

Community-Aware Adaptive Systems

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Abstract: Communities of practice have been studied widely in organizational science for knowledge sharing and learning process. Consequently, organizational systems have to be designed and engineered with communities as stakeholder in the continuous requirements engineering processes of modern service-based architectures. Here, we discuss preliminary ideas, how to represent the community context of ongoing change processes in these architectures explicitly and how to adapt the information system design and engineering process to the changing community context. We sketch future work on cross-media network analysis to create community-awareness in the information system design and engineering process.

1 Introduction

In this paper we focus on communities of practice (CoP) [Wen99] as an adaptation aspect for the community-centered requirements engineering (RE) of information systems (IS). Due to the continuous evolution of CoP the needs of its members are changing over time. We postulate that the current CoP state represents an additional context aspect for information system change process. We emphasize that the CoP state description consists not only of gathered user profiles, but also contains data such as information flows, social interactions and intensity of information exchange. The pure collection of data from users is not enough to elicit the community needs. The requirements specification of IS must contain two more facets: the media used in the ongoing discourses between the community members and the explicit links to the created artifacts. Only the models of these three facets inclusively the information about their connectivity presents a full context description of information systems [DMDJ⁺98]. Unfortunately, the evolution of community needs depending on community current state is not an exhaustively researched area yet. We propagate to trace the changes in the information systems over the time, using a three-faceted description model proposed in this paper. Based on the gathered information we extract community requirements for information systems according to the CoP state.

2 Context Awareness

Many different definitions can be found for the word context. Originally, this term comes from linguistic and "is not an encapsulated representation of an intended meaning, but rather is a cue that allows the anticipated audience to construct an appropriate meaning" [Win01]. For example a phrase "driving with the speed of 30km/h" can be interpreted differently: for a bicycle this velocity is a very high speed, whereby, it is almost nothing for a car. Obviously, the context is crucial for entire understanding of any situation. The first definition of context in information systems was not general, but rather application related. Schilit and Theimer [ST94] described "context aware computing as the ability of a mobile user's application to discover and react to changes in environment they are situated in" .

Nowadays, "the increasing technological progress and the associated integration of software systems in a wider range into our everyday life require for more flexibility and multi-functionality of the systems" [SS07]. Still the open question is which context to consider. Though in order to achieve the desired flexibility, the relevant adaptation aspects must be stated. In addition, the context must be shareable. Concerning the example from above, if somebody did not know, what bicycle is and how fast it drives on average, the mention of the term "bicycle" will bring no extra clue to the user. Obviously, the development of the context aware software is a non-trivial task.

In our work we want to limit our investigations to information systems and create a framework for RE of context aware collaboration systems. Since a long time the importance to adapt information systems to the requirements of collaborating users has been realized. Nevertheless, the context for adaptation of such systems is still defined very fuzzy. An approach often applied for the definition of context is to pick out one reasonable context model defined by a software engineer and then to assign "hard-coded" alternatives to the context parameters, leaving out other aspects. For example, the authors [EES⁺04] proposed "system framework, [which] has been designed to adapt various information types to different clients. The system can serve standard desktop systems as well as low-resource PDAs". They do not pay any attention to the needed information adaptations for certain user groups, but only to the technical aspects. In studies where the user specific information is taken into account, only the context of one distinguished user is considered [Liu07]. These studies claim that "in order to develop a new context-adaptive system providing passengers preferred entertainment services to reduce his/her negative stress intelligently and effectively the following research problems should be addressed first: [...] a conceptual control framework of user preferred music [...], a user profile model [...], user preference learning algorithms". User, user and the lonely user, but what is if he/she has a friend flying with the same flight, or how is the user influenced by the actions of the passengers sitting next to him? Unfortunately, this information remains unattended.

The IT-world moves away from the development of big monolithic systems to service oriented architectures (SOA) [SKC07]. In theory, potential customers just do a market research, find out which of the offered services satisfy their needs in the best way and than buy or rent those. Thus, in the future service providers will even not know who and why and also combined with which other services will use their product. Consequentially,

the focus on the stakeholders in the RE processes shifts from the people, who were responsible for the original specification of the IS to the communities of practice using the systems. These end users become the new stakeholders in the ongoing change processes needed to adapt the service-oriented architecture to altering needs of the organization and external markets. Adaptation process depends on getting a clue what the community really wants. Organization of this elicitation process is difficult due to the number of stakeholders involved, the complex inner life of communities and the problems of interaction and articulation within the communities. In our paper [KSC06] we propose to "include a community context into the adaptation process, arguing that addressing stereotypical users is less restrictive and that it avoids undesired cognitive and social lock-in situations". Unfortunately, modeling of community oriented context or community awareness is not a trivial task. CoP presents a continuously changing network-like system with many complex socio-psychological factors to be considered.

3 Modeling Community Awareness

We postulate community context as an essential aspects for awareness of information systems. Therefore, we head our research to investigation of communities and its properties. The description of a current community state depends not only on its current conditions, but as a vivid system also on its previous states, its socio-psychological characteristics, media used for communication and other context factors. Thus, a model, which combines all these aspects, must be designed to present the context of the community aware system. Obviously, a framework for CoP state description must be developed. One can think about the characterization of CoP by social network analysis, e.g.: betweenness, connectivity, etc [WF94]. However, as stated in the introduction these parameters are not enough for CoP description. It is impossible to develop and debate concepts separately from the media through which they are communicated. Thus, media has to be modeled as a part of the context. We also claim that there is one more aspect that must be considered for the creation of a full CoP model: artifacts created by community using the media applied. In figure 1 all three facets proposed for the community oriented context description are illustrated. As one can easily see, not only the aspects themselves, but also the connectivity between them must be captured.

To summarize, the community-oriented context consists of three aspects: CoP, its goods in form of artifacts, media used and, additionally, the connections between them. A new meta model must be designed for description of the proposed context structure. Afterwards the context models can be applied in RE of community aware systems. For the development of community-aware systems an evolutionary model for the community state is required. To the best of our knowledge, no well-established evolutionary model exists so far. In order to create such a model, a meta model for community state description has to be designed first. Next, the evolution processes of community states have to be modeled. This can be gained by means of traceability of community transformations over time followed by the analysis of collected information. We hope to design a behavior model of community aware systems. The results will represent learnt experiences and will be applied

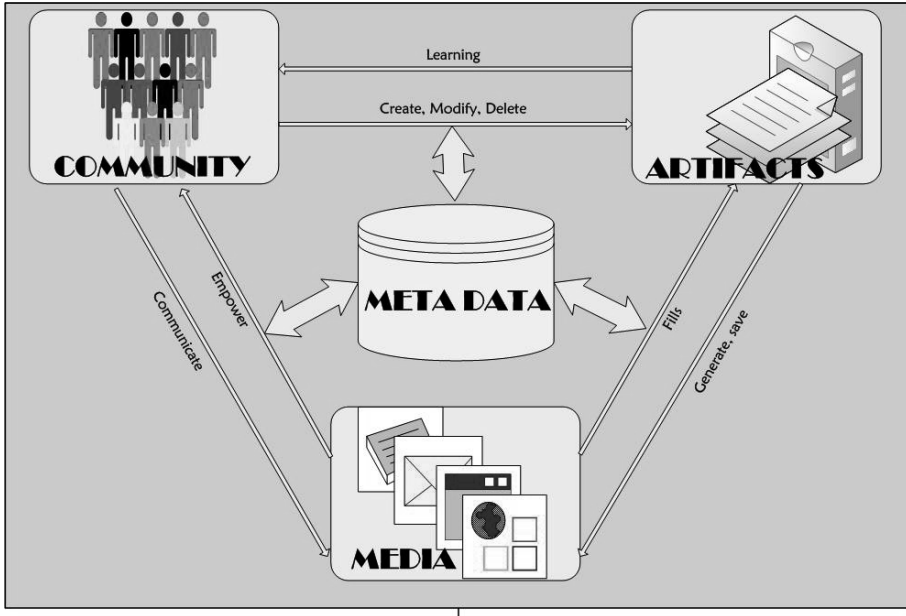


Figure 1: Community oriented context

in RE processes of community-aware information systems. Concerning our aims to support community-aware systems, the model for the representation of the community state must be designed in the first place. This model should describe the state of community members, the media applied and created artifacts.

For the media and system description several meta models, which can be taken as basis, exist. Especially the use of MPEG-7 and MPEG-21 [Kos03], allows effective meta data crosswalking with other XML based standards in technology enhanced learning by means of simple mapping rules realized e.g. in Xpath [KSC06]. We postulate that social network analysis (SNA) properties of communities, such as betweenness, closeness, centrality, etc. will specify essentials part of the community state descriptions. The analysis of network properties is based on our previous work on SNA [KSCJ06]. Further, the connectivity of the three context aspects has to be modeled. Hereby, our experience from the IS development will be employed [JK02].

As soon as the community model is completely specified, we will create an evolutionary model of community context transformations. This can be done with help of the traceability framework proposed by Pohl [Poh96]. Pohl emphasizes that "the trace information must be recorded during process execution (in our case model evolution) and be captured and related to the inputs used and the outputs produced by action". Using this approach, we plan to trace the evolution of the models over time. In order to model transformation processes of the models the collected data needs to be analyzed. The recognition of the evolutionary patterns in the data can be simplified by the re-contextualization of the gath-

ered information. For this purpose storytelling techniques can be employed [SKSJ06]. We have demonstrated that our storytelling approach is suitable for community learning purposes because of its support of both episodic and semantic memory concepts on the one hand and a clear, simple, understandable and easy to follow story concept on the other hand. Created stories of model evolution over time can also be applied as a learning material for new and peripheral members in the community of practice. Pohl [Poh96] stated that "the rationales, which lead to the current state, are an essential source to reuse". Therefore, in order to make reuse of the designed model possible we propose to capture it in the form of social patterns. Each pattern should provide the information for the community-aware system development process depending on its state. Such patterns can be later applied during RE processes. The importance of context during RE processes is shown by Sitou and Spanfelner [SS07]. They propose a model-based approach for RE in context-aware systems that explicitly elaborates an integrated model of the usage context. As in the case of community-aware systems the context described by the community model presented above should displace the usage context in the presented RE approach.

4 Conclusion & Future Work

We claimed that the whole community represents a customer of the collaborative system and not a single user. Therefore, the community profile has to be considered as a relevant context. The community description only is not enough for the full community oriented context definition. Additionally, the media used for the communication have to be considered. Furthermore, the current settings of the information system, its limitation and restrictions represent undoubtedly an essential part of the context. Therefore, we proposed to use a three-faceted context model, which represents not only the meta data of the three aspects listed above, but also describes the connectivity between them. In the DFG-funded project CONTICI (www.contici.org) we will realize our community-aware RE approach for community information systems based on modern service-oriented architectures. Main work areas will be the traceability of evolutionary changes in the models and the integration with the context models from our partners.

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