

Ontology based knowledge management for organizational learning

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Abstract: Recent research in workflow management for public administrative organizations is focused on the application of intelligent information technologies on the basis of workflow management systems for virtual organization modeling. In the systems, intelligent knowledge base is used to represent knowledge within organizations; thus, response to environmental changes is allowed on the basis of historical situations, and also according to employees' knowledge and experiences captured within the modeled organization. Such approach enables to develop systems that can resolve current problems and offer expert view on the current problem solution. This paper describes a system based on e-mail communication and a web portal that is suggested for management workflow processes in administrative organizations.

Key Words: Ontology, workflow, organizational learning, system architecture

1 Introduction

The ontology based workflow management improves administrative processes in three ways [9]:

Improves the quality of work: Usually the large amount of documents or e-mails has to be processed to successfully accomplish the administrative work. This kind of work requires the broad knowledge of rules (laws, internal instruction, etc.) as well. The system based on ontology can encapsulate such knowledge. Moreover it can capture the solutions of past processes and propose the most proper one. This leads to error-proof administrative process

Saves the processing cost: Proposed system can advice user with actions to be taken and suggest user with solutions which are related to current user's working process. The colleagues also will have overview upon the personal assignments of current working processes. The documents are processed in straightforward way, so the users of system evade the processing of the same thing twice.

Time savings: The documents can be quickly and easily reused and processed according to its ontological description. Therefore, the user never needs to manually find related document within the file system. Moreover, the proposed system will inform user about the progress of current workflow activity and about the pending processes.

A case study of the approach – process of military exercise preparation in Centre of simulation technologies National Academy of Defense is presented here. The presented system is based on e-mail communications and a web portal. Building ontology for the system goes out from a detail analysis of the workflow process associated with military exercise preparation and organization that is presented in Section 2. Section 3 describes the architecture of the designed system and details of the ongoing implementation. A summary and some future work ideas are given in the Conclusion.

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2 Generic and domain-specific ontology

Ontology base makes knowledge system more generic, unique and adaptable. Creating ontology requires not only the skills in information technologies but also a great knowledge in the modeled domain. The basic principles for building ontology may be derived from the CommonKADS methodology [6], which deals with the common principles of knowledge systems development. Generic and domain ontology have to be designed for the system. Generic ontology is built for any administrative process. Common classes as Person, Process, Activity, etc., and also all relations among, them have to be defined. Building domain ontology requires detailed analysis of processes in the application domain then therefore for the pilot application the analysis of military exercise preparation and organization process was done.

2.1 Case study - Workflow of administrative process in army training centers

The system RAPORT [7] is designed for a pilot application – organization of military exercise in a Centrum of Simulation Technologies (CST) National Academy of Defense (NAD) in Liptovský Mikuláš. CST organizes and performs the training and education of officers for headquarters' staffs and commanders with support of information and communication technologies.

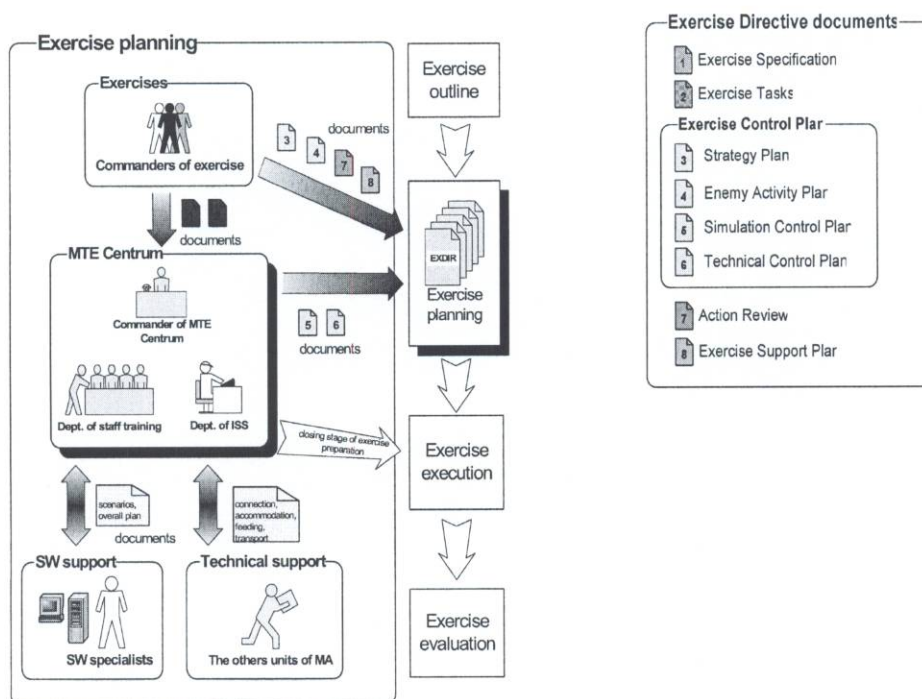


Figure 1 Organization of a military training in a CST NAO

The exercise organization in CST is realized manually using office software. On the basis of assigned tasks, CST staff realizes the requested activities and account for the quality of exercise organization. However, the organization preparation of military exercise is distributed among the staff members. The coordination is made during control meetings,

where individual team members inform about the status and quality of task solving. In case of absence it can come into time overrun, which can cause breach the schedule time of military exercise organization and next breach of exercise requirements. Absence of a team member, e.g. due to illness, can be rather negative for this work. Such absence means absence of information about task fulfillment status. However, CST organizes several overlapping military exercises during a training year; thus, overlapping of information about the organization of individual exercises can occur, and this results in further difficulties. The process of exercise organization is depicted in figure 1.

Process of military exercise can be divided into three parts.

- Exercise preparation: determine the content, topics, tasks and targets of military exercise, preparing the scenarios of military exercise, simulation and technical plans, choice of localities for military actions by digital maps of terrain, etc.
- Exercise execution: the aim is to satisfy the determined targets of military exercise, learn to use the needed documents, react on arise military situations, etc. Exercise performs by computer software, which simulates military actions of officers, military groups and military techniques.
- Exercise evaluation after realization of military training activities. The documents and information about exercise preparation is archived.

Officers of Slovak army are responsible for military exercise preparation (mainly outline of exercise), execution and exercise evaluation from point of military activities.

2.2 Design of the system ontology

The *specific workflow process* is modeled by *activities*. Every activity is described by its input *requirements* (documents, actors or other activities), its *outputs* (usually documents) and *engaged persons*. The state of the workflow can be easily defined by the *context* that describes the finished activities, available documents and persons. Anytime some new resource is included within context of the workflow process, the proposed system will test the instances of class *EventTemplate* to match the context and requirements of *EventTemplate instance*. If the match occurs, the system creates the *instance of Event class* and activates the activity described in *property activityClass* of matched *EventTemplate instance*. The activities are not loosely coupled; instead the conditions are defined for activity execution what makes more flexible way for workflow definition. Figure 2 depicts an abstract workflow modeling and activity modeling.

Abstract workflow class models the prescription of workflow instance construction. First of all, user (initiator of workflow) or system must find out the type of workflow, before it'll be initiated. An instance of such abstract workflow should be, for example, preparation of military exercise. Each instance of abstract workflow has assigned *AbstractEvent instances*, which define the templates for new workflow activity building. The context of such instances is periodically matched according to current workflow context. When the required context is subset of current context then new activity may be initiated. The type (ontology class) of activity is written in the *property activityClass*. The new event is created to interconnect the activities, which could serve for later workflow reconstruction and analysis [3], [5].

The current context is the most often changed by assigning a document or a person to the workflow process. However the person assignment can be done by the responsible person via a portal very easily, the documents should be assigned automatically without user intervention. For this reason, the tool of semantic annotation was developed to automatically recognize the context of incoming document (usually email) for context adjustment [2], [4].

The context property has different meaning for different classes. In the *Workflow class* it means the current workflow status. Its value changes over time the workflow is running. In the *Event class* it means what was the state of the workflow when activity was invoked.

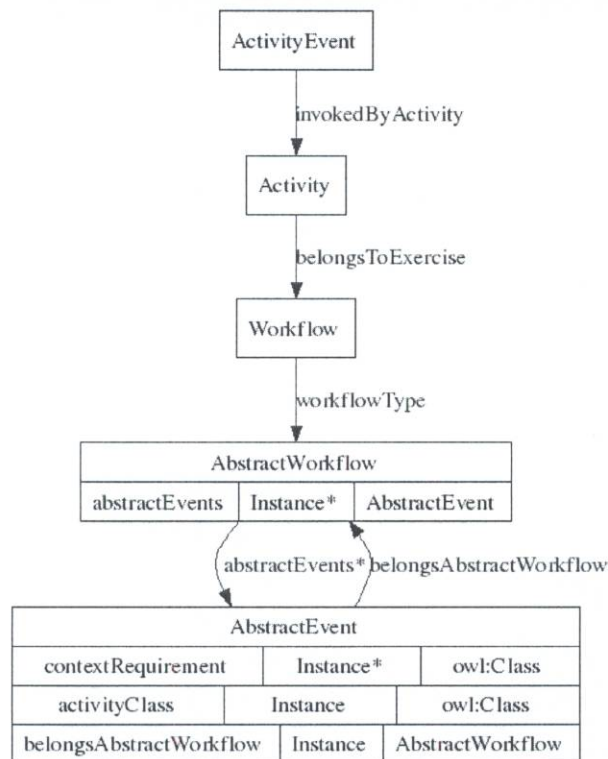


Figure 2 Abstract workflow modeling and workflow activity modeling

3 System architecture

The architecture of the RAPORT system is designed in the generic way that can work for arbitrary administration process. The system will be tested on the above described administrative process in the CST. The system architecture comes from the following requirements:

- Collect experience from users and present them to other users working in similar working context;
- Check current training plans for important deadlines;
- Prepare necessary information (predefined emails, documents, formulas) before deadlines with user's awareness.
- Support user's experience exchange and collaboration.

The architecture is presented in the Figure 3. It presents a 3 layered architecture: data layer, process layer and presentation layer. As in several current projects, important background of the system design is its ontology, which defines structure and relationships among experience entities; ontology is the main mechanism used for the representation of information and knowledge, definition of the meaning of the terms used in the content language and the relation among these terms.

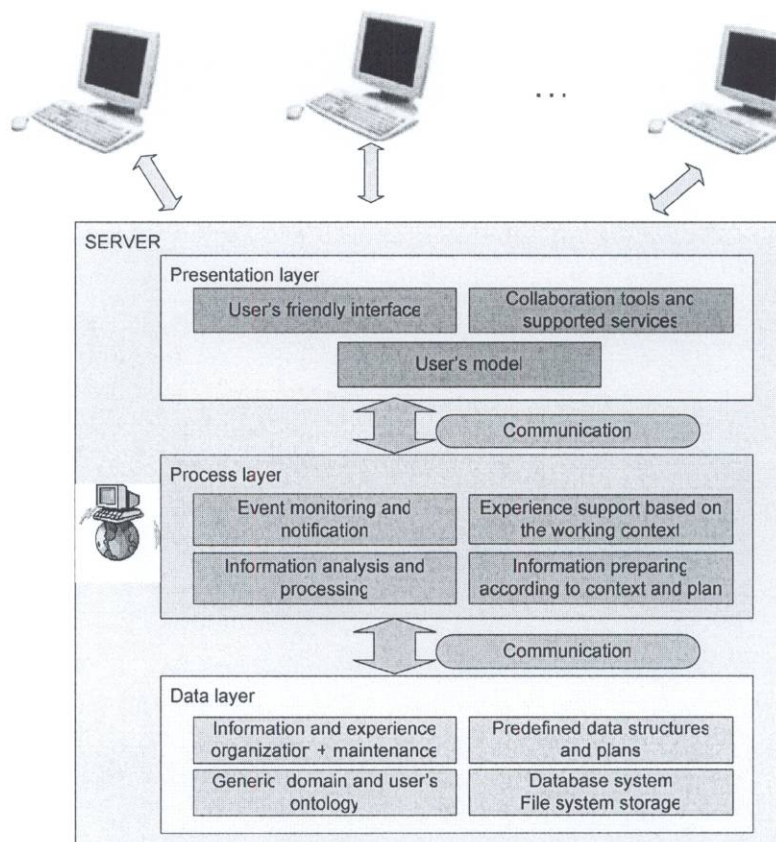


Figure 3 RAPORT system architecture

Data layer: Data layer ensures functionality of the database and the file system repository. Information and knowledge are organized and maintained for the use of the process and presentation layer. The generic, domain-specific and user-model ontology are also stored in the data layer in OWL format and in database. Predefined structure of such as documents, formulas, templates and predefined plans of training activities are stored here. Such information and data can be managed and modified by the system administrators.

Process layer: is the heart of the system. Its functionalities are designed to fulfill the system requirements. The functions of the process layer are:

- ensure event monitoring and notification,
- information analysis,
- creating of ontological data based on accessible resources and context, storing them through Data organization and maintenance as experience for further use.
- creating active notes based on the current working context and previous experiences in the data layer and providing them to users through the presentation layer
- preparing required information (documents, emails) related to the current working activity and working context according to the predefined templates, structures and accessible knowledge

Presentation layer: provide transparent, user-friendly and adaptable middleware for presentation knowledge and information to users. To fulfill this purpose, the presentation

layer describes the user model with user ontology in the background. The user ontology is generic personal ontology that is firm extended for the army environment. The user ontology is already well-integrated with the domain-specific ontology and is accessible from the data layer.

The infrastructure of the RAPORT system is as follows: the OS is Linux Mandriva 2006 with MySQL database and mail server PostFix. For implementation, the Java technology (J2SE, J2EE) is used. The web container will be chosen between Apache and Tomcat. The middleware will be PHP or JSP according to the choice of the web container. Auxiliary technology of transformation such as XML, XSLT, CSS ... are also necessary and required. Except for that, the generic and domain ontology are designed according to CommonKADS [7] methodology. The editor is Protégé and OWL is the ontology language of description. The Jena library will works as the middleware for ontological data. The development of the portal is in the design stage. The consultations about the basic portal functionalities continue with future users of the system. The reason of decision and comparison for portals and other implementation environments will appear in another paper in near future.

4 Organizational learning

This paper describes design of knowledge management system for organizations with administrative type of processes. Big advantage of such solution is in relatively easy implementation on the assumption that the organization has e-mail communication and internet access established. Web portal provides all necessary information about workflow processes and e-mail communication enables automatic or semi-automatic notification about deadlines, required actions, and changes in plans, etc. There exist a lot of software tools to support workflow management, referred to as groupware. Although they are assumed to manage workflow activities of two or more workflow participants, not all groupware products are real workflow management systems. Many organizations with administrative processes have couple of works to carry out that can be formalized and structured according to internal directives and instructions. It is not required to use the complex workflow management system in such organizations, because there are just very few well defined processes.

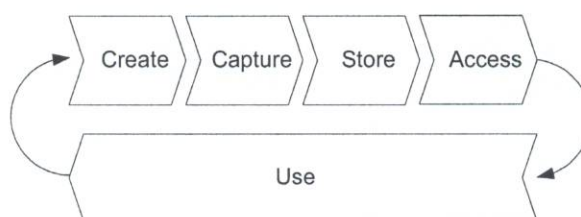


Figure 4 Knowledge management lifecycle

Workflow management and knowledge management systems are designed except others to serve organization mobile employees in doing their everyday work. Research within the area is focused mainly to analyzing administrative workflow processes in general with the aim to find a framework and general structure for modeling such processes, and to analyzing knowledge in public organization, to identify the knowledge gained via experience and that, which exists in form of various types of instructions, regulations, and standards. The general knowledge management lifecycle is depicted in figure 4. Organizations usually have more

workflow processes executed in time; thus, overlapping of information about the status of individual activities, and processes can occur, and this results in further difficulties.

Using knowledge system avoids the problems related to the missed information or knowledge. The knowledge management support system allows automation of organization processes and enables access to required information on the basis of interactive communication with organizational staff. The system enables to control readiness of particular processes and documents, and evaluation of actual status of workflow activities for each workflow process and each workflow process agent separately. Such system provides users appropriate information according to their roles and competences within the organization and according to their special roles in the workflow process instance. Once the workflow process instance is established each workflow agent has all duties and terms defined in the ontology as instances of the abstract workflow process. The ontology based knowledge management enables to define flexible workflow process and all instances of the process are adjusted to the real and special requirements (e.g. shorter periods, lack of needful information, absence of some employees, etc.). Employees that are working on their duties within processes can write down any notes and hints. Another form of capturing experience is from e-mail communications. E-mails related to the workflow process instance is clearly identified in the Subject by workflow process instance ID. They are annotated and stored together with written notes and hints within the system and presented to the users for further reuse. Generally there are two ways how to support employee: provide users active hints on the basis of the context and/or provide users relevant solutions from the history. Practically it is realized through documents that are stored in the database. When the user works on a document related to an activity, another document with a similar content is provided by the system. A case based reasoning is used to find similar documents in the database.

5 Conclusions

The approach of the knowledge management the design of the system architecture in the administrative process in army training centers is build based on the long-term work in this research area within EU RTD IST projects mainly PELLUCID [2], [8] (A Platform for Organizationally Mobile Public Employees), and a Slovak national project NAZOU [10] (Tools for acquisition, organization and maintenance of knowledge in an environment of heterogeneous information resources). The idea of active notes/advice comes from the DÉCOR [1], it is further developed in the PELLUCID and RAPORT. The difference and new in the RAPORT is the combination workflow in the administrative processes with email processing, that is more lightweight and has found wider usage in SMEPs (Small and Medium Sized Enterprises) and in administrative organizations as well.

Comparing to other workflow management systems, the described approach provides a lightweight solution for many public organizations that do not need to implement a complex workflow management systems. Using ontology makes the system domain independent.

This approach has found its place not only in the project, but it can be widely used in similar cases for automatic processing for knowledge management and can be applied in many areas with the similar specifications.

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