A Use Case of Service-based Knowledge Management for Software Development

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Abstract

Large, international cooperative efforts pose high expectations for knowledge management support. In this paper we present a use case of a knowledge management solution in an international research project, which offers several novel features applicable in other cases as well. The primary goals are to make the implicit knowledge explicit, to organize knowledge objects according to multiple criteria of multiple user roles and to serve this knowledge to users in an interactive way adapting Web 2.0 principles. A Knowledge Management System called the BREIN Roadmap has been realised applying service-based knowledge management using PROMOTE® supporting developers and externals who want to make use of the know-how and software components of the project.

Keywords: knowledge services, service-based knowledge management

1 Introduction

A crucial success factor for research projects is to enable the distribution of the results and the insights to the community and to the outside world to allow the take-up and ensure the sustainability of the project. In EC funded research projects, experts from several countries and organizations work towards a common goal. All of them bring their existing knowledge, experience and culture into the project, and produce results jointly, which are of interest for a greater community. The challenge is that the knowledge is highly distributed, very heterogeneous and mostly not directly accessible as it resides in the people's heads.

Therefore, knowledge management tools are assumed to help project participants to share current project knowledge and contribute to it. Furthermore, new project members and people outside the project should be supported as well to acquire knowledge about the project.

In the paper we introduce the knowledge management approach and tools applied in the BREIN project [BREIN, 2009]. BREIN is an Integrated Project dealing with the development of an intelligent grid infrastructure. Our goal is to make the implicit knowledge explicit, to organize knowledge objects and to facilitate the usage of the BREIN knowledge objects for the project consortium and for externals who are interested to make use of the BREIN platform.

The paper is structured as follows: Chapter 2 introduces the PROMOTE® methodology which has been the selected knowledge management approach. Chapter 3 presents the concept of service-based knowledge management. Chapter 4 provides details about the use case in BREIN where a knowledge management system for software development has been realised. The focus is on the three phases the system is based on: Knowledge Management, Knowledge Usage and Evaluation. In chapter 5 the conclusion and outlook is provided.

2 The PROMOTE® Methodology

PROMOTE® is a methodology for process oriented knowledge management that has been developed in the EC Project PROMOTE (1999-11658) and continuously improved in both commercial projects [Mak et al., 2005] and EC co-funded research and development projects (Akogrimo [Akogrimo, 2009], AsIsKnown [AsIsKnown, 2009] and BREIN [BREIN, 2009]).

Overall, process-oriented knowledge management has three different viewpoints [Woitsch, 2004]. (1) The processes are seen as content, using the graphical representation in combination with a textual description in order to make implicit organisational knowledge about working procedures explicit. (2) The second interpretation sees processes as an integration platform for knowledge management. The processes provide the starting point for requirements that need to be fulfilled by the knowledge management system, similar to Model Driven Architecture (MDA) which also takes models as starting point. The functional specification of the knowledge management system is based on knowledge intensive activities within the process. (3) The process is seen as a management approach for knowledge. It is the most advanced evolution of knowledge management as it raises its efficiency.

The PROMOTE® methodology is based on the Business Process Management System (BPMS) methodology [Junginger et al., 2000; Karagiannis et al., 2002]. This methodology guides organisations through developing knowledge management strategy, designing, developing, and implementing a process based Knowledge Management System (KMS).

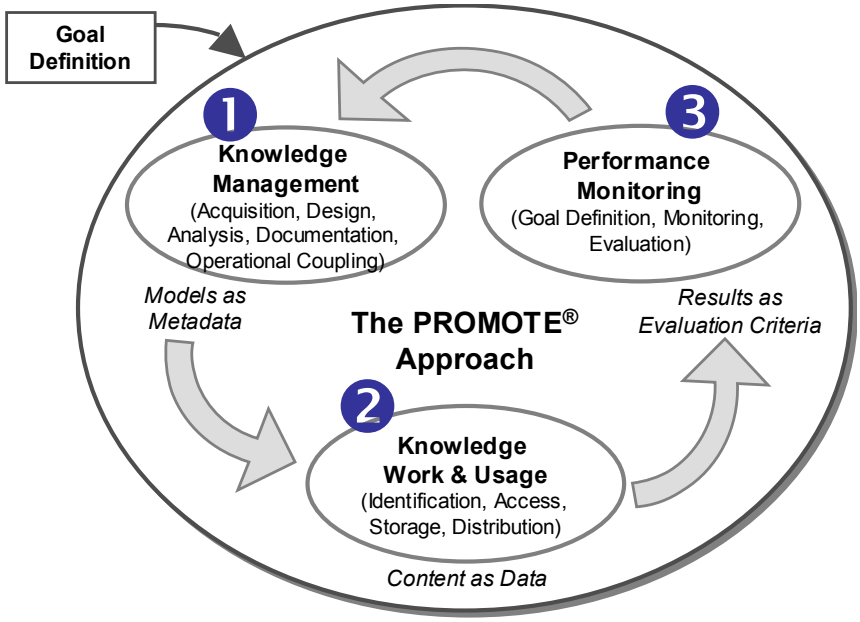

Figure 1. The PROMOTE® Approach

Within the PROMOTE® approach the goal definition as strategic decision enables the derivation of the requirements of the KMS. These requirements affect the first phase of the iterative cycle the Knowledge Management (1), where models are used to acquire, design,

analyse and document. To reduce the complexity of modelling formal models, a graphical modelling environment is used. The design phase also includes the configuration and integration of knowledge products. Therefore some of the knowledge products have to be virtualised to be provided as knowledge services. Operational coupling is used to transform the models for Knowledge Work & Usage (2), which deals with knowledge identification, access, storage and distribution. To enable a continuous improvement of the KMS, the results are evaluated (3). Therefore goals and criteria for performance monitoring and evaluation have to be defined. Finally, the results of the evaluation are used as input for further improvement thus leading to a continuous improvement cycle.

3 Service-based Knowledge Management

The term service in the context of service orientation refers to the well-defined principles of encapsulation, loose coupling, contract, abstraction, reusability, composability, autonomy, optimisation and discoverability [Erl, 2009] that characterize a piece of software. Following the service oriented approach tools and available resources are provided as services. The concept of virtualisation may be used to provide tool functionality or humans as services. Virtualisation is one of the key concepts of a service grid, which can be adopted to provide any resource – even not technical resources – with a service interface. Service oriented knowledge management therefore relies on the assumption that successful implementation and execution of knowledge relies on tools, resources and human services that can be virtualised. The aim of knowledge services is to describe the service in the knowledge management domain via semantics, thus lifting them to a higher level, to so called knowledge services. These services may be provided electronically or by humans, but require per se knowledge. Knowledge services are defined through the semantic description on a conceptual level independent of the actual technical realisation. The service concept is therefore the basis for the technical integration of different tools and conceptual integration that considers the meaning of a service.

4 The Use Case in BREIN

BREIN (acronym for "Business objective driven reliable and intelligent grids for real business") is an Integrated Project co-funded by the European Commission under the Sixth Framework Programme (2002-2006). The project consortium consists of 17 partner organisations whose aim is to develop an intelligent grid [Foster et al, 2004] infrastructure to significantly reduce the complexity of current business-to-business collaborations. One crucial aspect of the development of the platform is to define how software can be implemented and how existing applications can be integrated. This integration is concerned on the one hand with the services that are part of the BREIN platform and on the other hand the integration of the platform with already existing legacy applications that run on top of it. The challenge is the knowledge provision to the relevant stakeholders to adequately support their integration tasks. Therefore in BREIN a Knowledge Management System (called the BREIN Roadmap) has been implemented to tie together the methods, tools and the conceptual framework.

Looking at BREIN as a knowledge object as depicted in Figure 2, a lot of sources for explicit and implicit knowledge can be found. Here the iceberg metaphor is useful: Explicit knowledge in BREIN, as well as in other projects, can be found in the form of deliverables, internal documents, diagrams, videos, and code samples. Below the waterline lies the implicit knowledge within BREIN, which is stored in the brains of the BREIN consortium members in the form of experience, procedures and unwritten rules, which is the far larger amount of knowledge.

Our goal is to make the implicit knowledge explicit, to organize knowledge objects and to facilitate the usage of the BREIN knowledge objects for the project consortium and for externals who are interested to make use of the BREIN platform.

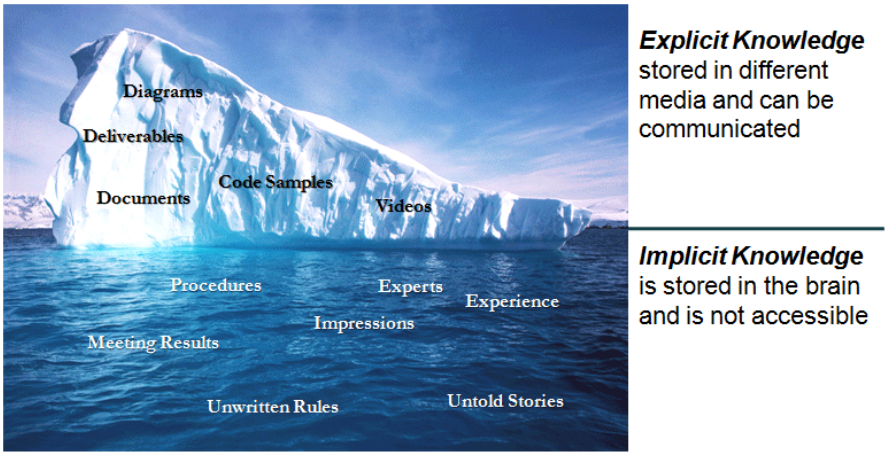

Figure 2. BREIN as a Knowledge Object

In order to do this the previously introduced PROMOTE® approach has been applied. Based on the three phases of the approach (see Figure 1) the following subchapters describe the design, knowledge work and usage as well as the evaluation of the Knowledge Management System.

4.1 The Knowledge Management Phase

The first phase of the iterative approach is the "Knowledge Management" where models are used to acquire, design, analyse and document. The model-stack is based on 5 layers:

- Knowledge maps (providing a high level overview of the system and knowledge products)
- Knowledge resources (collecting resources such as documents, code, videos, diagrams, etc.)
- Topic maps (structuring the knowledge according to its content)
- Process models (defines activities and its sequences to fulfil a certain task)
- User profiles (defines roles and the according skills needed)

The starting point was the identification of knowledge products and the stakeholders with the help of the consortium partners. This approach has shown to be useful as these products are easy to understand and facilitates building a KMS without the need of being an expert. Identified products cover for example a UML repository for the collections of UML diagrams documenting the platform, search engines to find and access information, graphical roadmap representations, yellow pages, file- and code-repositories, etc.
The user groups have been defined as business manager (BM), project manager (PM), the head of development (HD), developer (D) and the integration team (IT) – using different products to reach their goals [Woitsch et al, 2008]. Table 1 shows an extract of the mapping of the identified products, the relevancy for the user groups and the service type (electronic (E) or human (H)).

For the detailed definition of the KMS and its contents a number of workshops and face to face meetings have been organized. The first ones focused on a common understanding and the definition of its scope and contents. Based on a top down approach modelling sessions defined the structure of the knowledge space in form of concept maps. Another five workshops with the experts of different fields of the project produced the processes that

answer the most prominent questions related to the usage of BREIN and the integration and implementation of software for the BREIN platform.

Table 1. Extract of Identified Knowledge Products

Product	Description	User Group	Type
Graphical model representation	A web user interface with a graphical model representation, providing different entry points	All	E
UML repository	A collection of UML diagrams, concerning the architecture and specific components offering search functionality	HD, D, IT	E
Bug reports	A tool for the documentation of bugs	D, IT	E
Search engine	A tool that allows advanced searching mechanisms within the knowledge base	All	E
Integration report	A template to document integration efforts	D, IT	E
Document repository	A repository containing best practice reports, manuals, documentation, etc.	All	E
Yellow pages	A directory of experts, services, tools	All	E
Experts	Experts in a specific field, consortium partners with specialized expertise	All	H
Wiki	Application integration Wiki, BREIN Glossary providing explanation of related terms	HD, D, IT	E
Mailing list	The BREIN mailing list	All	E
Documentation (Javadoc)	A documentation of BREIN architecture components and their API	HD, D, IT	E
Introduction videos	Introduction video for the BREIN architecture and each building block	HD, D, IT	E
Overview presentations	Introduction slides for BREIN relevant topics	All	E
Shared file space	BREIN subversion system	All	E
Functionality integration template	A template defining a specific BREIN functionality and the integration steps necessary	HD, D, IT	E
Code sample repository	Collection of code samples, tips and example services	D, IT	E

In parallel, a bottom up approach was followed to collect existing knowledge in form of deliverables, documents, code fragments, etc. These were matched with the top down derived requirements. The gap that resulted after the matching of needed resources and the existing ones was filled with newly created documents, guidelines or other resources exactly serving these needs.

The last step in the knowledge management phase was to make the system operational where the identified products have to be instantiated by a concrete service. For each product at least one tool had to be found. From the candidate tools the most appropriate ones have been selected for use in the runtime.

The Knowledge Management phase is supported by various tools. The acquisition of models is supported for example by import of data from spreadsheets or by graphical Web Modeller that provides full modelling functionality for the complete model stack and allows creating, editing and viewing of graphical models.

The Web Analysis tool provides functionality to analyse the created and annotated models. A human user can find out which knowledge resources or activities have not been annotated yet, which causes them not to be linked. The objective of this component is to help the user to design a correct model, which is ready for publishing. Apart from that, import and export mechanisms allow the exchange with other systems.

4.2 The Knowledge Work and Usage Phase

In the second phase “Knowledge Work & Usage”, the models are used for knowledge identification, access, storage and distribution. For this phase each layer provides entry points for different purposes and different user categories.

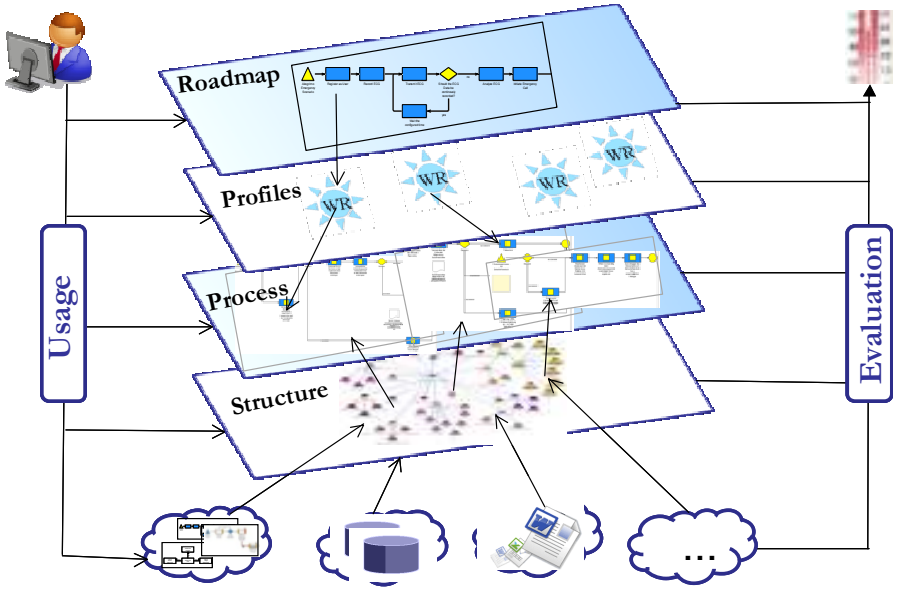

Figure 3. Model Stack of PROMOTE®

The higher the layer the more sophisticated are the access mechanisms as they can take advantage of its model and the models of the lower layers. Starting from the lowest level the access is supported as follows (as depicted in Figure 3):

- Knowledge resources: Direct access to knowledge objects is provided through searching and browsing. This is intended for regular users of the system that want to specifically access a resource and are familiar with its usage.
- Structure: Topic-based access to knowledge objects provides help and documentation for dedicated issues. Experienced users that want to get information about a topic might use this layer.
- Processes: Process models guide users through typical activities while providing necessary knowledge objects. The most prominent tasks (e.g. Technical introduction, Adding new service to BREIN, Create Service Level Agreement template) are modelled as detailed processes and can be either viewed or interpreted by the "Process Stepper" (see below).
- Profiles: User profiles group participants according to their roles and expertise provide specialized views on the knowledge space by focusing on the relevant aspects for each role. Business users for example are not bothered with technical contents.
- Roadmap: An overview layer, which is meant for new users, directs users to the desired processes or entry points for their information need. This is done by asking some questions, and based on the according answers the system finds the most appropriate entry point.

A special tool for the roadmap and the process model layer is the "Process Stepper" (Figure 4), which is an interactive guidance system developed in the Austrian research project called AWA. The "Process Stepper" is an AJAX (Web 2.0) graphical user interface for using the collected process models of BREIN. The "Process Stepper" guides the user through the selected process model. The tool presents the user a questionnaire like interface, collects the user answers and builds with the help of these answers a user profile. The profile serves as a basis to guide the user to the adequate information and provide suggestions about relevant resources. A business user for instance will not be provided with technical details but rather high level information. On the other hand developers are provided with technical resources, UML diagrams or code snippets.

Figure 4. Knowledge Work and Usage – The BREIN Process Stepper

Apart from the acquisition of knowledge, the "Process Stepper" also provides the resources to the user. For each step of a selected process (Figure 4), the description gives the overview of the current task, while the related documents listed below the description can be used as support material. The related documents are provided with their relevance measure. The "Process Stepper" also displays contact info and an image of the expert(s) who may help in performing the current task. Users can also contribute in different ways to this knowledge: they can rate the help materials with respect to relevance and usefulness to concrete process steps or they can even enhance the knowledge base by uploading new resources. They can also provide comments about process steps using integrated Wiki pages.

At each step of the "Process Stepper" the users are offered different knowledge items, which could be relevant for them. The users ratings will be used to increase the relevance measure and enhance the system by giving future users the better rated more relevant knowledge items first.

Wiki pages are a good way to enable users to contact each other or the BREIN community, discuss any issues or problems occurring and publicise the recommended solutions. This way they cannot only help each other but can create a Q&A (Question and Answer) like document of the resources, which will help future users.

The "Process Stepper" still offers opportunities for enhancement. The integration of a live chat service could improve the community building power of the system, and hence, could improve the number and/or quality of the ratings, user uploaded documents and best practices. In the future, for a better user experience, more Web 2.0 technologies could be utilised.

4.3 The Evaluation Phase

It is important for the quality of the system to regularly evaluate and improve the system. Three basic types of evaluation are considered in the project. Expert evaluation, log analysis and user feedback. In the first case experts using the affected system are asked to use the tool and discover missing steps, features or resources in the system.

Figure 5. Monitoring Cockpit of the Evaluation Phase

The second method is the log and system analysis. In this case the resources are rated, depending on how many users requested them and how they rated them. If one resource is not requested at all or only a few times, then it is either not interesting or not linked properly from the relevant places. Whether a resource is properly linked can be easily determined in the knowledge base. Some resources are requested by a lot of users, and rated as good, so these can be offered to the other users as well, as they seem to be really helpful. In the other case, if a resource is requested by a lot of users but has a bad rating, these are the ones which have to be improved or rewritten as users are interested in them, but are not satisfied with the content.

The third method of evaluation is the user feedback, which can be either direct, such as filling out a questionnaire about the system, or indirect, by looking at the Wiki pages or ratings of the users.

The Monitoring Cockpit offers rich controlling and analysis functionality. The data to be evaluated can be filtered and be provided through different views to the Knowledge Manager, who can take the input to improve the system in the next iteration. It offers views at highly abstract levels as depicted in Figure 5, but also allows stepping into the details in case a problem has to be investigated in detail. The cockpit is based on ADOscore® [ADOscore, 2009], which supports the alignment, implementation and realisation of a Balanced Scorecard. For the visualization of the data "traffic light" signals are displayed as well so that the Knowledge Manager can easily detect undesired developments and react at an early stage.

5. Conclusion and Outlook

The success of BREIN will strongly depend on its applicability and the possibility of integrating existing applications with the framework. To support this, existing expert know-how has been made explicit and is provided to new developers and potential adopters utilizing the PROMOTE® approach. One advantage of the approach is its comprehensiveness.

The focus of developers in BREIN is not the Knowledge Management System and their resources are limited. Nevertheless PROMOTE® and the knowledge product concept provide easy entry points for accessing knowledge. The presented use case is reasonably generic so that it demonstrates the applicability of the technology in other types of cooperative efforts.

The clear and comprehensive procedure and the concept of knowledge products gave all stakeholders a common understanding and fostered the conceptual coupling of the system. The concept of knowledge services builds the basis for the operationalisation of the system as the system requirements and technical challenges are hidden. The system is built of heterogeneous tools, yet every service is autonomous, so the system can be built step by step.

An important aspect is the increasing usage of virtualized resources and services in the knowledge management area. In order to allow the orchestration of services future solutions will consider concepts such as the ESB (Enterprise Service Bus) on a technical layer. On the knowledge layer of the service oriented KMS the Knowledge Bus (K-Bus) becomes a reality. The K-Bus uses an ontology to align all application layer domain models with K-Bus models. In the EC project MATURE [MATURE, 2009] one of the tasks is the development and deployment of the Knowledge Bus in similar application scenarios involving orchestration and provision of access to the available virtualised knowledge services and knowledge products.

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