WEB-BASED KNOWLEDGE NUGGETS FOR ARCHITECTURE KNOWLEDGE MANAGEMENT

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Abstract: This paper presents in-process knowledge management for technical information, managing architecture knowledge nuggets, and implemented as embedded toolbar and Web repositories façade. The façade encompasses a plug-in and approach for documenting, reviewing and communicating knowledge nuggets. The nuggets are concise representations of architecture knowledge addressing best practices, design patterns, review comments and any additional architecture concerns. The knowledge activities are embedded during the lifecycle of software product development, namely, in-process, and may foster reuse of architecture artifacts. The façade is a Web accessed system to existing and new organizational knowledge management systems, and can serve as an access point from within any existing information system (e.g., service desks). Utilizing the Web based knowledge façade reduces the time-to-value in making architecture decisions while increasing the quality of the resulted artifacts. In addition, the facade provides on-the-fly access to relevant information and best practices related to architectural design decisions during routine R&D and deployment activities.

1 INTRODUCTION

Over the past years, we have witnessed an increased focus on knowledge management (KM) as a major part of organizational strategy in knowledge-intensive organizations and as a significant driver for business process design and reengineering (Gronau and Weber, 2005; Remus and Schub, 2003). KM enhances the ability of knowledge-intensive organizations to continuously learn and adapt, and to rapidly respond to changes in technology, market, and customer preferences, mainly by improving their knowledge-intensive business processes (KIBP) (Lonnqvist, 2005). KM has been defined as the systemic and organizational process of acquiring, organizing and communicating knowledge for employees who may use it in order to be more effective and productive (Wong, 2008). Constantinescu (2008) posits that a major objective of KM is to provide access to stored knowledge components in order to improve decision-making and to facilitate knowledge acquisition by the knowledge workers. Objectives of KM research have focused on knowledge types and dimensions, KM frameworks, and measuring and reporting intellectual capital. Skyrme and Amidon (1998, p. 20) state that "knowledge management is becoming a core competence that companies must develop to succeed in tomorrow's dynamic global economy". KM initiatives may result in significant benefits to the organization, helping to determine business strategy and process design, as well as providing competitive advantage (Kannan and Aulbur, 2004).

A phenomenon in knowledge-intensive organization is knowledge workers spending ever-increasing amounts of time for messaging, creating documents, searching for information and knowledge, and engaging in other knowledge information-intensive activities. But, despite this great time commitment, according to Davenport (2006), knowledge workers have been mostly left to their own devices, with little help from their organizations in how to perform key information and knowledge tasks effectively and efficiently. In addition, such devices, or the technologies used to handle personal information and knowledge, have

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been largely separated and un-integrated within their main working processes (Davenport, 2006).

Web 2.0 technologies, which foster social collaboration, offer ways to cultivate and exploit knowledge sharing in enterprises and provide new form for KM (Kirchner et al., 2009). Large organizations explore the potential of these new tools and concepts for KM across the enterprise (Anderson, 2007). However, while Web 2.0 tools are characterized by net effects, simplicity, ease of use, and low cost, human factors may impede efficient application of Web 2.0 technologies, in particular the need to motivate people to create content (de Barros Campos, 2010).

In the context of software architecture, empirical evidence show that architects capture and reuse previous architecture solutions, lessons learned from former reviews, implementation experiences of their peers, and other relevant knowledge only sporadically and not-frequently (Sherman et. al., 2010). This prolongs the architecture design process, as well as the follow-up review process. We postulate that lack of embedded, simple to use, and holistic access to knowledge systems in the architects working environment, hinders them from contributing to and consuming from shared knowledge repositories.

Our in-process KM for technical information manages architecture knowledge nuggets and is implemented as embedded toolbar and Web repositories façade. The approach and technology aim at reducing the time-to-value in making architecture decisions and constructing architecture blueprints and documentation. This will increase the quality of the resulted architecture artifacts needed during the software development lifecycle and reduce required efforts and time-to-value.

The rest of the paper is organized as follows: The next section briefly describes our research approach; Section 3 details the Web-based knowledge nuggets system we propose for architecture knowledge management, followed by a discussion and conclusion in Section 4.

2 RESEARCH APPROACH

Our research employed the design science research methodology, which aims at understanding a problem domain and developing a solution that takes into account interactions among people, organizations, and technology (Hevner et al., 2004). Design science seeks to create innovative capabilities and products through which the optimal information systems analysis, design, implementation, management, and use can be undertaken (Denning, 1997). Following this notion, we propose a solution which provides methods and tools for systematic and efficient capturing and sharing of architecture knowledge nuggets, which are concise presentations of architecture knowledge, over Web-based access. Our solution will be embedded in the natural working environment and process of software architects and the technical community throughout the development lifecycle, thus fostering communication within the technical community. These include, for example, communication among architects, between architects and reviewers and among reviewers involved in the development and implementation process.

3 CONCEPTUAL SOLUTION

This section describes the fundamental components of the proposed system and provides prototypical scenarios where it can be utilized.

3.1 System Features

The system enables:

- **Rapid architecture design** – The ability to select from former architecture components or aspects that are relevant to the current solution.
- **Process and labour efficiency –** The enabling of communication and sharing of knowledge throughout the software development lifecycle.
- **Integrity and accuracy** – The enabling of automated document creation (e.g., inserting reused knowledge within a document). This will lead to reduction of effort and the retaining of high integrity and accuracy by automating document creation.
- **Knowledge association** – The ability to present a knowledge nugget describing the essence of architecture decisions.
- **Embedded knowledge façade within a software development process** – within the working environments and processes that allows both knowledge contributing, knowledge source identification and knowledge tagging for further search and retrieval options.
- **Knowledge creation segregation –** ensures that only the right knowledge workers can contribute specific knowledge within the

specific context/process of their task. In case generic knowledge is constructed, it is handled on dedicated, existing, open knowledge systems, and accordingly, reduces the level of trust of the generated knowledge.

- **Knowledge efficient purification** – based on workflow automatic rules and identity management, and according to the creation segregation, knowledge nuggets can be approved automatically. For example, a knowledge nugget created by the acting chief architect will always be approved automatically, whereas novice architects' knowledge contribution will be heavily scrutinized.

3.2 System Structure

Figure 1 depicts the knowledge nuggets conceptual architecture.

1. **Nuggets Creation Toolbar** component enables contribution of temporary creation of content to be purified. The toolbar includes: *Artifact*, *Link*, *Blog*, *Discussion*, and *Tagging*. An internal component enables users role based access control, managing privileges for knowledge construction within a, software process, and domain (e.g., only the architect of a product can change the product information). Thus, segregation of duties is maintained, increasing the level of trust on the generated knowledge quality. The nuggets creation toolbar includes:

- *Artifact*: handles tangible knowledge artifacts such as standards, design patterns, patents, evaluation of specific information (e.g. rationale of a design decision, tips and tricks), and more.
- *Link*: handles linkage pointers to organizational information systems such as a document in a repository, a record in a wiki system, a component in the component catalog and an architecture document (e.g. Top Level Design Document – TLDS).
- *Blog*: handles a journal regarding the specific information at hand; for example, an architect's "to-do" list, within the architecture modeling tool, where design comments and project related notes are kept.
- *Discussion*: handles stakeholders' discussion, for example, reviewers' comments regarding a design solution.
- *Tagging*: handles tagging creation and usage for tagging unstructured knowledge.

2. **Knowledge Nuggets Analysis** Toolbar for *Quality Evaluation* and *Analytics Calculations:*

- *Quality Evaluation:* enables definitions of reviewers, purification, and migrating of transient knowledge nuggets to permanent, over the Web, nuggets store. In case the knowledge was constructed by an identified, privileged user, within known tools and phases of the process, the system can recommend a rapid knowledge approval, significantly reducing the amount of knowledge purification labour. Naturally, manual approval and purification can always be conducted.

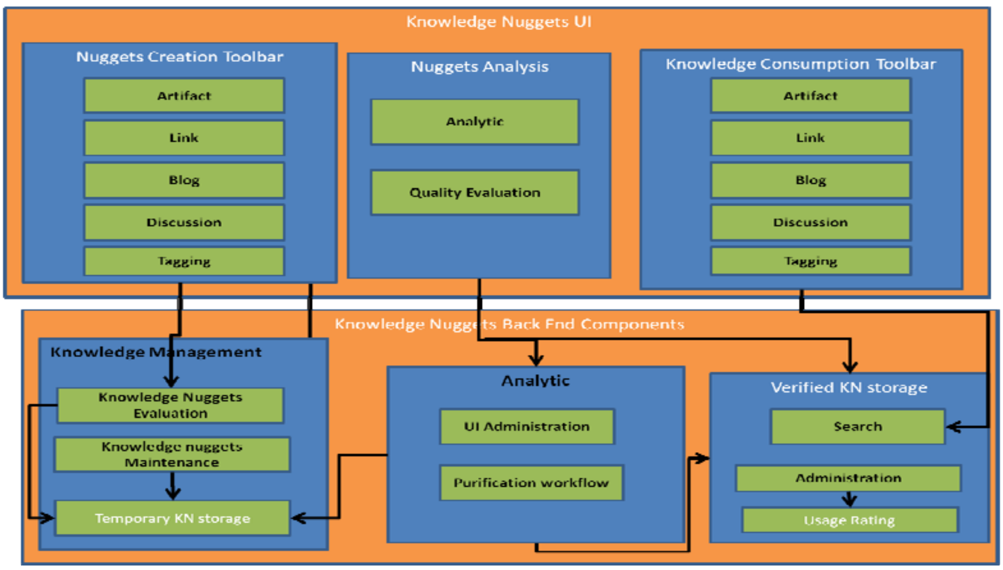

Figure 1: The embedded façade conceptual architecture.

- *Analytics Calculations*: either by automatic measures or people’s evaluations. It is aimed at rating contributed knowledge, and enabling the community to improve and expand the nuggets.

  Knowledge Consumption Toolbar for knowledge usage. This separate component usually does not prohibit user access, although it can do so when needed. Using a dedicate Web Services for Remote Portlets (WSRP) 286[1], this consumption toolbar can be embedded within any organizational Web based system that supports a portal, as a regular façade for the information. The consumption toolbar elements are similar to the creation component; however, only enable searching purified, high-quality content, such as Artifact, Link, Blog, Discussion, and Tagging. Namely, only after the item has been moved to the permanent knowledge storage, following analysis for confirming its quality.

The system server-side components, can be WSRP portals such as LifeRay enterprise portal[2]. LifeRay provides many of the technologies needed to construct our conceptual architecture. Some examples for managing knowledge are Web content, tags and categories, document and image management. For community of review, LifeRay offers website tools, breadcrumbs, page ratings & flags. For security and role based access, LifeRay offers user directory and LDAP Integration.
Consequently, the portal Web site enables workflow and knowledge management processes, as well as federated accesses to the remote existing organizational systems. Since the embedded UI is organized as WSRP 286, the toolbars are JSR 286[3] plug-in portlets, and can be embedded in existing enterprise portals, as well as be consumed from rich UI via their WSDL interfaces.

The system components are:

3. **Knowledge Management**: components
   - Knowledge nuggets evaluation: handles the evaluation if a newly created knowledge nugget, based on feedback regarding the importance and accuracy of the captured knowledge.
   - Knowledge nuggets maintenance: handles knowledge purification for ensuring the quality of the captured knowledge.
   - Temporary knowledge nuggets storage: contains all the nuggets contributed by the community, prior to being approved. The data is pending analysis and accordingly, removal and update into the permanent, verified data storage.
4. **Analytic**: User Interface (UI) Administration and Purification Workflow:
   - Analytic: handles the mining of the nuggets repository for displaying the statistics regarding the nuggets and contributors. This feature can serve as a motivation trigger for knowledge contributions.
   - UI administration: handles the plug-in components so more options for knowledge capturing will be added or removed. In addition, Permanent information will also be handled (i.e. URLs of the information systems) so that the user will not need to enter various information systems while using a specific system.
5. **Verified Knowledge Nuggets Storage**: Search, Permanent Nuggets Storage, Usage Rating
   - Search: handles search options for finding nuggets according to free text, a specific nugget (i.e. artifact, evaluation) or tag.

Figure 2 illustrates how the knowledge nuggets toolbar is embedded within an architecture modeling tool and used during the architecture design process, starting from receiving a software requirements specifications (SRS) document and ending by delivering a top level design specifications (TLDS) document. The toolbar is used during the decision making process of both architecture design and architecture review.

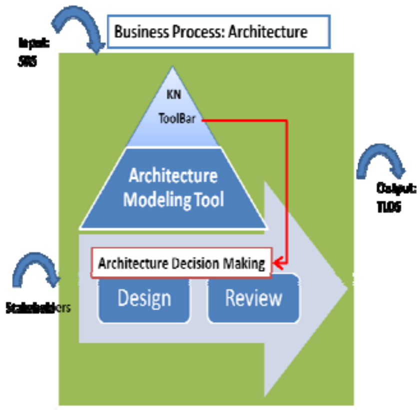

Figure 2: Conceptual Model for the Knowledge Nuggets Solution – Illustrated on an architecture modeling tool.

3.3 Prototypical Scenarios

In order to illustrate the proposed conceptual

[1]http://en.wikipedia.org/wiki/Java_Portlet_Specification
[2]http://en.wikipedia.org/wiki/Liferay
[3]http://www.jcp.org/en/jsr/detail?id=286

architecture, several scenarios (use cases) are presented.

3.3.1 Activation Scenario – Knowledge Nuggets Contribution

The emerging technology department reveals a new trend – for example, IPv6. The emerging technology employee will be able to insert artifact regarding this new standard including all relevant information, by creating a knowledge nugget called IPv6 via the Artifact option in the knowledge nugget creation toolbar. All relevant material from different sources will be linked to the knowledge nugget via the Link option, including – where relevant – a blog related to this topic. There is a possibility to discuss the knowledge nugget for evaluation and enhancement. Finally, the knowledge nugget is tagged (e.g., protocol, standard).

3.3.2 Activation Scenario – Knowledge Nugget Evaluation and Purification

After the new IPv6 knowledge nugget was inserted, the knowledge nugget should be analyzed and evaluated. If the user, who inserted the knowledge nugget, is a privileged user (e.g. the chief architect of the relevant product), the knowledge nugget will be automatically approved. Otherwise, experts in IPv6 will be allocated for the purification workflow for evaluating and refining the new knowledge nugget.

In another scenario, during the implementation phase a problem occurred that resulted in a need to change the architecture. The implementer can add retrospect evaluation to the architecture document within the knowledge nugget, through the implementation and analytics components.

3.3.3 Activation Scenario – Knowledge Nugget Consumption

The architect designs a solution, which supports the standard IPv6. For linking the solution to the explanation of IPv6, the architect, while designing a solution on the architecture modeling environment, clicks on the Artifact and the Standard options and chooses the Standard IPv6 to be linked to the current solution. After the linkage is set, it can be used to automatically integrate it within the architecture document, or it can facilitate other stakeholders' understanding of the IPv6 concept.

4 CONCLUSIONS

This short paper presents a conceptual framework of a KM system, which aims at solving challenges in KM in the context of architecture processes in software engineering. The system enables knowledge capture and reuse during the architecture activities and throughout the software development lifecycle. Moreover, it efficiently reduces the amount of labor usually associated with knowledge construction, and leverages context, identities and authority as basic rules for rapid purification. Using modern Web 2.0 and portlets technologies, such as LifeRay enterprise portal, we can provide a systematic plug-in and method for capturing and reusing knowledge via same look-and-feel tools embedded in the working environment and within the business process.

The need for quick responses to the intricacy of the rapidly-changing environment leads organizations to develop their KM infrastructure (Lustri et al., 2007). Lustri et al. (2007) show that KM infrastructure is a key factor that intensifies the organizational competency by accelerating time for the development of competencies. Our approach, although targeted primarily for architecture process improvement, is relevant for any technological management system by enabling a "divide-and-concur" approach that simplifies knowledge creation and consumption, bringing the knowledge to be part of the regular working environment (such as a modeling tool), rather than the commonly used solutions located within dedicated knowledge system. Thus, our Web-based remote solution is an in-process, embedded façade for technological knowledge management. Furthermore, the embedded approach supports the creation of tools that automate the production of architecture documentations and decisions, while reusing existing knowledge.

The research provides a conceptual framework for an infrastructure that facilitates knowledge sharing; however, cultural, social and human factors barriers are yet to overcome when implementing it in organizations. Future research will address implementation and evaluation of the proposed conceptual framework in enterprise IT organizations.

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