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DYONIPOS: Proactive Support of Knowledge Workers

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Abstract: While efficient and effective knowledge management plays an increasingly important role in knowledge-intensive organizations knowledge management usually brings additional work and fosters red tape. DYONIPOS (DYnamic Ontology based Integrated Process OptimiSation) causes no additional work because it creates knowledge out of existing artefacts. Knowledge workers require a certain degree of freedom in structuring their own tasks [3]. This essential freedom often conflicts with the organization's need of standardization, control and transparency [5]. DYONIPOS solves this dilemma by automatically supporting knowledge workers with the required knowledge just in time. DYONIPOS sets up an organizational knowledge base, derived from existing artefacts out of various repositories. By using semantic and generic knowledge discovery technologies coupled with semantic integration and semantic enrichment DYONIPOS activates the buried knowledge treasure of an organisation. A context-sensitive, intelligent and agile assistant offers this knowledge to the knowledge workers [5].

DYONIPOS was nationally funded. A research and a use case project were implemented in parallel to foster instant transformation of research results to practice. DYONIPOS was awarded best proposal of its call. The pilot phase with 180 users will end in mid 2009 and DYONIPOS will be brought to product status.

Keywords: Knowledge Management, Knowledge Work Support, Semantic Technologies, Research Project DYONIPOS, Use-Case, Public Administration.

1. Knowledge Management – Radically Renewed for E-Government

1.1 Why Knowledge Management for Public Administration?

E-Government means not only the use of information technology to improve the exchange of service and information with citizens or businesses. E-Government also means the use of information technologies to improve internal information, data and service quality. Public administration work is knowledge work par excellence, because information of governmental organizations is widely scattered and civil servants are confronted with an overload of information. The knowledge of an organization can be classified into three kinds of information: public domain knowledge, partly available knowledge and tacit knowledge. Public domain knowledge is available for all knowledge workers. This knowledge is often stored online on the intra- or Internet and accessible through search engines or knowledge databases. Partly available knowledge is only accessible for individual or specific groups of knowledge workers. This kind of knowledge is often stored on the employee's PC or the organization's server. The third kind of knowledge – tacit knowledge – is in the minds of employees and therefore only available to the owner of the knowledge. For a knowledge worker it is very time consuming to find the adequate

knowledge in the existing overload of information. If tacit knowledge is needed, the receipt of required resources depends on chance.

1.2 The Aims of DYONIPOS

DYONIPOS meets these challenges without creating any additional work. Its aim is to provide personal, agile and proactive support for the knowledge worker by means of proactive, context-sensitive knowledge delivery and processing of next steps. DYONIPOS provides all kinds of knowledge that has been released for the organizational knowledge database, provided the user has the right to access this knowledge. In the case of tacit knowledge the name of the information owner will be supplied. Another aim is to support the process engineer through information about the recorded ad hoc processes, e.g. visualization of the workflow and process, landscape visualization of similar tasks and sub processes. The process engineer can use this information for improving standard processes or compiling statistics [5]. Furthermore, DYONIPOS creates and continuously updates an individual as well as an organizational knowledge base. This knowledge base makes the organization's growing knowledge available.

1.3 A Joint Venture of Scientific Research, Economy and Public Administration

DYONIPOS was organized in two parallel projects: A research project was carried out in parallel with a use case project. The DYONIPOS research project started on 2 January 2006, and was completed by the end of the second quarter of 2008. The DYONIPOS research consortium consists of m2n consulting and development gmbh (a private innovation company), Know-Center Graz (the Austrian competence centre for knowledge management and itself a joint venture between Graz University of Technology and private economy), the Institute for Information Systems and Computer Media (IICM) of the Graz University of Technology as well as HP Austria as an IT company. Together this consortium developed the DYONIPOS prototype. The DYONIPOS research project was financed by the "semantic systems" program within FIT-IT, an Austrian research program provided by the Federal Ministry of Transport, Innovation and Technology (BMVIT). The proposal of the DYONIPOS project was awarded the best proposal of the regarding call.

In order to ensure the applicability of DYONIPOS, a parallel use-case project was carried out by the Directorate General for Information Technology of the Austrian Federal Ministry of Finance (BMF). The BMF is one of the Austrian key players in the field of e-Government and develops e-Government systems for its own but also for other public administration bodies. So the BMF has the experience to develop and rollout big IT-Systems also for other administrations. The BMF also has good practice in stakeholder involvement [4] and DYONIPOS was developed by following a strictly stakeholder oriented approach.

Anyway after a six month pilot DYONIPOS will be brought to product status and will then be available for the market and therefore for any knowledge organisations.

2. Research Project DYONIPOS

DYONIPOS is based on automatic and semiautomatic knowledge management methods and technologies, e.g. knowledge discovery, semantic systems, knowledge flow analysis, and process visualization. Semantic technologies enable the handling of structured as well as unstructured data from knowledge intensive processes [5].

2.1 Knowledge Discovery Technologies

The discovery of work patterns, the just in time delivery of relevant information and the suggestion of next steps are the major functions of DYONIPOS [7]. To provide these

functions DYONIPOS captures the user's knowledge work, discovers the inherent tasks and processes and supports the knowledge worker with information.

The first challenge is the observation of the knowledge worker's interactions with and reactions to the system and existing application data. This observation generates the so called low-level sensor data on the application and operating system level [3]. The second challenge is to develop adequate techniques to discover the work patterns and to automatically support the users with appropriate information. The third challenge is to detect how knowledge workers can be supported effectively [6].

In order to capture the worker's patterns a java tool called DYONIPOS task recognizer has been implemented [7]. At first DYONIPOS records all interactions between the user and her/his computer; these are the so called "events", e.g. mouse clicks or key strokes. Different sensors of the context observer module observe all interactions of the user with the desktop environment. DYONIPOS uses a key logger program to record and log all recognized events [6]. The observed events are stored in the so called event log. This monitored data is the basis for determining work patterns. The next step is to reduce the immense quantity of data and to assign events to event blocks by filtering and relation analysis. This allows the elimination of irrelevant data, e.g. mouse movements. Through relation analysis, a set of events can be bundled into an event block. At present, generic rules, application based rules and web browser based rules are applied for bundling events into event blocks [7]. Generic rules are based on the title of the window currently opened by the user (usually data set name and name of the used program). A reason for the assignment of events to an existing event block is e.g. the title of the window currently opened. The implementation of further rules for assigning events to event blocks can easily be accomplished. The methods used for learning task assignments are k-nearest neighbour classification, Support Vector Machines based on graph kernels (see [1]) and the possibility to train the classifier, that is, the above mentioned bundling agent, by means of task assignments done by the user. A method to detect tasks, which is the next level of semantic enrichment, is clustering based on similarity between content and structural features and the scatter/gather approach. The assignment is initially performed by the user, but after a training phase, in which DYONIPOS learns the classification features, tasks will be detected automatically. The transition from tasks to the next level – processes – is based on the combination of individual tasks that have been carried out by different knowledge workers. Methods similar to those described above will be used by DYONIPOS, when the system learns how to assign tasks to processes. Furthermore the application of the ProM Framework will be used to extract processes (see [6]).

2.2 Semantic Technologies

DYONIPOS is a modern information system that supports the users by proactive delivery of contextual information (resources) while the knowledge workers are doing their daily work. The application of ontologies is useful in such a system, because they ensure interoperability and the development of "new" knowledge. Furthermore, ontologies are used for the learning process of the user context. The structure and the recognition of context, the knowledge base and the internal program flow are based on ontologies. Ontologies can also be used for the unambiguous description of information resources. As a consequence, RDF is a key technology of DYONIPOS [9]. All events, event blocks and tasks described in section 2.1 are represented and stored by RDF-Triples [2]. This means all data extracted from metadata (e.g. from integrated applications), documents, presentations, e-mails etc. will be saved in a structured manner. For example, the DYONIPOS ontology consists of the concepts "Person", "Organization", "Document" and "Topic". An example for a concrete "Person" may be the employee John Q. Public. John Q. Public works at the Federal Ministry of Finance and has written some articles about semantic technologies. The

circumstance described above results in the following concrete classifications: John Q. Public is an object of the concept "Person", the Federal Ministry of Finance is an object of the concept "Organization", all written articles are objects of the concept "Document", and the identified "Topic" is semantic technology. The following relationships exist between the objects: John Q. Public is employed by the Federal Ministry of Finance, John Q. Public is the author of some articles; John Q. Public deals with the topic of semantic technology. Further conclusions drawn are the following: John Q. Public is an expert in the topic of semantic technology and the Federal Ministry of Finance deals with the topic of semantic technologies. The newly learned knowledge – e.g. that John Q. Public is an expert in the topic of semantic technology – is a recognized resource of DYONIPOS. It should be mentioned that for privacy reasons only knowledge concerning persons who are registered DYONIPOS participants will be discovered and stored and later on supplied.

3. Use-Case Project DYONIPOS

Parallel to the research project DYONIPOS the use-case project DYONIPOS was implemented in the Directorate General for Information Technology (DG-IT) of the Federal Ministry of Finance in Austria. Administration work is knowledge work par excellence, because the flood of information is immense and the existing knowledge is widely scattered. In order to accomplish their daily work, the knowledge workers in public administration need the following additional knowledge:

- Where is the relevant information stored?
- How can this information be found?
- How relevant is the delivered information?

The challenge is to automatically provide the administrative employees with the information they need. Consequently the above mentioned additional know-how is made available by DYONIPOS. Other objectives are to support the employees of the DG-IT without creating additional work by means of knowledge management and to ensure the privacy of the knowledge workers. DYONIPOS supports this challenge. Due to this fact DYONIPOS will be used for efficiently and effectively supporting the daily work of the individual employees in the DG-IT. The DYONIPOS task recognizer supports the employees with the necessary knowledge, which is produced by semantic cross-linking of the relevant information from the existing repositories and processes. Additionally, DYONIPOS independently develops new relations between the sources of knowledge. This explains, for example, that the DYONIPOS task recognizer at the one hand supports the user by visualization of existing documents, files or websites etc. and on the other hand displays the new generated information such as the name of the person who has the specific know-how. The Ministry or rather fifteen employees supported the research consortium. Together they worked on the realization of the research results and they ensured the transformation of current scientific results to an easily useable software solution. The staff of the ministry shared its domain specific know-how with the research consortium, by supporting the development of DYONIPOS base technologies.

Initial interviews with employees have been carried out to obtain an impression of the kind of work and how this work is done. The results of these interviews provide the information which sensors should be developed and which events the sensors should observe. The researchers found out that the employees work especially with the following standard applications: Microsoft Office tools, Internet Explorer and the e-mail system Novell GroupWise. That is why a first research step was to develop sensors to observe events of these applications. In addition to the observation of these standard applications the final DYONIPOS prototype records all electronic artefacts from the electronic record management system (ELAK), the file-system on the servers, the mail-system as well as the

specific application KOMPASS, a proprietary system to administrate persons, resources and authorizations. The usage of “connectors” makes it easy to add additional repositories.

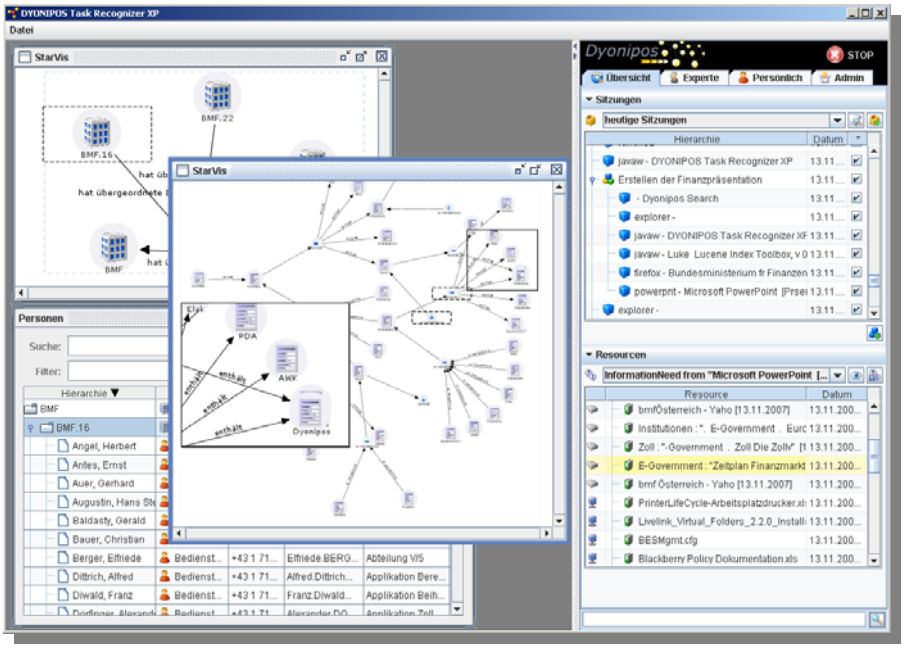
The implementation of the use-case is structured in three evaluation phases. These tests serve as basis to support the improvement of the DYONIPOS functions e.g. by a continuous refinement of the rules to assign events to event blocks. In the first test phase of the pilot software ten key-users took part to support the work of the researchers. The test was operated over a period of five weeks from April to May 2007. The main objective of the first test was to gather detailed information about the key-users. The preliminary data collection has been implemented, as the user’s input (keystrokes and mouse moves) and the user’s work context. Further objectives were to test and evaluate the recording and analysis module of the DYONIPOS proactive assistant. In addition to the test and the evaluation key-users also had the possibility to express concrete requests concerning the functionality and graphical user interface of DYONIPOS. Therefore the key-users had the chance to take part actively in the design process of the system. At this stage the prototype DYONIPOS was stored and implemented on the local hard disc of each personal computer of the participating key-users. A central storage on the server had not been carried out. The employees were introduced in the software handling and had to do a manual assignment of event blocks to tasks. In this phase the DYONIPOS task recognizer proved to be able to record all events and event blocks and to display the automatically recognized information needs of the user. In order to support the user, the system displayed the identified and classified resources. A coloured dot indicates the level of matching between the determined information need and the offered resources. Green light symbolizes high, a yellow point average, and a red point low matching between information needs and resources. Furthermore the key-user had the possibility to actively search for information in the iteratively generated resource repository by using the search field. Only after the user actively pushes the ”start button” the DYONIPOS task recognizer records the activities of the key-user. This activation enables the key-user to use the suggested resources and to search for more information in the generated knowledge base. The possibility to switch off DYONIPOS and to delete the detected actions ensures the knowledge worker’s privacy.

The collected information will serve as training basis for the DYONIPOS Task recognizer. Furthermore the key-users had the possibility to evaluate the functions and to document suggestions for improvement. The results of this first test were stored in log files and documented in test protocols and questionnaires.

3.1 The Application DYONIPOS

Figure 1 shows the graphical user interface of the DYONIPOS task recognizer window. Different flags allow the navigation between the various supplied resources and functionalities. At the screenshot the flag “Übersicht” is opened. At this flag all recorded events (e.g. mouse clicks and movements as well as key-board input and system interactions) and event blocks are displayed at the top. Central the so called “Information Needs” are mapped. Only after the detection of events DYONIPOS starts with the identification of information needs and suggests next tasks, resources and experts. All identified resources were displayed in the bottom field. These are resources of the individual as well as of the organizational knowledge base. Furthermore the key-user has the possibility to search actively for information in the iteratively generated resource repository by using the search field. This search field is displayed in the screenshot at the bottom next to the magnifying glass. At the flag “Experte” the name of the experts can be displayed or the specific topic, which the organization deals with. At other flags the adjustment of the DYONIPOS functionalities can be carried out, e.g. the deletion of knowledge, which is stored at the organizational knowledge base.

Figure 1: Screenshot of the DYONIPOS Task Recognizer



3.2 The results of the practical tests

Through evaluation of the log files, questionnaires and the test protocols it was possible to derive the following information and operating figures about the key-user and about the DYONIPOS Task Recognizer: Typical activities which a key-user implements are: project work, description and modelling of process, writing of protocols, compiling of statistics, participation in discussions, executive functions, searching in the Internet, providing of presentations, etc.

- A key-user performs the following activities without PC support: mental work, meetings, telephone calls and face-to-face discussions with other employees.
- A key-user uses the following tools to do the daily work: text processing tools, spreadsheet programs, presentation programs, web browsers and file explorer, e-mail and calendar, the electronic record management system (ELAK), different SAP systems, specific application programs, database and data mining tools, different information retrieval systems (Google or other special search applications) and occasionally image editing tools.
- A key-user often interrupts her/his activities because of: telephone calls, e-mails, individual spontaneous requests of other employees but also planned meetings.
- A key-user usually uses the following information sources: the Internet (basically Google), the documents stored on the hard disc on her/his own PC, the server-side data collection, the existing documents on the mailbox, paper based documents, meetings as well as vocational and private social networks.
- A key-user uses the following programs and IT applications to search for information: Internet search machines (Google and Wikipedia), SQL navigator, Windows search on PC and server, as well as the search function of the e-mail system.
- A key-user implements approximately 50% up to 90% of his/hers complete work by computer support (mean value: 74.4%).
- A key-user executes 25% to 90% of his/hers communication via computer (mean value: 60.6%).

- A key-user executes at least one task and maximal 15 tasks per day by computer (mean value: 7.8%).
- A key-user works parallel at least at 2 tasks up to 8 tasks (mean value: 5)
- A key-user daily spends between 2.1% and 60% of his/hers working time by accessing information (mean value: 16.1%).

A basic result of the evaluation is that key-users always work on several tasks at the same time. This information represents a challenge for DYONIPOS, because it is an objective of DYONIPOS to provide just in time information based on the context. Furthermore we found out that a key-user uses different searching tools and search in very heterogeneous sources. An objective of DYONIPOS is to support the work of the user by proactive and context-sensitive information delivery. DYONIPOS searches for information in different repositories to supports the user. DYONIPOS implements the function of a searching tool but in addition creates cross-links between the context of different repositories to deliver existing information and new generated information. Using DYONIPOS the knowledge workers receive transparency over the existing sources of information. DYONIPOS gives additional references about the relevance of the found search results which include all currently available information.

The second test phase started in January 2008 and required 28 days. A fundamentally improved version of the prototype DYONIPOS which establishes an organizational knowledge base, with new functionalities and which also includes artefacts stored on server as well as electronic records was proved now. In the second test the former manual assignment of event blocks to tasks worked automatically. The key-user just observed this assignment, by doing corrections of wrongly assigned event blocks and by confirmations of correctly assigned event blocks.

3.3 Next steps

Finally the third test phase starts in September 2008. The requirements of the users and the research results from the first and the second test phase were successfully implemented in the system. In the third testing phase the key-users will test the whole functionalities of DYONIPOS. This test will take 75 days. This third test will be closed with an evaluation and documentation of the use-case results in a final project report.

In 2009 the whole DG-IT or rather all 180 employees will take part in a final test of the pilot system DYONIPOS. A final evaluation will be done after half a year of practical experience. Based on this final evaluation the decision will be made whether DYONIPOS will be used just by PA or whether it should be brought to the market as a software product.

4. Results and Lessons Learned

It was the principle aim of the DYONIPOS Project to follow a completely new approach of knowledge management. It was definitely the aim of DYONIPOS to create absolutely no additional work for the knowledge workers, but instead to extract knowledge out of artefacts already produced by the organization, this by using semantic technologies and methods of knowledge discovery. These aims are reached – the pilot is up and running.

The parallel implementation of the funded research project and the use-case project made it possible to exchange ideas between research and practice constantly; this was useful for both projects. Furthermore the inclusion of all stakeholders [4] such as researchers, users, IT experts and also the staff council in the development process assured that the results of the research project DYONIPOS could be transformed optimally and in real time into a practical software application.

Especially the joint venture between scientific research, economy and public administration worked very well in the specific dual project setting of a scientific and a use

case project. So this model – the "DYONIPOS Innovation Model" – can be recommended for an instant transfer of scientific research results to innovative practical IT applications. This DYONIPOS Innovation Model and its optimization will be object of further research.

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