SEMANTIC LEDGER TECHNOLOGY

A methodological approach for development and deployment of data sharing in complex organizational networks | Spek, J.C. (Jacco)

TNO innovation for life

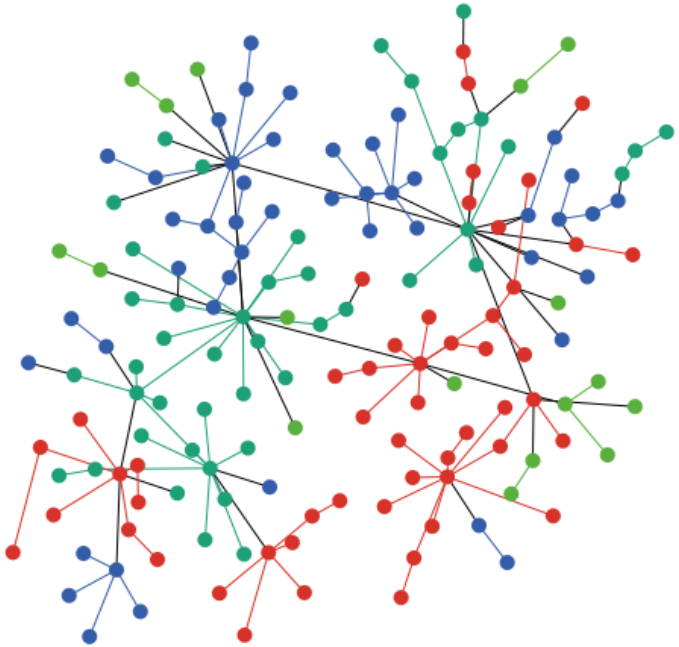
ARE THESE PRODUCTS REALLY ORGANIC?

- Unverifiable claims
- No trust in supply-chains
- Complexity of modern supply-chains
- Value of certifications (Fraud)
- Food-safety
- Recalls
- Compliance is hard to prove

DATA SHARING IN COMPLEX NETWORKS IS HARD

Because:

- Incompatible data-structures
- Confidential data
- Narrow contexts
- Variety of contexts
- Data-silos
- Changing landscape of participants



IDEAL SOLUTION

- Automatically publish interoperable data structures
- Independent of context
- Into a single trusted system
- Where data can be shared **privately** and **confidentially**
- Publication of business rules and knowledge models
- Compliance is easily verifiable

- **Is this possible?**

SEMANTIC LEDGER TECHNOLOGY

- Combine **immutability** of distributed ledgers with interoperability of **semantic technology** to create an immutable ledger to register and trace value-assets:
  - Enable data **transparency, traceability and interoperability** through- and between, supply-chains
  - Publication of formal business rules and knowledge models (semantics)
    - Prove compliance
    - Real-time insight in validity of assets (certificates, roles etc.)
  - Single-point-of-truth (The ledger)

- It also provides transactional confidentiality:
  - Ensure privacy and confidentiality of transactions

BIGCHAINDB + W3C Semantic Web

DISTRIBUTED LEDGER TECHNOLOGY

- Core functionalities:
  - **Immutability**
    - Data cannot be removed or altered
  - **Distributed infrastructure**
    - Infrastructure is not run- or owned by a single party
    - Ledger functionality is independent of any node, it cannot be shut-down by a single party.
    - “one system” to store and retrieve data
  - **All data are assets**
    - Ownership is registerred
    - Data ownership can be transferred

SEMANTICS

- Semantics:
  - "*Semantics is the linguistic and philosophical study of meaning in languages*"
    - Describes meaning of, and relationship between terms
    - Provides the rules for interpreting the syntax
  - Semantic models are called **ontologies**.
    - Formally represent the world in terms of entities, events and scene in a logical form (such as description logic).

SEMANTIC TECHNOLOGIES USED

- **RDF** (Resource Description Framework)
  - Method for conceptual description of information
  - Subject-predicate-object graphs
  - Resources have unique resource identifiers (URI's)
- **OWL** (Web Ontology Language)
  - Knowledge representation language (Ontologies)
  - Expressed in RDF
  - Open world
- **SHACL** (Shape Constraint Language)
  - Language for validating RDF graphs against shape conditions (like XML schemas)
  - Closed world

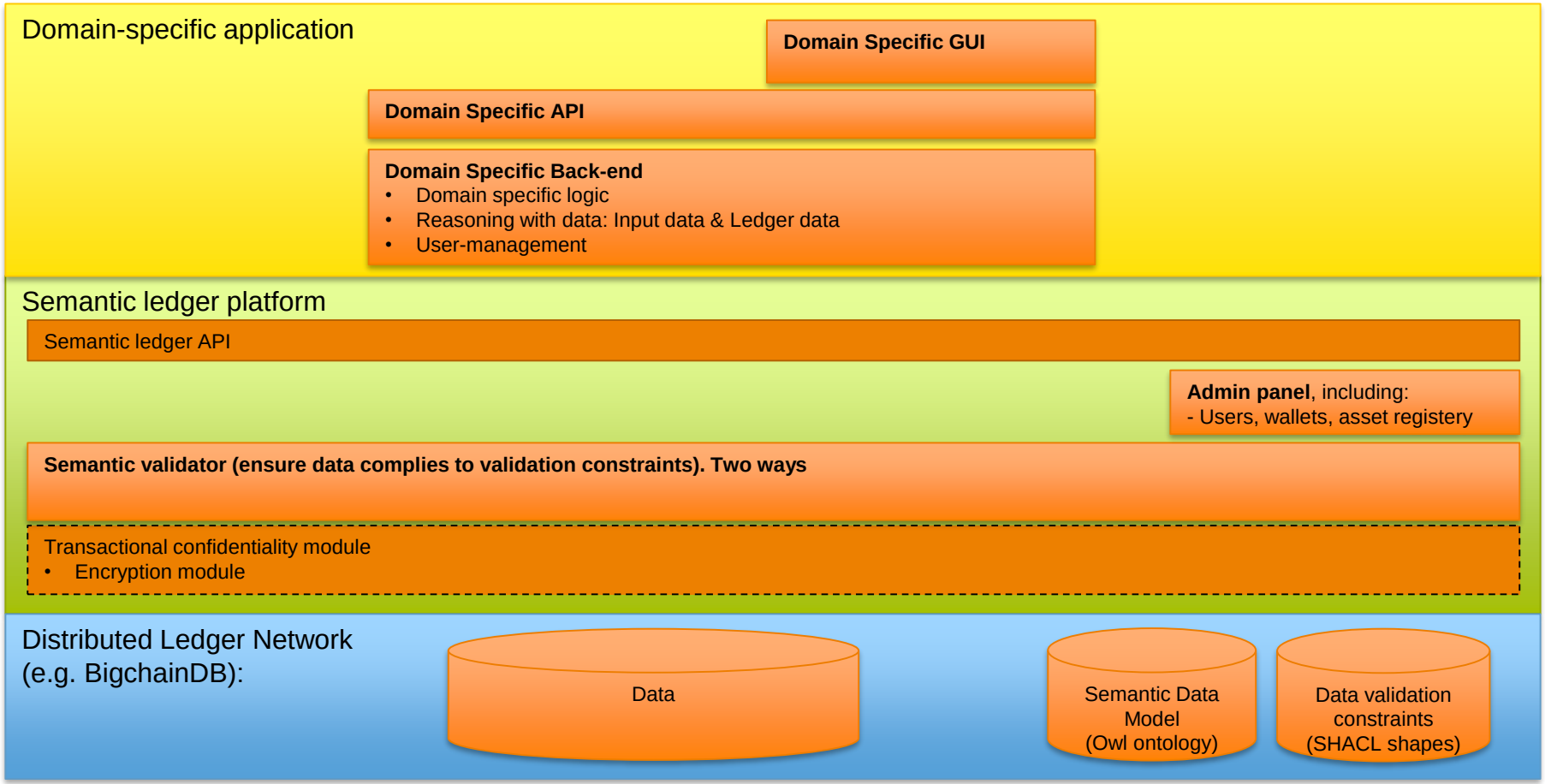
ROLE OF SEMANTICS IN THE PLATFORM

- Give ‘meaning’ to the published data (using ontologies)
  - Conceptual relation between attributes of data-objects
  - Domain/range of attributes
- Specify constraints and rules for data
  - Cardinality of attributes (*A published certificates has **exactly one** expiration date*)
  - Format (*‘expiration date’ contains a valid date-format*)
- On-chain data become ‘semantically interoperable’
  - Refer to other data-objects with unambiguous, shared meaning
- **Allows business rules to be specified and validated**

ROLE OF DISTRIBUTED LEDGER IN THE PLATFORM

- Provide **immutable** ledger to timestamp statements
  - *At time X, statement Y was done by actor Z*
- Transfer and trace ownership, custody, validity of data-assets (Certificates/products etc.)
- Register statements about statements
  - *Auditor: "Farmer John used illegal pesticides, so his certificate is revoked"*
- Real-time insight in the validity of data-assets
  - Recalls of products down-chain when something goes wrong
- Prevent fraud
  - Mass balance of certified produce cannot change → 100kg of certified produce cannot become 1000kg down-chain

ARCHITECTURE



CURRENT PROJECTS

- Supply-chain transparency
  - Agri-food
  - Commodity trading
- Rail logistics
- Business process verifiability
- Legal cannabis compliancy


THANK YOU FOR YOUR ATTENTION
Jacco Spek (jacco.spek@tno.nl)
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