

Blockchains and Linked Data for Agrifood Value Chains

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Outline

- ▶ The Challenge of Linked Data in the agrifood value chain
- ▶ The need for tracking and tracing
- ▶ The potential of Blockchain Technology
- ▶ Linked Pedigrees
- ▶ Linked Pedigrees on the a Blockchain
- ▶ Conclusions

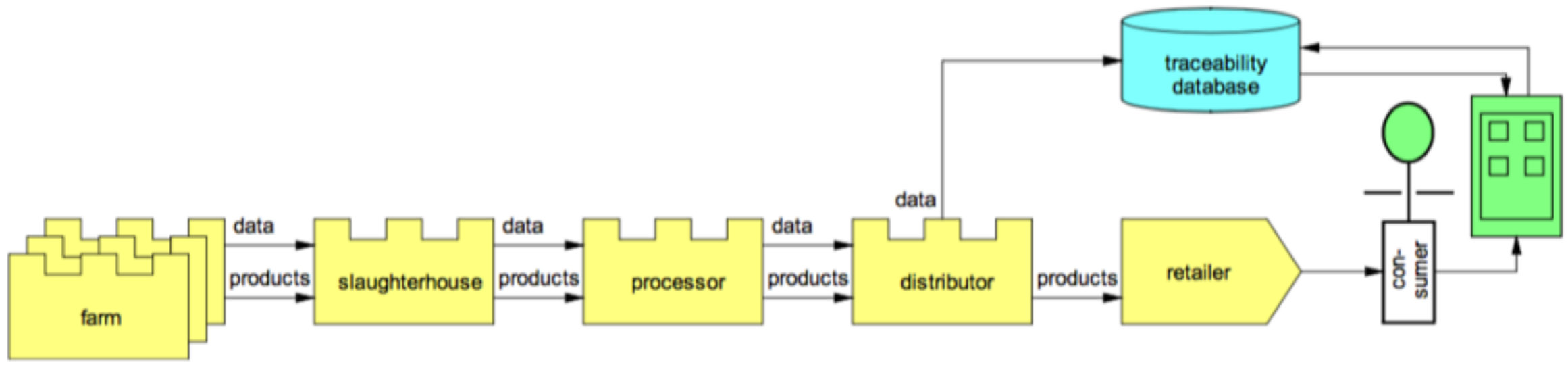
The Absence of Linked Data in the Value Chain

- ▶ Linked Data is largely absent from the value chain (i.e. from farm to consumer)
- ▶ Possible exception is Schema.org, and integration of the GoodRelations Ontology/Product Types Ontology.
- ▶ A few academic attempts to use ontologies in the **value chain** (See Tomic et al. 2015, Verhoosel et al. 2016, Solanki and Brewster 2015)
- ▶ Some limited *application* of Linked Data methods in value chain (e.g. BigTU Project)
- ▶ but no real uptake. Is this the wrong question?

The need for tracking and tracing

- ▶ Core challenge in value chain is tracking and tracing, due to food recall, food integrity issues and food crises.
 - ▶ Major importance in cases such as E.Coli (EHEC) 2011, horse meat 2013, or Italian Organic Food crisis 2011.
- ▶ EC's General Food Law (178/2002) requires *one up - one down* documentation (usually on paper, until relatively recently)
- ▶ Very slow system — it took **6 months** to map the horse meat supply chain.

Current architecture



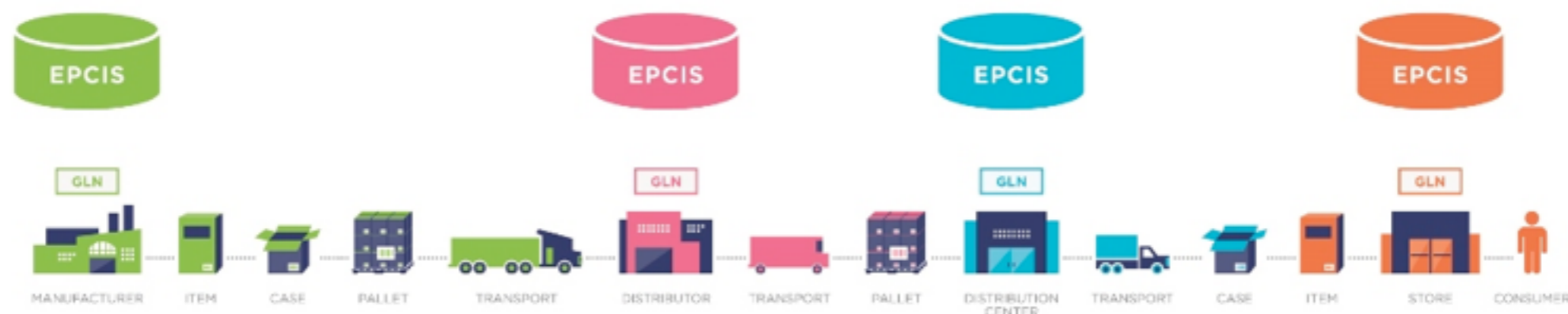
GS1 EPCIS

- ▶ Core standard in supply/value chain - used with barcodes and RFID
- ▶ Event based, each time you scan an EPCIS event data occurs
- ▶ Beyond that allows “barcode (GTIN) → master data” look up

PHYSICAL EVENT DATA WITH EPCIS

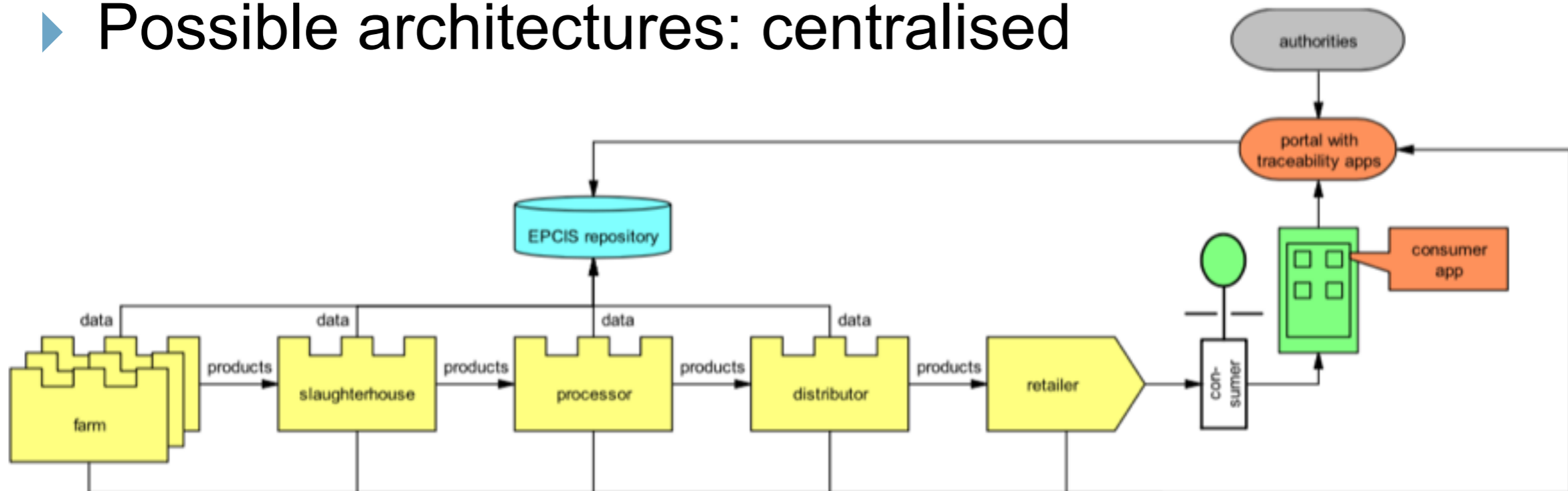
WHAT GOES INTO EPCIS

WHAT	GTIN (5391234567892)
WHERE	GLN (5391234000009)
WHEN	Date & Time Stamp (2009-10-27 10:00:00)
WHY	Business Step (receiving)



Problems with EPCIS

- ▶ Possible architectures: centralised

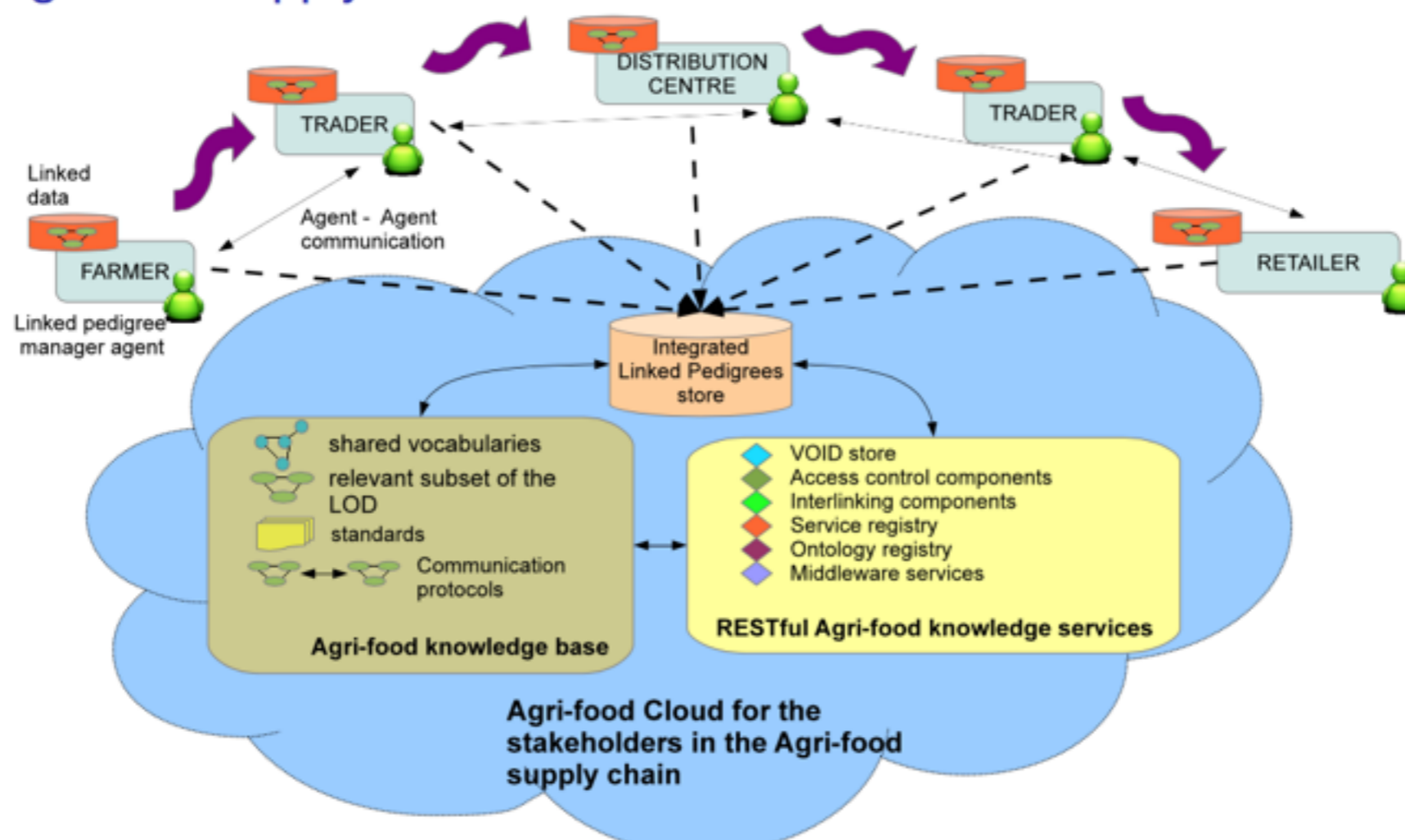


- ▶ Commercially/politically unacceptable

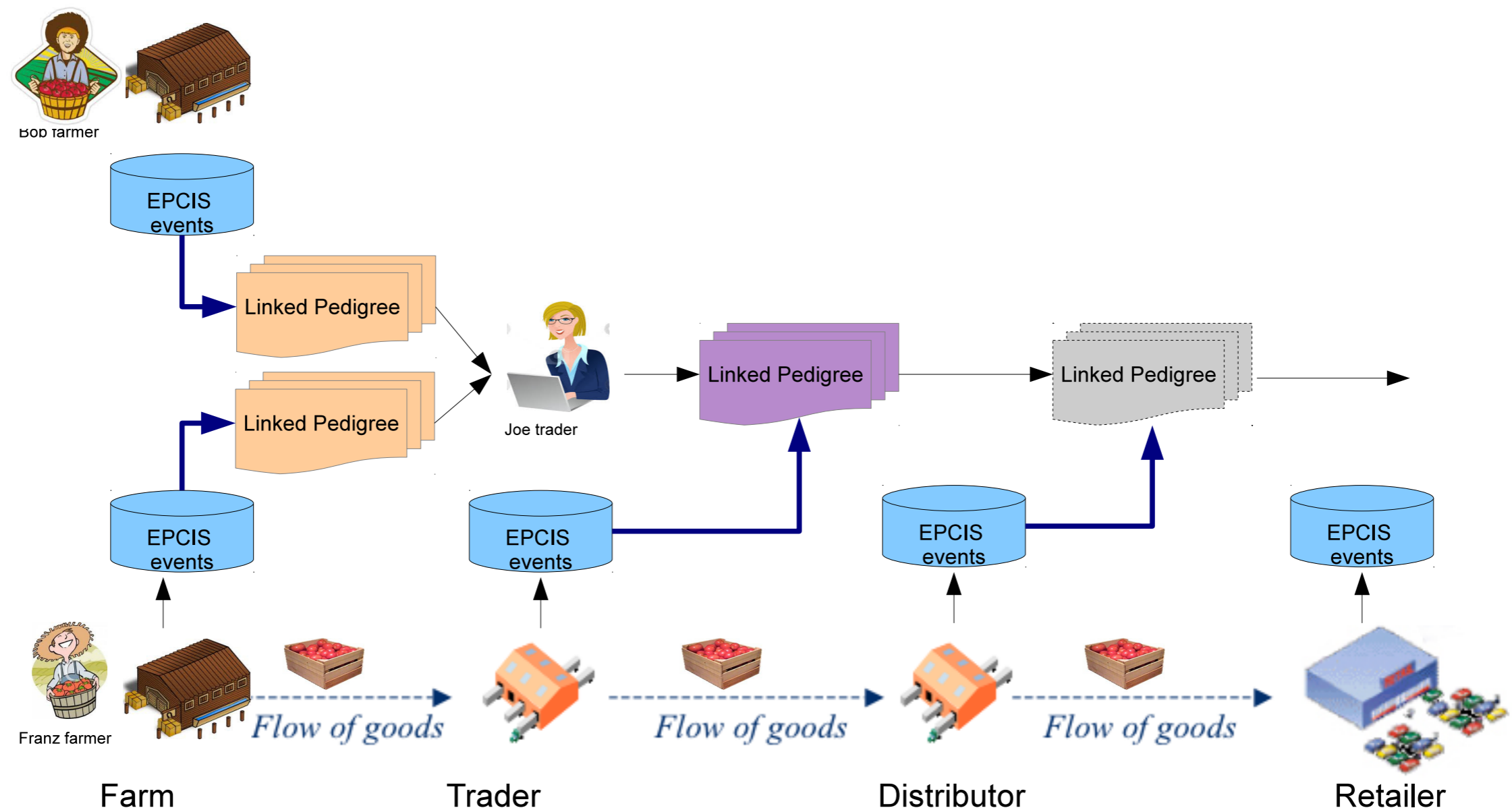
Linked Pedigrees

- ▶ Proposed 2-3 years ago (cf. Solanki and Brewster 2014/2015) - formalisation of EPCIS as Linked Data - using two ontologies.

Agri-food supply chain



Result



Possible Typical Queries

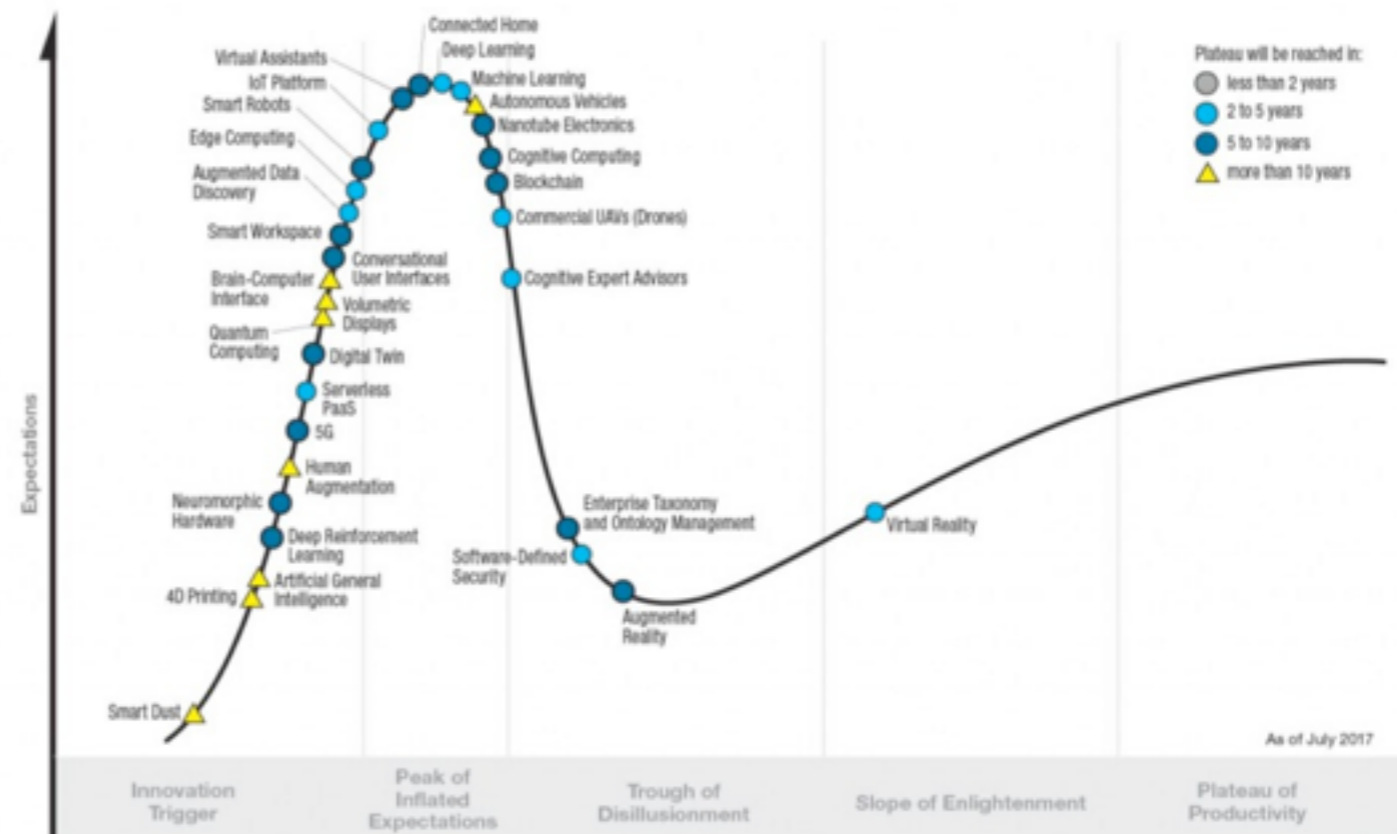
- ▶ Tracking ingredients: What were the inputs consumed during processing in the batch of wine bottles shipped on date X?
- ▶ Tracking provenance: Which winery staff were present at the winery when the wine bottles were aggregated in cases with identifiers X and Y?
- ▶ Tracking external data: Retrieve the average values for the growth temperature for grapes used in the production of a batch of wine to be shipped to Destination D on date X.

Blockchain Hype



HYPERLEDGER

<https://ww2.frost.com/news/press-releases/frost-sullivan-identifies-2017-global-blockchain-startup-map/>



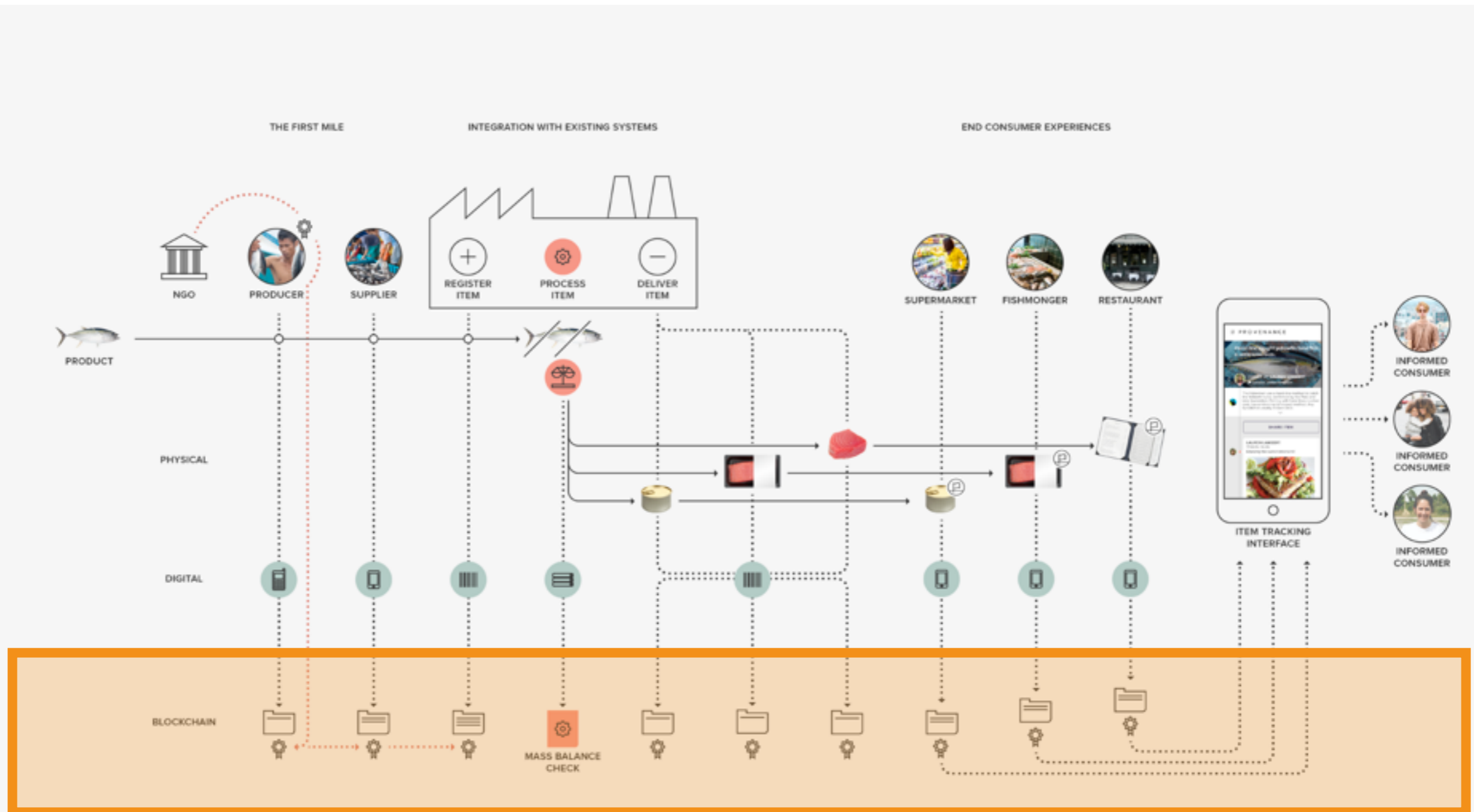
Supposed Blockchain Benefits

- ▶ **Decentralized / shared control** - situations where enemies need to work together for their mutual benefit, e.g. banks, perhaps in agrifood supply chains
- ▶ **Immutability / audit trail** - situations where it is of prime importance to have an immutable audit trail, where users cannot change data post hoc, e.g. Everledger for diamonds, perhaps for certification in agrifood
- ▶ **Assets / exchanges** - situations where the assets can live on the blockchain e.g. stock exchanges, currency or energy exchanges, perhaps for local agrifood marketplaces.

Why blockchain in agrifood?

- ▶ Partly due to general hype that Blockchain is a **solution to everything**
- ▶ Partly due to the perception that Blockchain is a “universal database that all actors can transparently read and write to”.
- ▶ Partly due to ignorance - e.g. belief that it would be easy to put lots of data on the blockchain and control access (neither are true)

Provenance.org: Tune Fish Example



Provenance.org technical approach

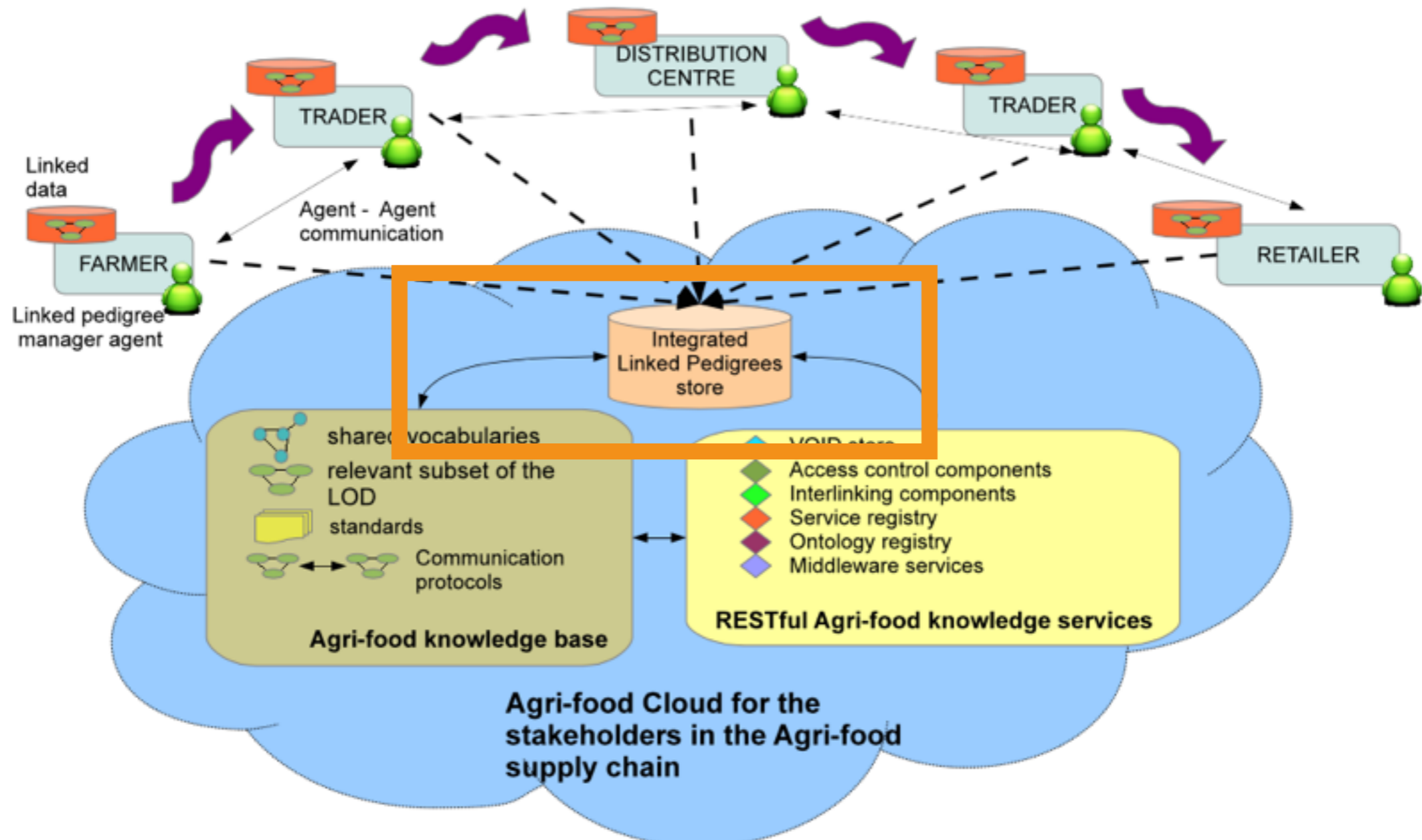
- ▶ Most information is stored on the digital platform.
- ▶ **Ethereum blockchain** is used to store snapshots of data (e.g. food certification, or data from smart phone app).
- ▶ Blockchain provides **immutable proof** that the data was true at a certain point in time, using hash of data placed on public Ethereum blockchain.
- ▶ Data on *platform* can be queried and compared with hash. Data on the blockchain can only be *compared* for integrity.
- ▶ **Because current blockchain technology is very limited**

Blockchains and Linked Data

- ▶ Use GS1's EPCIS standard to generate traceability event data.
- ▶ Each actor has their own repository/database
- ▶ Expose RDF based Linked Pedigrees with URIs/URNs
- ▶ Use a blockchain to store only URIs

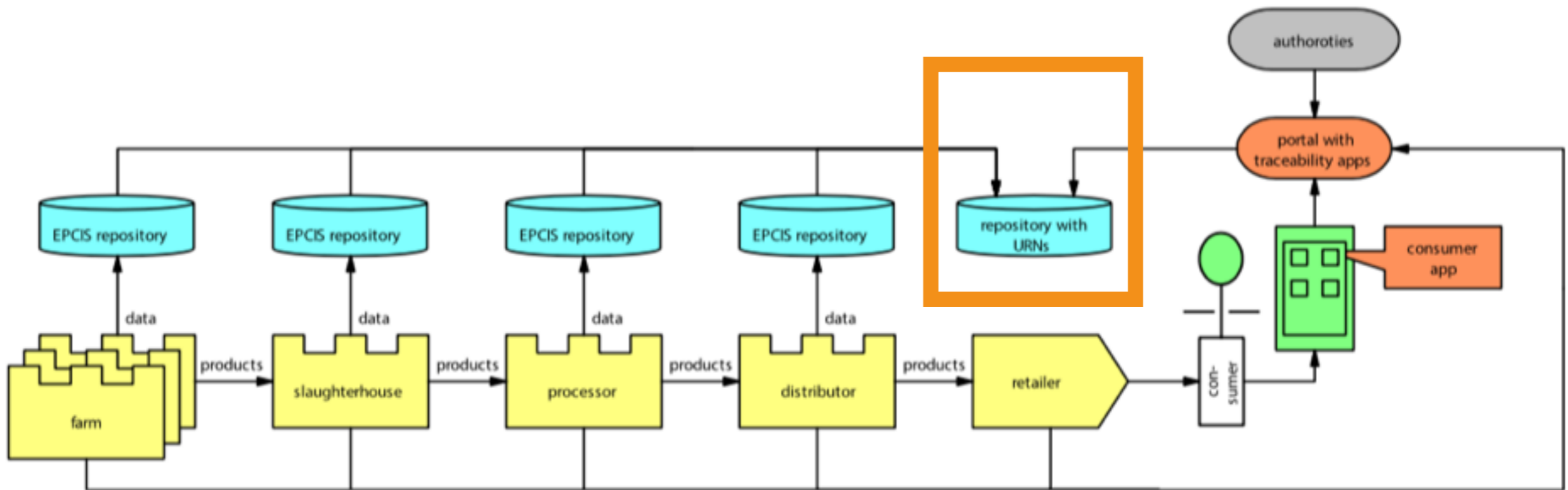
Linked Pedigrees on a Blockchain

Agri-food supply chain



Not dissimilar to ...

- ▶ Scholten et al. 2016 proposed but “unfeasible” architecture



Linked Pedigrees on a blockchain

- ▶ Allows permanent recording of food product trajectory
- ▶ Multiparty encryption can allow access only under given conditions or roles
- ▶ Potentially overcomes trust and permanence issues characteristic of food value chain.
- ▶ Remember the Italian organic scandal

Conclusions

- ▶ Blockchain technology is far more limited in its application than most people allow
- ▶ One **good** use case is in food traceability
- ▶ Combination of lack of trust between participants and need for permanent records creates and opportunity for blockchain + linked data

Acknowledgements

- ▶ Research partially supported by the Dutch national Techruption Blockchain project <http://techruption.org/>
- ▶ For TNO's work on blockchains consult <https://blockchain.tno.nl/>

