

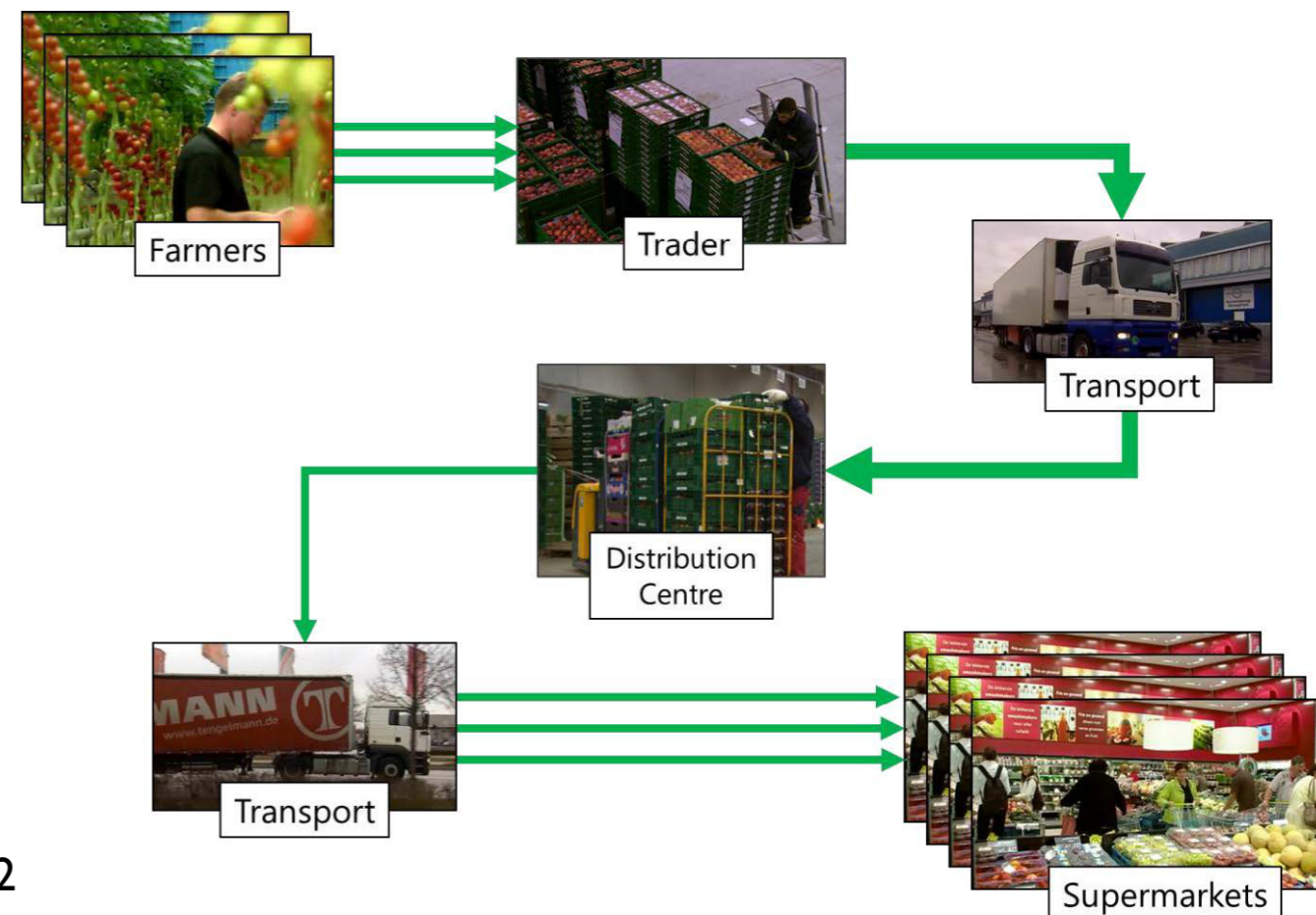
# Semantics in the Agri-food Value Chain

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# The Problem

- Lack of data integration in the agri-food supply chain
- between farmers, aggregators, retailers and consumers



# Drivers for Data Integration

- Need for visibility and transparency - tracking and tracing
- Desire for food awareness - on the part of consumers, but not only
- Regulatory pressure - e.g. EU Regulation 1169/2011 - demands detailed ingredient data
- New business opportunities .....

# Food Crises and Scandals

- Major driver for greater data integration (whether open or closed).
- E. Coli in Germany in 2011 - Spanish growers lost over €200M
- Horsemeat scandal across Europe in 2013 - impact very great on some supermarkets
- Both scandals suffered from lack of data and data integration
- Need for greater supply chain transparency = need for data integration

# The Problem of Trust

- Consumer perspective: I do not know enough about the food I eat
- Farmers perspective: I do not want to give away data - it is my data, I do not know what people will do with it.
- In both cases, **centralised** systems undermine trust



# Working with the Existing Standard

- The existing standard is GS1 = Barcodes and RFID
- Latest version called EPCIS
- Worldwide, used on packages goods, but ...
- ... relatively narrow range of data represented
- ... only what is on the packet really

# GS1 standards for Supply Chain visibility

- GS1: a neutral, not-for-profit organization dedicated to the design and implementation of global standards and solutions to improve the efficiency and visibility in supply chains.
- Core GS1 standards: **EPCIS 1.1 & CBV 1.1**
- The Electronic Product Code (EPC): provides products with unique, serialised identities.
- Electronic Product Code Information Services (EPCIS): provides a set of specifications for the syntactic capture and informal semantic interpretation of EPC based product information.
- CBV supplements EPCIS by defining the structure of vocabularies and specific values for the vocabulary elements.
- Events as abstractions for traceability.

# SW & LD for Visibility in Supply chains

- Purpose:
  - To bridge between existing standard and semantic technologies
  - Provide a rigorous formalisation of the GS1 standard
  - Allow easy integration with other vocabularies and data
- **Result:**
  - A set of ontologies: EEM, CBV Vocab, OntoPedigree.
  - Streams of EPCIS events.
  - Event-Based traceability artifact: Linked Pedigrees.
  - Algorithm: automated generation of linked pedigrees from EPCIS events and counterfeit detection.



# The Architecture: Linked Pedigrees

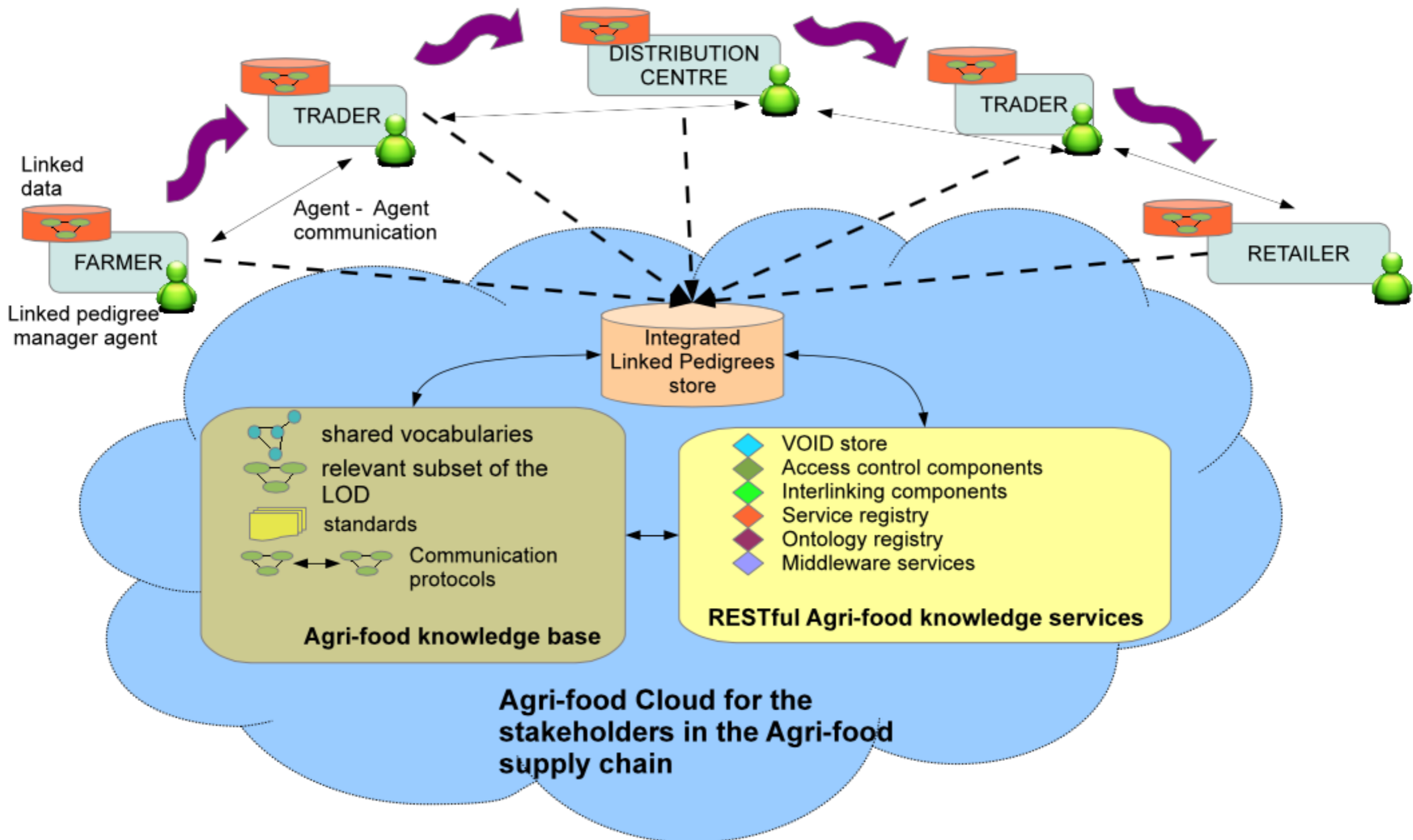
- Based on “pedigree” concept common in pharmaceutical industry - an audit trail which record path of ownership
- Based on GS1 standards (pedigree standard + EPCIS)
- “Linked pedigrees” use semantic web/linked data principles
- Involves formalisation of EPCIS standard in two ontologies

# Linked Pedigrees

- Datasets described and accessed using linked data principles.
- Encapsulate the knowledge required to trace and track products in supply chains on a Web scale.
- Facilitate the interlinking of a variety of related and relevant data, i.e., GS1 product master data with event data **PLUS other data outside the GS1 system.**
- Based on a domain independent data model for the sharing of knowledge among Semantic Web/Linked data aware systems deployed for the tracking, tracing and data capture.
- Product knowledge shared among partners as products physically flow downstream or upstream in the supply chain.

# Linked Pedigree Architecture

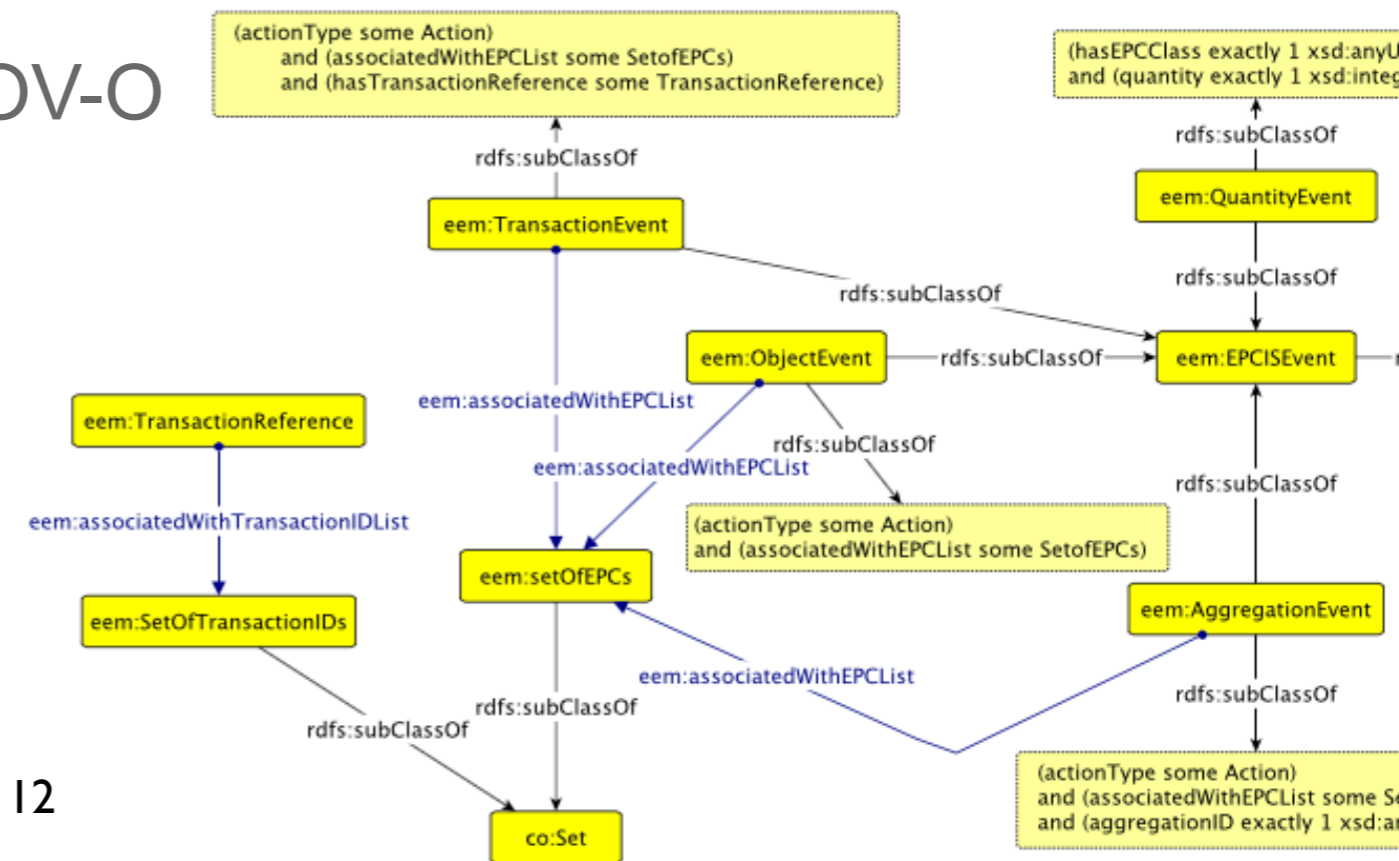
## Agri-food supply chain



# The Ontologies: EEM - The EPCIS Event Model

- A domain specific, ontological information model.
- Focuses on a tight conformance with the EPCIS 1.1 standard and Simplicity.
- Explicitly defines relationships with CBV 1.1 entities through CBV Vocab.
- EEM has been mapped to PROV-O

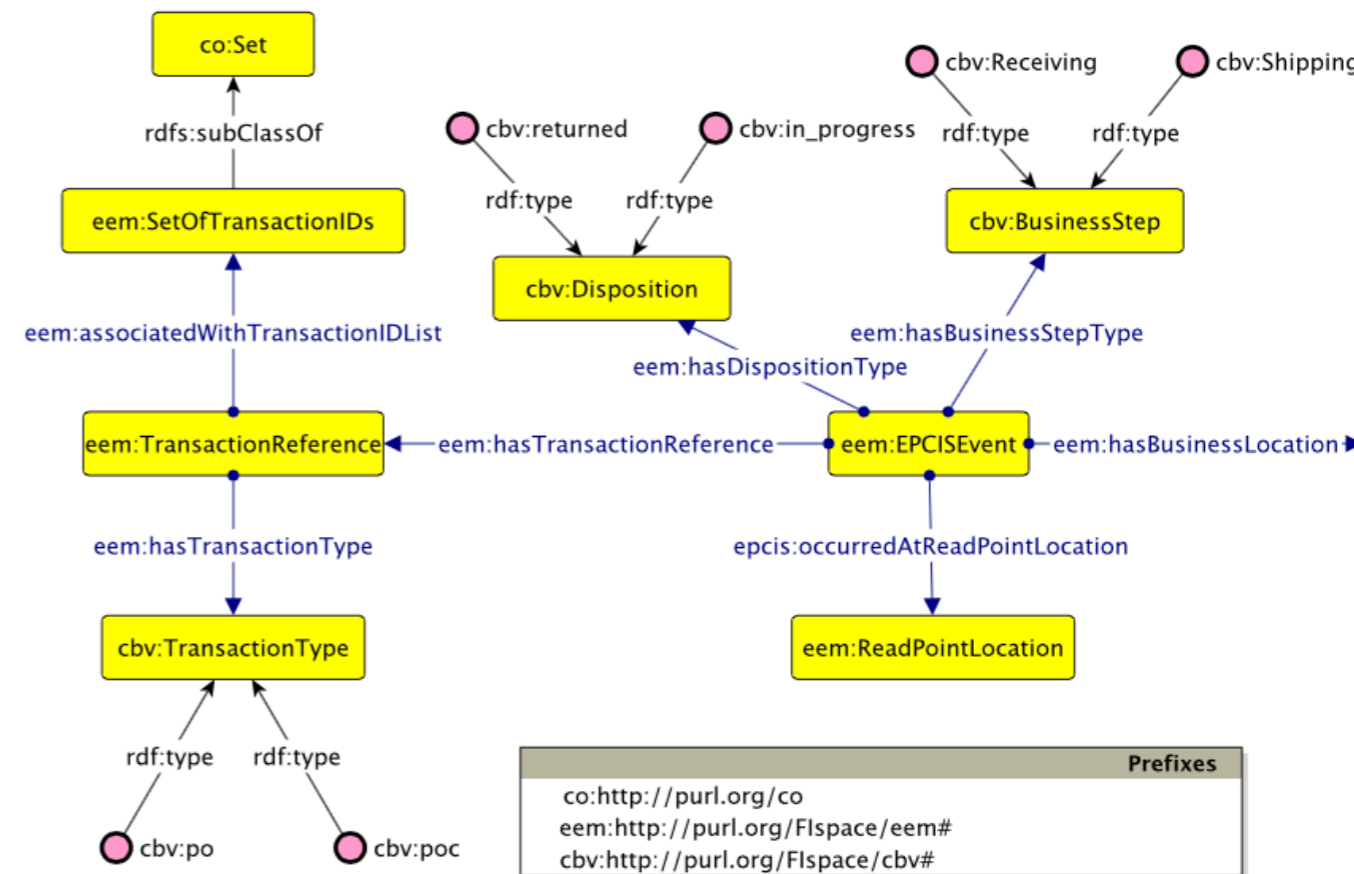
<http://purl.org/eem#>



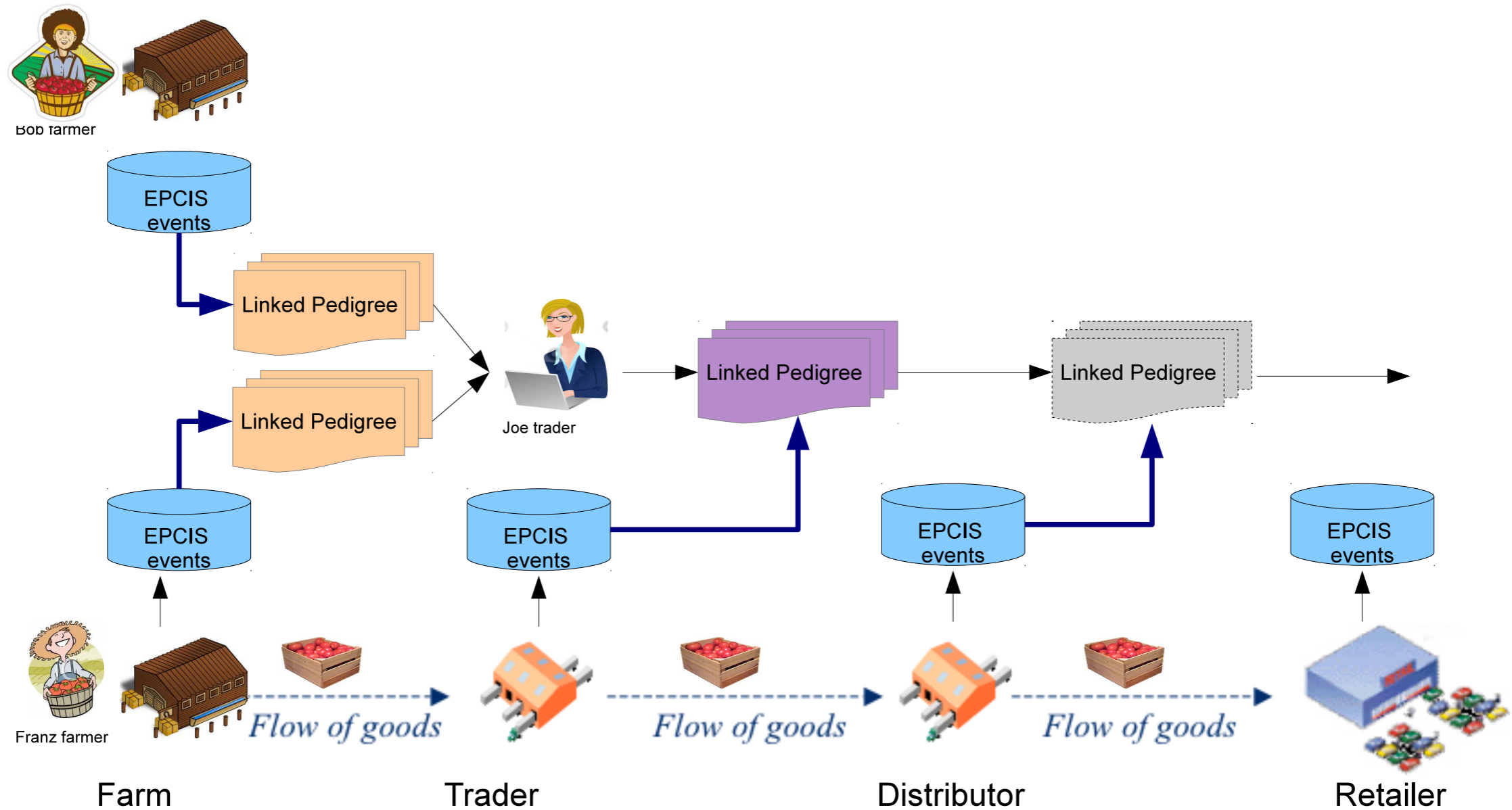
# The Ontologies: CBV - Core Business Vocabulary

- Companion to EEM
- defining vocabularies and specific data values that may populate the EPCIS data model

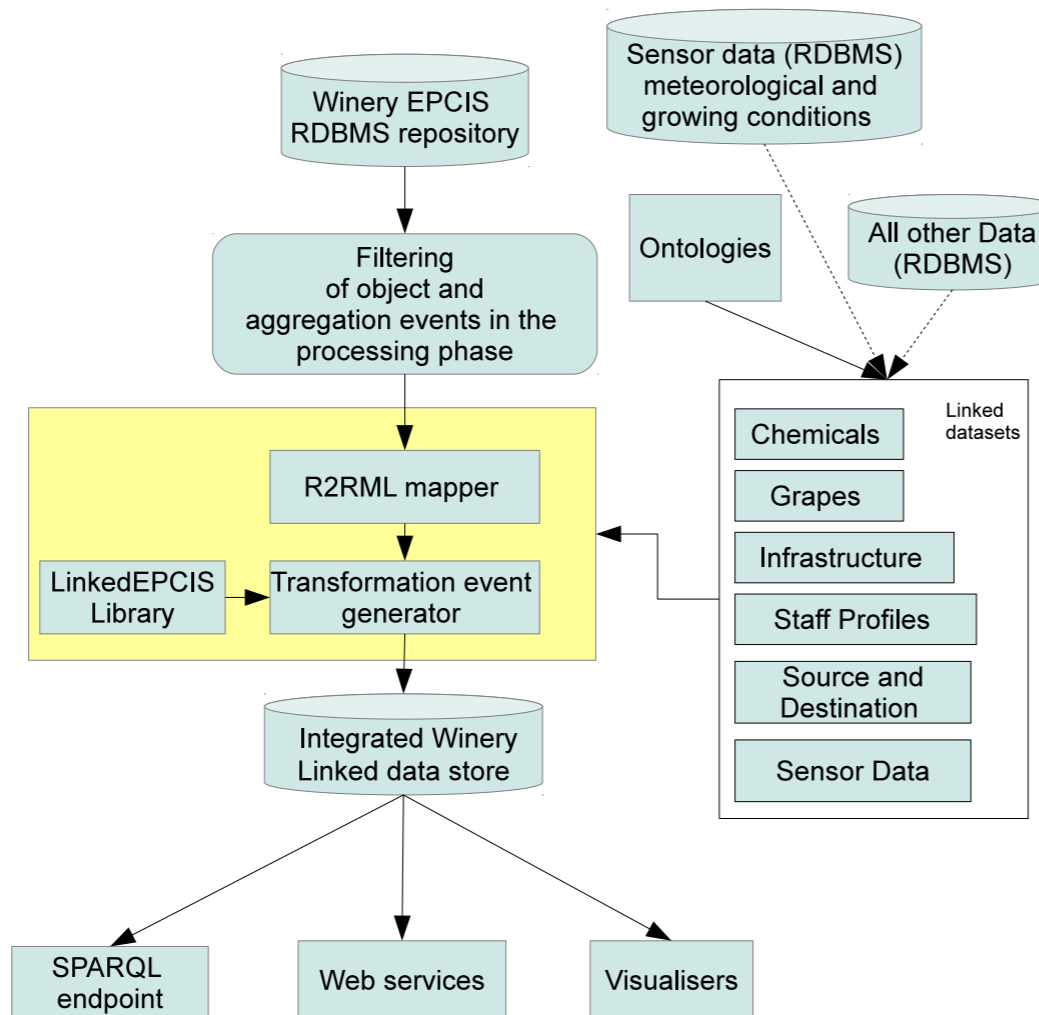
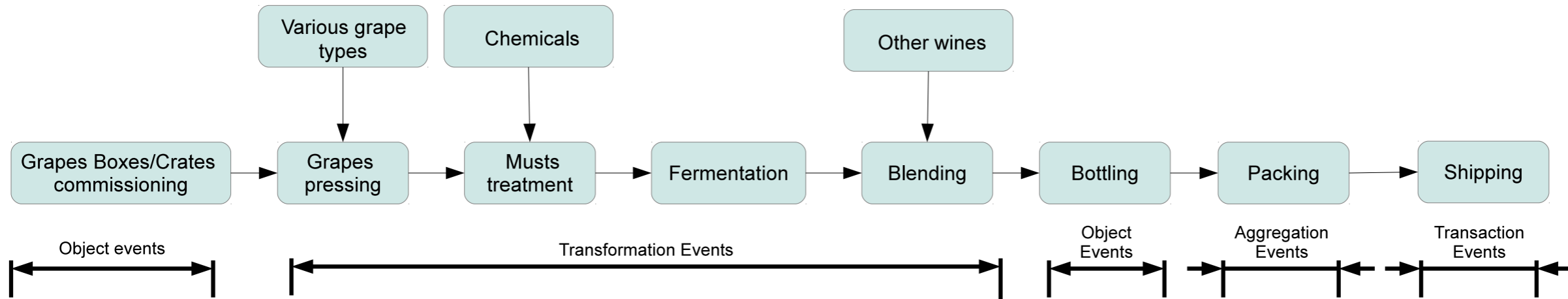
<http://purl.org/FIspace/cbv#>



# Result - 1



# Result - 2



# 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.



# Conclusions

- Semantic technologies need to play a part not just in research but also in food production and supply chains
- The current agri-food system faces data integration problems we are all aware of.
- With Linked Pedigrees, we have presented one possible approach that allows interlinking of data structures with existing standards, and the wider resources available in the web of data.

# Questions?

# Acknowledgements

- The work presented here was largely the work of Monika Solanki (<https://w3id.org/people/msolanki>), supported by the Flspace project



# Further Information

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