DiLAS: a Digital Library Annotation Service

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ABSTRACT

In most contemporary digital library management systems (DLMS) the contents are conveyed to the user as a "collection of information items", which can be searched or browsed. However, this paradigm is often not sufficient to cope with embedded usages, for which access to the contents is not seen as an isolated activity, but as part of a larger work process, where interaction with other users, editing and annotating documents need to be integrated.

Up to now, annotations have been - in most cases - stored together with the documents they refer to in a central DL repository. With the advent of decentralized DL architectures in Grid or Peer-to-Peer environments, but also in Service-oriented architectures, these design choices need to be revised by technical solutions that allow us to manage annotations independently from a particular DLMS. To this end, the authors are participating in a research project, named Digital Library Annotation Service (DiLAS), aimed at designing and developing an architecture and a framework able to support and evaluate such a decentralized annotation service.

KEYWORDS

annotation, digital library annotation service, evaluation of annotation.

1 INTRODUCTION

The research field regarding the design and development of software systems which are able to provide annotation capabilities on the content that they manage is very active and productive. Yet the problem of how to incorporate annotations is usually faced separately in the field of digital libraries (DL) and collaboratories without exploiting the synergies that can be common to both fields. Our research work represents an effort to face these issues together in both fields. This way we can benefit by the methodological tools coming from both fields in order to define a comprehensive model for annotations and to design an annotation service that can be seamlessly plugged into different digital libraries and collaboratories.

2 BACKGROUND IN ANNOTATION RESEARCH

The authors have already developed a number of annotation systems targeted to different application domain users. Among those systems there are: COLLATE (Collaboratory for Annotation Indexing and Retrieval of Digitized Historical Archive Material), URL: http://www.collate.de/ (Brocks, Stein, et al, 2002; Frommholz, Brocks, et al, 2003), DAFFODIL (Distributed Agents for User-Friendly Access of Digital Libraries), URL: http://www.daffodil.de/ (Klas, Fuhr, and Schaefer, 2004), IPSA (Imaginum Patavinae Scientiae Archivum: Image Archive of the Paduan School) (Agosti, Benfante, and Orio, 2003; Agosti, Ferro, and Orio, 2005), and MADCOW (Multimedia Annotation of Digital Content Over the Web) (Bottoni, Civica, et al, 2004; Bottoni, Civica, et al, 2005).

2.1 COLLATE

Ensuring scientific collaboration with other experts in the cultural domain was one of the most crucial challenges in COLLATE. The goal was to develop a cultural collaboratory, supporting interpretative work on mostly textual material. The starting point for collaborative work comprised already existing data in form of binary image representations of the digitized source documents. Producers (i.e., film scientists or archivists) submit scanned material to the system. Once the document is stored, user-generated metadata (cataloguing, indexing, annotating) is created collaboratively. If, for instance, a user retrieves a specific document and the metadata already associated to it, he might be willing to contribute additional knowledge, e.g., comment upon an annotation by another user or complete missing cataloguing information. In the Humanities, collaborative work usually occurs when scholars discuss their ideas in a group. The text resulting from the contributions from different participants is called a "discourse". The discussion usually starts with a historical document from the COLLATE collection which needs to be catalogued, indexed, and interpreted. Especially the latter task is prone to spawn a discussion when scholars have different opinions and background knowledge. Therefore annotations are subject to further annotations, which finally results in complex discourse structures, which document the way to a collaboratively elaborated common interpretation of the historic source. In COLLATE, we defined an annotation model based on discourse structure relations and nested annotations in order to model this type of scientific discourse. The model comprises different relation types ranging from the factual (e.g. comparison, contradiction) to interpersonal level (e.g. agreement) of the discourse.

2.2 DAFFODIL

DAFFODIL is a user-oriented system to access federated digital libraries to support integrated strategic search as well as collecting and interpreting the documents at hand. For the latter, basic annotation mechanisms are implemented within the system. The user is given the possibility to annotate every digital object managed by DAFFODIL. Collaborative work is supported among groups by providing mechanisms to share annotations and to annotate others' annotations in turn, creating an annotation thread reflecting the results of the discussion about a certain document and its content. While the underlying annotation model is not as comprehensive as, e.g., the one defined within COLLATE, one of the advantages of the agent-based DAFFODIL framework is that it can be easily extended with new functionality and services. Therefore, DAFFODIL is an excellent candidate for the integration of novel annotation concepts and services.

2.3 IPSA

IPSA supports annotation and personalization of image digital archives. The final goal is to provide end users with tools for performing scientific research on images taken from *illuminated manuscripts*, which are the manuscripts that include illustrations and, in the past centuries, were manually and artistically decorated by the application of colours, gold, or silver. Illuminated manuscripts are still the subject of scientific research in different areas, namely history of arts and history of science, and all the disciplines that are related to the content of an illuminated manuscript - e.g., botany, astronomy, and medicine. To this aim, a digital archive of images should be enriched with a set of tools that enables the study of the development of scientific illustrations across the centuries. One of the most important aims of the research on illuminated manuscripts is the disclosure of hidden relationships between illustrations belonging to different manuscripts. In particular, researchers aim at discovering if illustrations have been copied from images in other manuscripts, if they have been merely inspired by previous work, or if they are directly inspired by the nature. In particular, researchers should be able to create links for connecting an image to another image that is related, in some way, to it. It is important to keep in mind that images belong to different manuscripts and their relationships may not be obvious. According to user requirements, the use of annotations has been proposed as a useful way of accessing a digital archive and sharing knowledge in a collaborative environment. Annotations have been modelled according to the Entity-Relationship schema, described in detail in (Agosti et al, 2004; Agosti, Ferro, and Orio, 2005). It can be useful to clarify the notions of link typologies and of historical paths across images, which were a major user requirement. A concept that has been introduced by researchers in the field of illuminated manuscripts is the one of *chains of derivation* across images. Each chain has a *progenitor*, which is an image that has been created through a direct inspection of reality. Subsequent authors may have directly *copied* or *elaborated* that

image. These new images may be the source of inspiration for other authors and so on, creating a chain of references to previous works. Moreover, images can be related one to the other because of some similarities between them even if they are not part of the same historical path. Given these considerations, a link type ontology is under development according to user requirements and feedback.

2.4 MADCOW

In MADCOW, the annotated document is a multimedia one: a web page including text, images, audio and video files; moreover, the web note itself can be a multimedia object as well, being composed, for example, by text and images; it can be private or public; since it can be displayed as a web page, it can be annotated in turn. MADCOW is organized in a client-server architecture, where the client is a plug-in for a standard web browser and the servers are repositories of annotations to which different clients can login. Independently of their location, annotations are produced and stored according to an XML format, which incorporates contributions from existing standards for the management of semantic content and for multimedia formats over the Web. The Document Type Definition (DTD) for annotations corresponds to a part of the schema for the annotation database, so that a common format can be used for producing an annotation, querying the database, and extracting the results for the query. Specific user interfaces for retrieving and filtering annotations have been defined, as well as for establishing a default annotation server for a document. As the design of MADCOW separates platform-independent from platform specific components, it can be implemented as an integration to different browsers (on the client side) and different web servers (on the server side). Moreover, MADCOW allows different pre-established types of annotations, such as explanation, comment, question, solution, summary, and so on; in this respect, MADCOW opts for a solution similar to the one of COLLATE, which models annotations as different types of dialog acts.

2.5 Background in Evaluation of Annotations

Experience in evaluations have been gained through empirical analysis of the role of annotations within a large worldwide software company, based in a European Country. The project was about studying collaborative aspects of a combined recommendation and annotation tool. To this end, a user and usability study was made in order to inform the design of such a tool. The goal was to enhance a business system with a tool for more effective collaboration and cooperation within a specific work-group. Assigning and searching for experts and knowledgeable people is crucial for a large company. The purpose was to collect data on: potential expert users: characteristics and needs; different tasks: goals, workflows, current practices; environments of use: groups (in-house/distributed), types of tasks.

In order to achieve this, we applied and deployed a set of methods such as: informal expert interview; focus group; diary protocol; follow up questions.

Using the methods above, different stages of the methodology could be outlined:

1. *Preliminary Requirements Specification*: an informal initial definition of users' needs was gathered via a discussion with expert representatives;
2. *General scenarios outline*: on the basis of what emerged in the informal discussion above, a *proposed scenario* were suggested, representing the work-tasks and their interaction with the proposed system;
3. *Scenarios and Preliminary visualization*.

One result from the study was that the people in the work group collaborated more than they were aware of. In fact, they collaborated in almost every single task they performed (e.g. Hansen and Järvelin, 2004). Annotations were also used to keep track on experts and colleagues within a project, and in this way an annotation-tool can be used as an awareness-tool as well to keep track on what, who and when things are being done in a project. Annotations could be attached to different types of texts (reports, programming code etc) and different media types. However, if the (physical) distance is too narrow between the colleagues in a group (let say that they are in the same room or have rooms close to each other) the annotation-tool will not be used because human-human discussion is actually preferred. The collaborative activities in the project were affected by parameters such as time, cultures, and languages due to the fact that this is a world-wide operating company. Similar results have been reported in Hansen and Järvelin (2005).

Likewise, experience in empirical evaluation of users' experience with annotation systems has been gained within the Collate project (2000-2003). The empirical evaluation, which was led by Risø

National Laboratory, was based on the framework for cognitive work analysis and the framework for prototype evaluation based on work analysis, both developed at Risø National Laboratory (Rasmussen, Pejtersen and Goodstein, 1994).

The empirical evaluation was conducted in two phases. The first phase was carried out as field studies of the three film research archives involved in COLLATE, following the framework of cognitive work analysis (Pejtersen, Albrechtsen, et al., 2001; Hertzum, Pejtersen, et al., 2002). The second phase was conducted as field experiments, following Risø's framework for prototype evaluation (Rasmussen, Albrechtsen, et al., 2003). The field experiments took place as an evaluation workshop, involving expert users from the three film archives in Collate and a team of evaluators (Andersen, Cleal and Albrechtsen, 2004; Cleal, Andersen and Albrechtsen, 2004; Albrechtsen, Andersen, et al., 2004). The evaluation workshop was based on the users' definition of task scenarios, using the COLLATE prototypes for cataloging, indexing, searching and annotation of films and their related materials.

The major results from the evaluation collaboratory are that annotation did not function as a distinct task during the users' collaboration in Collate, but rather that annotation functioned as a new and fruitful *collaborative and individual strategy for social navigation and information navigation* for the users, to support

i) distributed mutual awareness of DL content and coordination of work amongst the users (coordinative annotations),
ii) mutual learning and mediation to end-users, through the expert users' explicitation and sharing of expert knowledge about collection content (personal and community content annotations).

3 VISION AND MOTIVATIONS

Today's digital libraries fall into two categories: i) collections of electronic resources, with services that support users' information searching, based on codes of practice for information management, such as cataloguing, indexing and design of knowledge organisation systems; ii) common knowledge spaces, with services that support users' sharing of knowledge, in addition to information access to electronic resources (see for instance, Borgman, 1999; Lesk, 1997). The first category accentuates the information infrastructure of Digital Libraries, in terms of an information model and associated services that define information access, information flow and information management. The second category retains the emphasis on information infrastructure, but gives priority to developing social infrastructure of Digital libraries, in terms of services for knowledge creation, knowledge sharing and interactive communication by and amongst users (for a definition of infrastructures in large information spaces, such as Digital Libraries, see Star & Ruhleder, 1994).

The DiLAS research on annotations applies to the latter category of DL development. The mission of DiLAS is to foster change in users' interaction with DLs and contribute to developing services for social infrastructure in DLs. This mission is addressed through the provision of a new independent annotation service for interactive knowledge creation and sharing. It is DiLAS' vision that the new annotation service inspires the users to become active and visible contributors with new knowledge. The annotation service enriches the DL contents and usage, the users personalize the information in a new contextual learning opportunity, and they collaborate by sharing this new knowledge.

The current body of knowledge on users' collaboration on annotations of digital collections is diverse. On the one hand, annotation is defined as tagging of electronic documents, where the users' contributions are constrained by conventional information models and codes of practice for managing the flow of information in the collections. A possible advantage of the underlying normative models for users' annotation is that they can be generalized across domains and collection and allow for harmonized exchange of structured data. However, users' information access across such user-tagged collections would at the same time be constrained by the applied information models. Such models impose a strategy of structured information access to the users, which implies the notion of specific and well-defined information needs for the users. (cf. eg. Rasmussen, Pejtersen & Goodstein, 1994). On the other hand, annotations can be defined as more or less structured interactive user comments, which are intended for social navigation through the medium of annotations to collection resources and users' interactive comments to annotations. Brocks et al (2002) define annotations as collaborative discourse in Digital Libraries, based on an annotation model of discourse structure relations and implemented in the cross-cultural film collaboratory Collate. However, the annotation model is quite distinct from the information model of the Collate system and represents an innovative approach to

modelling users' interactive discourse in DLs.

4 COMPUTER SCIENCE PERSPECTIVE

We will now discuss some use cases we think an annotation system should support. First of all we define some user-level use cases which reflect the functionality an annotation tool might offer to the user. These use cases imply certain system-level use cases which comprise the functionality we think a generic annotation service like the one proposed here should have. Some, but not all of the system-level use cases will be implemented in a first DiLAS prototype, while some of the user-level use cases might be subject to implementation in an annotation application offered to the end user. All use cases are a result of our own experiences with the development of annotation systems or observations of common annotation applications.

4.1 User-level Use Cases

Several core use cases on the user level can be identified.

- *Create annotations*. Users should be able to create different kinds of annotations and annotate several kinds of digital objects in the repository. These annotatable objects might not only be documents. Virtually every digital objects or even sets of them can be the target for the creation of annotations. Annotations might be textual comments or remarks, as well as typed links between digital objects or markings and highlightings. Another aspect of the creation of annotations is making explicit the meaning of an annotation; this can be done by letting the user select one or more annotation types.
- *Modify and delete annotations.* In general, it should be possible that users modify and delete their own annotations. However, in a collaborative environment, these operations might be critical, since annotations made by others might depend on the annotation to be modified or deleted. It is thus crucial to support some policy for modification and deletion, and probably versioning of annotations.
- *Set the scope of annotations.* Users should decide about the scope of their annotation. If the system allows for groups a user can be member in, it should be possible for the user to determine if the annotation is private, shared within a group, or public.
- *List annotations.* When users view a selected digital object, they should be able to get a list of all associated annotations, be it their own or annotations made by others which they have access to.
- *Browse annotations.* In case of nested annotations, users should be able to browse annotation threads. Furthermore, if annotations are references to other digital objects, it should be possible to browse the network of digital objects and referential annotations.
- *Search and retrieve annotations.* It is obvious that users want to retrieve their or others' annotations which might be interesting for them as well. As annotations are also a means to remember things (Ovsiannikov et al, 1999), searching for annotations is also a strategy to search for documents, which is in accordance to the discussion in (Agosti et al, 2004; Agosti and Ferro, 2005a) where annotations are identified as being beneficial for document access and retrieval.

4.2 System-level Use Cases

The different use cases discussed above lead to a couple of system-level use cases which build the core functionalities needed by many annotation applications.

- *Group and user management.* To support the different scopes an annotation can have, existing users and groups in the DLMS have to be mapped onto a group and user model in DiLAS.
- *Create and store annotations.* The annotation service must enable the creation of new annotations being of certain types. Annotations, as well as the digital objects they refer to, should be identified by a Uniform Resource Identifier (URI). It should also be possible to attach some metadata to a newly created annotation, like title and author. Except of annotations, digital objects are not stored in the annotation service, so it only sees the URIs of the objects managed by the DLMS, but not the objects themself. Refer to (Agosti et al, 2004 ; Agosti and Ferro, 2005b) for a discussion on how to store annotations in a repository and relate them to the digital objects in the DLMS.
- *Delete and modify annotations.* Basic operations to modify or delete annotations. While the annotation service has to check whether the operation is allowed or not for a given user, a certain policy for deletion and modification of annotations like discussed above is not an issue on the

system level, but on the user level, since such policies can differ depending on the application.

- *Set scope of annotations*. The scope can be private, shared or public.
- *Query and fetch annotations.* The easiest scenario is to fetch an annotation with a given URI, but also more complex scenarios are thinkable. For the search and retrieve user scenario, it is desirable to fetch annotations being of a certain type or belonging to a certain user or group. Furthermore, it should be possible to fetch all annotations referring to a digital object to assist the browse and list annotations use cases. Advanced retrieval functions can be supported by fetching all annotations created in a certain time period. While the query and fetch system use case is not supposed to provide advanced retrieval functionality, it should offer some basic means whose output can be used for further processing in the annotation application.

5 SOCIAL INFORMATICS PERSPECTIVES

Although the perspectives from social informatics and computer science are usually regarded as alternatives, and in most project they exclude each other, we believe that in the case of establishing annotation services that are well engineered and helpful to the intended users of a DL application, both aspects are needed as complementary strategies in a comprehensive approach.

As was mentioned before, the use of annotations in a DL system changes the characteristics of the application. While most DL systems are designed as storage or repository systems where item can be stored and maintained by a certain class of users - the "librarians" - and searched, retrieved and read by a wider spectrum of user classes - ranging from casual end-users to skilled domain experts - the annotation facility enables the users to act in completely other roles. They may act as authors, reviewers, and publishers. They engage in discussions, provide evaluations, and create interpretation contexts for the annotated sources. In other words, such a DL system is not only used as a storage device, but can more appropriately be described as a communication environment for authors, publishers, readers, teachers, and students. Therefore, when designing a DL application which is intended to support a more dynamic usage of digital assets by providing annotation functionality, it is necessary to determine a correct metaphor for this user environment. The design process needs to identify the specific parameters of interaction or communication process which is to be supported by the system.

We need to employ modelling techniques from social informatics to describe the prerequisites, assumptions, needs, and intentions associated with a text (or alternatively, any other data object) which is entered as an annotation to given document by a user in a certain situation. For instance, a scholar annotating an object with observations, notes etc. for his personal use should be given the opportunity to keep his annotations private. In other situations, annotations can be regarded as utterances in a discussion among members of a project team, or a teacher and his students, In other cases, annotations may be intended as public statements for wider audience, like a scientific paper. Other communicative situations may arise when complex workflows are involved, which require a certain sequence of actions, e.g., when processing a customer's complaint, a library user's request etc. Therefore, the specification of a specific DL application should go beyond mere technical use cases, which only describe dataflows and the conditions of data manipulations. Other dimensions, such as access rights, social obligations (e.g. a question from a team member should be answered, a request from the teacher should be fulfilled), privacy and data protection (notes I took only for myself should not be accessible by others) are to be taken into account.

A generic service supporting the use of annotations in a wide range a different scenarios therefore needs to provide the basic functions needed in many situations, in a way that they can be combined freely to implement the given communicative metaphor.

6 USER-CENTERED DESIGN AND EVALUATION

6.1 User-centered Design and Evaluation

In User-centered design, the user is in focus. User-centered design is now a well established perspective and point of departure when designing artefacts such as systems and components. It is nowadays usually required that some sort user-oriented approach is applied when designing artefacts that will be used by humans. By definition, user-centered design techniques focus on potential users and their characteristics, their tasks, and their environment (Wood, 1998) whose work is to be supported by an application. This means that functional requirements will be developed based on the

user's viewpoint and are referred as user requirements. A general conceptual framework for a user-centered design process involves the following activities:

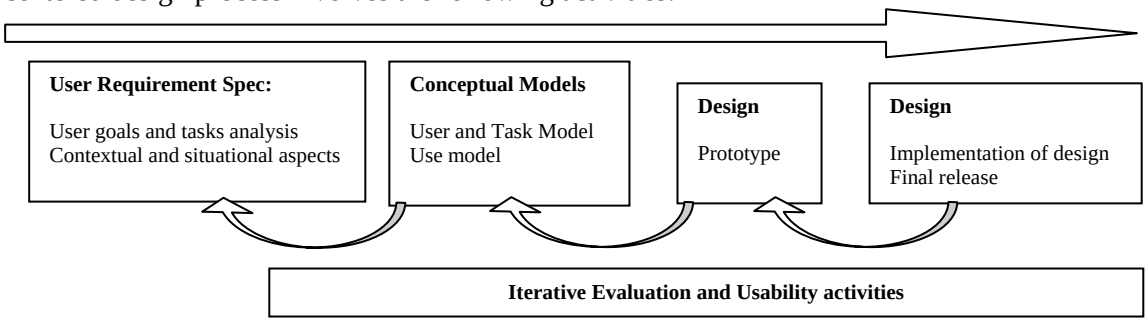

Figure 1: *Simple model of relationships between design stages*

This process is an iterative process and one of the main important issues within the user-centered design is to *bridge the gap* between what people need (user requirements) and how to design these requirements (interface design). Another characteristic of user-centered design is to integrate knowledge and expertise from different disciplines, which may contribute to the design.

6.2 User-centered Evaluation

The goal of user-centered evaluation is primarily to gain knowledge about the usability of a design or product as regards to specific community or user population. User-centered evaluation can also consider the process aspect, i.e. how the users' needs have been addressed throughout the design of the product. In both cases, the evaluation can be done for very specific work contexts. The reasons to evaluate are several and might span from getting a quick informal feedback on a design that may take place on-site among real users as well as more planned and controlled evaluation procedures, such as performing laboratory or field experiments in settings built for those purposes. However, in any case, user-centered evaluations consider the study of a system/tool (artefact) to be evaluated (mock-ups/prototype/final product) from the following three perspectives:

1. User characteristics, their preferences and strategies
2. Types of activities that users will do/tasks they perform (predicted/known)
3. The environment in which the system is used, either in the natural work setting or in a controlled laboratory setting.

In general, there are 2 types of evaluation approaches: the *formative* and the *summative* evaluation approach. The formative evaluation approach involves a close cooperation with the design process in order e.g. to check that the ideas applied are still working with focus on usability and usefulness *during* the design process. *Formative evaluation implies, therefore, a product-oriented as well as process-oriented view of the design.* The summative approach is generally *product-oriented* and is applied in *the end* of a project when a product has been developed order to make judgements about the finished item.

The evaluation of the DiLAS annotation system will be performed as a formative evaluation.

7 SYSTEM ARCHITECTURE

As already discussed, one of the goals of our project is to design and develop a generic annotation service, that is a service that can be easily used into different DLMS. To this end, the architecture of the DiLAS system consists of three layers – the data, application and interface logic layers. This decomposition allows us to achieve a better modularity within DiLAS and to properly describe the behaviour of DiLAS by means of isolating specific functionalities at the proper layer. The data logic layer manages the actual storage of the annotations and provides a persistence layer for storing the objects which represent the annotation and which are used by the upper layers of the architecture. In order to make it as flexible as possible, an abstract API for the functionalities of the storage has been defined. This API, in turn, allows for accessing different system to perform the actual storage of the annotations. In the first prototype of the DiLAS system we use the MADCOW system as actual storage for the annotations, but for the final prototype we are going to integrate also the BRICKS system as storage provider.

The application logic layer provides advanced functionalities that make use of annotations, such as for example the search and retrieval of annotations described above. As in the case of the data logic

layer, we defined a set of abstract API that make the access to the DiLAS service functionalities independent from the particular implementation provided.

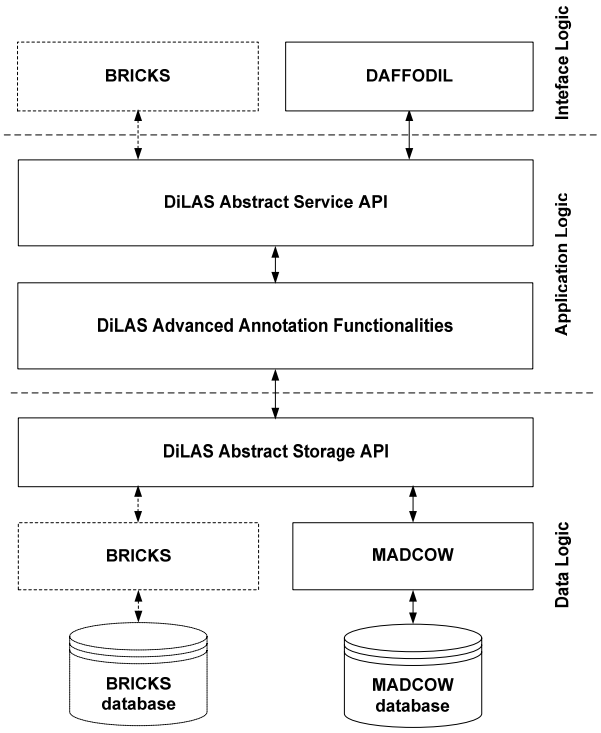

***Figure 2** : Architecture of the DiLAS system.*

The interface logic layer is devoted to manage the interaction with the end-user. It depends on the system into which DiLAS is going to be used and relies on the DiLAS Abstract Service API in order to provide the functionalities described above to the end user. For the first prototype of DiLAS we use the DAFFODIL system in order to carry out the described user-level use cases, but in the final prototype the BRICKS system will be supported as well. Note that these two systems offer different kinds of functionalities based on annotations, but these functionalities are obtained as composition of the functionalities provided by the DiLAS Abstract Service API.

Note that the three layers decomposition reflects the viewpoint of DiLAS with respect to the external world. For example, the interface logic could be a user interface, but it could be also a completely autonomous system that relies on DiLAS. This is the case both of BRICKS and DAFFODIL which are autonomous systems, with their own user interfaces, and make use of DiLAS in order to provide annotation functionalities. The same reasoning holds for the data logic and the MADCOW system.

In conclusion, the proposed architecture is modular and quite flexible: the integration of the DAFFODIL and BRICKS systems as interface logic and the integration of the MADCOW and BRICKS systems as data logic provides us with a concrete example of the flexibility of the proposed architecture.

8 KEY DILAS ACTIVITIES

In the previous section we identified some system-level use cases which should be supported by the annotation service. While it is certainly desirable to implement all of these use cases, the first DiLAS prototype will focus on a subset of this functionality which is needed to perform a proper evaluation of our idea of a generic annotation service. To show that the generic service can be applied in different environments, we will integrate the service into DAFFODIL and BRICKS which will support certain user-level use cases using DiLAS.

8.1 DiLAS Functionalities

As an example the user-level use cases are introduced in the following.

- *Create annotations*. In DAFFODIL, users will be able to annotate documents, folders and (nested)

annotations by writing textual notes. Some metadata like author, date and title of the annotation are stored as well.

- *List annotations.* All annotations belonging to a document or folder should be displayed in a threaded way, e.g. in a tree.
- *Browse annotations.* It will be possible to browse annotation threads and jump to link targets.
- *Search and retrieve annotations.* Users will be able to search for their own annotations or for annotations of a certain type.

8.2 DiLAS User-centered Evaluation Plan

The DiLAS project defines the overall aim of a formative evaluation as gaining knowledge about how the present design of decentralized annotation services complies with the needs of the prospective users. Knowledge gained about the users' actual activities and feedback during their use of the Annotation Function will inspire future developments of annotation services and tools for digital libraries. The overall goal of the evaluation is to investigate to what degree the annotation system meets the users' characteristics, their activities and tasks, and their environments.

This evaluation will uncover how well the system will be accepted by individual and collaborating users, who have varied demographic features, education, experiences, competence, and perceptual and cognitive resources. In addition, how well it supports the users' individual and subjective performance criteria and those agreed upon during collaboration, as well as those performance criteria that are imposed by the environment. The evaluation should also clarify how users choose the strategies relevant for annotation work, such as analytical search, and browsing in keywords and keyword structures, and thus embark on information navigation and social navigation as well.

8.3 Evaluation Activities and Tasks

Annotation work involves many possible individual and collaborative tasks such as creation of new knowledge, distribution and sharing of knowledge, information retrieval, knowledge management such as classification and indexing of knowledge, and translation of knowledge. The question here is whether the DL supports several coherent activities and the entire task repertoire of users, such as writing annotations that are intended for mutual awareness and coordination, as well as writing personal annotations and annotations for a community that are intended for mutual learning. This evaluation will identify if the information is adequate for the decisions to be made during the different kinds of annotation work.

The annotation system regard annotations as enrichments of the Digital Library content in their own right. They are intended to be more or less structured interactive user comments to digital library collections or comments to other users' annotations. Therefore, the support from the system during users' communication with other people, and the possibility for collaboration and coordination of annotation activities will be evaluated. This can be done when users are using one annotation system or several annotation systems across several digital libraries. Another evaluation will focus on the knowledge domain and its representation in the content of the digital library in order to compare how well the objectives of the users' work with annotation is supported by the annotation function of Bricks and Daffodil.

These perspectives also indicate the three chronological evaluation phases that will be conducted with each of the Annotation Functions in the two digital libraries.

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