unique product and processes
 - non-trivial
- IP video cameras
 - How many and where to set them up?
- What to detect?
 - Which AI methods/pre-trained models to use?
 - How to train them?
 - How to use them?
- Edge-Fog-Cloud
 - What computing resources and process automation?





- Construction worker
- Person without a helmet in safety zone
- Supervisor
- Construction site manager

How many workers are currently at the site?

Was the construction site manager present at 12:00 CET today and where?

How reliable is the information, false alarm?

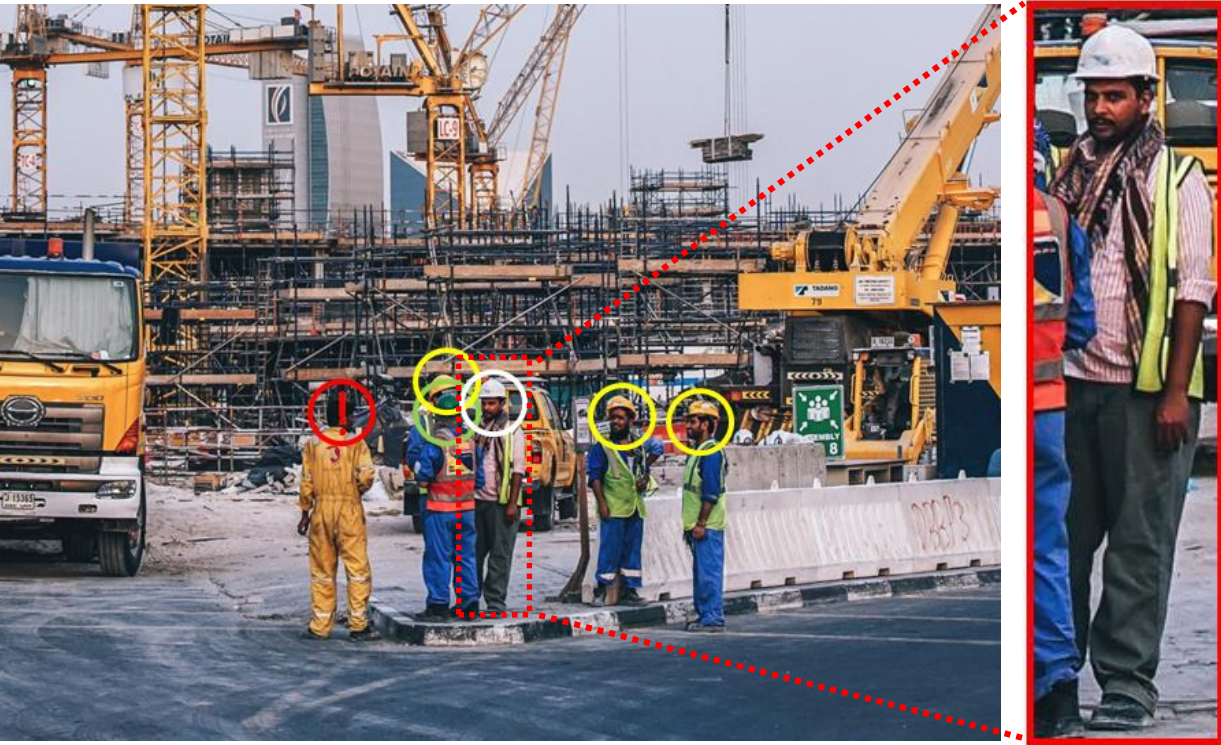
Splitting the site map into zones of interest, e.g. danger zones.

Safety at Work: Helmet Detection



- A construction site must operate under certain standards and safety precautions
- A supervisor must observe status and events at site:
 - Are all workers wearing protective helmets?
- Possible automation and enhancement:
 - Helmet detection as an AI application
 - Produce alerts for supervisor when workers do not wear protective helmets

Observing the Construction Site



The worker observed in the video:

SAFETY

- Is he wearing a helmet?
- Which colour is the helmet?

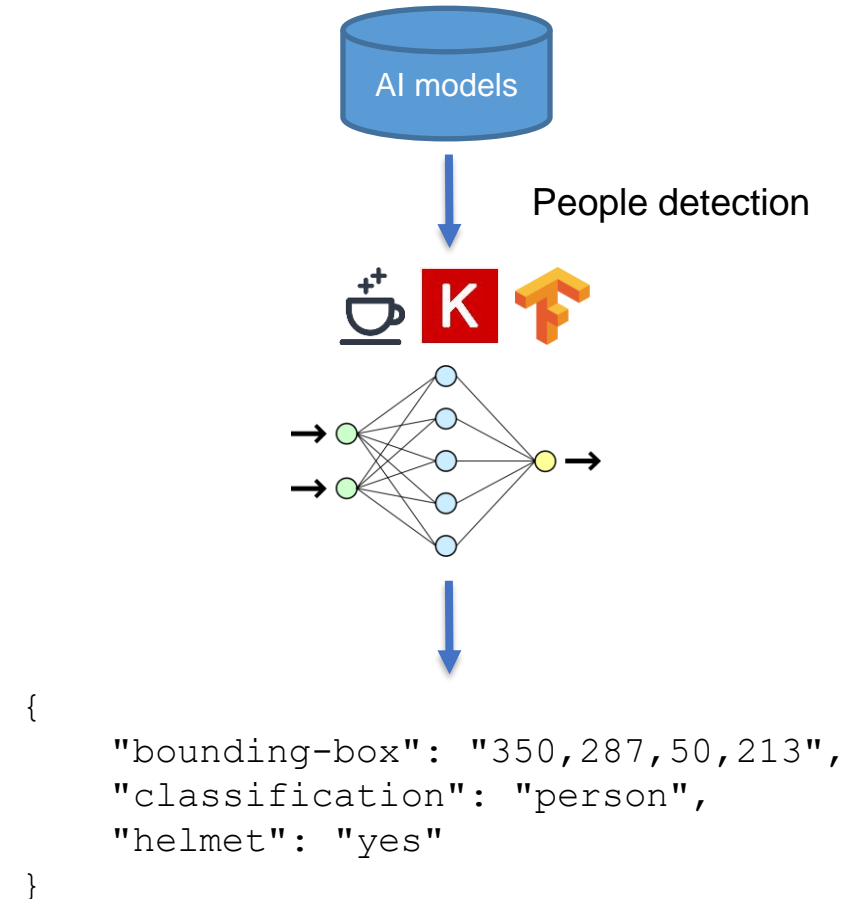
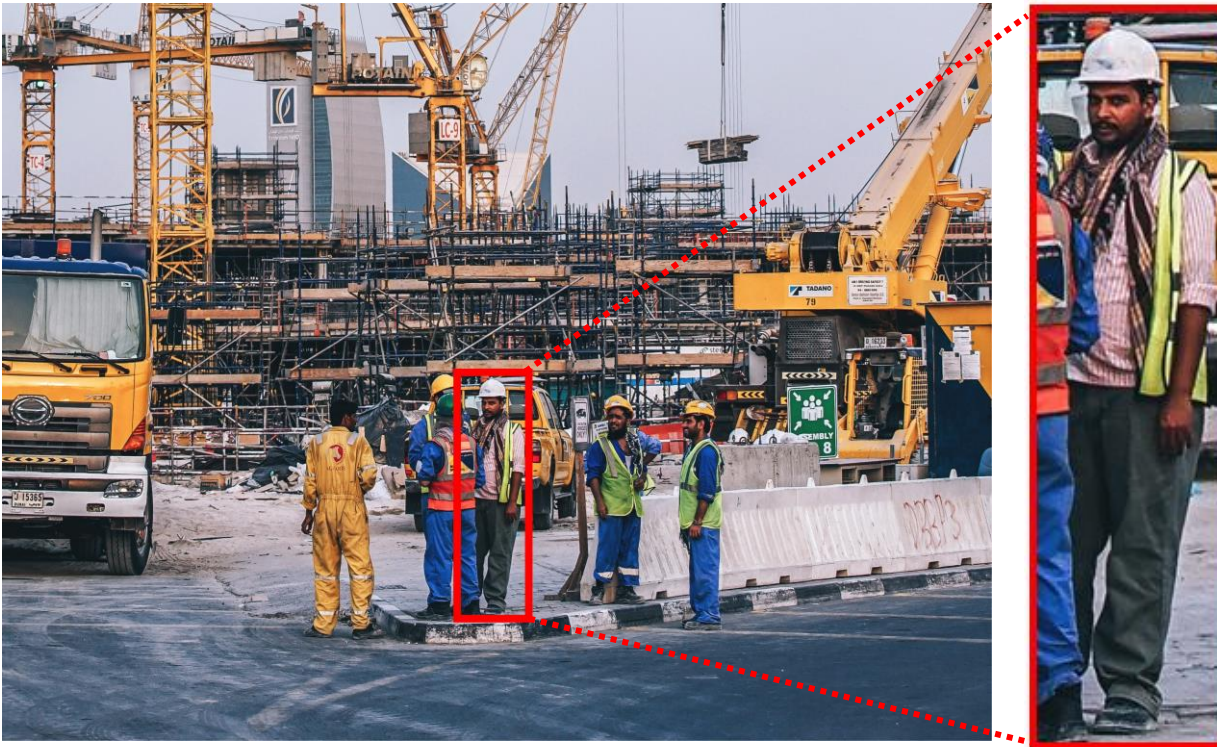
SECURITY

- Does he wear a safety vest?
- Is he a company employee?

PRIVACY!

- Is he happy?
- Was he at work yesterday?
- Who is he conversating with?

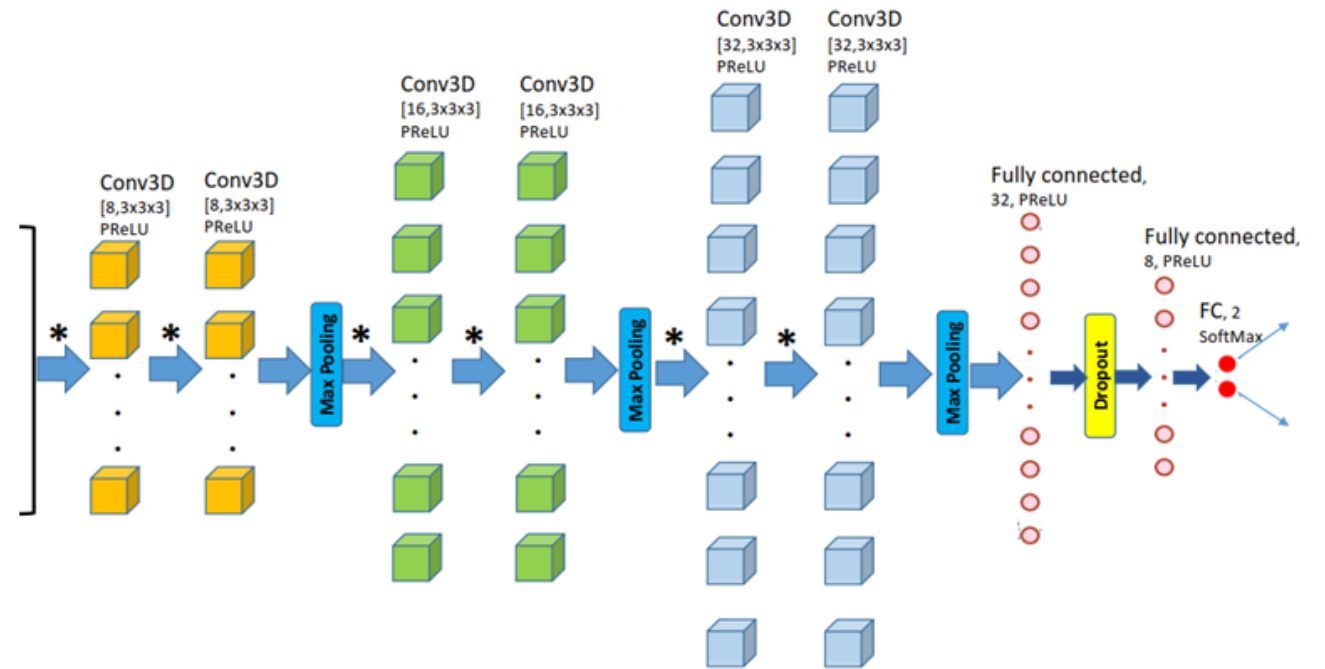
Using AI (Deep Learning): Data, AI Methods/Models, Information, Knowledge





0.00 s.

Deep Learning in the Fog



Example: TensorFlow

Car plate
number
recognition

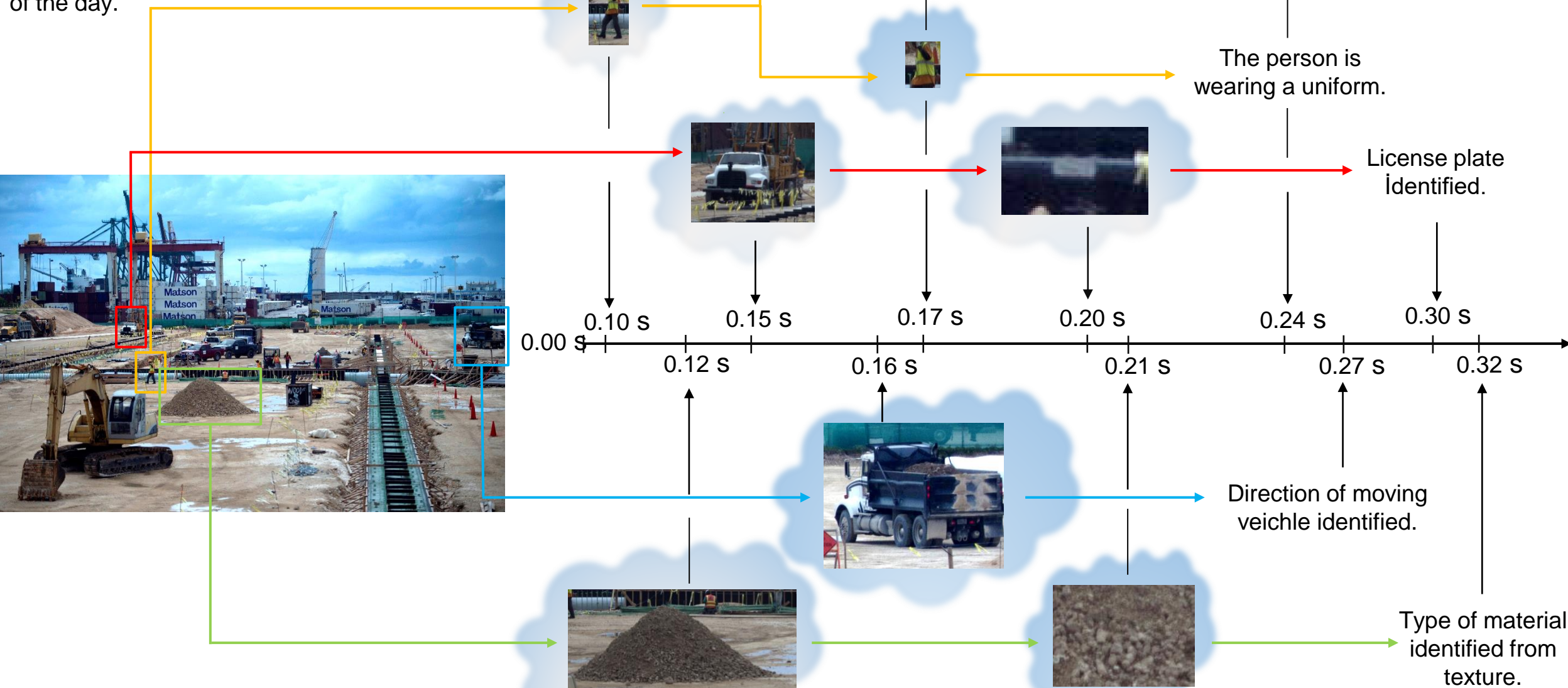
Material
type
recognition

.....

Helmet
detection



- 1) Different AI methods may be needed at different time periods of the day.
- 2) Decide what to identify in certain time of the day.

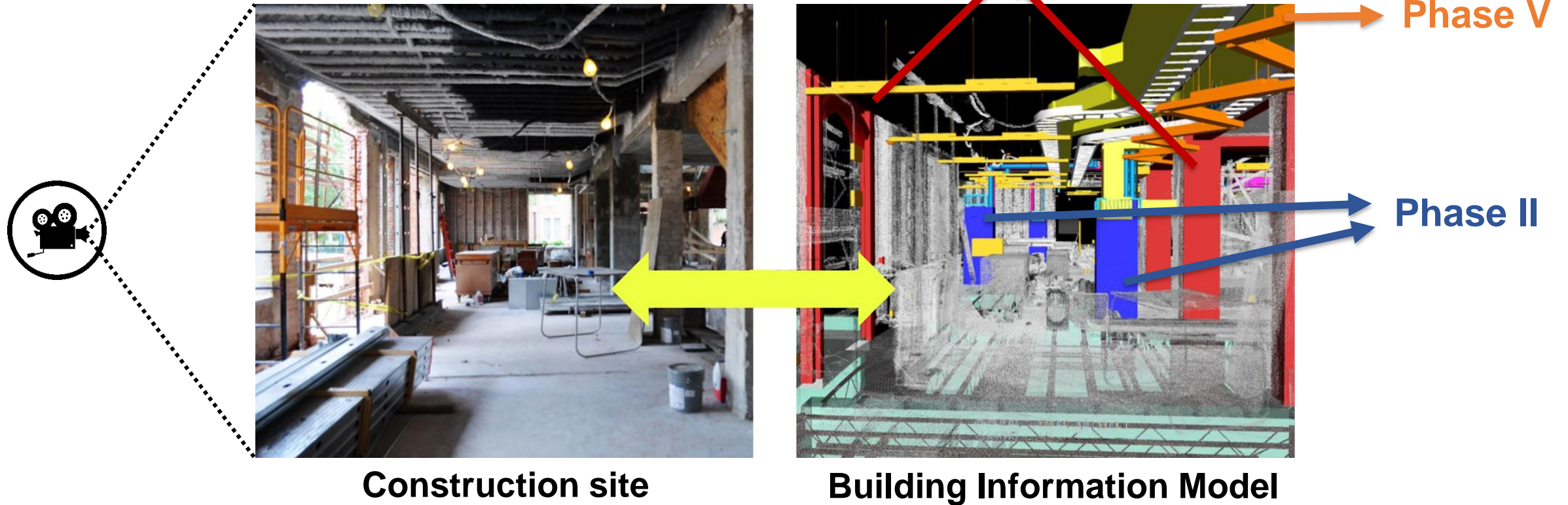


Modular, multi-purpose training and distribution of AI methods, which takes advantage of distributed computing.



Digital Twin: From Reality to Augmented Building Information Model

Construction progress tracking



Is everyone wearing a helmet?
If not, ring the alarm bell.

Is everyone wearing an uniform?
If not, ring the alarm bell.

What type of building materials are
currently on site?

Are there any unregistered
cars on the site?
If yes, notify the security.

Bricks should be stored.
If found, notify the site engineer.

Air temperature is exceeding working
limits, notify the site engineer.

CO₂ Emission levels are higher than it
should be, notify the site engineer.

Possible colision between crane
and electric wires detected,
notify the site engineer.

Earthquake warning recieved
from earthquake observatory,
ring the emergency alarm bell.

**Integrating the
information in a
knowledge base**

Is anyone unhappy?

Who is the
unknown visitor?

Are there any
bricks around?

Digital Twin

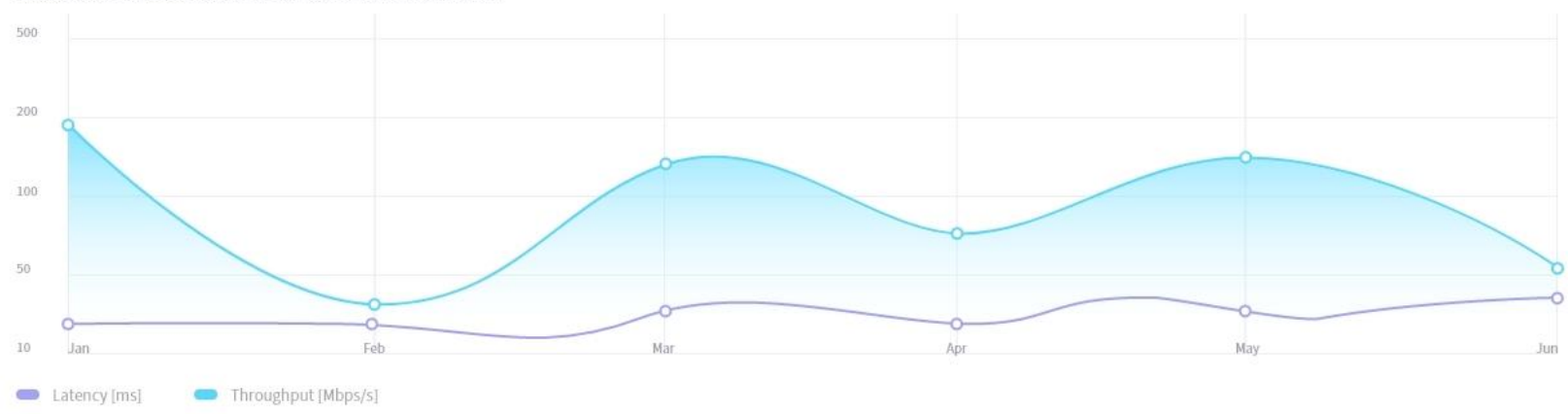


- Home
- Dashboard
- Notifications
- Services
- Help Center
- Settings

Network Monitoring

node ID: 25288ee1-c06d-4320-af66-4b43a42639d4

Last 6 months



Available Computing nodes

Show All List



Canada	\$29,193
Brazil	\$18,832
Slovenia	\$19,758
Russia	\$23,078
Australia	\$29,193

Video Surveillance

Camera ID: f3c0c1b9-030a-45ba-84ad-e21b1f76d7f3



Smart Contract Management

- START CONTAINER
- TOP-UP 60 MINUTES
- STOP CONTAINER

Container 85809a3be1d0 is currently running.
Remaining minutes: 47
Stream URL is:
<http://522.ablak.arnes.si:5000/construction.ts>

Smart Contract

Transaction: 0x3f9798c96271e1dc05538d005ff3372aa6827acacd18056c727c90093b8c7fa8
From: 0x1a4a8c3ec4505d47c0a298d473c8ffef3ffef3
To: 0x3a143841c5229431407da203ab91866ec6b25695

Please note that container start/stop actions may take between 1-5 minutes.

New contract

My wallet

0x1a4a8c3ec4505d47c0a298d473c8ffef3ffef3

Container

AI-1-YOLOv3

Container Wallet

0x3a143841c5229431407da203ab91866ec6b25695

QoS Requirements

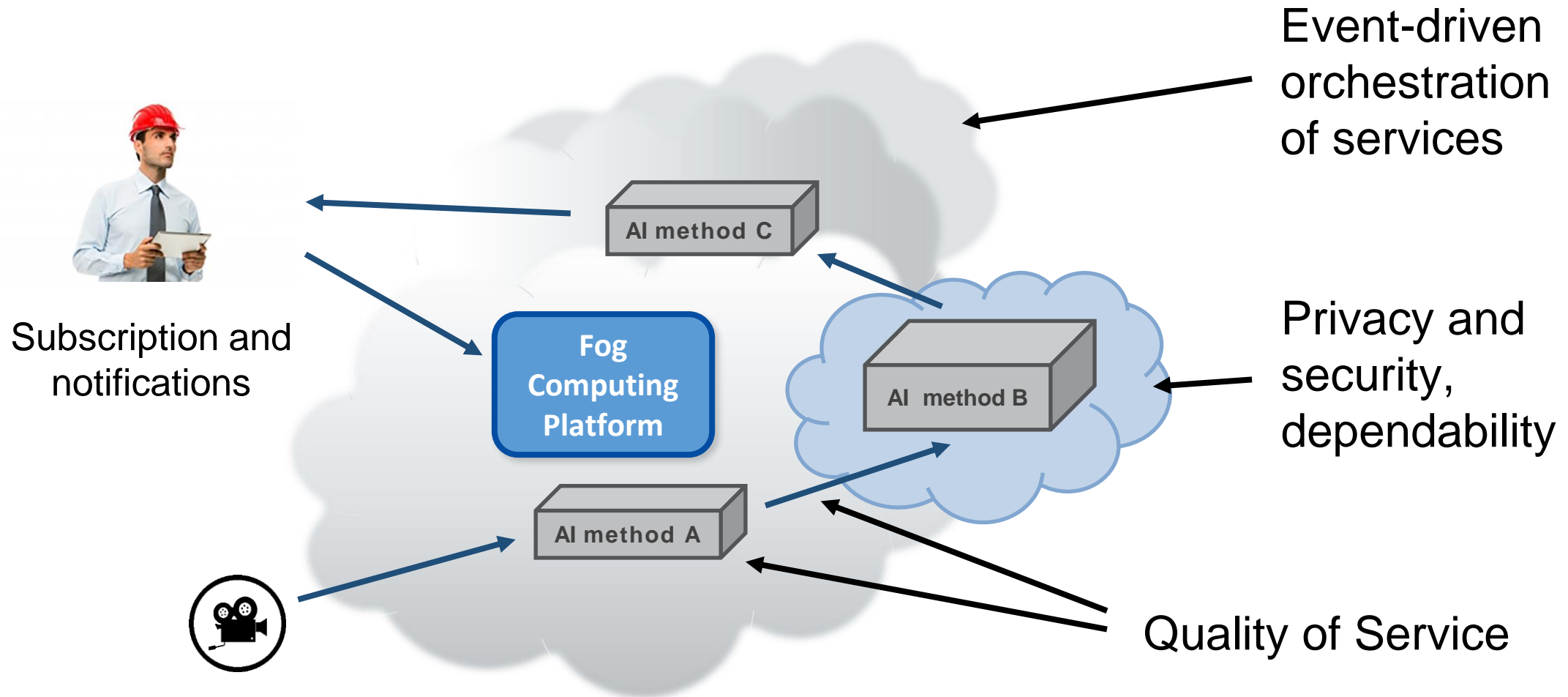
Network Latency [ms]	Network Packet loss
50	10
Network Throughput [Mbit/s]	Minimum FPS
10	30

TOTAL AMOUNT + GAS FEE 0.001021

EXECUTE CONTRACT

AI method price: 0.000000006 ETH

Fog Computing and the Problem of Trust



6 ECTS

Fog Computing for Smart Services



ONE



Internet of Things • Artificial Intelligence • Cloud Computing • Blockchain

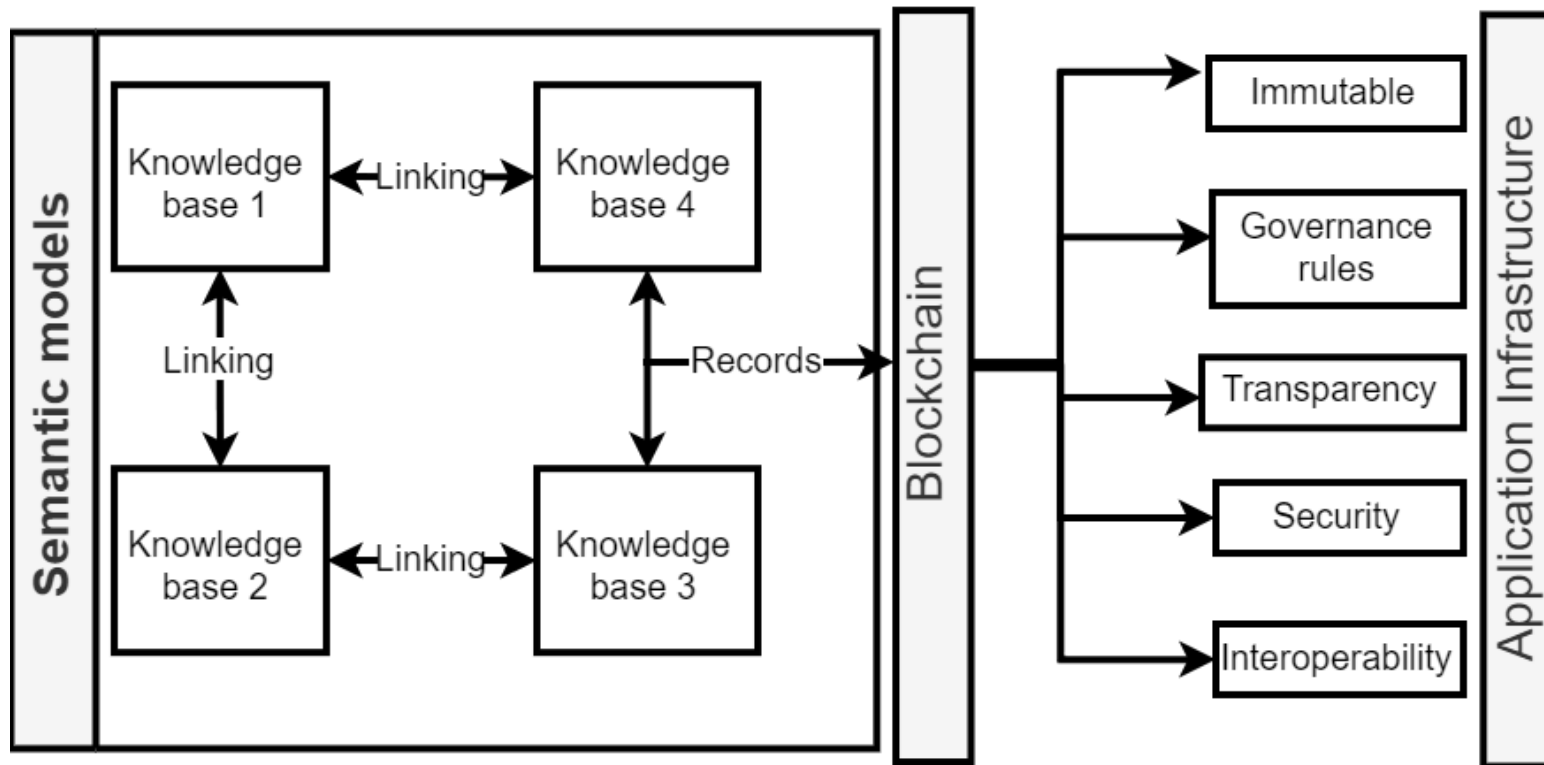
NE COMMISCEATUR NEBULA

INSCRIBERE

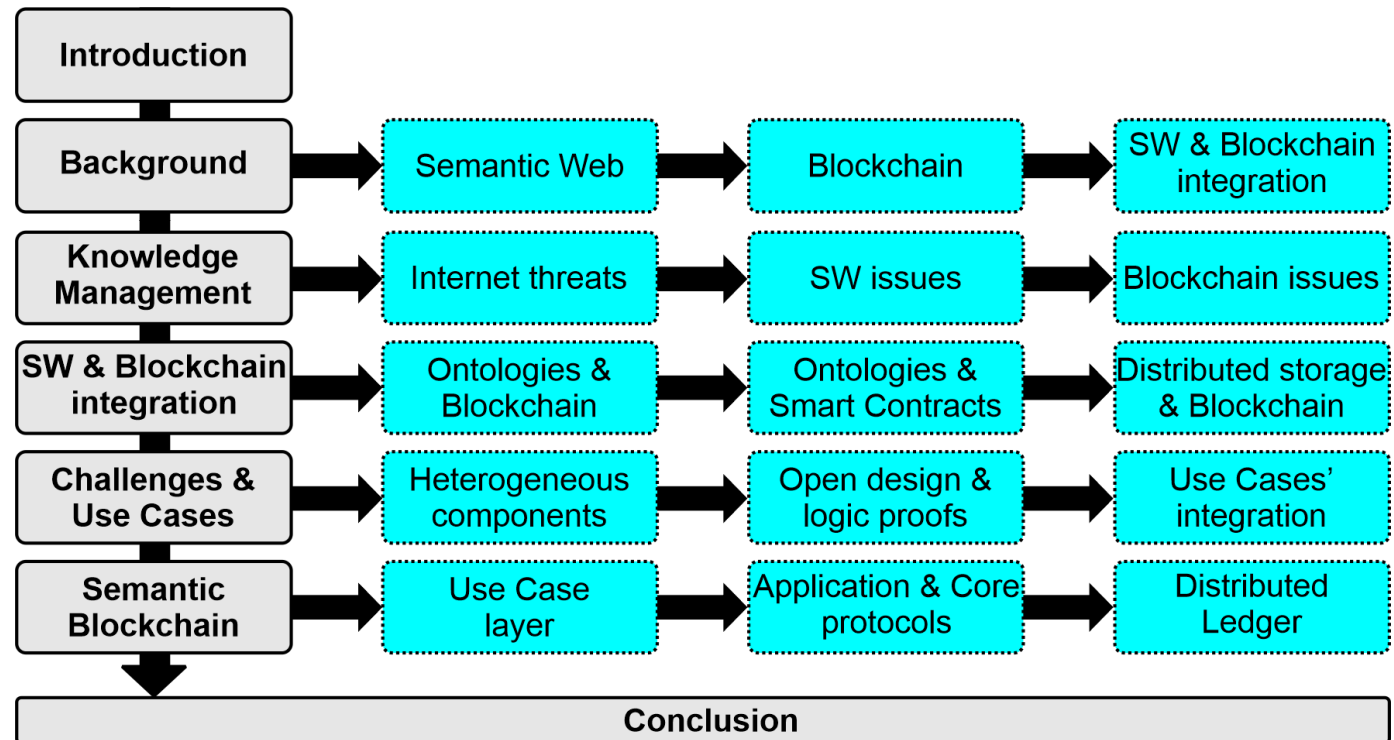
INVESTIGATED ASPECTS OF DATA QUALITY

- High-level semantics
- Completeness
- Uniqueness
- Timeliness
- Validity
- Accuracy
- Consistency
- Integrity

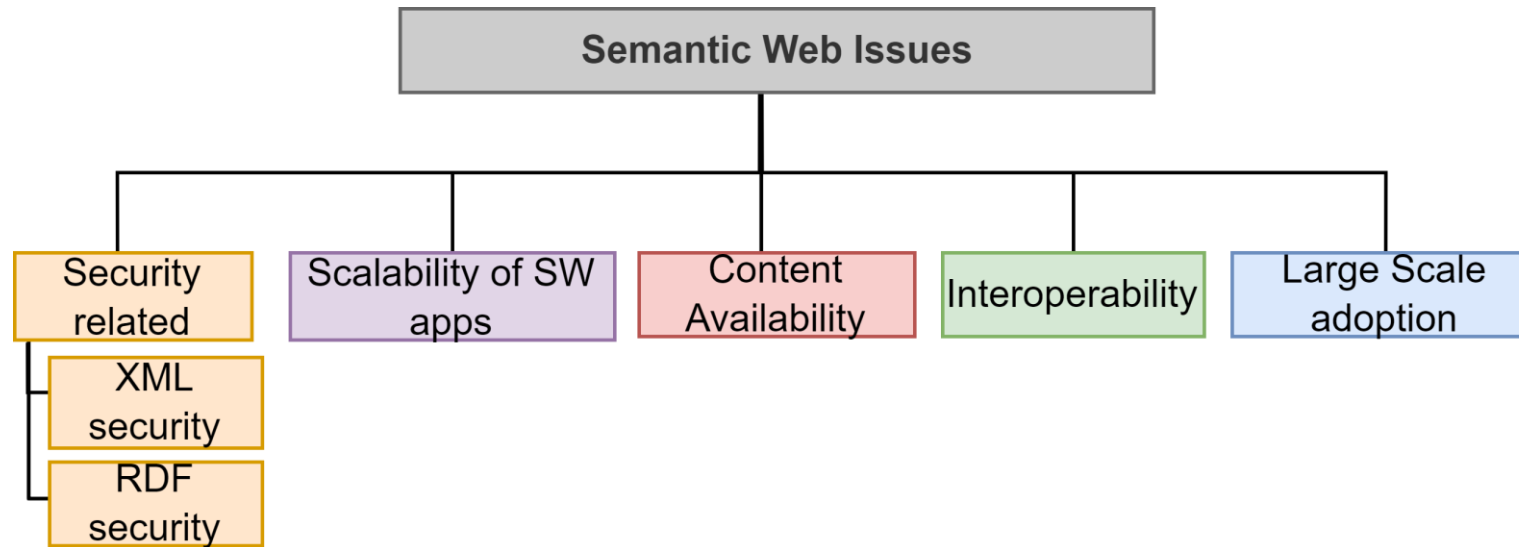
CONCEPTUAL SW+BC INTEGRATION



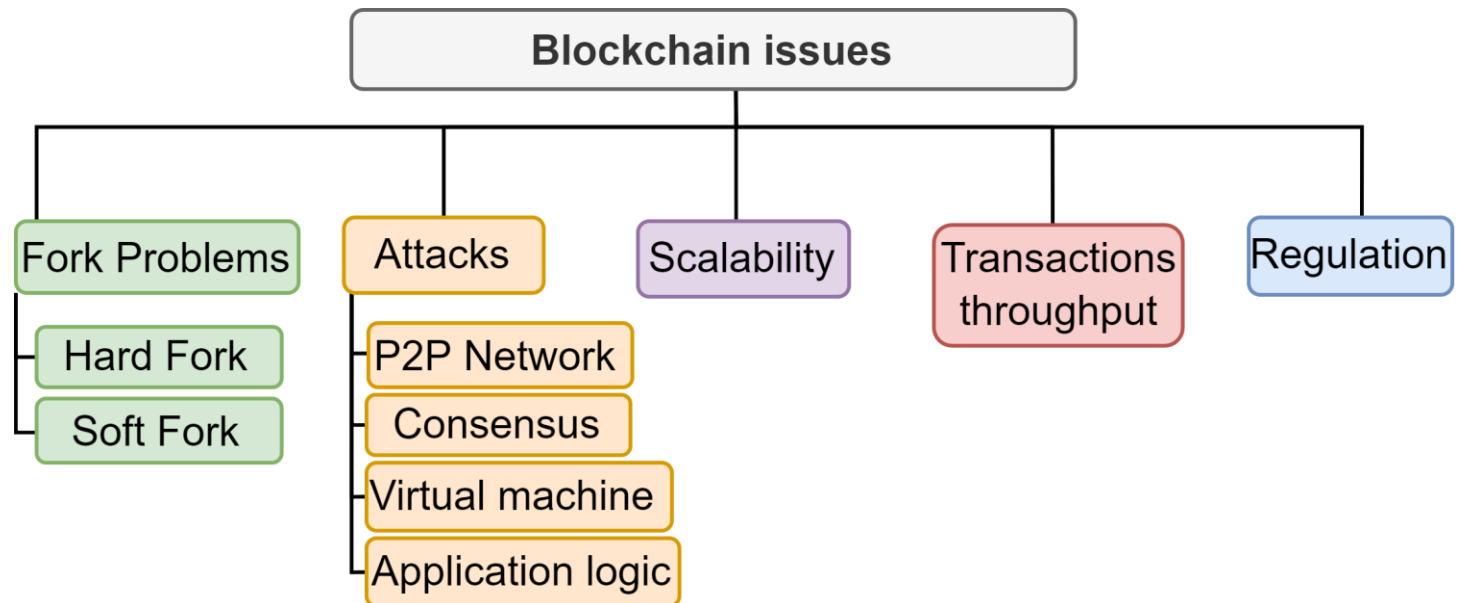
INTERMEZZO



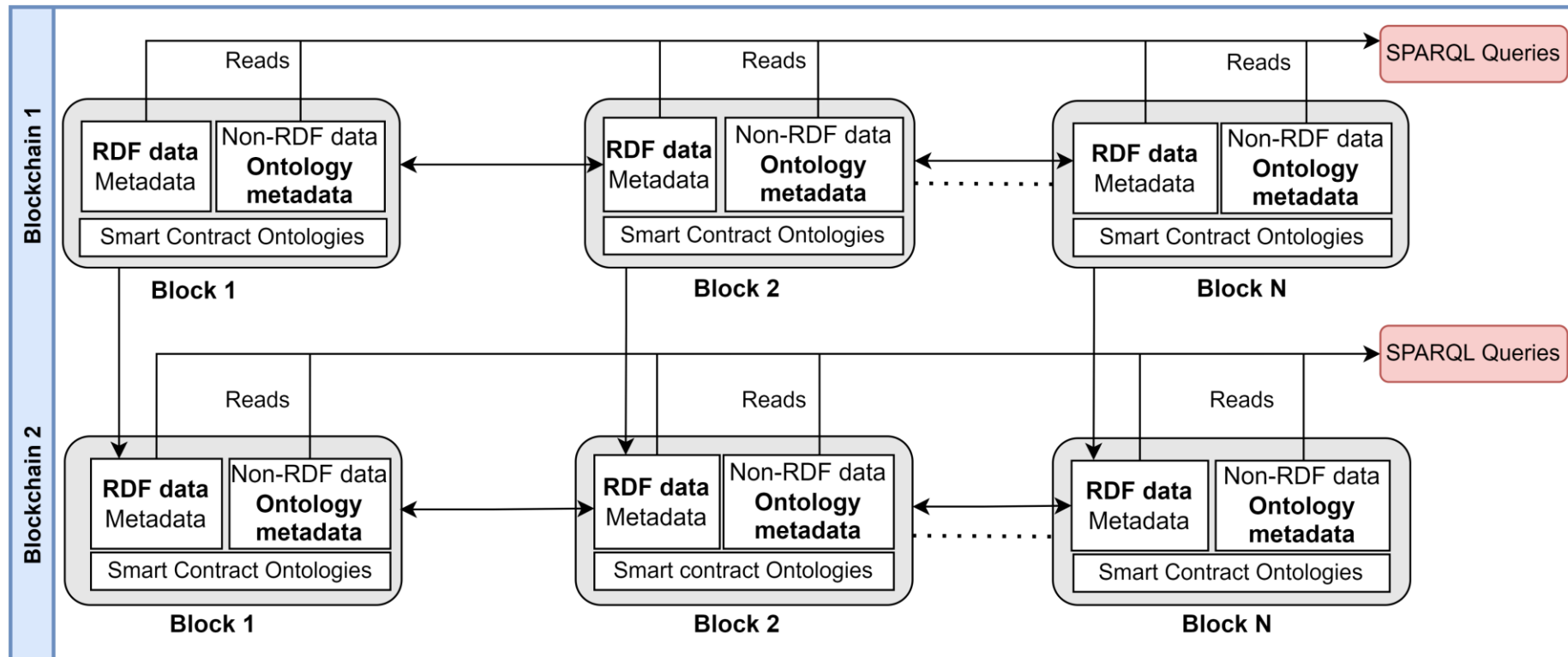
SEMANTIC WEB ISSUES



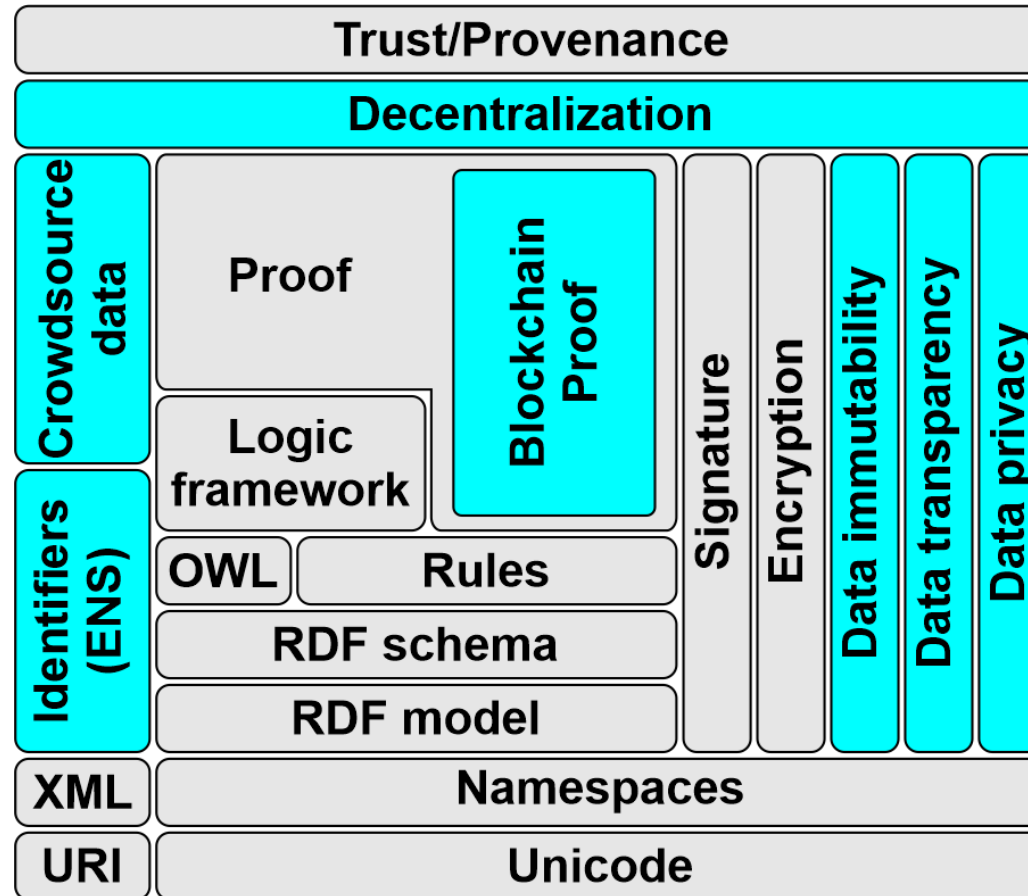
BLOCKCHAIN ISSUES



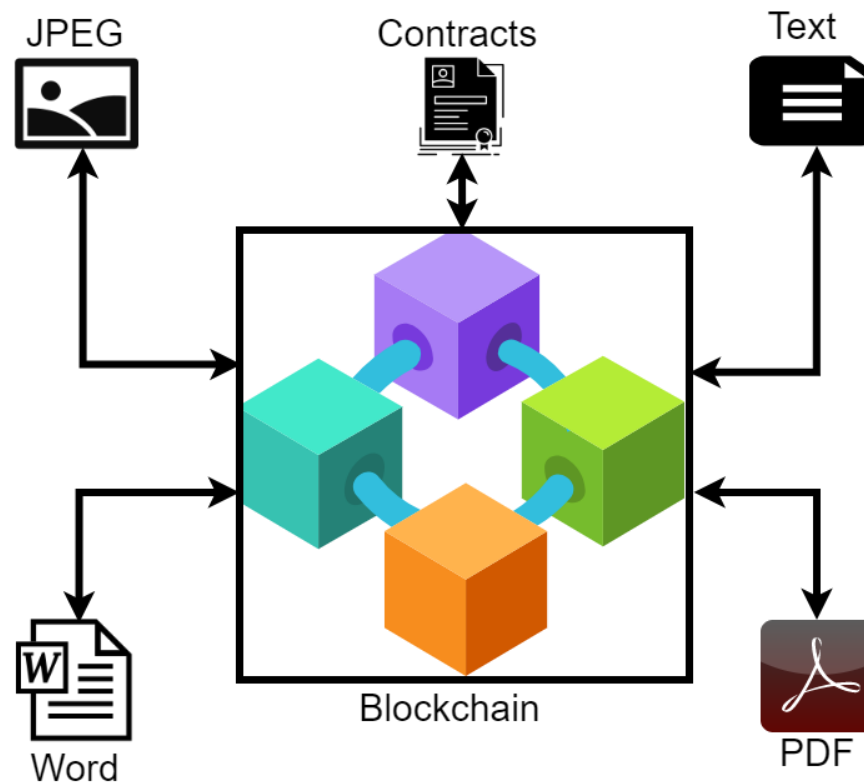
SEMANTIC WEB INTEGRATION INTO BLOCKCHAIN



BLOCKCHAIN INTEGRATION INTO SEMANTIC WEB STACK



OFF-CHAIN DATA INTEGRATION

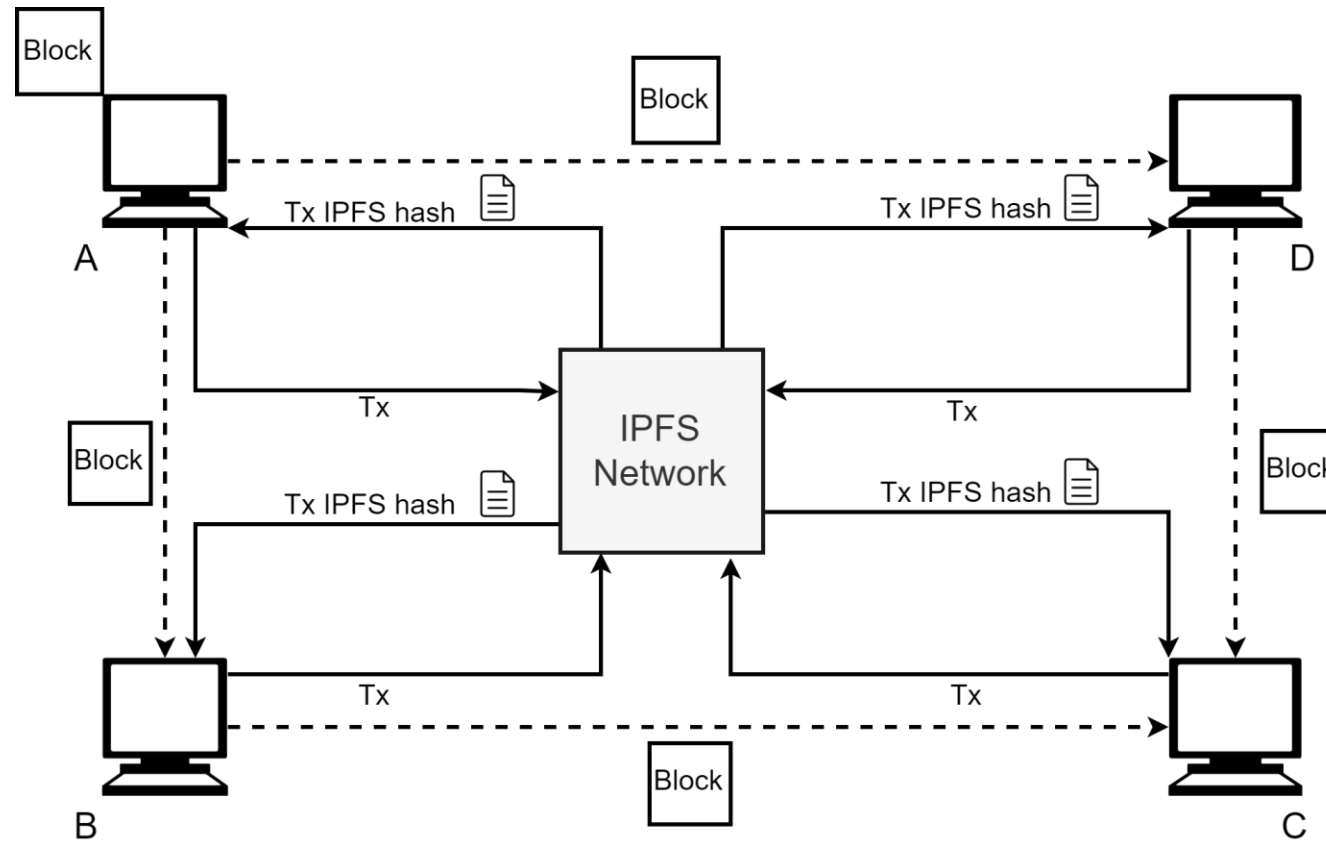


STRUCTURED DATA AND BLOCKCHAIN

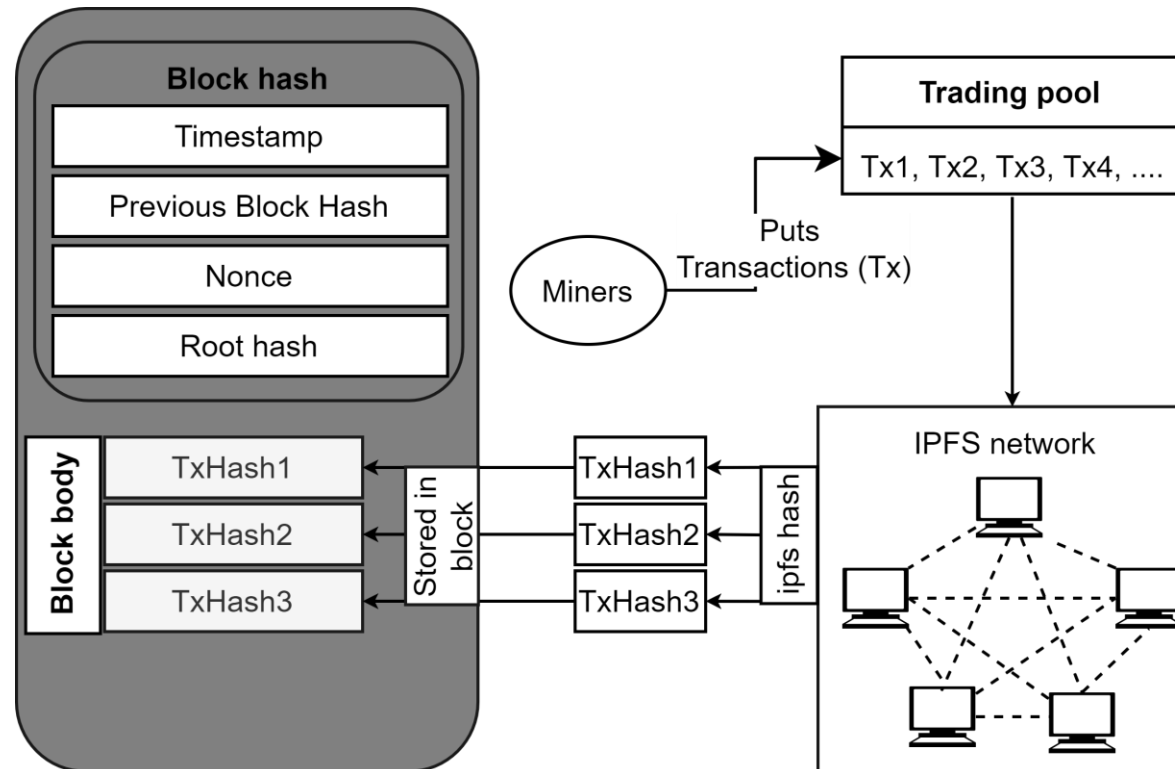
Table 10: Storage of structured data in combination with databases and BC

	BigchainDB	ProvenDB	Fluree	AuditChain	Exonym	Graphchain
Blokchchain network	Ethereum, Hyperledger Fabric	Bitcoin	Hyperledger Fabric	Ethereum	Permissioned	Hyperledger Fabric
Immutability	✓	✓	✓	✓	✓	✓
Versioned data	✓	✓	-	-	-	-
MongoDB compliance	✓	✓	-	-	-	✓
Query capabilities	✓	✓	✓	-	-	✓
Chain structure	Hashchain	Merkle Tree	Merkle Tree	Merkle Tree	Merkle Tree	Hashchain
Use Cases	intellectual property, identity, verifiable credentials, supply chain, gov- ernment	regulatory compliance, finance, In- tellectual property, legal documents, government, secure systems	MRO, credentials, iden- tity, supply chain, insurance	governance, interoperabil- ity, network services	asset and identity man- agement, supply chain	automotive, finance, real estate, public sector, tourism

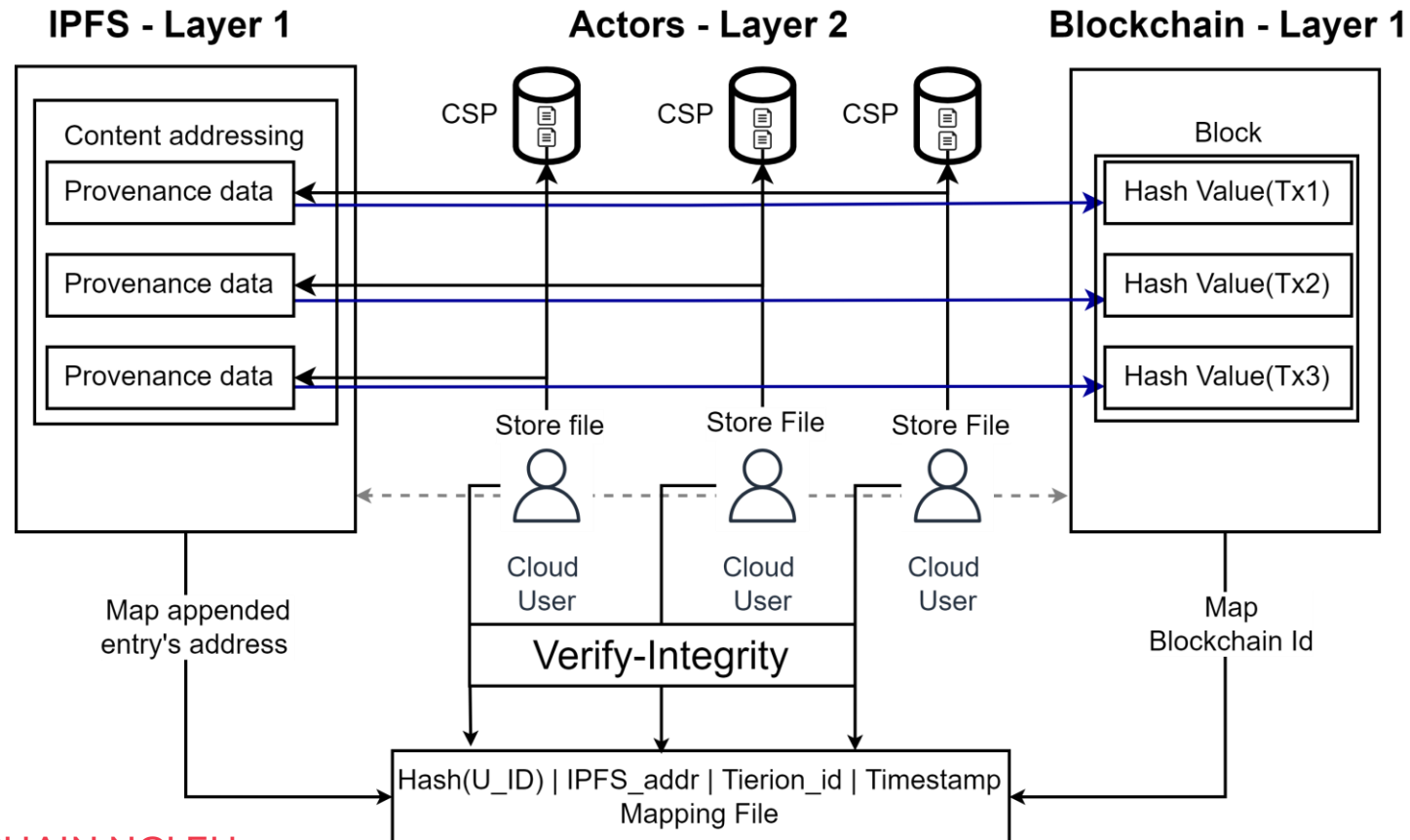
IPFS STORAGE MODEL FOR BLOCKCHAIN



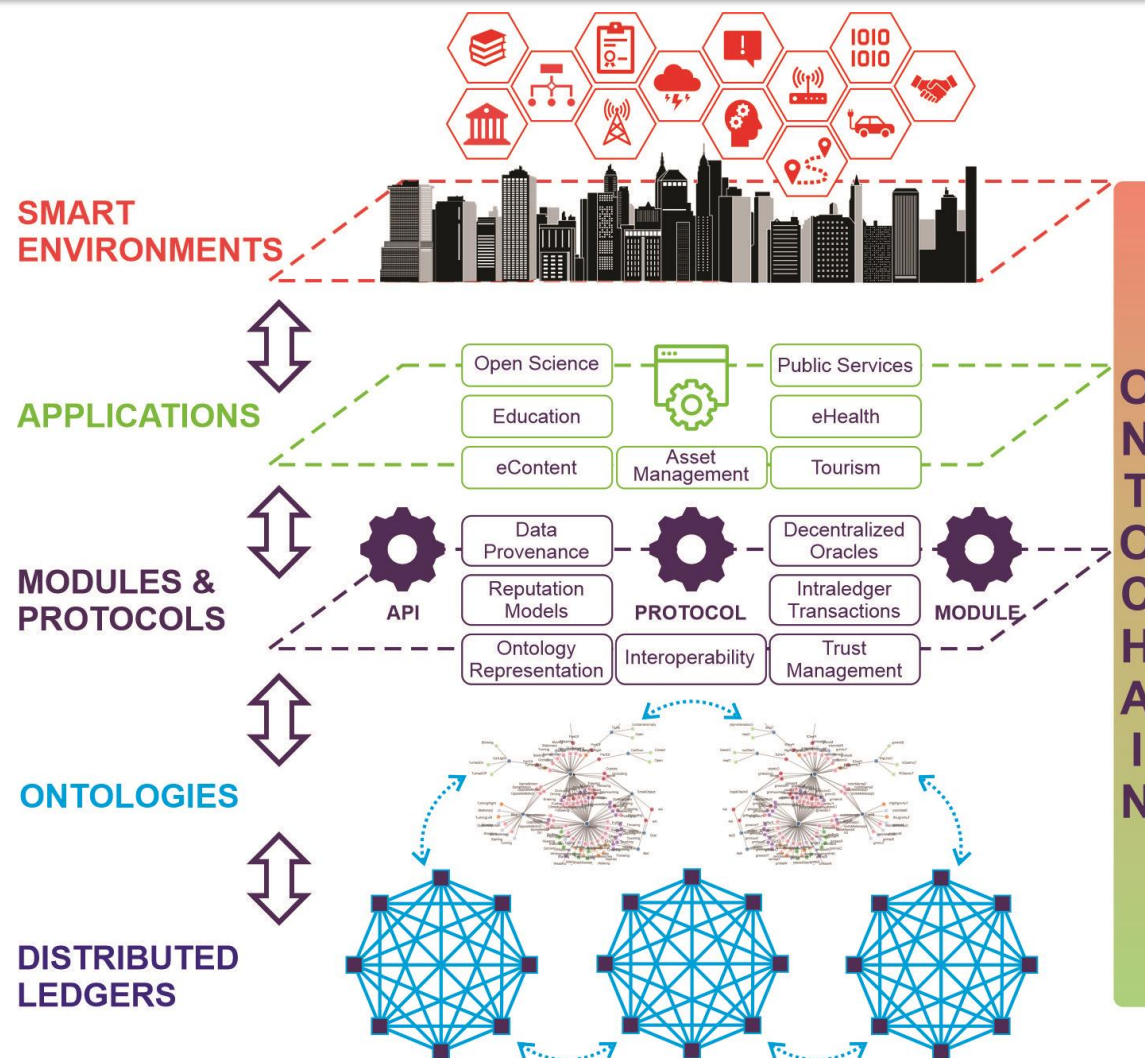
BLOCK-STRUCTURE FOR IPFS STORAGE FOR BC



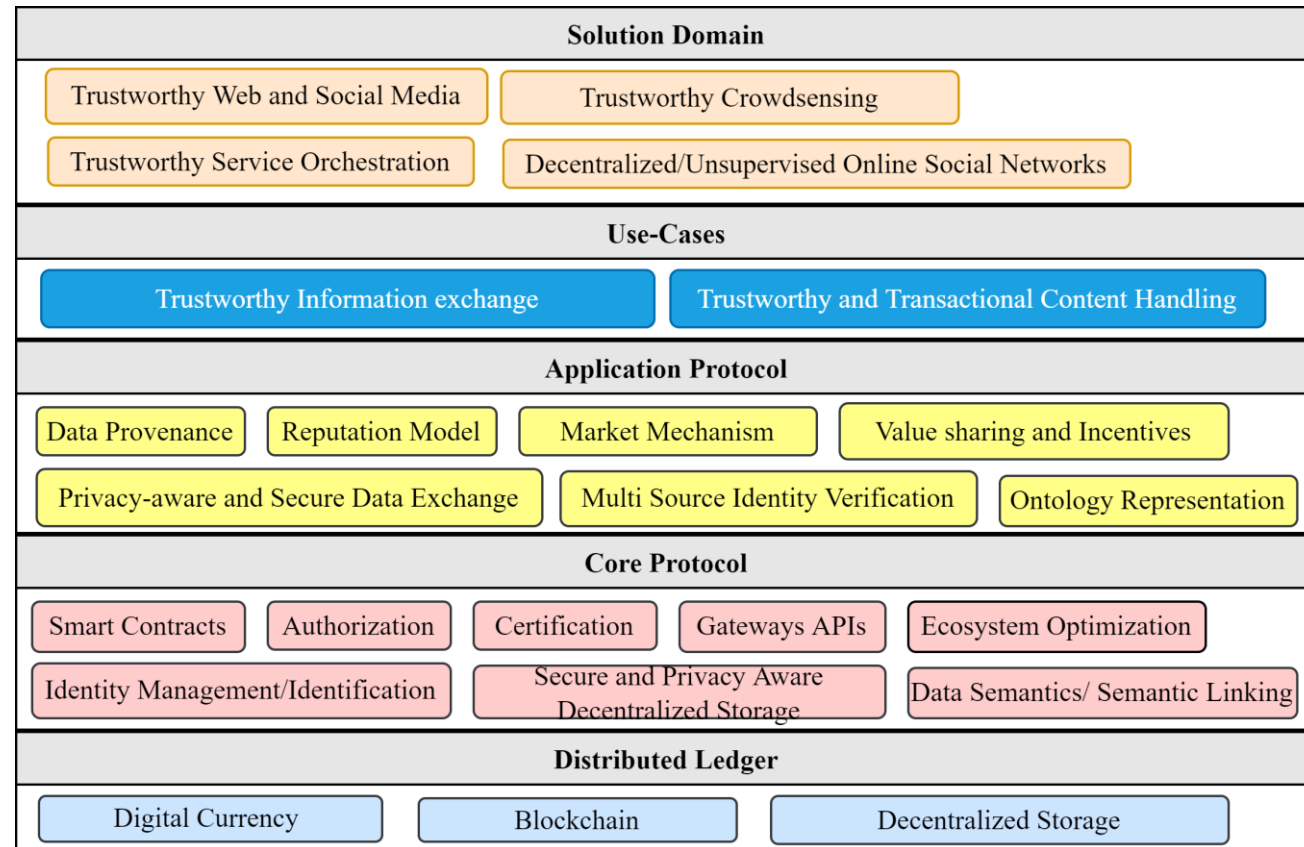
PROVENANCE DATA STORAGE WITH IPFS AND BC



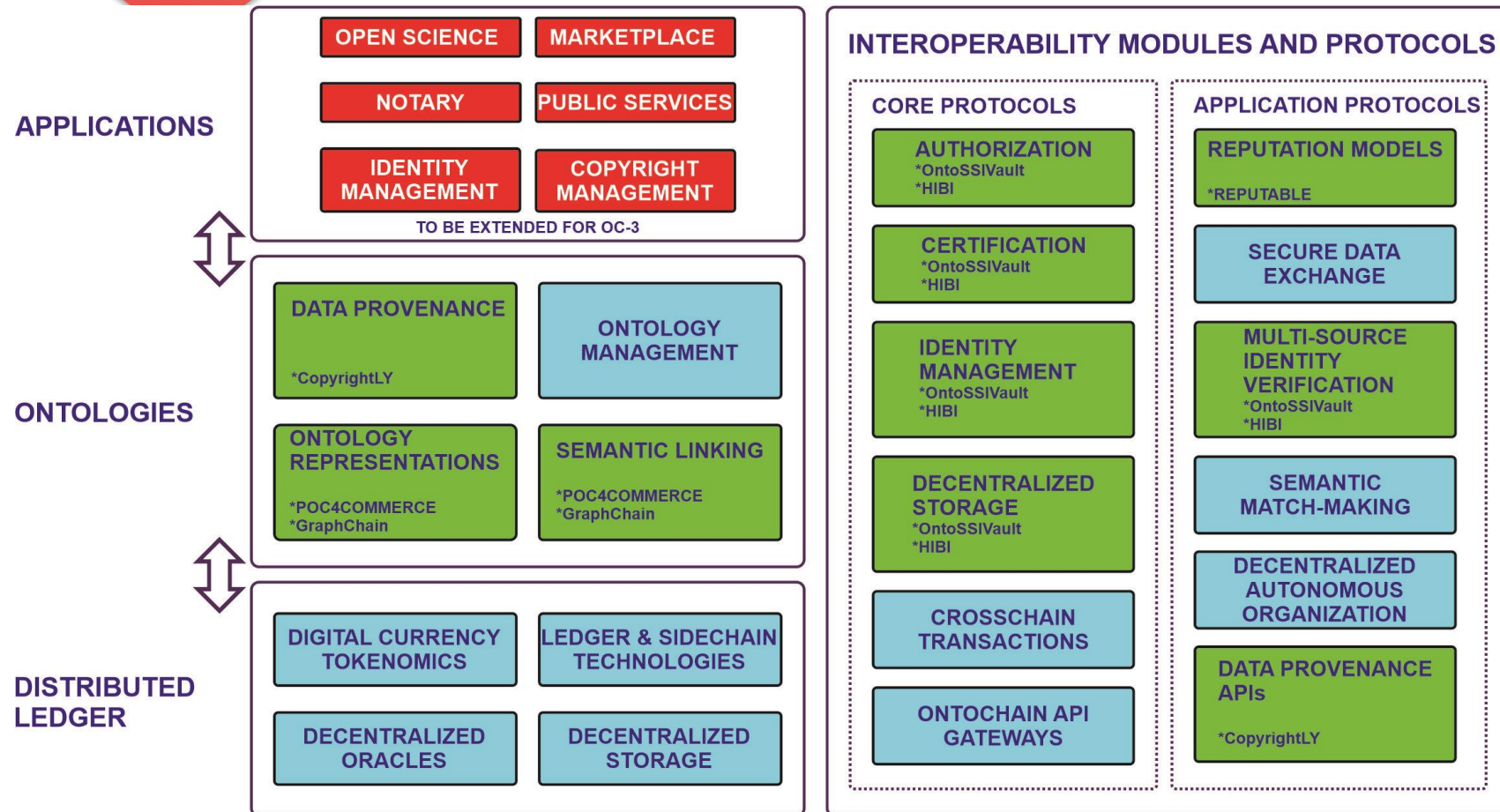
TRUSTWORTHY APPLICATIONS



ARCHITECTURE

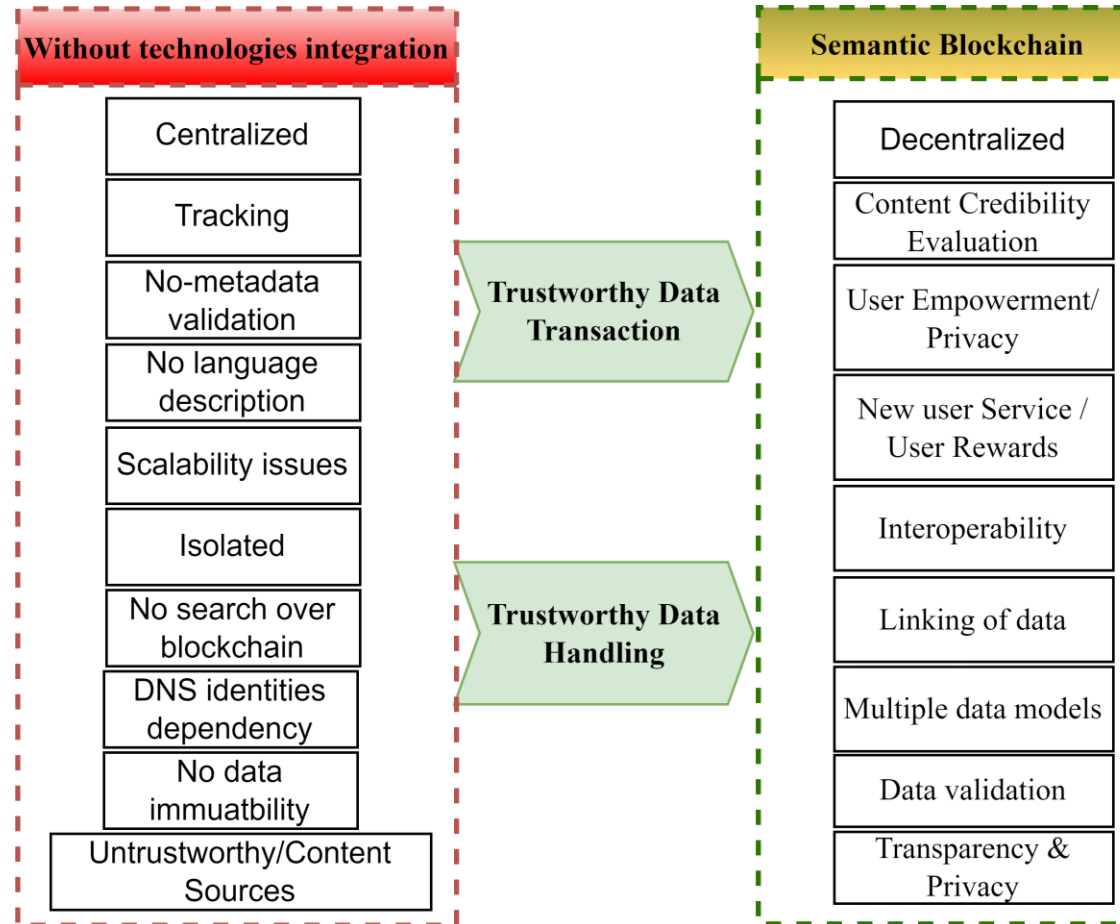


ONTOCHAIN PROJECTS: 30



OPEN CALL 1
OPEN CALL 2
OPEN CALL 3

ONTOCHAIN PROSPECTS



STAY UPDATED AND GET INVOLVED!



ontochain.ngi.eu



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[/company/ontochain](https://linkedin.com/company/ontochain)



f6s.com/ontochainproject



[/channel/UCcF7Ovd99lOKcjMGQdnhlvA](https://youtube.com/channel/UCcF7Ovd99lOKcjMGQdnhlvA)

Thank You for Your Attention!



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957338

