Concept of a Tool Wrapper Infrastructure for Supporting Services in a PLE

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Abstract. As one of the most relevant way of learning after apprenticeship is the informal learning an implementation of a PLE should try to support the learner by mashing up services and tools of every day work, creates cross links between them and gives motivation and support for personal and individual style of learning.
This paper presents implementations and ideas for the whole collection of necessary pieces of software to provide a PLE in a bottom up manner. A server implementation is introduced which is based on a SOA approach and which includes an extractor for metadata of file objects. This module is furthermore able to run a semantic analysis on unstructured texts which results in for example in high-quality keywords and identification of persons. Taking this as technical background the *social functions* are explained which are identified as the functions a PLE is supposed to provide more than any knowledge management or e-learning software. Closing, these functions are converted in ideas of possible implementations of tools and services, back up by graphical mock-ups.

Key words: service orchestration, PLE, knowledge management, learning

1 Introduction

The research on personal learning environments (PLEs) is a young field with few active researchers but becomes more and more relevant in context of e-learning. One of the biggest gaps of formalised learning management systems (LMS) is the point of missing support of informal learning. Moreover, it's mainly institutionalised and set up for vocational training in organisations. This results in missing incentives and motivational barriers of using these systems [5]. The more relevant part of our learning behaviour is learning in an informal and incidental way [7] which is supposed to be supported by a PLE. This kind of learning occurs mainly at work, often motivated by problems occuring at work. Therefore, one of the most important goals is to improve the individual way of learning which improves the overall performance of the organisation. This can be achieved by taking the users preferences, context and social network into account.

The first peace of software which tried to implement basic aspects of PLEs was *Colloquia* in the year 2002. Later on for example, the project *PLEX* [1] came with slightly different solutions of service mashups.
This paper tries to give a concept and ideas how an infrastructure for a PLE can look like and which services would help to support the identified *social functions* of a PLE. A PLE should be seen as concept of an individual customisable set of tools and services not as special application [2]. Therefore this paper doesn't try to cover all aspects a PLE is supposed to support but provides ideas of basic tools that support learning, knowledge sharing, presenting, and reflecting. The PLE concept of an orchestration of tools and services needs an underlying architecture for realisation. An existing server and a module for analysing unstructured information is basis of the provided tool ideas. Therefore the paper is structured as follows: Section 2 gives an introduction to the *Knowledge Server (KNS)*, the implemented server architecture which manages the orchestration of different services. Section 3 illustrates *MetaXsA* a tool for metadata extraction and analysis of unstructured information like texts. After that, section 4 introduces the idea of splitting expected functionality of PLEs in *media functions* and *social functions* followed by the concept of a tool which might cover some of the social functions and services which support informal learning. Concluding this paper finishes with an outlook for future work and some points of interest where the authors see the most needs for research.

2 Architectural concept for a tool wrapper infrastructure

Personal Learning Environments are characterised by a rich heterogeneity of services. A tool wrapper architecture infrastructure to support these services has to offer very flexible ways of interacting with data from different information sources. Current approaches to support workplace learning (c.f. [8, 10]) have to consider the increasing number of enterprise application, communication methods and various information access methods.

The productivity and efficiency of an organisation depends on how fast information can be shared with each other. In large organisational IT infrastructures employees are wasting valuable working time by searching for appropriate information in the various available information sources. One would wish to have a single access point to all the information objects within the IT infrastructure. Via this *Single Point of Information (SPI)* one could easily interact with the existing information objects - one could read, manipulate, share or simply reflect them [9]. These typical functions of a PLE have to be supported by a technical substructure, that can easily interact with various different information sources and that provides generic services, usable by a PLE.

2.1 The KNS as exemplary SPI implementation

The KNS is an entirely service oriented architecture (SOA), designed to be the technical basis for free to configure knowledge management. Its main principles

are simplicity, extensibility, and configurability, which is the basis for personal learning. As most of the learning at work happens in an informal way [], in most cases the learning material has to be looked up by the learner itself. Furthermore, a kind of understanding and of reflection happens by applying the new knowledge. Though, the way of learning is very individual which expects very individual peaces of software to support it. A PLE can be seen as a box of expert tools [4], where each of them is the best for individual tasks. And as the several tasks depend on the users work, the toolbox should be composable by the user itself, not by the software developer. These aspects implicit preconditions on the server side in a technical way and has strong influences in the user interface. First the server structure is described in order to summerize afterwards the implementation of the proposed flexibility.

To support those principles, we decided to implement an adapter concept which allows to easily exchange information systems or re-configure the existing ones. Figure 1 shows a schematic representation of the KNS architecture.

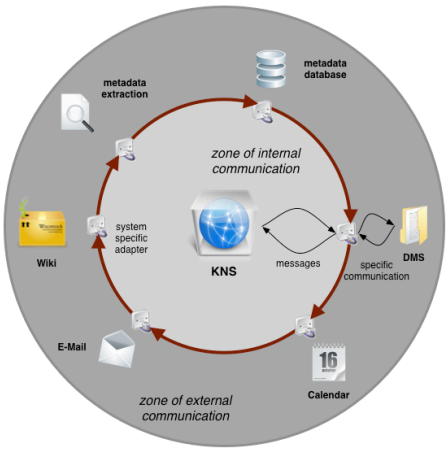


Fig. 1. Schematic representation of the KNS architecture

The adapter which connects external back-end systems to the server builds the border between the zone of internal and external communication. The internal communication is based on predefined messages using JMS [3] based communication with the server. The communication in the external zone is back-end specific so that the adapter transform the data from the external communication into the internal one. A workflow engine controls the steps to achieve an aim. The concept is designed to provide the possibility for easily stringing together several steps to achieve the according task. Adding a new external system con-

[3] Java Messaging Service

notes implementing a new adapter and creating a new workflow which has to be deployed into the server. This is an easy way to plug new systems as the server itself doesn't need to be changed.

Due to its modular and strictly service oriented architecture, the generic concept of adapters and a self-adapting central database, the KNS is an ideal foundation for a highly configurable PLE. In fact, the adapter concept reflects the flexibility and configurability on the server side. This provides the technique to mash up knowledge intensive back-end systems and bundle them under one manager with an access for GUIs. This is the basis for providing a deeper connection between knowledge objects and persons, without loosing the capability for the user to work with their usual software. Moreover, it gives the possibility to develop tools that highly support the personal learning by using such connections and visualizing them. The availability of a central user directory and of a tool for automatic metadata extraction and semantic analysis let arise possibilities of creating thematic and social networks from the data within the system. Therefore, a tool for automatic metadata extraction and semantic analysis of information objects was developed, called MetaXsA. It's introduced in the next section.

3 Analysis of information objects

To support the vision of a Single Point of Information and valuable PLEs the (semi-)automatic extraction of high-quality metadata is one of the main challenges. With MetaXsA we developed a KNS-module that is responsible for the metadata extraction and semantic analysis of any information object within the system. The main MetaXsA service analyses consigned information objects and returns an extended LOM [11] file containing the extracted metadata. MetaXsA stands as abbreviation for *Meta*data *e*xtraction and *s*emantic *A*nalysis and currently consists of two components: the metadata extraction and the semantic analysis. The first component uses several extractors to extract metadata information included in the information object. The semantic analysis comprises semantic modules which investigate the parsed object with respect to semantically relevant metadata. The metadata extraction works with three different tools for metadata extraction of files. These tools analyse the files and the results are compared on consistency. In case of meanderings a majority decision is made. If three different results are the output, one of the extractors is choosen, that was evaluated to return usually the most authentic results [12]. The results of this extraction process are saved in the LOM schema and passed to the semantic analysis.

The functionality of the semantic analysis is structured via modules. A set of modules forms an information extraction pipeline which can easily be extended by additional modules. Contextualisation of information needs knowledge spaces describing the context. Therefore modules can implement webservices to access knowledge spaces which allow the administration of the module databases by either user or connected databases [3].

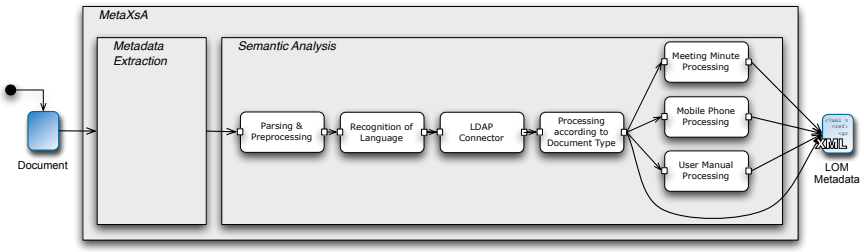


Fig. 2. MetaXsA-Pipeline.

Modules can create and access annotations at the document, thus allowing a build-up of module dependencies. Every module extracts one specific metadata-set and returns a quality value describing the certainty of the extracted result. The current implementation of the semantic analysis component comprises seven different modules including among others a keyword extraction module and a LDAP connector. The keyword extraction returns a selection of high-value keywords belonging to a document. On the one hand, this is done by a part-of-speech tagger [13] and on the other hand this can be supported by a user who can administer lists of keywords and regular expressions which are of special interest.

We are currently developing on MetaXsA to make it more flexible and to improve its stability. Furthermore we are adding another module to MetaXsA which makes it possible to decompose complex information objects in order to analyse each part of the information object. In the case of wiki articles the new module will split the textual part of the wiki article from any media object and analyse each of the objects. In a further step of the processing the resulting metadata will be set in relation to each other and then passed to the KNS.

MetaXsA will be amplified by some other modules, that allow specific handling for special information objects such as e-mails, calendar data and blogs. Contingent on the availability of widely distributed information objects in various sources new possibilities of analysis arise. Not only metadata about one information object will be of interest, but the relatedness between several (similar) information objects from different sources becomes gripping. By analysing the explicit as well as the implicit relations between metadata of information objects it will then be possible to create thematic clusters and applicable visualisations. Using the metadata in combination with personal profiling approaches enables to combine the thematic clusters with networks of users. Those amplifications will then be able to deeply support PLEs with contextualised information, appropriate visualisations and strengthened personal learning successes.

The combination of the previously described server architecture and MetaXsA supports the personal learning in a way of providing one access point to information objects and newly generated connections between them. By connecting

information and generating new information, it's possible to access much faster searched information. Moreover, contextualisation, achieved by semantic analysis, gives the possibility to automatically adapt to user preferences and therefore my enhance the learning success as the user might get more individually correct and specific information. A last important point is the fact, that the user might see the advantages of social networks and information networks and therefore is more motivated to actively support those networks, for example by writing blogs, wikis and so on.

4 Relevant functions of a PLE

Considering context information of a user's work, providing visualisation tools for relationships between knowledge worker or information objects and (for future work) the maturing of knowledge is directly derived from most of the relevant functions a PLE is supposed to support. Keil speaks in [6] of media functions in several priorities (primary, secondary, tertiary) to point out the relevance of several functions which have to be supported by a digital medium in order to get value added. The most important primary functions are arranging and rearranging, linking and distributing as these are functions not supported by non-digital medias without deforming the medium itself. For example, it's not possible to rearrange the content of a blackboard, you have to dispunge and rewrite it in another order. This holds for all physical media. In conclusion, this is a function which can only be realized by digital medias, but is hard to solve for every kind of knowledge artifacts.
A PLE should support these kinds of media functions too but is supposed to offer more. In the following this should be called *social functions* in order to spot on personal and social aspects. A personal learning environment is characterised by the individual orchestration of tools and services [2] for mainly informal learning activities and a key point of informal learning is the social network of the learner [2, 5]. Consequently, the social network should be always visible and accessible. Following, the above mentioned most relevant social functions are described together with recommendations for the implementation in a PLE.

Share A key point of a Personal Learning Environment is supporting to share the users knowledge. However, what is shared, when and with whom is far more complex. Tools could be developed, for example, which allow sharing to be the property of any particular artefact. A PLE might also include tools to facilitate collaborative work and collaborative work flows.

Networking Networks lie at the heart of a Personal Learning Environment. A PLE might be defined at a personal or individual node in a networked collaborative learning environment. It must be emphasised that a PLE is not a document management system (although of course documents may be part of a PLE). PLE tools might allow social representation of networks and networking interchange. Such tools might also allow social association between people, knowledge and artefacts.

Reflecting Reflection is a central activity in developing learning. Reflection is particularly critical in an information rich (or information overload) environment. Reflection involves questioning, challenging and seeking clarification and forming and defending opinions and supporting or challenging the opinions of others. A PLE could provide (micro-)tools for supporting these processes.

Presenting We all have a need to present our ideas, learning and knowledge in different ways and for different purposes. It may be that we merely wish to present some work in progress for feedback from others. We may also wish to present parts of our work for a seminar or for a job application. A PLE could offer the functionality to select and summarise ideas and learning and develop a presentation in different formats according to need. Some forms of presentation may be unique instances for example a presentation at a conference, others may be more recursive e.g a C.V. Tool also need to take into account that presentation may involve different media.

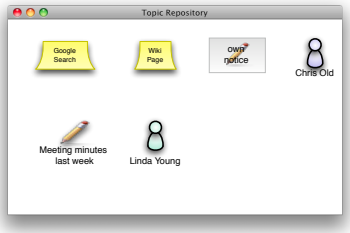
Representing The representation of learning and knowledge within a PLE may be seen as a more complex functionality of presentation. Whilst a presentation will draw directly on artefacts within the PLE, a representation will attempt to show the underpinning knowledge structures of such artefacts. A PLE could include tools for visualisation and tools which allow to visualise the connections between knowledge objects in a dynamic way. They might also allow the dynamic re-rendering of such structures either through the interrelationship of the artefacts and the underpinning knowledge structures. The representation of knowledge might be an individual activity but might also form part of a wider community activity.

In combination with the media functions these give a conceptional background for a PLE implementation.

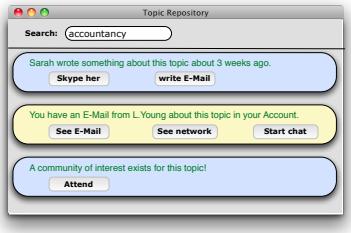
5 Ideas of tools and services supporting social functions

This section provides concrete ideas of tools which (partly) support the above mentioned social functions. In order to enforce functions like presenting, a topic based information object repository is a possible tool. Figure 3(a) shows a GUI which is derived from this idea. The key point is providing a central point where all pieces of information concerning a specific topic can be gathered. This could consist of objects of different types like files, links to URLs, contacts, notes created inside this GUI and many more. However, this is a concept of a GUI implementation which also follows the above described idea of the SPI. So without any differentiation a place for accumulation of information and information sources could be provided. This can represent a knowledge workers context in a specific period or process. Based on this concept qualities like networking, reflecting and in some kind representation of a knowledge worker can be achieved by additional supporting services.

One of the overall aspects is networking which can be fostered by providing always the relationship to the author and editor of an information object. It could be provided by a tool which supports the work with information objects. Figure 3(b) shows a search GUI for repositories, information objects and communities that provides for every entry a link to the according person or community. This would also create the possibility of having social connections bound to the actual work process and drifts away from the search for a well known expert.



(a) Possible view on repository of information objects.



(b) Tool for finding information objects and ressources.

Fig. 3. Two ideas for GUIs that support a PLE

On base of sharing personal networking can increase easily. This could be fostered by applying sharing as an attribute of information objects which results in a transfer the common active process of sharing into an ubiquitous property of objects. As this is not possible out of the file system, it's important to give the appropriate incentives that sharing is a default state. As mentioned above, part of reflecting is feedback, discuss and think about it's own opinions. An integrated and overall available communication service like a forum could enforce discussions and results in feedback which would fulfill this claim, at least in a functional manner. Furthermore hints for additional or more specific information could be proposed by other users. This would be enforced, if other users would be able edit the repositories which results in a collaborative context based accumulation created by a community. Probably it is possible to derive a knowledge maturing process from the development of such a repository.
The initial proposed server architecture would be an appropriate base for the orchestration of the described underlying tools and services. It would manage the links to the sources in the repository and the relation of discussions and repositories.
MetaXsA as analysis service can provide automatically extracted connections between persons and information objects, can index the repositories which makes it easier to find them by a search engine, can provide proposals for persons with an expertise to include them in a repository and could include the version changes in the data holding LOM files, which represent information objects.

As proposed a PLE can be seen as orchestration of services. Ongoing from the bundling of information objects and sources, several services are needed which fulfill the expectations of standard media functions. For instance, a search engine is needed, to support the finding of repositories or repository objects. Furthermore, MetaXsA is set up for classifying types of documents and though can be augmented for classifying repositories. Such a process would result in several positive properties: First, you have the possibility to improve the search engine as a taxonomy of topics could be used to return result similar to the given keyword. Second, it would be desired to classify it after a specific ontology which has the advantage that semantic relationships could be considered for almost every work step, e.g. create, search, read. These semantic relationships probably could lead to efficient services investigating the maturing of the structure and the assignment of items to the ontology.
Summarising, such a system would not only provide search on a database that manages all information objects. It allows for freely connecting needed knowledge bases and therefore build a work specific server base. The automatic metadata extraction and semantic analysis allows for generating new connections and is supposed to be able to analyse user specific data in future. But as good this pieces of software might be, one of the biggest problems is the usability and the incentive to use it. Using buzzwords, the software has to be eye catchy, easy and fast. A possibility is the use of Adobe AIR [4], which can easily result in eye catchy software that can be very fast and is a desktop application with the possibility for server connections.

6 Outlook

Concerning the server architecture the main goals are developing further adapter for connecting backend systems and basic features such as a Kerberos [5] based authentication method which supports the SPI approach. The semantic analysis tool is going to be extended for structural analysis and a learning classification of information object on base of taxonomies.
The PLE concept needs for research on several points. First, on the level of the describing model, a differentiation between informal learning and information retrieval should be defined, as well as how is the interaction between people based on machines and what cannot be represented by a technical implementation of a PLE. Furthermore, ideas should be collected, which services support learning and how they can be connected. Last but not least, considering the implementation of a PLE, there seems to be a conflict between some desirable services like contextualisation and privacy. Furthermore, it must be one of the aims that the appearance as well as the usability provides an incentive to use the software. Actually, workplace learning needs to be analysed more deeply, to acquire a clear understanding on how PLEs can support the indiviual learning process.

[4] `http://www.adobe.com/products/air`, last viewed on: 2008-07-13
[5] `http://tools.ietf.org/html/rfc4120`, last viewed on 2008-07-14

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