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## **DYONIPOS: Proactive Knowledge Management**

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### **Abstract**

Efficient and effective knowledge management plays an increasingly important role in knowledge intensive organizations. That's because on the one hand knowledge workers need more and more knowledge to fulfil their daily work and on the other hand because the ad hoc part of a process increases. In addition the knowledge acquisition for the knowledge workers is increasingly catchier because of the growing information overload and the heterogeneity of the systems in use. Therefore the vision of the research project DYONIPOS (DYnamic Ontology based Integrated Process OptimiSation) is to support the knowledge workers automatically with the required knowledge just in time, while avoiding additional work and violations of the knowledge worker's privacy. Furthermore DYONIPOS will support knowledge organizations by developing an organizational knowledge data base, supporting the management of the knowledge data base and visualizing of topic hierarchies and landscapes. DYONIPOS sets up a context sensitive, intelligent and agile assistant based on semantic and generic knowledge discovery technologies [Rath, A. Kröll, M. Andrews, K., Lindstaedt, S., Granitzer, M., Tochtermann, K., (2006)].

This article is structured as follows: Section 1 addresses the relation between the applied approach and the challenge in e-Government and summarizes the aims of the research project DYONIPOS. In Section 2 the semantic and knowledge discovery technologies used are presented. The paper concludes with the presentation of the use-case project, showing current results of the tests and screenshots of the updated DYONIPOS application.

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

## Knowledge Management and E-Government

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 intranet 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. The research project DYONIPOS meets these challenges. Its aim is to provide personal, agile and proactive support for the knowledge worker by means of proactive, context sensitive knowledge delivery. 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. 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. The DYONIPOS vision of knowledge management is, that knowledge management works for us, not that we work for knowledge management. Furthermore that the system should adapt to our wishes and needs not our adaptation to the system and that the knowledge worker has no additional work to do for knowledge management. For reaching the project visions, a completely new approach with technologies „on the leading edge“ are used to develop the prototype DYONIPOS. Conventional search applications currently supply only documents, but DYONIPOS delivers also the knowledge stored in these documents.

## Research Project DYONIPOS

The DYONIPOS research project started on January 2nd, 2006, and was completed by the end of the first quarter of 2008. The DYONIPOS research consortium consists of m2n consulting and development gmbh<sup>1</sup>, Know-Center Graz<sup>2</sup>, the Institute for Information Systems and Computer Media (IICM) of the Graz University of Technology<sup>3</sup> as well as HP Austria<sup>4</sup>. Together they were developing the prototype DYONIPOS. 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)<sup>5</sup>. The proposal of the DYONIPOS project was awarded best proposal of the regarding call.

## Knowledge Discovery and Semantic Technologies

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 handling structured as well as unstructured data from knowledge intensive processes [Rath, A. Kröll, M. Andrews, K., Lindstaedt, S., Granitzer, M., Tochtermann, K., (2006)].

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<sup>1</sup><http://www.m2n.at>

<sup>2</sup><http://en.know-center.at/>

<sup>3</sup><http://www.iicm.tu-graz.ac.at/rootcollection?timestamp=1188552118992>

<sup>4</sup><http://welcome.hp.com/country/uk/en/welcome.html>

<sup>5</sup><http://www.bmvit.gv.at/en/index.htm>

## **Knowledge Discovery Technologies**

The identification of knowledge gaps, the just in time delivery of relevant information, the supply of associated concepts related to the corresponding topic and the further analysis through filtering and evaluation of the delivered information are the major functions of DYONIPOS. To provide these functions DYONIPOS captures the user's knowledge work, discovers the inherent tasks, 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 data is the so called low-level sensor data on the application and operating system level [Maier, R., (2005)]. 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 effectively supported [Tochtermann, K., Reisinger, D., Granitzer, M., Lindstaedt, S., (2006), Rath A., Kröll, M., Lindstaedt, S., Granitzer, M., (2007)].

In order to capture the worker's patterns a java tool called DYONIPOS task recognizer has been implemented [Rath, A., (2007)]. At first DYONIPOS records all interactions between the user and their 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 [Rath A., Kröll, M., Lindstaedt, S., Granitzer, M., (2007)]. The observed events are stored in the so called event log. This monitored data is the basis for determining the 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 [Rath, A., (2007)]. Generic rules are based on the title of the window currently opened by the user. 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 [Kröll, M., Rath A., Weber, N., Lindstaedt, S., Granizer M., (2007)]) 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 are detected automatically.

## **Semantic Technologies**

DYONIPOS is a modern information system which 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. Not only the structure but also the recognition of context is based on ontologies. The knowledge base and also the internal program flow are based on ontologies. In addition ontologies can be used for the unambiguous description of information resources. As a consequence, Resource Description Framework (RDF) is a key technology of DYONIPOS. Resource Description Framework RDF is an ontology language, a formal language used to encode ontologies. An ontology represented in RDF language consists of classes of entities within a domain, properties of classes, individuals belonging to classes and constraints on classes and properties [W3C webpage (2008)]. An RDF-Statement or RDF-Triple is based on the subject (resources), the predicate (property), and the object (value). The subject identifies the described object, the predicate defines the data in the object, and the object represents the actual value [W3C webpage (2008)]. All events, event blocks and tasks described in section 3.1 are represented and stored by RDF-Triples [Kröll, M., Rath, A., Granitzer, M. Lindstaedt, S., Tochtermann, K.,

(2006)]. This means all data extracted from metadata, 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 stored and supplied.

## **Use-Case Project DYONIPOS**

Parallel to the research project DYONIPOS the use-case project DYONIPOS is implemented in the Directorate General for Information Technology (DG-IT) of the Federal Ministry of Finance, Austria. 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 provide the administrative employees automatically 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 creation of 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, e.g. 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 support the research consortium. Together they work on the realization of the research results and they ensure the transformation of current scientific results to an easily useable software solution. The staff of the ministry shares 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 Livelink-system (a system to store office documents in a specific server environment) as well as the specific application KOMPASS, a system to administrate persons, resources and authorizations.

The implementation of the use-case is structured in three evaluation phases. These tests serve as basis to support the improvement of the functions of DYONIPOS 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 occurred over a period of five weeks from April to May 2007. Main objective of the first test was to gather detailed information about the key-users. The preliminary data collection has included the user input and the work content. 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 the 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 has not been carried out. The employees were introduced in the software handling and had to do a manual assignment of event blocks to tasks. The collected information served 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.

### **The Results of the First and the Second Test Phase**

Through evaluation of the log files, questionnaires and the analysis of the first and the second test derive the following information and operating figures about the key-user and the DYONIPOS Task Recognizer. A basic result of the evaluation of the first test 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 support the user. DYONIPOS implements the function of a searching tool and creates cross-links between the context of different repositories to deliver 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 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 [Makolm, J., Orthofer, G., (2007)] – such as researchers, users, IT experts and also the staff council – in the development process assures that the results of the research project DYONIPOS can and will be transformed optimally and in real time into a practical application.

The second test phase was started in January 2008 and took approximately two months. A fundamentally improved version of the prototype DYONIPOS which establishes an organizational knowledge base, with new functionalities and which also includes artefacts stored on the server as well as electronic records was proved through 13 key-users. 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. Results of the second test phase are the following helpful suggestions of the key-users: For a knowledge worker more detailed context information of an information resource would be needed. Furthermore the opening of search results directly in the operational application could improve the continued processing and would save also time. Additional the analysing of individual search results could be beneficial. Another main point was that the training of the tasks is too much time-consuming. Further the conclusions were drawn, that the detection of tasks is absolutely sufficient to support the knowledge worker with the appropriate knowledge. Therefore the second prototype enables the classification of detected resources and the visualisation of topic landscapes (see Figure 1). In the topic landscape, resources which are

thematically similar are mapped at close regions. Further the selection of different resources as well as the display “how similar they are” is possible.

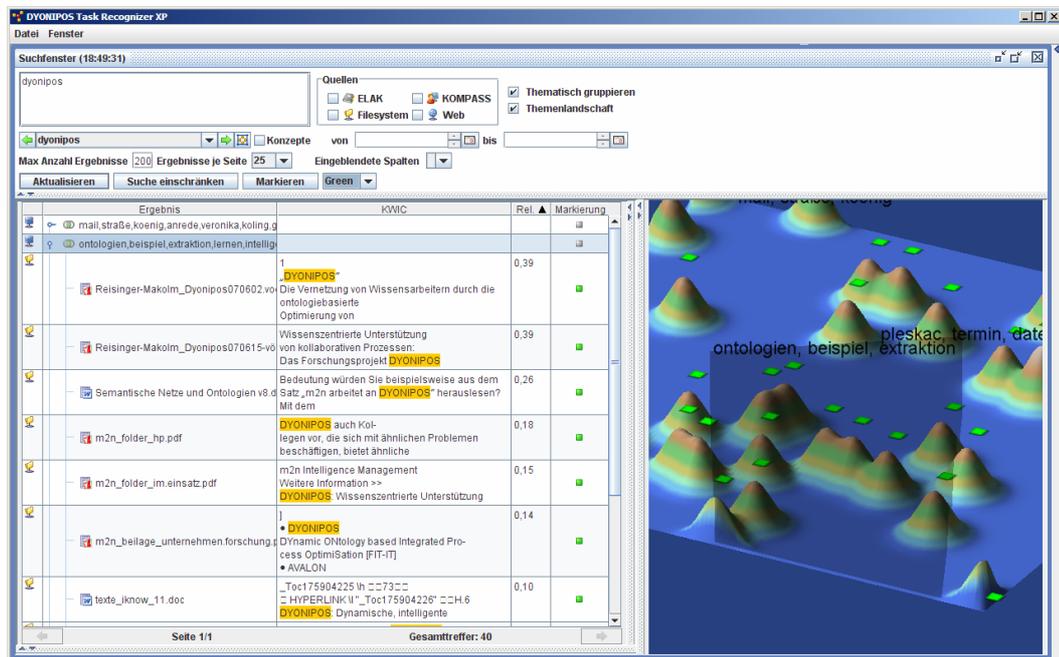


Figure 1: DYONIPOS enables the display of information in topic landscapes

Figure 2 shows the graphical user interface of the DYONIPOS task recognizer window for the third test phase.

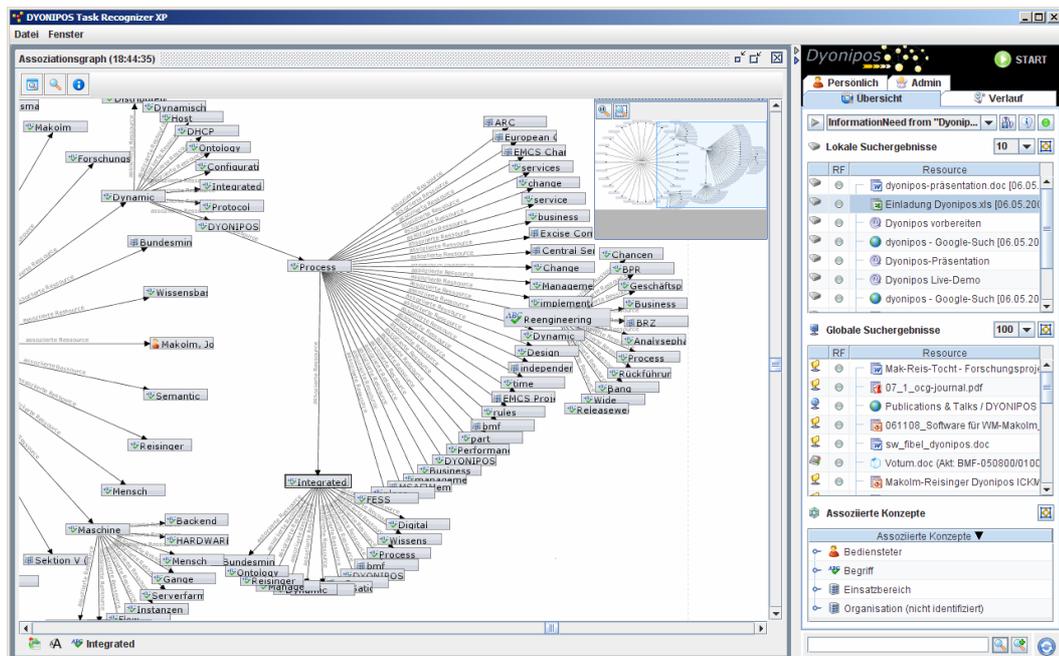


Figure 2: Screenshot of the DYONIPOS Task Recognizer

Like in the second test phase, different flags allow the navigation between the various supplied resources and functionalities. At the screenshot the flag “Übersicht” (overview) is opened. At this flag the so called “InformationNeeds” are mapped at the top. The deduction of “InformationNeeds” occurs automatically, but for performance reasons the related resources are only measured after a click on the activating button. After this the detection of the individual and global resources related to the “InformationNeeds” gets started. Through further filter criteria e.g. filtering on associated persons or organisation, the located search results can be improved once again. In addition also the associated concepts such as the name of experts, terms, application areas and organisations corresponding to the particular topic are offered. “InformationNeeds” will be stored and may be calculated again at a later date. All located resources are opened directly in its operational application; this means that e.g. a located e-mail through double click will be opened in the used e-mail application. A key-user has also 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 left side of the screenshot an association graph is opened. This graph shows the different associated concepts regarding a selected resource. At the flag “Persönlich” (individual) the adjustment of personal DYONIPOS functionalities can be carried out, e.g. the deletion of knowledge, which is stored at the organizational knowledge base. At the flag “Verlauf” (progress) all finally opened resources will be displayed. Furthermore the release of these resources to the organizational data base is possible at this flag. The flag “Admin” is only available for administrators with the corresponding authorisations. This flag contains diverse control functions for assembling of the index, the internal system procedures, the KOMPASS-mappings etc.

Finally the third test phase starts in May 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 also 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. Starting in the end of 2008 the whole DG-IT or rather all 180 employees will take part in a final test of the prototype DYONIPOS. The final evaluation will be done after one year of practical experience. The documentation and evaluation of this final test provides the basis for the decision whether DYONIPOS will be used in the DG-IT further on. In the same way the decision will be made whether DYONIPOS should be advanced as a commercial tool or not.

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