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Advances in Developing Web-based DSS in the Domain of Cereal Grain Drying, Handling and Storage

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ABSTRACT

Emerging technologies enhancing implementation of more advanced software were analyzed and applied to upgrade the standalone DSS *Ziarbit,* developed by the authors in past years, to a form of a Web-based decision support system embedded in Semantic Web frameworks. The system was developed to support design and management of cereal grain drying, handling and storage facilities. New technologies were used for problem domain analysis, UML diagramming, knowledge representation and Semantic Web implementation, and recent Microsoft programming environments were applied (.NET 4.5, ASP .NET 4.5, C++/CLI and C# available in Microsoft Visual Studio 2012, and Windows Phone SDK 8). In order to ensure interoperability, a concept of Internet-based Knowledge Center (IKC) was introduced and the new system was developed within the IKC framework.

Keywords: Web application, decision support, .NET technologies, cereal grain processing, Semantic Web, Poland.

1. INTRODUCTION

For farmers, agriculturally-related businesses and industries involved in grain drying, handling and storage it is necessary to have prompt, relevant and reliable information to make better decisions and maintain quality standards. Fast, flexible access to information available on the Web is essential. It could be attained by keeping decision support software up to date, especially by taking the advantage of innovative and effective ICT opportunities. New advanced technologies available for developing Web-based decision support applications can increase functionality, reliability, usability, maintainability and performance of such applications (Weres et al., 2010, Kozłowski et al., 2011). Integration of information derived from diverse sources and transformation of the DSS to an adoptable Semantic Web-based DSS is a strong trend for future system development (Blomqvist, 2012, Janjua et al., 2013, Kluza et al., 2011). Additional new possibilities are offered by smartphone applications for interaction between users and servers (Esposito, 2012, McWherter and Gowell, 2012).

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The objective was to indicate, implement and analyze emerging technologies useful either for developing new systems or for upgrading old-day standalone applications to a form of Web-based decision support system embedded in Semantic Web frameworks. Implementation of new technologies was exemplified by an upgrade of a standalone DSS *Ziarbit* developed by the authors in past years (Weres et al., 2007) with an intention to support design and management of cereal grain drying, handling and storage facilities.

2. MATERIAL AND METHODS

The new version of the "Ziarbit" Web-based decision support system was developed with the use of several methods appropriate for project management (Hundhausen, 2012) and software engineering (Sommerville, 2010), especially for the problem domain analysis and UML 2.4.1 diagramming, knowledge representation and Semantic Web standards (Kluza and Weres, 2012), and recent Microsoft technologies (Nagel et al., 2012, Troelsen, 2012). As programming environments, .NET 4.5, ASP .NET 4.5, C++/CLI and C# 5.0, available in Microsoft Visual Studio 2012, and Windows Phone SDK 8 were chosen. To satisfy the goal of interoperability and reusability of existing Web-based knowledge (Weres et al., 2010, Kozłowski et al., 2011) a set of Semantic Web languages was used (Blomqvist, 2012, Janjua et al., 2013, Kluza et al., 2012). In particular, to ensure the interoperability, an original concept of Internet-based Knowledge Center (IKC) was introduced (Kluza et al., 2011, 2012), this concept became a framework for the new system development.
A light version of the system was also developed for smartphones, on the basis of methods appropriate for smart apps development (Esposito, 2012, McWherter and Gowell, 2012)

3. RESULTS

The model for the problem domain (Fig. 1) was based on three principles:
1) To identify. Identification and description of knowledge domains (their terminology, vocabularies, steps of the process and so on).
2) To describe. Design of the datasets required to be part of DSS scenario (knowledge comes into the solution from RDFa annotated resources, outside from the IKC space in the form of existing ontologies and semantic vocabularies (LinkedData space) and also from custom designed ontologies from within the IKC). Due to the lack of the semantically (in terms of Semantic Web technologies usage) enabled resources, the preparation of such outside resources was also required.
3) To consume. Creating an Agent Service and/or Software to consume the knowledge from the IKC space.

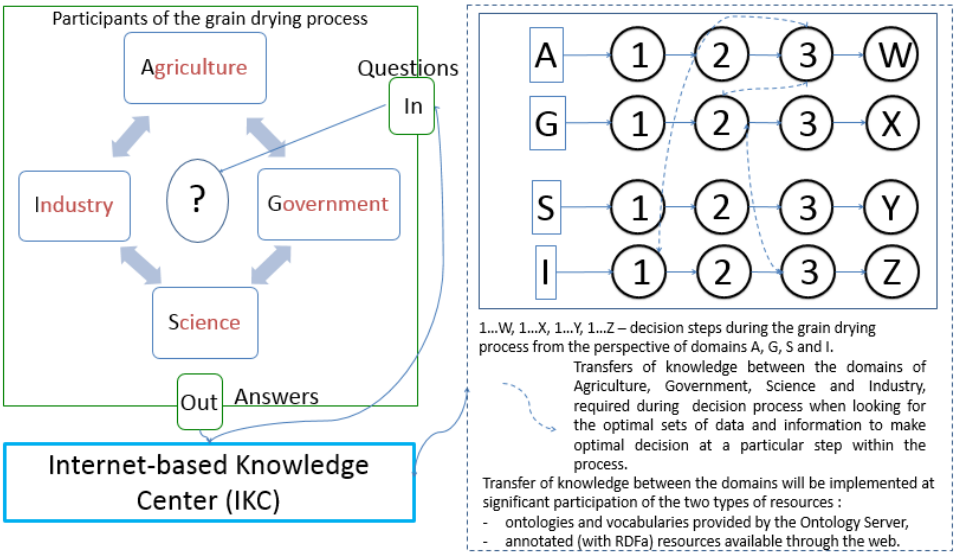

Figure 1. Model of the Internet-based Knowledge Center (IKC).

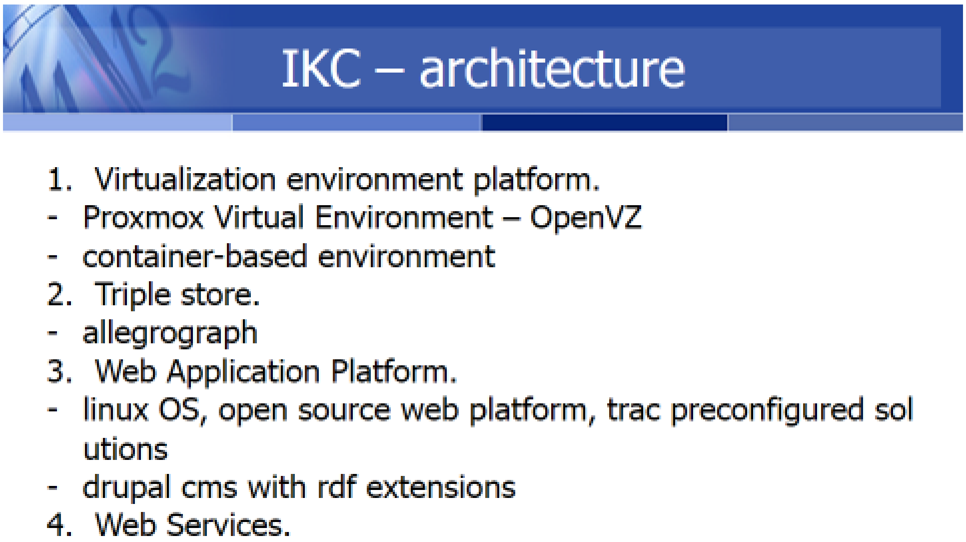

Figure 2. Architecture of the Internet-based Knowledge Center (IKC).

The core elements of the IKC architecture (Fig. 2) were based on the principle: mature, stable and proven technologies and software available for free.

- Proxmox Virtual Environment, PVE (Fig. 3) - the openvz container based solution, which enabled rapid building of the required environments along with prototyping and trying many different configurations and settings. In addition, the environments created on top of the PVE could be built with usage of turnkey Linux distributions preconfigured for the specific roles – like Web Server – and with the TurnKey Hub Service they could be automatically backup on the Amazon S3 platform.

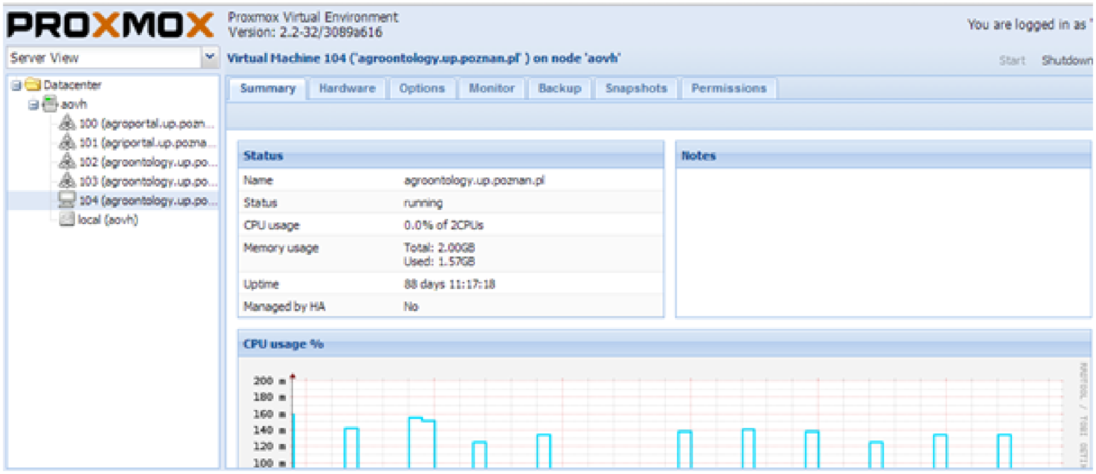

Figure 3. Proxmox Virtual Environment.

- Protégé Desktop ontology editor (Fig. 4) was used as the main ontology development tool and configured to work with visualization and reasoning plugins.

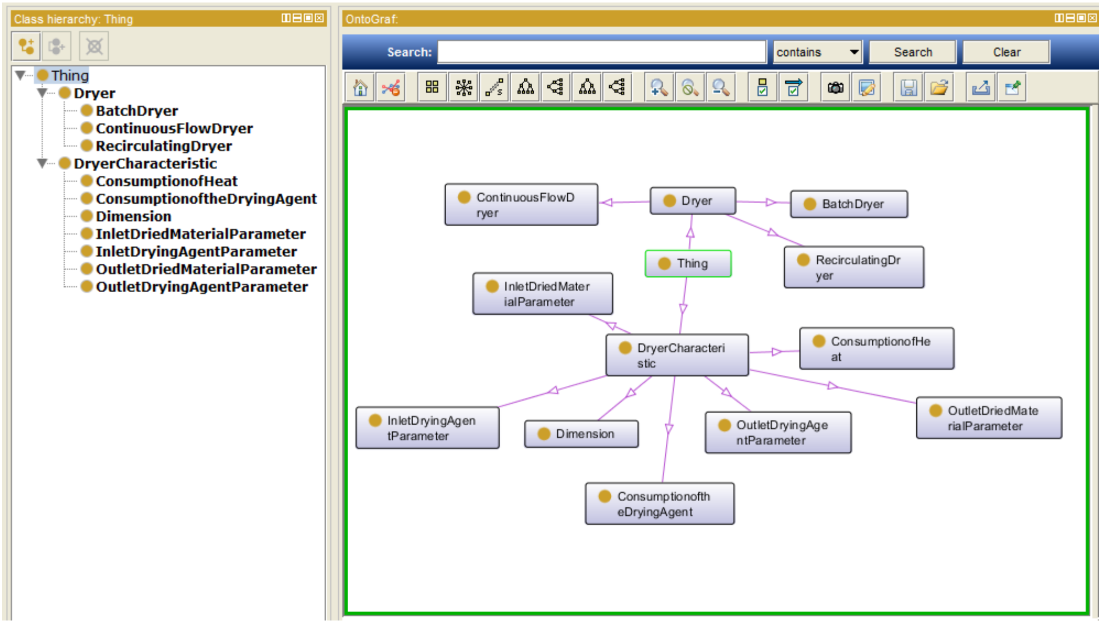

Figure 4. Protégé Desktop ontology editor.

- The data model for the domain of grain drying, handling and storage (Fig. 5, Fig. 6) was approached from four main perspectives. The resources available: websites, publications, academic manuscripts, agricultural fairs, advertising material and leaflets, technical documentation, European and national laws and regulations, they were taken under close consideration. Based on that, ontologies which captured the knowledge from those sources were designed and built.

- AllegroGraph enabled the access to the created domain ontologies and vocabularies. The datasets were explored with the use of Queries section and SPARQL language.

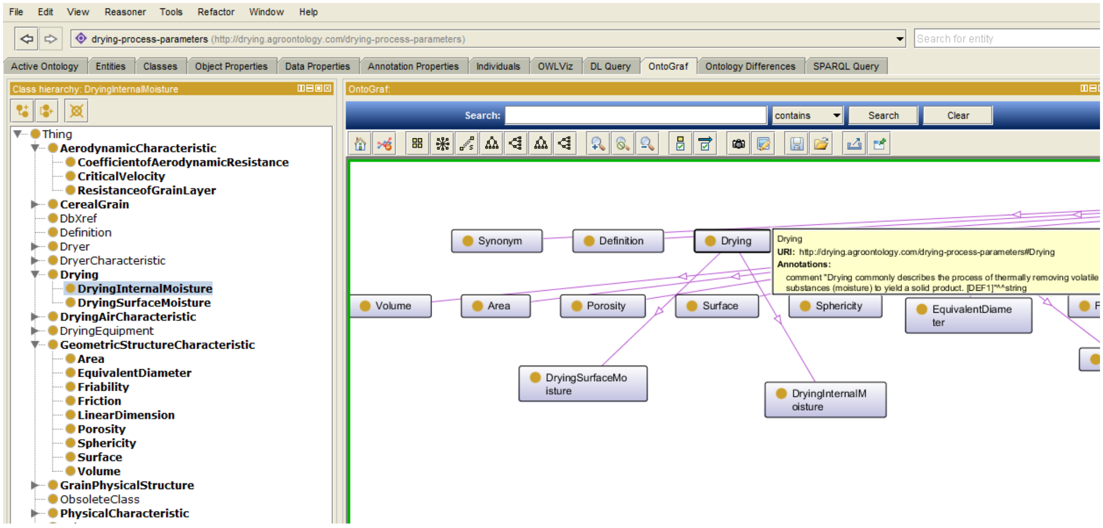

Figure 5. The data model for the domain of grain drying, handling and storage – selected parameters for drying.

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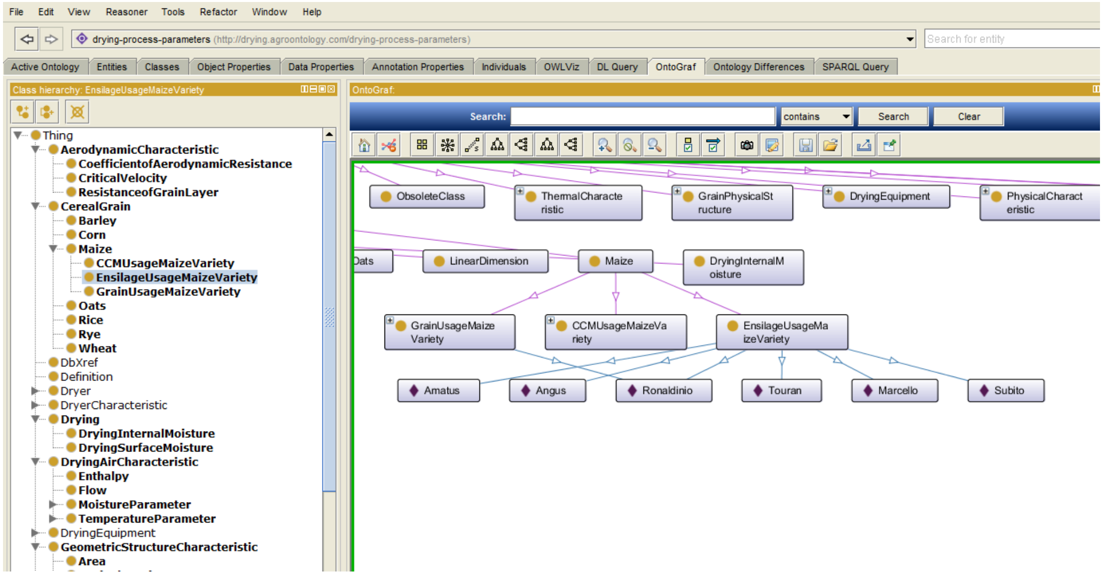

Figure 6. The data model for the domain of grain drying, handling and storage – selected parameters for cereal grain.

A new approach to a decision support system for agriculture was elaborated due to implementation of recent advances in ICT, and a new version of DSS *Ziarbit*, a software application for analyzing, designing and managing cereal grain drying, handling and storage was designed (Fig. 7). Ontologies required for semantic processing approach were constructed, and the Internet-based Knowledge Center was the framework for the analysis. A pioneer smartphone application to communicate with the server was also developed. DSS *Ziarbit* was composed of:

1) databases for grain drying, handling and storage;
2) simulation and performance analysis (calculation of drying air properties, simulation of the moisture content changes in grain, computation of drying systems performance);
3) decision support for selecting appropriate equipment and conditions for drying cereal grains, with the access to data available online.

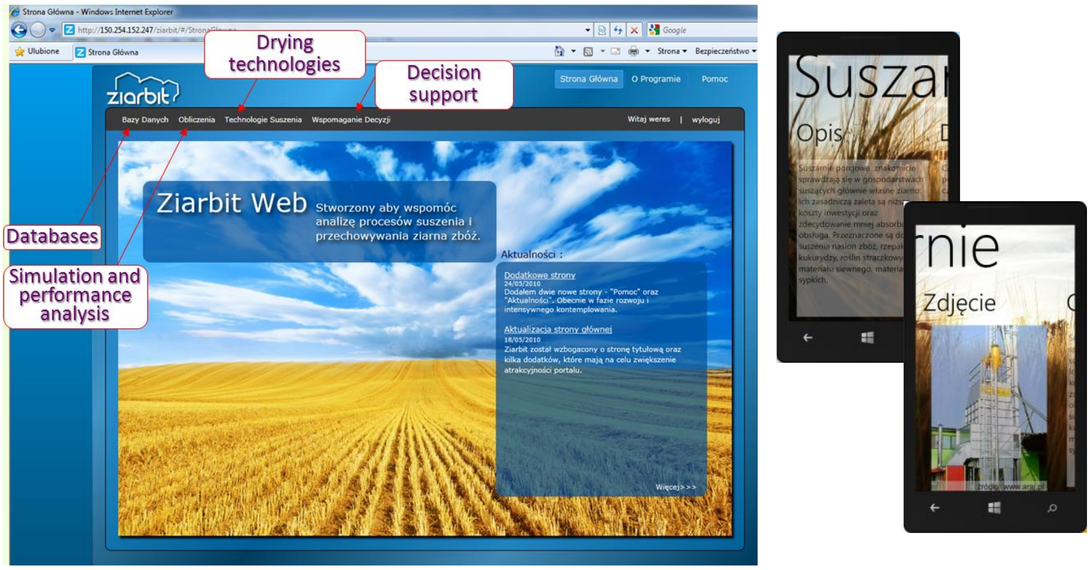

Figure 7. *Ziarbit* - a Web-based DSS for designing and managing cereal grain drying, handling and storage. PC client (left), smartphone client (right).

4. CONCLUSION

Advanced technologies available on the .NET Framework and useful for developing Web-based DSS for agriculture were indicated and implemented. The new version of Semantic Web-based decision support software for analyzing, designing and managing cereal grain drying, handling and storage was designed and implemented. The Semantic Web concept was turned into reality with the help of the Internet-based Knowledge Center, developed originally within this work. A test version of the smartphone application to enhance a mobile access to the system was also constructed. Conformance to software engineering standards during the whole software development process was a critical factor for accepting the developed application in operational, practical environments.

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C0301

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