EPCIS-based tracking and tracing of returnable transport items in the food supply chain

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Agenda

1. Motivation and research objectives
2. Methodology
3. Expected results
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3. Expected results
Background

• Food safety and traceability have drawn more and more public attention.
• Paper-based traceability systems are not adequate for timely and accurate tracing of products.
• Auto-ID especially RFID technology brings new opportunities for improving tracking and tracing process in supply chain.

An intelligent Container as well as the IT-infrastructure are going to be developed in the FORFood project for improving safety and traceability in the food supply chain.
The most common problems in RTI management in the food supply chain:

- Asynchronous material flow and information flow
- Inefficient information management and exchange between trading partners
- No transparency of RTI flow in the supply chain
- RTI Losts
- No real time identification and notification of problems
- Inefficient logistic processes
- Traceability not possible
- ……

How could it be improved?
What is EPCIS?

EPC Information Service (EPCIS) is an EPCglobal standard designed to enable EPC-related data sharing within and across enterprises. It is the crucial component of the EPCglobal-network (a global approach for internet of the things) and enables a useful semantic interpretation of Auto-ID data to improve supply chain transparency and visibility.
Introduction – EPCIS Event

EPCIS Event with XML Binding

When →
What →
Where →
Why →

EPCIS Repository

Middleware

Object Event
Aggregation Event
Quantity Event
Transaction Event

Event Type | Function | Application areas
--- | --- | ---
Object Event | Observation of EPCs | Receiving area, Shipping area, etc.
Aggregation Event | aggregation of child EPCs to a parent EPC | Cartons loaded onto RTIs, RTI loaded into truck, etc.
Quantity Event | Counting quantity | Inventory, etc.
Transaction Event | EPCs are linked to business transaction | EPCs are linked to a purchase Order, etc.
Research Objectives

• Investigation and adaption of EPCIS for tracking and tracing of RTI as well as products in the food supply chain.

• Development of a web application for EPCIS-based tracking and tracing in the food supply chain
  – Design and development of a **discovery service**;
  – Visualisation of **traceability** of RTI as well as products;
  – Investigation and implementation of EPCIS-based **Event Management**;
    (Environment Monitoring, Breaking of defined rules )
  – Deduction of KPI in the supply chain based on EPCIS-Event analysis.
Agenda

1. Motivation and research objectives
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Key data elements for supporting tracking and tracing process

- Key data elements for tracking and tracing:

<table>
<thead>
<tr>
<th>RTI</th>
<th>Case (Carton, Colli)</th>
<th>Product*</th>
<th>Location</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>• <strong>GRAI</strong> (EPC) - Global Returnable Asset Identifier</td>
<td>• <strong>SGTIN</strong> (EPC) - Serial Global Trade Item Number</td>
<td>• <strong>GTIN</strong> (EAN) – Global Trade Item Number</td>
<td>• <strong>SGLN</strong> (EPC): Serialized Global Location Number</td>
<td>• Local Time</td>
</tr>
<tr>
<td>• <strong>SSCC</strong> (EPC) - Serial Shipping Container Code</td>
<td></td>
<td>• <strong>Lot Number</strong></td>
<td></td>
<td>• Time offset</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• <strong>Expiry Date</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Further important data:

  Container Status (e.g. repaired, to be cleaned), Temperature, etc.
Simulation of EPCIS-Event driven food supply chain

Why Simulation?

• Only few real-world implementations exist that can be directly examined;

• Simulation can be relatively easily extended for different application scenarios;

• Large amounts of EPCIS-Events can be generated in short time for developing and testing High-Level applications.

What are simulated?

• Material flow;

• Identification points with middleware function, which serialized the reading events into EPCIS-Events with XML binding;

• Abnormalities such as over-threshold temperature, RTI lost, etc.
Key identification processes in forward Logistics
## Mapping between key processes and EPCIS-Events

<table>
<thead>
<tr>
<th>Supply Chain Tier</th>
<th>Key Process</th>
<th>Event Type</th>
<th>Action</th>
<th>Extension Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>1. Tag cases (with packed products)</td>
<td>ObjectEvent</td>
<td>ADD</td>
<td>EAN_Code, Lot_Number, Expiry_Date</td>
</tr>
<tr>
<td></td>
<td>2. Load cases onto pallet</td>
<td>AggregationEvent</td>
<td>ADD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Bring pallets to shipping area</td>
<td>ObjectEvent</td>
<td>OBSERVE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Load pallets onto truck</td>
<td>AggregationEvent</td>
<td>ADD</td>
<td></td>
</tr>
<tr>
<td>Central Distribution Center</td>
<td>5. Unload pallets from truck</td>
<td>AggregationEvent</td>
<td>DELETE</td>
<td>Over_Thres_Temp, Temp_TimeStamp</td>
</tr>
<tr>
<td></td>
<td>6. Bring pallets to receiving area</td>
<td>ObjectEvent</td>
<td>OBSERVE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7. Unload cases from pallet</td>
<td>AggregationEvent</td>
<td>DELETE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8. Load cases into container</td>
<td>AggregationEvent</td>
<td>ADD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9. Bring containers to shipping area</td>
<td>ObjectEvent</td>
<td>OBSERVE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10. Load containers onto truck</td>
<td>AggregationEvent</td>
<td>ADD</td>
<td></td>
</tr>
<tr>
<td>Local Distribution Center</td>
<td>11. Unload containers from truck</td>
<td>AggregationEvent</td>
<td>DELETE</td>
<td>Over_Thres_Temp, Temp_TimeStamp</td>
</tr>
<tr>
<td>(Cross Docking)</td>
<td>12. Bring containers to receiving area</td>
<td>ObjectEvent</td>
<td>OBSERVE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13. Bring containers to shipping area</td>
<td>ObjectEvent</td>
<td>OBSERVE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14. Load containers onto truck</td>
<td>AggregationEvent</td>
<td>ADD</td>
<td>Over_Thres_Temp, Temp_TimeStamp</td>
</tr>
<tr>
<td>Retailer</td>
<td>15. Unload containers from truck</td>
<td>AggregationEvent</td>
<td>DELETE</td>
<td>Over_Thres_Temp, Temp_TimeStamp</td>
</tr>
<tr>
<td></td>
<td>16. Bring containers to receiving area</td>
<td>ObjectEvent</td>
<td>OBSERVE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17. Unload cases from container</td>
<td>AggregationEvent</td>
<td>DELETE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18. Unpack products from case</td>
<td>ObjectEvent</td>
<td>DELETE</td>
<td></td>
</tr>
</tbody>
</table>
Key identification processes and reverse Logistics

Other possible processes: cleaning, maintenance

Status change:
To be cleaned  <- - -> cleaned,  repaired <- - -> to be repaired
Information system

EPCIS Repository

Capture interface

HTTP

Web Service

EPCIS-Events in XML Binding

XML interface

Simulation Model

```xml
<?xml version="1.0" encoding="utf-8" standalone="no" ?>
- <epcs:EPICSBinaryData>
  - <EventList>
    - <AggregationEvent>
      <eventTime>2011-04-09T08:36:20.0000</eventTime>
      <eventTimeZoneOffset>+02:00</eventTimeZoneOffset>
      <parentID>urn:epc:id:sscc:1000000.0000000008</parentID>
      <childEPCs>
        <epc>urn:epc:id:sgtin:1000000.123456.57</epc>
        <epc>urn:epc:id:sgtin:1000000.123456.58</epc>
        <epc>urn:epc:id:sgtin:1000000.123456.59</epc>
        <epc>urn:epc:id:sgtin:1000000.123456.60</epc>
        <epc>urn:epc:id:sgtin:1000000.123456.61</epc>
        <epc>urn:epc:id:sgtin:1000000.123456.62</epc>
        <epc>urn:epc:id:sgtin:1000000.123456.63</epc>
        <epc>urn:epc:id:sgtin:1000000.123456.64</epc>
      </childEPCs>
      <action>ADD</action>
      <bizStep>urn:epcglobal:epcs:.bizstep:fmco.commissioning</bizStep>
      <dispose>urn:epcglobal:epcs:disp:fmco:in progress</dispose>
      <readPoint>
        <id>urn:epc:id:sgtn:1000000.00001.2</id>
      </readPoint>
    </AggregationEvent>
  </EventList>
</epcs:EPICSDocument>
```
Development of a demonstrator for EPCIS-based tracking and tracing

Web Application

Visualised Traceability

Event Management

Statistical Analysis

Discovery Service

EPCIS Manufacturer

EPCIS Distributor

EPCIS Retailer

EPCIS RTI Pooler

External Data Sources (e.g. EDI)

Manufacturer Discovery Service

External Data Sources (e.g. EDI)
Agenda

1. Motivation and research objectives
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3. Expected results
Expected results

• Framework for EPCIS-based tracking and tracing of RTI in the food supply chain: Guidelines, extensions.

• Development of a simulation model for simulating Auto-ID enabled material flow and generating realistic EPCIS-Events

• Design and implementation of a Discovery Service

• Recommendations for integration of EPCIS with current information systems e.g. EDI system.

• Recommendation and first implementation for EPCIS-based product (Contents of RTI) tracking and tracing in the food supply chain

• Development of a functional Web-demonstrator