Integration and standardization in arable farming practice: a service-oriented approach[1]

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Abstract

KodA is a large research and technology development program that aims to put knowledge into practice for Dutch arable farming. Integration and standardization problems hamper the use of ICT systems that are considered as key enablers to achieve aimed objectives. An in-depth study investigated underlying problems of the current situation and provided an overview of current state-of-the-art solutions. A service-oriented architecture (SOA) approach is considered the most promising concept for solution directions. The study resulted in a vision for the future on integration and standardization along with a road map to implement this vision. This consists of a development of new - and adaptation of existing - applications according to common standards and agreements, driven by customer wishes. In parallel, a central, independent authority should be established for incremental development, control and maintenance of standards. It is extremely important that development is linked to real business cases of partners involved in KodA. The problem statement can be characterized by the chicken-and-egg dilemma, which came first? It is tried to tackle this problem by implementing relatively simple cases on pesticide and geographical information data first, to obtain a basic procedure to open up other data sources in a standardized way. This paper describes results of the investigation and the first succeeding steps that were taken in Dutch arable farming in relation to the problem of integration and standardization.

Key words: standardization, arable farming, service-oriented architecture, ICT adoption.

1 Introduction

The research and technology development program 'Knowledge in the field of arable farming', abbreviated as KodA, aims for sustainable farm practices in the field of arable farming by putting knowledge into practice in an applicable way. In KodA, about 60 arable farmers, their suppliers and processors (about 12 large companies), work together to improve quality and efficiency of arable crop production. This co-operation takes place in so-called interactive learning networks in which tasks for innovation are gradually implemented (Geerligs and Wolfert, 2007). It is a large program with a total budget of 8 MEuro, in a private-public partnership with the Ministry of Agriculture.

Modern ICT is seen as a key enabler to achieve the program's objective. By means of ICT, the farmer is able to use and deploy knowledge, information and data in an efficient way. Development of integrated management support systems in which actual, state-of-the-art knowledge and farm-specific data are combined, is regarded as a key prerequisite for further development. In a programming study, it was

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concluded that several factors hamper integration of these systems (Wolfert et al., 2005). Standardization was identified as one of the major problem areas that has to be solved to allow for integration to be improved. The KodA partners also stated that development of standards should go hand-in-hand with development of applications that prove the applicability of standards.

In a follow-up study an in-depth inventory was made of problems and developments regarding ICT-integration and -standardization. This has led to a long term vision and strategy on this subject along with a road map containing recommendations and a description of first concrete steps to be taken. This paper describes and discusses the results of this study. It will also provide the latest developments on this theme in the KodA program.

The study was carried out by a small project team while a group of experts was consulted by discussions during workshops and reviews on draft versions of a report. The experts had a background in research, development and application of ICT in agriculture.

2 Key findings

2.1 Current situation

In a survey of the current situation in Dutch arable farming different architectural components and different types of information were identified.

Architectural components:

- farm management systems, mainly administrative systems on financial and crop production processes
- decision support systems: research and advice applications
- machinery (e.g. tractors, storages)
- information-exchange between chain partners (processors, suppliers, government)
- general technical infrastructure (internet, wifi, GPS)

Information types:

- historical (farm) information from an internal or external database
- information from research (reports, more and more electronically available)
- advices
- actual production information by monitoring and sensing
- product information from processors
- administrative data from government
- general information like weather data, market prices

Currently, farmers too often have to re-enter the same information for different purposes or they cannot automatically exchange information between different systems which hampers the use of applications for advise and knowledge use. The flow of information also doesn't sufficiently link up with everyday management activities of a farmer. Although there are already some good examples of information exchange, an integrated approach is still hard to find. Two dimensions can be distinguished: a horizontal one for applications within the farm domain, and a vertical one for integration within the food production chain. For the latter, an authorization body for standardization in the arable sector already exists, called 'EDI-teelt'. It focuses on defining, maintaining and deploying standard XML messages to exchange company-, parcel- and production-related information. 'EDI-teelt' is an association of mainly processors and farm management software providers. It is a 'light-weight', virtual organization, based on small workgroups that develop specific standards in which members voluntarily participate. At the moment, there is hardly any activity on standardization in the horizontal domain: actual farm management processes.

2.2 Vision on integration and standardization

A general infrastructure is needed as a sort of glue that allows to combine different components and information flows into working information systems. It is expected that quick-wins can be made when

software developers adapt their applications to common standards for data exchange and make data and software services accessible within a service-oriented architecture (SOA). The future vision on integration and standardization of ICT in arable farming is based on this SOA approach, which is visualized in Fig. 1. At the left side, we depict different components that hold specific data or applications. The intention is clearly not to merge them all into one large integrated data warehouse or application. That is practically unfeasible and there is often many resistance against it for reasons of privacy, property rights or other ones. The idea is that relevant information is actively made available by web services, which can be implemented by adopting worldwide standards based on SOAP (Simple Object Access Protocol), WSDL (Web Services Definition Language) and BPEL (Business Process Execution Language). SOAP, WSDL and BPEL in its turn are based on the XML-standard for electronic information exchange. Thus, XML messages describe a piece of information that can be used to develop other applications or services that fully comply with the agreed upon information standard. These applications or services can integrate several pieces of information and functions that are necessary for management support. The basic idea of web services is that all information is available at any time and any place through the internet. A 'yellow pages' component is necessary in order to know what services and applications are available and what information they can provide. For web services this has already been arranged by the worldwide used UDDI registry (Universal Description, Discovery and Integration). Portals can be useful as a theme-specific web-interface for viewing the UDDI and applications and services in a user-friendly manner. However, as more devices (handhelds, board computers) are using an internet communication interface it is desirable that several components directly communicate with each other.

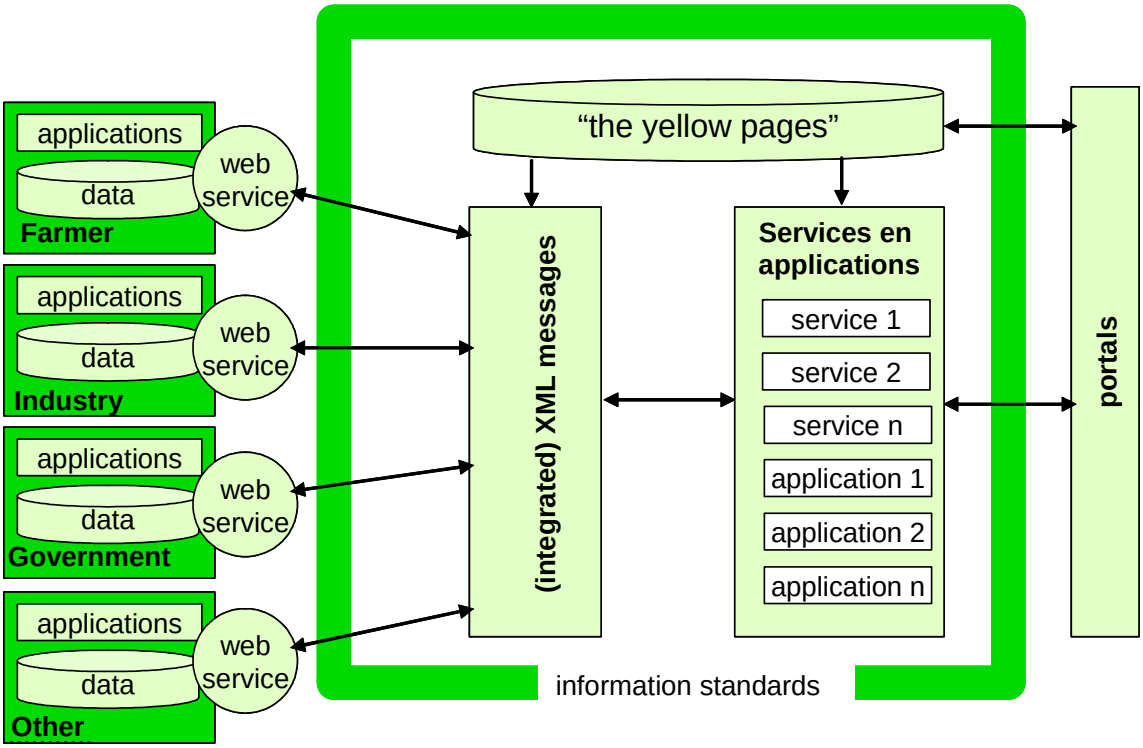

Fig.1 The service-oriented architecture (SOA) philosophy as applied for arable farming

Some crucial prerequisites for this SOA-approach are

- development of applications and services should be left to the market
- there should be an open approach to standardization in which all relevant parties make agreements
- the standards must create added value for production
- the standards must be open for everyone and maintained at a central place
- standardization is not just a matter of hard infrastructure and technology, but just as important are agreements on models, concepts, semantics and ontology.

2.3 Road map for development

The road map to implement this vision is characterized by two parallel activities:

- development of new and adaptation of existing applications within a shared integration infrastructure and according to common standards and agreements, driven by customer wishes
- an incremental development of the integration infrastructure, comprising mentioned standards and agreements, guided by a central independent authority. This development can take place at various organizational levels:
  - *industry-wide*: one central institution that is coordinating industry-wide standardization, managing alignment with relevant international standards, supporting knowledge exchange within the sector, continuously monitoring the developments out of the industry and bringing in useful knowledge;
  - *coalitions*: cooperating companies, including service providers, research institutes and governmental organizations, that come to terms with specific subjects and develop new solutions based on agreed industry-wide standards and using industry-wide knowledge;
  - *individual organizations*: especially farmers, processing companies, and software companies that actively participate in coalitions and adapt their products to the agreed standards.

The different tasks, associated with these activities, can be allocated differently to these organizational levels. Several experiences in Dutch arable farming have learnt that a central organization should not be organized too 'heavily'. A network-coordinated organization with small staff is preferable. Such a dynamic organization should focus on sector-specific standards (small part of the total required standardization) and on providing services to coalitions related to adoption of external standards and usage of external knowledge. The coalitions at second level are crucial for the success of integration and standardization in Dutch arable farming. In table 1, the advised allocation of roles is summarized.

Table 1. Recommended allocation of roles to different organizational levels.

	Standards	**Models**	**Infrastructure**
Industry-wide	Set arable farming specific standards; Alignment with international standards	Develop overall reference process and data models; make them available for coalitions and monitor consistency	Gather and transfer 'state-of-the-art' knowledge about integration infrastructure
Coalitions	Support agreed standards	Develop specific models; Align with overall models	Design and implement integrations
Individual companies	Adapt software product interfaces to standards	Support model development and deliver input	Develop commercial products

Referring to the current situation, this will require major investments for all parties involved. The KodA program can provide some 'seed money' for this purpose, but in the end it should be a self-supporting system in which costs and benefits are made clear.

New projects should focus on quick-wins in order to achieve acceptance and a basis for support and to get the learning process started. The partners in KodA should be involved from the beginning of a project definition to provide a durable basis for support.

2.4 Recommendations

The recommendations from the study were:

- The KodA program should propagate the vision as described before at all possible organizational levels so that the basis for support is being increased and 'free riders behavior' is discouraged;
- An authority on standards must be established to develop, control and maintain standards that must be accepted by the complete arable sector; the current organization 'EDI-Teelt' is considered to be a good starting point;
- The realization must be stimulated, facilitated and financed in an appropriate way.

3 Discussion and actual developments

The results of this study were thoroughly discussed within the KodA program by the partners. It was concluded that:

- the KodA partners endorse the viewpoint on integration and standardization of the study but
- emphasize that development must be linked to real business cases and problems of partners that are involved in KodA; this means that developments should prove noticeable benefits for farmers and
- activities should link up with other national and possibly international initiatives so that resources are used efficiently.

This task can be characterized by the dilemma of the chicken and the egg: which one came first? A generic infrastructure with standards is first needed before successful applications can be developed on it and applications can only be called successful when they elaborate on the generic infrastructure. Hence, it was decided to start a project, dealing with relatively simple cases, but it should result in a general established line along which more complex cases can be dealt with in the future. This project started in December 2006 and comprises the following activities:

- provide for access to data of some data source by a web service from which these data can be retrieved 24 hours a day, 7 days a week, according to a public and commonly agreed standard.
- professionalization of the current authority 'EDI-Teelt' by:
    - updating, developing, maintaining and publishing the current standards in a service-oriented architecture;
    - making long-term agreements with the organizations involved in terms of service level agreements (SLA's) in order to ensure the availability and quality of the data;
    - writing a business plan to set up a new organization of 'EDI-teelt' (working name 'EDI-teelt+') that can sustain according to general market principles;
- description of the aforementioned activities in a procedure so that other cases of opening up data can be treated in the same way.

Two case studies were chosen to provide for proof of feasibility. One on pesticide data, in which a basic list of permitted pesticides is published by law by two governmental organizations: PD and CTB. A quick-win application is that the farmer can check *real time* whether a specific pesticide is permitted or not by using a web service. This application can be addressed, like a 'subroutine', within an existing software package. Probably, this is not really a 'killer application' but it will provide a proof of principle of how the service-oriented architecture will work. The other case study is in the field of geographical information, a field in which several farmers in KodA are highly interested in. In this case, data sources from on-farm crop and soil monitoring activities are also made available by web services. It was decided to choose for the theme of fertilizing and how soil and crop monitoring data can be integrated in order to generate specific advices for fertilizing for the farmer. Probably, other services (e.g. crop growth models) are also needed. The aim is ultimately also to translate this automatically to a farm machine, i.c. a fertilizer drill. The two case studies are schematically represented in Fig. 2.

The first challenge in these case studies is to implement the technical part: making the communication between systems components work by web services. However, this is just the technical part of the work and there are already many worldwide protocols, standards, procedures and toolkits available on how to implement an SOA-architecture. The real challenge is to co-ordinate the agreements between several organizational units involved. The organization in view 'EDI-teelt+' is expected to play a key role in this. On behalf of the total arable farming sector they can negotiate about the content of messages that web services provide and make contracts on availability and quality of the service. Beside this organizational role, EDI-teelt+ can also play a role in integrating standards at a precompetitive stage, before information is used in a commercial application. So, in one case a webservice can directly communicate with a web connector of a commercial application (route a in Fig. 2) or EDI-teelt+ can play a director's role and possible integrate it with other information (route b). For the geo-information case, route b is explicitly chosen to try out and demonstrate this principle. Time will learn how heavy the role of EDI-teelt+ in this process will be in the future.

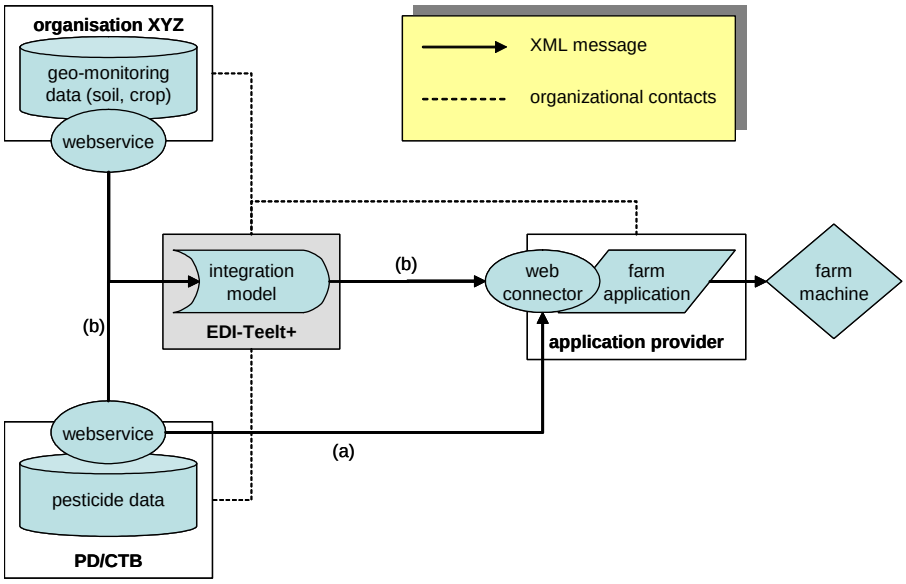

Figure 2 Schematic representation of the current two case studies on pesticides and geographical information that demonstrate the service-oriented architecture. Webservices that communicate with each other by XML messages form the basis, but appropriate interaction and agreements between underlying organizations is of crucial importance.

4 Conclusions

Integration of ICT-applications for farm management support in the Dutch arable farming sector is still a big challenge and major progress in the area of standardization and applications have to be made. In the current study an in-depth investigation of this problem situation was made. Developments should follow a service-oriented architecture (SOA) approach. This comprises several technical components, mainly implemented in web services and accompanying XML messages, but also a strong organizational component. For the latter component, a role is reserved for the existing authority in standards 'EDI-teelt'. The arable farming sector, as represented by the partners in the KodA program, agree with this development, but they also have some major preconditions. Beforehand, they don't want to put a large amount of money in setting up a new organization. The development of such an organization should go hand-in-hand with development of practical applications that solve their actual problems and demonstrate a proof of concept of the desired SOA-architecture. Hence, the first steps in the development of integration and standardization were made by defining two relatively simple case studies: on one pesticide data and one on geographical information, both in the context of farm management support. The two cases will be used to get a better view on both technical aspects of SOA-implementation in arable farming and organizational aspects focusing on professionalization of the current standards authority 'EDI-teelt'. The developments in this paper show that in the problem area of integration and standardization, involvement and support of stakeholders is very important and how this can be reached by following a step-by-step approach.

5 References

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