Sustainable development and improvement of the Semantic Web Portal

VIKTORIJA PONOMARENKO[1], LEONIDS NOVICKIS[2]
Faculty of Computer Science and Information Technology
Riga Technical University
Setas str.1, Riga
LATVIA
viktorija.ponomarenko@gmail.com, lnovickis@gmail.com

Abstract: - A lot of the progress is directly dependent on an information technology solution which could implement the task more quickly by saving time, money and energy. The life cycle of any kind of information system begins with its development and continues with transferring the results to the audience. The purpose of this paper to provide an overview of new Semantic Web Portal and its transferring process to potential end-users. Based on the key concepts of the technology transfer, the foreign experience and the best practices, it has been developed a new information technology transfer model and a way of its practical application, taking into account the environmental factors.

Key-Words: - technology transfer, process measurement, semantic web technologies, software configuration management

1 Introduction

The technology transfer is a topical theme worldwide and the number of scientific researches is only increasing annually. The life cycle of each information technology begins with its development and continues with the transfer of the result to the end user. The technology transfer provides the commercialization of the products generated as well as the promotion, patenting and the market introduction of the applied research results.

Nowadays software configuration management is not only challenge to choose optimal system for source code management. Complex software development projects with multiple mutually dependent components and high level of agility require two important things: firstly, in context of software configuration management, many tasks should be implemented such as source code manage managements, version control, build and deploy management, accounting of statuses of items, etc.; secondly, the mentioned implementation should be ready as soon as possible because agile methodologies require frequent releases of new versions of product [1].

The paper describes how Semantic Web technologies like OWL and SPARQL could be used to improve for implementation of software configuration management to perform transformations between different levels of models.

Based on the study aim this research proposal investigates the following questions:

Question 1: What are key terms and concepts of Semantic web portal?

Question 2: How to develop and improve the Semantic Web Portal further?

The paper is structured as follows: the second section describes Semantic Web technologies (like RDF, OWL, etc.) in the model-driven Software Configuration Management and potential advantages they could bring. The third section is concerned with how the Semantic Web portal could be improved to gain profit from the introduction of the IT solutions in the market. The last section of paper concludes the results.

2 Semantic web portal

The software configuration management (SCM – Software Configuration Management) is an information technology discipline which is responsible for tracking and managing any software changes. In order to ensure the quality of the final product, configuration management performs multiple tasks: identification of configuration units, version control, construction and installation governance, tracking of configuration units etc.

The semantic web technology (RDF and OWL languages) in the model-guided approach is used to establish the formal, machine-readable SCM ontology describing the concepts of SCM and relationships between them [1].

The model-guided approach is supported under the research programme of the Republic of Latvia [2] in order to develop the semantic web services for the logistics portal e-LOGMAR with the aim of

- completing the detailed analysis of the underlying semantic web services,
- researching how the semantic web technologies can be effectively integrated into the existing systems,

- developing and improving a methodology for the systematic development of the semantic web services,
- integrating the semantic web technologies into the software configuration management approach EAF.

Five most common semantic web service development technologies were analysed during the research: SADI (Semantic Automated Discovery and Integration), OWL-S (Ontology Web Language for Services), WSMO (Web Service Modelling Ontology), WSDL-S (Web Service Description Language-Semantics) and SAWSDL (Semantic Annotation for Web Service Description Language). According to the results of the technology analysis it was determined that, although the SADI technology offers fewer possibilities compared to the OWL-S and WSMO, it still facilitates the semantic web service significantly which could resolve the set objectives, development and maintenance. Another important SADI framework advantage is the open code.

After the technology analysis, the methodology for systematic RESTFul semantic Web service development was advanced and improved through SADI (Semantic Automated Discovery and Integration) framework.

The methodology includes the following four main activities [3]:

- Definition and placement of the domain and service (input and output classes) ontology,
- Generation of the skeleton service (Java class plug and other additional documents),
- Adding the business logic to a service (Java class and other required files),
- Compiling of the service and the placement of the acquired WAR (Web application ARchive) file in the application server.

This methodology was used to produce the semantic web services utilized in the Business portal e-LOGMAR in e-logistics. The developed services attempt to semantically annotate the information which is received from the services available in the portal. The information processed is related to logistics (available routes and their types, transport costs etc.). Several SADI services can be connected in a row and its completion results in receiving a continuous linked data (Linked Data) graph containing information regarding the initial input resource.

The services use modified logistic ontologies LogiCO and LogiServ from TNO.nl (Figure 1).

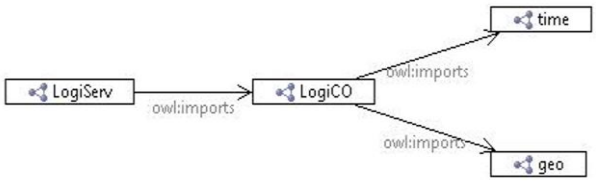

Fig.1. LogiServ and LogiCO ontology

The methodology for development and integration of services uses the model-guided approach in order to design, develop and maintain the web services as well as to ensure their reuse in other future projects. One of the key elements of this approach is the development of the RFL (Reusable Functions Library)[4]. This library enables the reuse of the automation functions in other projects and workflows.

The provided methodology of SCM based on model-driven approach and semantic web has been validated in the process of development of Business portal e-LOGMAR in e-logistics.

3 Technology transfer

The life cycle of each information technology begins with its development and continues with the transfer of the result to the end user. In reality, frequently, the prototypes that have been designed remain within the premises of the university and do not reach the public. Therefore it is crucial to draw attention to the sustainable development, improvement and the technology transfer process of the Semantic Web Portal e-LOGMAR. The technology transfer provides the commercialisation of the products generated as well as the promotion, patenting and the market introduction of the applied research results.

According to the European Commission Regulation [7], which provides a common understanding of the state of technology development and its position in the chain of innovation, the Semantic Web Logistics Portal complies with the pilot development research type. When assessing the state of the portal according to the level of preparedness of the technology, it is assigned to the 5th or 6th Technology Readiness Level (TRL). In cooperation with the industrial partners from Estonia and Central Asia the semantic web services were examined and demonstrated in an artificial environment where the portal semantic services had been integrated with real aid elements.

In total, 44 partners from various transport and logistics companies participated in the study.

The user feedback indicates that, in general, the portal functionality and user interface meet the requirements and are evaluated positively (Figure 3, Figure 4).

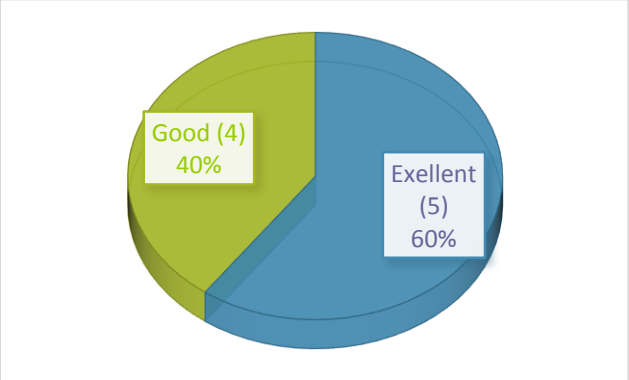

Fig.3. Assessment of the Semantic Web Logistics Portal functionality

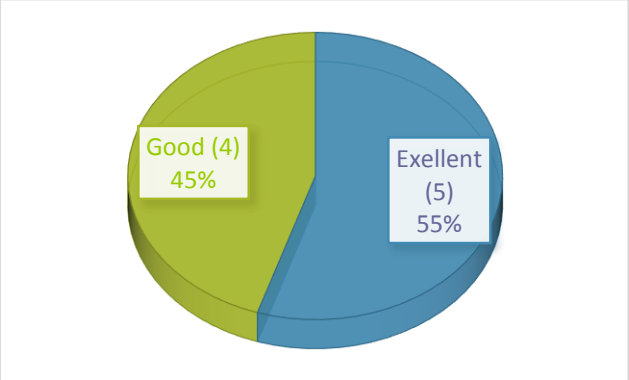

Fig.4. Assessment of the Semantic Web Logistics Portal user interface

For the elevation of the competitiveness of a new logistics portal and for the successful operation of the system, the prototype of the portal should be checked in a real environment (8 TRL).

By summarizing multiple sources [8-17] it can be concluded that most of technology transfer patterns include the following common parts:

- the transfer object;
- two or more participants involved in the technology transfer process;
- the interaction between the participants;
- the transfer method which involves a number of steps;
- the environmental factors influencing the technology transfer process.

In order to transfer the Semantic Web Logistics Portal to end users, it is offered to use the process oriented information technology transfer pattern which will allow for verification of the technology's development and commercialisation processes as well as to assess and improve them (Figure 4).

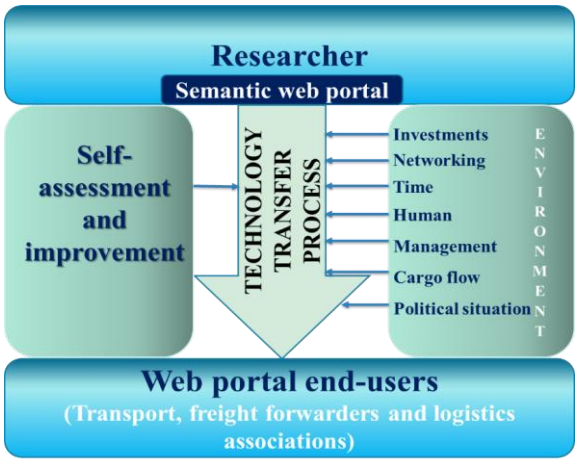

Fig.5. Transfer pattern of the Semantic Web Logistics Portal

By assembling the definitions of various scientists [18-23], the technology or knowledge transfer may be interpreted as the information transfer processes from the supplier to the recipient. In this case, the developer of the Semantic Web Logistics Portal has the role of the initiator (information supplier) of the information technology transfer and the developer passes the new IT solution onto the end user (information recipient): transport, freight forwarders and logistic associations.

For this matter a self-assessment method was designed which will predict the process of the list assessment and its further development (Table 1).

Table 1. IT Implementation and the commercialization processes of the IT solution

Process	Activities
P1.Software Implementation Process	✓ assessing the scale and complexity of the project ✓ selecting the tasks associated with reuse ✓ choosing the standards, methods, tools and programming languages in order to implement reuse; ✓ using the feedback mechanism; ✓ using the communication tools for informing and problem solving;

P2.Software Requirements Analysis Process	✓ assessing the software architecture, the interface and the design of the database, in accordance with the criteria for reuse;
P3.Software Architectural Design Process	✓ selecting a detailed theme for each component of the software. ✓ selecting database documentation; ✓ assessing the requirements for design and testing of the software according to the criteria for reuse. ✓ using the domain engineer feedback and communication mechanism
P4.Software Detailed Design Process	✓ selecting a detailed theme for each component of the software. ✓ selecting database documentation; ✓ assessing the requirements for design and testing of the software according to the criteria for reuse. ✓ using the domain engineer feedback and communication mechanism
P5.Software Construction Process	✓ reviewing the current test result documentation for reuse
P6.Software Integration Process	✓ establishing a system of integration; ✓ documenting the software components and test results; ✓ evaluating the integration plan, software design, code, tests and user documentation
P7.Software Qualification Testing Process	✓ documenting and carrying out the reusable qualification tests.
P8.Software Protection	✓ assessing the protection options for IT solution: copyright, trademark, patents
P9.Marketing & Commercialization	✓ identifying the candidate or the structure that has; ✓ the expertise and resources for market transfer; ✓ choosing the optimal commercialization path; ✓ identifying existing business relations; ✓ assessing the sources of funding/

The self-assessment system will ensure a common understanding of the technology transfer status and its position in the innovation chain. When assessing the state of technology development according to the implementation of the process, it receives the PRL qualification. Five process implementation levels (PRL) with percentage scale have been defined for assessing the Semantic Web logistics portal (Table 2).

Table 2. The IT solution assessment system.

PRL	Scale %	Description
0	0	Process not defined
1	25	Process is defined and started
2	50	The process has been completed and is assessed for further improvement
3	75	The process has been completed and is assessed for further improvement
4	100	Process has been completed, reviewed, improved and absolutely finalised

The self-assessment method of the information technology is based on:

1) IEEE information technology standard 1517TM - 2010 - The life cycle processes of the system and software – Software implementation processes [24] that allow:

a) increasing the quality of the information system,
b) shortening the duration of the information system and its maintenance,
c) reducing costs,
d) reusing the software developed.

2) the information technology process assessment standard ISO/IEC 33020:2015 [25], which allows:

a) assessing the developed information system,
b) defining and improving the quality of processes,
c) determining the information system profile with process ratings.

3) the typical steps of the technology transfer process as defined in several literature sources [26-28].

As a result, the technology transfer initiator, in other words, the Semantic Web logistics portal developer gains understanding of the development status of the portal with its strong and weak points. This understanding provides the opportunity to improve

and finalize the processes for successful commercialisation and gaining profit from the introduction of the IT solutions in the market.

4 Conclusion

The study aim provide an overview of new Semantic Web Portal, its key terms and concepts. New approach for implementation of software configuration management that uses technologies of Semantic Web and MDA approach decreases process implementation time by reusing existing source code for new processes. The proposed methodology of software configuration management has been validated in the process of development of Web-based business oriented portal in the area of e-logistics.

To to develop and improve the Semantic Web Portal, it is offered to use the process oriented information technology transfer pattern. The self-assessment system will ensure a common understanding of the technology transfer status and its position in the innovation chain.

Given technology transfer approach is also applicable for any process oriented activity assessment and improvement and can be adapted to any organization needs.

Acknowledgment

This work is partly funded by Latvian National Research Programme “Cyber-physical systems, ontologies and biophotonics for safe&smart city and society" (SOPHIS) Project No.2 “Ontology-based knowledge engineering technologies suitable for web environment”.

References:

[1] Bartusevics, A., Lesovskis, A., Novickis, L. Semantic Web Technologies and Model-Driven Approach for the Development and Configuration Management of Intelligent Web-Based Systems. In: Proceedings of the 2015 International Conference on Circuits, Systems, Signal Processing, Communications and Computers, Austria, 2015. Vienna: 2015, 32.–39.lpp. ISBN 978-1-61804-285-9. ISSN 1790-5117.

[2] Latvian National Research Programme “Cyber-physical systems, ontologies and biophotonics for safe&smart city and society" (SOPHIS) Project No.2 “Ontology-based knowledge engineering technologies suitable for web environment”.

[3] Bartusevics, A., Novickis, L. Model–Based Approach for Implementation of Software Configuration Management Process. In: MODELSWARD 2015 Proceedings of the 3rd International Conference on Model-Driven Engineering and Software Development, France, Angers, 2015, pp.177-184. ISBN 978-989-758-083-3

[4] Bartusevics A., Novickis L., Lesovskis A. An approach for development of reusable function library for automation of continuous processes. In: Procedia Computer Science, Volume 104, 2017, Pages 112–119

[5] Novickis L., Vinichenko S. Essential Logistics Principles for Creating a Web-Portal of Transport Services Consumers. In: Scientific Proceedings of the eLOGMAR-M Project. It &T Solutions in Logistics and Maritime Applications, ISBN: 9984-30-119-2, Riga, JUMI Printed House, 2006, pp.21-29.

[6] ICT Transfer Concept for Adaptation, Dissemination and Local Exploitation of European Research Results in Central Asian Countries, 2013-2015. {ONLINE} Available at http:// www.einterasia.eu {Accessed March 2017].

[7] European Commission. Horizon 2020 – work programme 2014-2015.General Annexe G. Technology readiness levels

[8] Goodman.J. Industry partners-- A technology transfer model for academia. OCEAN 75 Conference Proceedings , 1975, Pages: 850 – 854

[9] C. Herron, C. Hicks. The transfer of selected lean manufacturing techniques from Japanese automotive manufacturing into general manufacturing (UK) through change agents. In: Robotics and Computer-Integrated Manufacturing, Volume 24, Issue 4, August 2008, Pages 524–531

[10] E. Rao, J. Remer, D. Bauer. A model for development, transition and technology transfer leading to commercialization of security technology. In: 2014 International Carnahan Conference on Security Technology (ICCST) Proceedings, IEEE, 2015

[11] H..Taylor, E. Artman, J.P. Woelfer. Information technology project risk management: Bridging the gap between research and practice. In: Journal of Information Technology 27(1), JIT Palgrave Macmillan ,2012, pp.17-34

[12] C. Henrique, D.T. Gorschek Technology transfer - Requirements Engineering research to industrial practice an open (ended) debate. In:

2015 IEEE 23rd International Requirements Engineering Conference (RE) Proceedings, IEEE, 2015, pp. 414-415

[13] P. Diebold Vetro, A.D.M.. Fernandez. An Exploratory Study on Technology Transfer in Software Engineering. In: 2015 ACM/IEEE International Symposium on Empirical Software Engineering and Measurement (ESEM) Proceedings, IEEE, 2015, pp. 86-95

[14] I.Inrawan.,I.Sunaryo,R.N, Syafrian, R. Govindaraju The measurement of human ware readiness in a technology transfer process: Case study in an electrical machinery company. In: 2014 2nd International Conference on Technology, Informatics, Management, Engineering & Environment Proceedings, IEEE, 2015, pp. 321-325, doi: 10.1109/TIME-E.2014.7011639

[15] B. Wang. Requirements Traceability Technologies Selection for Industry. In: 2016 IEEE 24th International Requirements Engineering Conference Proceedings., IEEE, 2016, pp. 450- 455

[16] O.Sun, H. Feng. Innovating the New Model of Academy-Locality Cooperation. In: 2016 International Conference on Industrial Economics System and Industrial Security Engineering (IEIS) Proceedings, IEEE, 2016

[17] A.K Saini, V. Kumar Khurana. ICT based communication systems as enabler for technology transfer. In: 2016 3rd International Conference on Computing for Sustainable Global Development (INDIACom) Proceedings, IEEE, 2016, pp. 90-99.

[18] E. Rogers, M Everett. Diffusion of innovations. Free Press of Glencoe, New York, 1962, 1st.ed. pp. 282-283.

[19] D J..Teece. Technology Transfer by Multinational Firms: The Resource Cost of Transferring Technological Know-How. The Economic Journal, 87(346):242–261, Jan. 1987

[20] F. William, D. V. Gibson. Technology Transfer: A Communication Perspective. Sage Publications: Beverly Hills, London, 1990, pp. 393-404.

[21] P. Shiowattana, Transfer of Japanese Technology and Management to the ASEAN Countries. Tokyo. University of Tokyo Press, 1991, pp. 285-286.

[22] M. S.Spann, M Adams., and W. E. Souder Measures of technology transfer effectiveness: key dimensions and differences in their use by sponsors, developers and adopters. Engineering Management, IEEE Transactions on, vol. 42, no. 1, pp. 19-29, 1995.

[23] OECD. The knowledge-based economy, organisation for economic co-operation and development. Paris, OECD Publishing, 1996.

[24] 1517-2010 - IEEE Standard for Information Technology--System and Software Life Cycle Processes--Reuse Processes

[25] INTERNATIONAL STANDARD ISO/IEC 33020:2015. Information technology -- Process assessment -- Process measurement framework for assessment of process capability, Published in Switzerland

[26] An Inventor's Guide Technology Transfer at the University of California, Berkeley, Intellectual Property & Industry Research Alliances, pp.25

[27] Inventor's Guide, Stanford University, office of technology licensing, pp.25