



Project no. **212117** Project acronym: **FUTUREFARM**  
 Project title: **Integration of Farm Management Information Systems to support real-time management decisions and compliance of management standards**  
 Instrument: **Collaborative project**  
 Start date of project: **1<sup>st</sup> January 2008** Duration: **36 months**  
 Thematic Priority: **THEME 2 FOOD, AGRICULTURE AND FISHERIES, AND BIOTECHNOLOGY**

**Deliverable 4.2** Revision: **Final**  
**Definition of an interface for a knowledge repository**

Due date of deliverable: **30/07/2009** Actual submission date: **01/09/2009**

Work package 4: **Knowledge management in the FMIS of tomorrow**

Organisation name of lead beneficiary for this deliverable:  
**Helsinki University of Technology**

Authors: **Raimo Nikkilä (TKK), Edward Nash (UR)**

Accepted by Edward Nash, 01/09/2009

Accepted by Simon Blackmore, 01/09/2009

<b>Project co-funded by the European Commission within the Seven Framework Programme (2007-2013)</b>		
<b>Dissemination Level</b>		
<b>PU</b>	Public	X
<b>PP</b>	Restricted to other programme participants (including the Commission Services)	
<b>RE</b>	Restricted to a group specified by the consortium (including the Commission Services)	
<b>CO</b>	Confidential, only for members of the consortium (including the Commission Services)	

**Executive Summary**

The knowledge repository, identified as a system for delivering agricultural standards represented as encoded rules, consists of three primary elements. These elements are the catalogue server interface, through which the actual rule servers are discovered, the rule server interface and the encoding schema of the agricultural standards as rules. The encoding schema was specified as part of FutureFarm Deliverable 4.1.1. This document describes the server and catalogue interfaces and contains formal specifications as appendices.

The catalogue servers are a listing service for the rule servers to allow easy discovery of relevant rule servers for any given task. The rule servers have an interface similar to the catalogue servers and are intended to provide agricultural standards represented as a collection of rules and various metadata relevant to the use of the standards. The encoding scheme for the rules is an XML schema that describes how the agricultural standards and their metadata are encoded for convenient automatic management.

All of the described services are based on REST which is a simple yet powerful mechanism for implementing Web-services without resorting to the use of the more complex SOAP and related technologies. Existing technologies have been used extensively throughout the development process.

## **Introduction and scope**

The knowledge repository, in this context, is a combination of systems which provide access to agricultural standards encoded as formal rules for the purpose of automated assesment of compliance to these standards.

This document specifies the elements necessary for a complete interface to the system composing the knowledge repository. The rules are expected to be used both reactively (pre-operation) and proactively (post-operation evaluation) in the assessment of compliance but this interface is independent of any appliance of the rules and does not impose any restrictions on the matter. Though the rules are intended primarily for automated use, presentation of the rules for manual interpretation and evaluation is not restricted and is most likely necessary in cases involving agricultural standards which can not be represented in any reasonable formal manner.

The internal operations of the FMIS are beyond the scope of this document, as is the actual evaluation of the rules for the assesment of compliance.

The evaluation of the rules requires not only the rules themselves, but also considerable amounts of metadata that describes the rules and their combinations. A mechanism is also required to identify the data that is required for the proper evaluation of the rules. The identification of this data is not a trivial problem as standards are unlikely to be based on an identical ontology, meaning that there are semantic differences between the standards that must be managed during the evaluation of the rules. Common sets of meta-data and ontologies are technologies that can help alleviate this problem.

To access the encoded agricultural standards, the FMIS requires the address of a catalogue server. Additional catalogue servers need not be known as a catalogue server contains a listing of other catalogue servers. The initial catalogue server is assumed to be either known to the FMIS or inputted manually by the user.



OWS (Whiteside, 2006) since it provides all of the necessary functionality and is easy to implement.

All of the rules are encoded using RIF (Rule Interchange Format) Core (Boley et al., 2009), which is a standard under development by the W3C for the presentation of rules intended for automatic inference. The rules required for the agricultural standards are mathematically simple but require non-trivial metadata for the combination of rules and ontologies and related technologies to manage semantic differences between rules and data sources.

OWL (Web Ontology Language – McGuinness & van Harmelen, 2004) is used in its most simple form, OWL DL, which provides powerful descriptive features. The additional features provided by the more complicated OWL-Full are not required. The use of ontologies is restricted to descriptive features and there is no identified need for ontology inference or other advanced ontological functions.

Geographic information, which is essential for several rules, is presented in GML (Geography Markup Language – Portele, 2007), which is a standardised XML-based representation for spatial data.

Dublin Core (DCMI, 2008 – also specified in ISO 15836:2009) is a collection of metadata elements for the representation of common concepts within information. Metadata has been identified as crucial for the automated assessment of compliance and is required for both standards as well as individual rules. Since the ontologies of standards can differ, having at least a common subset of concepts is essential.

### **Workflow of the system involving the knowledge repository**

- The FMIS contacts a catalogue server and obtains a list of catalogues
- Relevant catalogues are identified
- The FMIS contacts relevant catalogue servers and obtains a list of rule servers
- Relevant agricultural standards are identified
- The FMIS contacts the rule servers and obtains the agricultural standards represented as formal rules
- Rules are used in automated assessment

Communication with the catalogue and rule servers can be achieved with any tool capable of generating an arbitrary HTTP request. For most operations, this request is

extremely simple, such as a GET request without a body, or a more complicated POST request with a large XML document as the request body. Appendices A and B contain the technical descriptions of all requests, replies and error conditions for the catalogue and rules servers respectively.

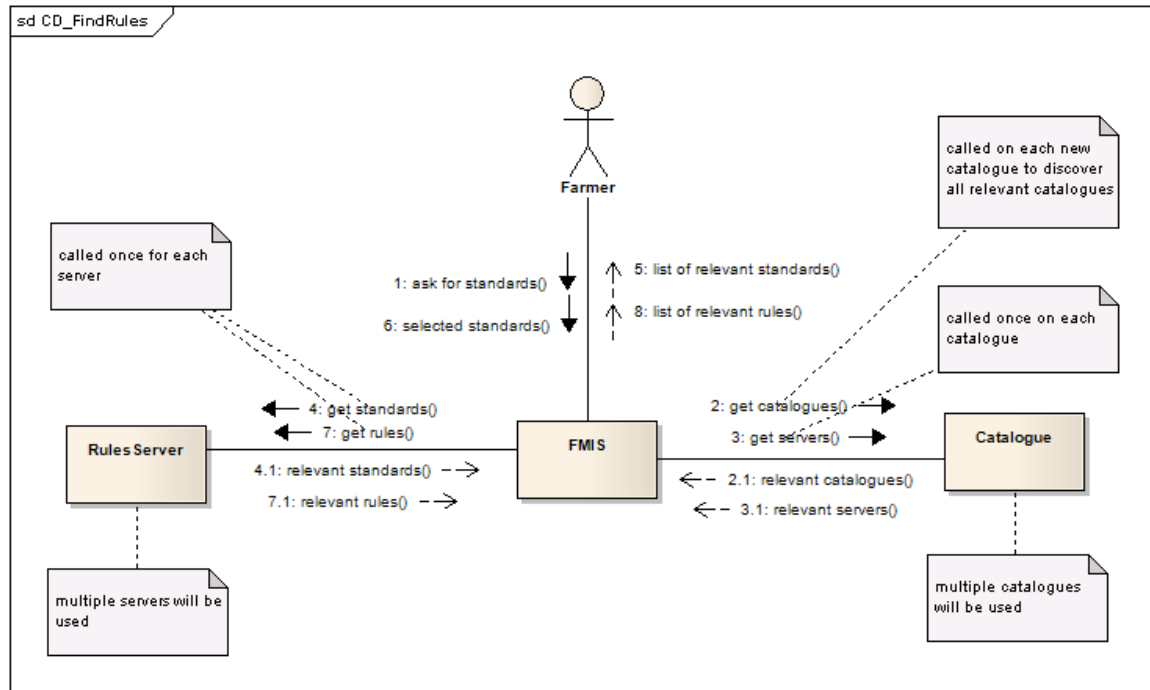


Image showing the expected workflow of the system for obtaining rules.

This document does not consider the identification of relevant catalogues or standards nor the actual evaluation of the rules. While the evaluation of the rules is intended to be automated, the selection of relevant standards is most likely to be a largely manual process. The data or the rules might require transformations as there are expected to be semantic differences between data from different sources. The technical details of these transformations are not considered but sufficient metadata is included with the standards and individual rules to make these transformations possible.

## Security considerations

Security of the knowledge repository must be guaranteed, meaning that the obtained lists of rule servers, standards and the actual standards themselves must be verified to be original and unaltered. A broken or missing rule might result in an accidental and involuntary failure to adhere to the standards and is thus unacceptable.

There are several good existing technologies to achieve the required degree of security. These technologies include encrypted connections (Rescorla, 2000), use of authentication (Franks et al., 2009) and TLS certificates. Since REST uses HTTP for communication, and all these security methods build on the basic HTTP connection, all these existing technologies can be used without additional work or modification of the interface specification.

## **Discussion**

The overall architecture is divided and at present there is no concentration of functionality anywhere as seems to be the present trend with web-services emerging as the leading technology for new systems. It is implied that there can be more than one catalogue server and most likely there will have to be several rule servers. Maintaining an up to date list of the catalogues, however, is an added technical complexity, especially since it is expected to involve inter-organisational communication and agreement.

The choice of REST over the more complete, and considerably more complicated, SOA family of protocols is technically sound as it provides all the necessary features at a fraction of the complexity of most of the alternative solutions for the implementation of web-services. However, REST-based services do require some special management and there are restrictions on what can be accomplished with REST. Should the requirements for the catalogue or the rule servers change considerably, the choice of REST for the implementation of these services might have to be revised.

The chosen security measures are as mainstream as security measures can be, but the TLS with the use of proper certificates has been successfully used in, for example, online banking for several years, an area where security is of utmost importance. More extensive security measures, such as one-time-passwords are not deemed necessary.

## **Appendices**

- A) Specification of a catalogue server interface
- B) Specification of a rule server interface

## References

Boley, H., Hallmark, G., Kifer, M., Paschke, A., Polleres, A., Reynolds, A. (Eds.), 2009. RIF Core Dialect. W3C Working Draft 3 July 2009. Available at <http://www.w3.org/TR/rif-core/> (18/08/2009).

DCMI, 2008, Dublin Core Metadata Element Set, Version 1.1. Available at <http://dublincore.org/documents/dces/> (18/08/2009).

Fielding, R., 2000. Architectural Styles and the Design of Network-based Software Architectures. Doctoral dissertation, University of California, Irvine, USA. Available at <http://www.ics.uci.edu/~fielding/pubs/dissertation/top.htm> (18/08/2009).

Franks, J., Hallam-Barker, P., Hostetler, J., Lawrence, S., Leach, P., Luotonen, A., Stewart, L., 2009. RFC 2617 – HTTP Authentication: Basic and Digest Access Authentication. Available at <http://tools.ietf.org/html/rfc2617> (18/08/2009).

McGuinness, D.L., van Harmelen, F. (Eds.), 2004. OWL Web Ontology Language Overview. W3C Recommendation 10 February 2004. Available at <http://www.w3.org/TR/owl-features/> (18/08/2009).

Nash, E., Nikkilä, R., Pesonen, L., Oetzel, K., Mayer, W., Seilonen, I., Kaivosoja, J., Bill, R., Fountas, S., Sørensen, C., 2009. Machine Readable Encoding for Definitions of Agricultural Crop Production and Farm Management Standards. FutureFarm Deliverable 4.1.1. Available at [http://www.futurefarm.eu/system/files/FFD4.1.1\\_Encoding\\_of\\_standards.pdf](http://www.futurefarm.eu/system/files/FFD4.1.1_Encoding_of_standards.pdf) (18/08/2009).

Pautasso, C., Zimmermann, O., Leymann, F., 2008. RESTful Web Services vs. Big Web Services: Making the Right Architectural Decision. Proceedings of the 17th International World Wide Web Conference (WWW2008), Beijing, China. Available at <http://www.jopera.org/docs/publications/2008/restws> (18/08/2009).

Portele, C. (Ed.), 2007. OpenGIS Geography Markup Language (GML) Encoding Standard, version 3.2.1. Open Geospatial Consortium, Wayland, MA., USA.

Rescorla, E., 2001. SSL and TLS: Designing and Building Secure Systems. Addison-Wesley Pub Co. ISBN 0-201-61598-3.

Rescorla, E., 2000. RFC 2818 – HTTP over TLS. Available at <http://tools.ietf.org/html/rfc2818> (18/08/2009)

Whiteside, A. (Ed.), 2007. OGC Web Services Common Specification, version 1.1.0. Open Geospatial Consortium, Wayland, MA., USA.