

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 <u>GoodRelations Ontology</u>/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





Problems with EPCIS



Commercially/politically unacceptable

from Scholten et al. 2016



Linked Pedigrees

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





Result BOD Tarmer EPCIS events Linked Pedigree Linked Pedigree ► Linked Pedigree Linked Pedigree Joe trader **EPCIS EPCIS** EPCIS EPCIS events events events events Flow of goods Flow of goods Flow of goods Franz farmer Farm Trader Retailer Distributor



PossibleTypical 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

Trigger

Expectation





HYPERLEDGER

https://ww2.frost.com/news/press-releases/frost-sullivanidentifies-2017-global-blockchain-startup-map/



Disillusionment

Productivity

TNO innovation for life

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



THE SUPPLY CHAIN

MCAMENT OF PHYSICAL ITEMS FLOW OF DIGITAL INFORMATION CASCADE OF CERTIFICATION 🔴 TRANSFORMATION PROCESSES



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





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



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- For TNO's work on blockchains consult https://blockchain.tno.nl/

