Mietzsch, Esther; Graf, Wolfgang; Martini, Daniel and Schmitz, Mario

TransparentFood: Requirements and solutions for tracking and tracing in the food sector

One of the objectives of the TransparentFood project is to create a blueprint proposal for a European Backbone Solution that provides basic and simple functionalities to enable integration of tracking and tracing systems across system boundaries and chains. After an initial requirements analysis, methods and technologies that can be used to build such a solution have been gathered, analyzed and evaluated. Reuse of existing standards and leveraging the capabilities and networks of existing organizations is a crucial factor in facilitating build-up and uptake of the envisioned backbone.

Keywords
Tracking and tracing, food safety and integrity, quality assurance

Abstract
Landtechnik 67 (2012), no.1, pp. 31–33, 1 figure, 7 references

Evaluation of statistical data on enterprise size distribution in the food sector in the European Union showed a specific structure of the sector. While the larger enterprises commonly are small in numbers but contribute a relatively large part to the economic outcome and to the percentage of bound labour force, small enterprises still play a major role in various stages of the food sector, especially in primary production and specialized retail stores. A restriction of necessary investments is therefore crucial for the success of a backbone solution. Access to the backbone could be provided using the internet and different models of service provision, however temporary outages and poor connectivity have to be taken into account.

Stakeholder expectations

Stakeholders' expectations have been derived from statements of the respective parties participating in a chain. Consumers are demanding convenience foods, a good quality/price relation, and confidence in safety and quality of food production. Stores and dealers expect due diligence from the whole food chain. Processors and transport is the link with the highest difficulties in documenting all factors for the traceability of the origin and all steps of production and transport. Farmers expect to gather data in an easy and secure way and need to feel confident that this information would not be used against their interest. Common to all stakeholders is the demand to be able to access more information than simple tracking and tracing data. Of special value to the companies in or close to primary production is the ability to also track forward to be able to adjust production and marketing accordingly.

Food properties and handling

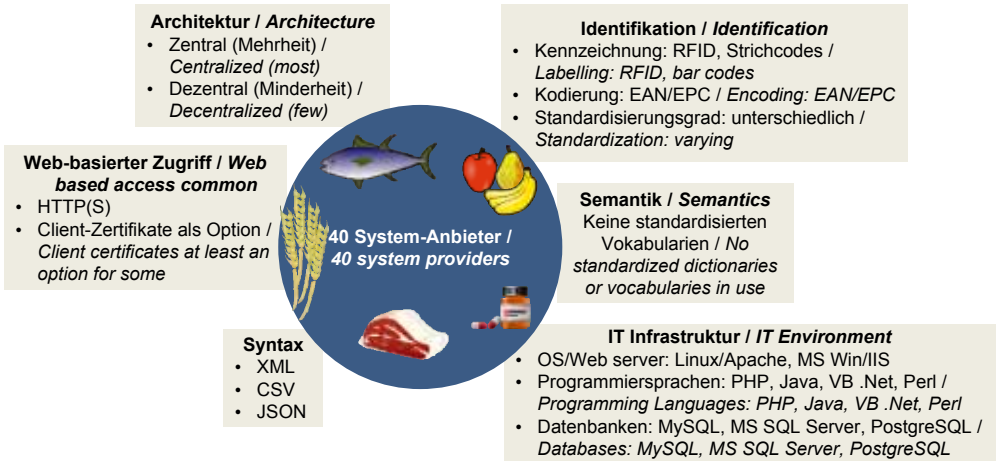
IT systems for food traceability face problems distinctive of the food sector. They mostly result from properties of food and the processes applied, such as mixing, dividing, handling of bulk material, processing with transformations, risk of deterioration and immaterial properties. A number of problems can be avoided by following best practices in handling. Others have to be dealt with on a technical level. An important aspect to consider is how identification schemes can be set up that support decentralized storage across different stakeholders and simple and efficient administration and querying at the same time.

The basic requirements on the traceability within the food chain are currently defined by the EU regulation 178/2002. A basic information set to enable tracking and tracing requires data on the shipping company, shipping timestamp, a product code and a lot number. To support transparency of additional information within the food chain, a "backpack" of further information is required, that allows for tracking depending upon chain scope, e. g. tracking attributes like "organically produced" or "fair trade". A problem to be faced in primary production is the lack of a well-defined and static traceability reference unit. Field sizes or animal groups can change over time and are often not treated uniformly.

Existing tracking and tracing systems

In desk research and with questionnaires, existing tracking and tracing systems have been analyzed as to what kinds of products can be handled with them, what functionalities they

Fig. 1



Existing tracking and tracing solutions

provide and what methods, standards and technologies they use [1]. Figure 1 gives an overview on the most important technical aspects. This should clarify if there is a common ground upon which the proposed backbone solution can settle.

Most common among the reviewed providers are the IT standards issued by the GS1 organization together with the Electronic Product Code (EPC). The majority implements a centralized data store, only few systems support a decentralized setup. Most systems do not require expensive investments, however for some of them special hardware is inevitable. Concerning the IT environment, a broad diversity can be observed. A variety of operating systems, web server software, programming languages and database systems is in use. It will therefore be important to consider portability in all of the technologies. None of the providers uses a standardized data dictionary. Semantic harmonization therefore will be one of challenges for data interoperability among systems.

In the next step, the available technologies were analysed according to the aspects organisational structures, protocols, syntax, semantics and identification.

Organizational resources

Various organizations provide standards and directions for data and information management in supply chains and in the food and agricultural sector [2]. Both public and governmental bodies (e.g. UN/CEFACT and UNECE on a global level, EFSA on a European level, limited term projects such as EuroFIR, various national governmental bodies) and private associations (e.g. GS1, EPCglobal, OASIS) are involved in this work. There are also a number of organizations providing basic and generic information technology standards (e.g. W3C, IETF, ISO JTC1).

Protocol

Protocols providing data exchange mechanisms in the eBusiness, supply chain and food sector include EDIFACT, the newer standard ebXML and EPCIS. EDIFACT and ebXML are mainly used for business transactions (order, delivery note, invoice) whereas EPCIS is a standard for the exchange of data on product movement. Most of the protocols currently available are based on the design paradigm of remote procedure calls using the SOAP technology. In this design, each service in a network can provide its own set of function calls which must be known in advance to all applications using this service.

Considering the scalability, flexibility and extensibility requirements given by the number of stakeholders involved and their different interests and the simplicity necessary to be able to also integrate small enterprises, these mechanisms are only suited in part for a backbone. Backbone services should rather follow a RESTful paradigm [3] that allows for easier global scalability and facilitated reuse of data in different contexts. RESTful web services are already in use by some of the system providers, and the method calls of HTTP upon which they are based are simple to implement and well understood.

Syntax

The most common syntax for data structuring is currently XML, used for example in ebXML, EPCIS or agroXML (in agriculture). An alternative to be considered is JSON, which is less verbose and more compact and thus allows for more efficient bulk transfer [4].

Semantics

Successful data exchange among anonymous partners on a global scale requires the use of a common language, in the best case based on controlled vocabularies. The most promising standards to build vocabularies are currently the Resource Description Framework (RDF/RDF-S, [5] and [6]) and the Simple Knowledge Organization System (SKOS, [7]) released by the World Wide Web Consortium. They provide methods to describe terms and relations among them and to build statements describing certain resources (objects, documents, processes etc.). Tools and programming libraries for these standards are readily available. Two main types of classification systems have been established in the food sector: hierarchical classifications

as used by the European Food Safety Agency EFSA, and faceted classification such as LanguaL. The AGROVOC thesaurus by the FAO is nowadays the most comprehensive multilingual thesaurus and vocabulary for agriculture.

Identification

To identify real-world objects, they can be marked using RFID, human readable numbers, bar codes or two dimensional barcodes like the DataMatrix code. The information stored in the tag most commonly is the Electronic Product Code (EPC), the Global Trade Item Number (GTIN) or a Uniform Resource Identifier (URI). Dereferencing mechanisms allow these identifiers to be used as internet addresses to execute service calls to request further information upon certain objects. 2D-Codes also allow for the encoding of further information such as expiration date, serial number etc.

Conclusions

To achieve flexible and dynamic information exchange the problem that various data dictionaries, thesauri and encoding systems within the food and agricultural sector exist which cannot easily interoperate with each other has to be tackled. Another issue is establishment for methods for the easy creation and management of unique object identifiers that are usable, accessible and affordable to small and medium sized enterprises in the food sector. All methods and technologies have to handle large amounts of data and to accommodate a large number of actors.

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Authors

Dr. rer. nat. Esther Mietzsch, **Dr. rer. hort. Wolfgang Graf**, **Dipl.-Ing. sc. agr. Daniel Martini** and **Mario Schmitz** are employees of the Association for Technologies and Structures in Agriculture (KTBL e.V.) in the team agroXML.