

## Chapter 36

# Enhancing Visibility in EPCIS Governing Agri–Food Supply Chains via Linked Pedigrees

**Monika Solanki**  
Aston University, UK

**Christopher Brewster**  
Aston University, UK

### ABSTRACT

*Data integration for the purposes of tracking, tracing and transparency are important challenges in the agri-food supply chain. The Electronic Product Code Information Services (EPCIS) is an event-oriented GSI standard that aims to enable tracking and tracing of products through the sharing of event-based datasets that encapsulate the Electronic Product Code (EPC). In this paper, the authors propose a framework that utilises events and EPCs in the generation of “linked pedigrees” - linked datasets that enable the sharing of traceability information about products as they move along the supply chain. The authors exploit two ontology based information models, EEM and CBVVocab within a distributed and decentralised framework that consumes real time EPCIS events as linked data to generate the linked pedigrees. The authors exemplify the usage of linked pedigrees within the fresh fruit and vegetables supply chain in the agri-food sector.*

### INTRODUCTION

One of the most important challenges in logistics and supply chains is information integration. Sharing of data and knowledge in a standardised manner along the supply chain is crucial not only to enable visibility, i.e., tracking and tracing of artifacts, but also to enable the more effective management of the supply chain. Business relations are increasingly globalised and loosely coupled thus making both standards and technologies for information exchange essential. This is particularly required in the food and agriculture sector due to the great complexity of the supply chains, and the importance of tracking and tracing for food safety and regulatory requirements.

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Barcodes and more recently RFID tags have provided initial solutions to this challenge. GS1<sup>1</sup>, a global organisation which manages barcodes, has provided an ever wider range of standards to facilitate end-to-end traceability and information sharing along the supply chain. The Electronic Product Code Information Services (EPCIS)<sup>2</sup> and the Core Business Vocabulary (CBV)<sup>3</sup>, collectively provide specifications for the representation of product traceability information (Främling, Parmar, Hinkka, Tättilä, & Rodgers, 2013).

EPCIS provides the technical specification to track product lots and generate messages for signalling the geographical progress and status of an item or set of items at each step of the supply chain. This is achieved by monitoring data generated within the business context of scanning a barcode or RFID tag and encapsulating it within the abstraction of an “event”.

EPCIS, however, as currently designed, does not provide the framework for sharing data across a multiplicity of supply chain actors. For information to be usefully shared, it must be interlinked and made available at all stages of the supply chain (with due regard for data ownership). A limitation of the current EPCIS specification is that though it does propose a mechanism to exchange and share data by providing an XML schema against which event data can be recorded, Web services implementing the specification are tightly coupled. Achieving interoperability between Web services becomes a challenging task and incorporating any future changes in the specification results in huge maintenance overheads.

Three critical issues that act as a hindrance to enabling information exchange in existing supply chain processes are the following:

- In supply chains, particularly in the agri-food sector, the flow of data is restricted by a very conservative “need-to-know” attitude such that essentially information flows only “one up, one down”.
- Although a very large number of items are scanned in food supply chains, and each actor records these events in their systems, there is no linkage of these data items across actors. This is due both to the cultural barriers to information exchange in the sector and the current set of technological solutions.
- Finally, the EPCIS XML schemas define only the structure of the data to be recorded. The semantics of data and data curation processes are informally defined. Their interpretation is left up to the individual EPCIS specification implementing engines, thereby greatly increasing the possibility of interoperability issues arising between supporting applications, e.g., validation and discovery services built over the event repositories.

In this paper we propose an information integration methodology that facilitates tracking, tracing and information sharing in the supply chain by exploiting Semantic Web standards and linked data technologies. Our approach draws requirements from real-time supply chain business processes in the agri-food sector that are involved in the tracking and tracing of perishable goods. We exploit two information models: The EPCIS Event Model (EEM)<sup>4</sup> based on the EPCIS specification, that enables the sharing and semantic interpretation of event data and CBV<sup>5</sup> its companion ontology based on CBV, for modelling the business context associated with events. We incorporate the models in a distributed and decentralised framework, which facilitates tracking and tracing of goods, potentially in real time, as well as the sharing of information about individual products. We propose the concept of “Linked pedigrees” - linked datasets curated by consuming EPCIS event data, product data and location data, which enable the capture of a variety of tracking and tracing information about products as they move among the various trading partners. In addition, we present “OntoPedigree”, an ontology design pattern for the

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