Georg Steinberger and Matthias Rothmund, Freising, Daniel Martini, Darmstadt, Christine Spietz, Bingen, Dirk Mallon, Bielefeld, and Edward Nash, Rostock

Integrating agroXML into an Agricultural Spatial Data Infrastructure

The standardised data-transfer format agroXML, as described in LANDTECHNIK 1/2007 [1], has been developed to ease the increasingly important exchange of data. Version 1.2 can currently be used by all software developers for the production of interface modules. However, spatially-referenced data are currently not sufficiently represented in agroXML. A concept for integrating geographic data into agroXML and the use of agroXML as a transfer format in spatial data infrastructures has been developed since the middle of 2005, as part of the pre agro collaborative research project.

DIa. Georg Steinberger and Dr. agr. Matthias Rothmund are scientists at the department Engineering in Plant Production of TU München; e-mail: *georg.steinberger@wzw.tum.de*
Dipl.-Ing. sc. agr. Daniel Martini is member of the scientific staff of KTBL in Darmstadt.
Dipl.-Inf. (FH) Christine Spietz is a scientist at the „Kompetenzzentrum für Innovative Informationssysteme" of the technical Highschool in Bingen.
Dirk Mallon is information specialist examined by state and employed by AGROCOM in Bielefeld.
Dr. Edward Nash is a scientist at the chair of „Geodesy and Geoinformation" of Rostock University.

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The requirement for the integration of spatial information can be split into two aspects. On the one hand, the agricultural operations which the data describe define these requirements. The use-cases and operating conditions in which the data are to be used, including in international contexts, must be considered. For instance, a basic crop-stand documentation requires a lower degree of detail than, for example, the documentation requirements of precision agriculture or a process analysis of machine usage. On the other hand, from a technological perspective, multiple possibilities for the implementation must be modelled and evaluated. The requirement to be able to present a flexible level of detail generally leads to generic and complex models. The use of existing standards should however ease the development of software components. For spatial information the standards of the Open Geospatial Consortium (OGC) can be used: Geography Markup Language (GML) as an XML dialect for spatial data and a range of web-service interface standards for defining the procedures of data transfer.

Service-oriented architecture for agricultural data exchange

To fully benefit from a standardised data format, an accompanying infrastructure for the exchange of data must also be realised. An architecture concept has therefore been developed and tested in a range of use-cases within the pre agro project. agroXML files could, of course, be sent via E-mail to business partners, but a real simplification of the work-flow and time-savings will only be realised through use of automated interfaces between data-sources and end-user software. The current state-of-the-art technology for this purpose is the use of web services as part of a service-oriented architecture. These allow functionality to be distributed between multiple computers in a network with individual modules being accessed through standardised interfaces. The farmer's software may then access many distributed data sources and processing functions. Using this mechanism, complex or very resource-intensive data processing tasks may be delegated and distributed. Relevant standards here are defined by the OGC: *Web Feature Service (WFS)* and *Web Coverage Service (WCS)* to deliver spatially-referenced information with a vector or raster data-model respectively, the *Web Processing Service (WPS)* for data-processing and the *Web Map Service (WMS)* for delivery of simple maps in graphic formats.

The majority of the currently-available implementations of the Web Feature Service interface only support a generic GML format with a so-called Simple Features Model. However, agroXML has a nested data-struc-

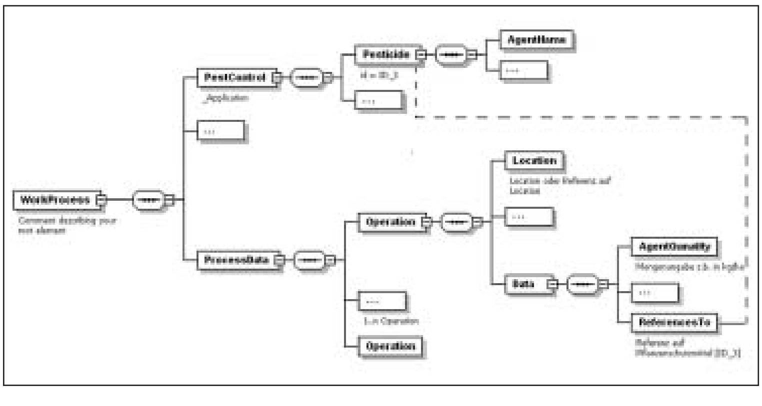

Fig. 1: Simplified view of a pest management job and process data presentation within the agroXML scheme of the pre agro test implementation

ture which is not easily transformed into this model and only uses some components from GML rather than being directly based upon it. The WFS standard is nevertheless designed to support the use of complex schema and formats other than GML. The existing XML technology XSLT allows the enhancement and simple conversion of data and datastreams. Using XSLT therefore allows OGC-Standard web-services to interact with agroXML.

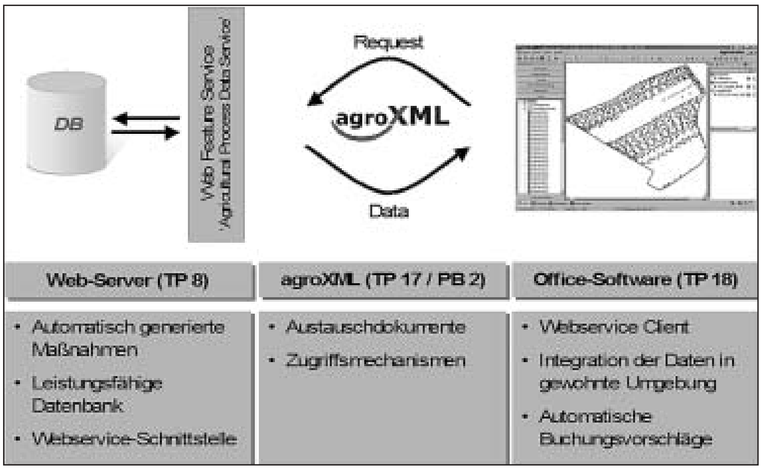

Fig. 2: Import of process data information into the field index software (Use case, implemented in cooperation of part projects (TP) within the group (PB) 2 "Information Management" of the pre agro research project)

Representing sub-field specific data in agroXML

Prototype models for the representation of spatial information have been tested as part of the pre agro project [2]. These will be successively integrated into the agroXML standard based on requirements and acceptability.

The representation of agricultural processes at a sub-field level is of particular interest in precision agriculture. For this, the main spatial reference is the farmed area with all its sub-zones und their related soil-, sensor-, yield-, application-, process- and work data. In order to represent this information in the agroXML test-version, the representation of the enclosing "application data" is separated from the detailed "process data". The information relevant to the whole area may then be represented in the "application" whilst the sub-field specific details are represented in the "process data" (*Figure 1*).

Test implementation

To test the data formats and architecture concepts, various use-cases have been implemented such as the contracting of a consultant for a soil test and the delivery of the analysis results [3] and the delivery of crop stand data with field boundaries and attribute information and the generation of a fertilisation map from multiple data sources. The direct integration in agricultural office software of data delivered from web-services is demonstrated based on the processing and delivery of machine process data (*Figure 2*). An agricultural process data service automatically processes the data gathered by working machinery [4]. Individual datapoints are allocated to agricultural operations with the help of specially-developed algorithms for data-analysis. The data may then be accessed directly via a web-service interface from compatible farm office software. For this, deegree, a free Web Feature Service implementation has been used. The level-of-detail in the information is determined by the office software and may range from querying the summarised data of a completed operation such as start- and end-time, machinery used and which crop-stands were worked through to the data of each individually captured process data point. This information is loaded into the office software as a template record entry. Spatial information such as the field boundary and process data point location can be visualised in the in-built GIS module. The complex and processor-intensive steps of analysing the process data as well as the disk-intensive safe archiving of the data are thus outsourced to a consultant's server. The farmer has access to the desired management information, can set the level-of-detail of the information appropriately for the current problem and concentrate on the management of the farm without having to spend time on file management and data conversion.

Conclusion and outlook

It has been shown that addressing many needs in a single agroXML format leads to deeply-nested XML structures. These are then not straightforward to use for data transfer with web services. In order to implement an automated data exchange with deegree, the database structures which were developed to better-integrate spatial data in agroXML had to be converted into a simplified internal format. Even with the awaited further development of web-service technologies, there will still in future be different interfaces required for different tasks and usergroups, although it is to be expected that these will largely be based on XML. The existing, and in future undoubtedly increasing, range of XML interface formats with which compatibility is desired, will require the integration of further services for data format conversions in future architecture concepts.

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