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## **Design of an Open and Distance Learning Framework Focused on Knowledge Management**

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### **Abstract**

*The main objective of the proposed Open and Distance Learning (ODL) framework structure is to foster the contribution, assessment and reuse of concepts and content in a secure and controlled manner. Based on Knowledge Management (KM) tools and concepts, pedagogues should be motivated and supported in reusing information and knowledge, instead of 'reinventing the wheel'. In particular, open issues such as content classification, distribution and representation, but also licensing and copyright problems as well as basic organisational and managerial aspects are addressed. The key aspect is not the invention of a new technology but the intelligent integration and exploitation of existing concepts and solutions. Specifically, it is suggested to integrate and utilise open standards to ensure platform independence and facilitate the development and integration of new requirements, concepts and third-party tools. The technical approach focuses on Portal concepts, which provide the technical basis to store, archive and retrieve structured and unstructured information in electronic format as well as means to communicate in asynchronous and synchronous manner. Furthermore, they allow personalising one's view on information and interfacing other systems in a consistent and unified way. In respect to the technological change, a modular and*

*expandable design has been chosen, which facilitates the integration of future concepts and techniques without the need for redesigning the whole framework.*

## **1. Background and Motivation**

In this paper it is argued that the core part of 'Open and Distance Learning' (ODL) i.e. all mediated forms of technology-based distance learning processes deals with Knowledge Management (KM). A similar view is also held, for instance, by Lundberg [27] who claims that basically all requirements and components of KM are reflected in the learning, teaching and research processes of academic organisations (see also [22]). Therefore, he argues that the academic organisation can be seen as a metaphor for knowledge management. According to Lundberg, the aim of KM is "[...] to contribute to organisational goals through the development of methods, techniques and technologies which contribute to the effective and efficient distribution of knowledge in the organisation"([27], p. 213). In the context of ODL, this aim has to be extended by copyright and security issues as well as inter-organisational information and knowledge distribution [41]. For reasons of simplicity, it is assumed that the term information refers to data (i.e. an event, letter, word, etc. out of context) that is put into a meaningful context and the term knowledge refers to the human ability to utilise that information (see [1], pp. 28 and [7], pp. 42 and pp. 262).

The proposed ODL framework is based on existing concepts and open standards (i.e. standards that are defined and implemented by a large number of universities and/or companies), and emphasises on managing and reusing knowledge of pedagogues. The key aspect is not the invention of a new technology but the intelligent integration and exploitation of existing concepts and solutions (see [23], pp. 112 and pp. 119). It is not seen as a substitute for existing off-the-shelf ODL products but as a platform to combine such tools with other information sources and tools. The importance of open standards as a delivery platform is also stressed in [41], p. 107 and p. 122, because it is assumed that this approach will help to keep overall cost low.

The framework considers the requirements of the teaching, management and administration domains of academic organisations primarily from a technical point of view. In particular, open issues such as content classification, distribution and representation, but also licensing and copyright problems are addressed. Current Internet/Intranet concepts and solutions are discussed and combined with a new approach that facilitates KM in a secure and controlled manner in the context of ODL. Consequently, this paper focuses on Portal concepts, which combine tools to store, archive and retrieve structured and unstructured information in electronic format as well as means to communicate in asynchronous and synchronous manner ([9], [10], [14] and [26]). Furthermore, Portals allow personalising one's view on information and interfacing other systems in a consistent and unified way (see [23], pp. 160). In respect to the technological change, a modular and expandable design has been chosen, which facilitates the integration of future concepts and techniques

without the need for redesigning the whole framework (e.g. integration of mobile communication protocols).

It can be assumed that the support for open standards to ensure platform independence and facilitate the development and integration of new requirements, concepts and third-party tools is an important approach in the field of ODL. This need is also identified in [41], p. 122, for deploying courses and supporting learners but this paper suggest using open standards to support the process of developing courses as well. In particular, directory access systems such as LDAP (Lightweight Directory Access Protocol) (see [18], pp. 67) can be used to provide unified (i.e. platform independent) authentication information and generic personalization information (e.g. user profiles) on an inter/intra-system level (see [23] p. 182). In order to back the dissemination of ODL courseware, there is also a need for standardising data and information as well as integrating copyright and licensing mechanisms ([25], [34], [45], [54], [55] and [69]). For instance, the Dublin Core (DC) metadata standard [45], which facilitates the description of a wide range of networked resources, as well as the Resource Description Framework (RDF), which is being specified by the World Wide Web Consortium (W3C), provide useful concepts to share and exchange information as well as to protect intellectual property [69] (a popular example of a platform independent technology to describe and represent information in a standardised and system independent way is the eXtensible Markup Language (XML)). However, there are still a lot of open issues and it is not clear whether the concepts and solutions, which have been developed so far, will meet the needs of teachers and learners, respectively, and whether they will be accepted by the market (see [34], p. xi, xii and xiv).

In general, such a framework should provide means to gather, classify and assess ODL concepts and courses in terms of usability, practical relevance, reusability as well as financial aspects. It should also provide means to reuse existing courseware, without violating copyright provisions. This requires the definition of the necessary organisational and technical structures that encourage pedagogues to share their experience and work with other colleagues. In other words, the efficient transition, management, classification and controlled transfer of knowledge are the most important factors in assessing, deploying and reusing ODL concepts and courses ([24] and [49]). On a higher level, a similar approach is suggested in Salford University's ODL evaluation report: "Salford University has identified the need to create a seamless environment that incorporates several ODL technologies in a way that supports effective teaching and learning. It is important to realise however that although it is important to have a suitable technological infrastructure it is the pedagogical and didactic issues that must remain uppermost in the minds of implementers." ([41], p. 106).

In general, the following problems have to be addressed in the process of defining an ODL framework (see [21], p. 161 and [41], pp. 26):

- Institutional strategy / policy
- Domestic cultural aspects and the culture of project partners
- Pedagogic aspects

- Organisational and managerial aspects
- Maintenance and operations
- The technological infrastructure
- Flexibility and adaptability

In addition to these problems, the proposed framework focuses on the following issues:

- Content classification concepts
- Knowledge management and transfer
- Reuse and licensing strategy / policy
- Performance, incentive and measurement system (see [15], p. 5 and [17], p. 113)
- Accreditation policy (see [34], pp. 17 and [47])
- Standardisation and extendibility

## **2. Major Contributions and Shortcomings of Existing Approaches**

The area of Open and Distance Learning is concerned with pedagogical concepts and theories ([21], [24], [36], and [39]), studies, definition of frameworks and general reports as well as evaluation reports on tools and prototypes ([12], [16], [21], [28], [30], [39] and [67]). In [8], a comprehensive survey of ongoing ODL co-operations, projects and activities in higher education is given ([58], [59] and [64]). An important aspect stressed by most authors is the careful planning of all ODL activities from a pedagogical, organisational, financial, managerial and administrative point of view (see [24], p. 234). Also the potential benefit for teachers in terms of reusing existing courseware and materials is identified (see [2], p. 29) but without considering 'non-technological' barriers such as a lack of incentives to participate in the sharing process. The findings and recommendations of research in the area of KM can help to fill this gap (see [1] and [23], pp. 110).

The necessity to support open standards and standardise information has also been addressed by the IMS Global Learning Consortium [51], which is leading the Instructional Management Systems Project to define standard protocols that developers and creators of products and services should incorporate in order to facilitate interoperability between educational course building programs as well as search and reuse of course material. The definition is based on open standards such as XML and the DC metadata standard specification and focuses on implementation issues. This approach however does not consider pedagogical and managerial issues and does not address the management of information and knowledge in a more general way, which is our intention. Promising fields of application of metadata concepts ([44], [45] and [51]) are Learning Objects, which are basically reusable instructional components [65].

Although Knowledge Management (KM) is not a new concept (see [17], p. 106), its aim, scope and methods in the context of today's organisational structures and processes are difficult to specify and define in a concise way. In general, KM is not a concept that is solely driven by Information Technology (IT) but a combination of different approaches, which utilise various IT tools and concepts such as information management systems, expert systems, Artificial Intelligence, group ware, etc. Especially Nonaka's (see [27], pp. 63) investigation of organisational knowledge creation processes, based on the distinction between *explicit knowledge* (i.e. knowledge that is available in formal, codified categories) and *tacit knowledge* (i.e. knowledge that has not yet been articulated or that is known at a non-verbal level and is difficult to being explicitly described), provides a useful basis for defining the necessary organisational and technical requirements to support a framework focused on KM (see section 7).

A large part of the available literature investigates KM in the context of corporate environments and competing markets ([1], [4], [5], [6], [15], [17] and [24]) and uses concepts such as Organisational Memory and Organisational IQ as central metaphors (see [23], pp. 15 and pp. 85 and [27], p. 211). As a consequence, certain aspects such as copyright and representation issues are disregarded.

Especially consulting firms such as Ernst & Young and Andersen Consulting, which primarily rely on the knowledge of their employees, but also companies such as SAP, Lotus and IBM ([56] and [57]) have put KM into practice by developing sophisticated Information Technology (IT) and organisational structures to support and foster KM. Also the sociological and psychological problems in the context of knowledge management and transfer are investigated in the literature (see [1], [5], p. 44 and [24], p. 4). In order to overcome or at least ease these problems, the importance of defining and incorporating a system of incentives and accreditation is stressed (see [17], p. 113). Nevertheless, there are practically no technologically oriented frameworks that incorporate all technical aspects of KM (see [23], pp. 143).

The area of classifying and retrieving information can be divided into ([19], [35] and [42]):

- Clustering (unsupervised classification) and
- Discriminant Analysis (supervised classification)

There are a number of different clustering techniques, which can be divided into hierarchical (single link and complete link techniques) and partitional techniques (square error, graph theoretic, mixture resolving and mode seeking techniques) as well as fuzzy clustering, artificial neural network techniques, evolutionary approaches, etc. (see [19], pp. 274). Clustering is especially useful in data mining and document retrieval. Consequently, various clustering tools are available that can be used in combination with Document Management Systems [61]. Some authors concentrate on representation issues i.e. on the question as to how the results of a clustering process can be represented. Rauber [31], for instance, has developed a digital library that displays classified data using a two-dimensional topological representation.

Image classification and retrieval techniques are either based on metadata (i.e. data that describes the content of an image) or the image itself. The latter are referred to as Content-based Image Retrieval (CBIR) (see [11], pp. 13), which in general does not provide the same quality as document classification techniques because of different technical influence coefficients, more classification criteria and performance problems. On the other hand, metadata based techniques are problematical because of potential human errors, cost intensive generation and language dependencies. The same problems are also typical for the classification of streaming media where the classification problem is even more complex since a video clip, for instance, can be classified according to its sequence of images but also its sound track. Projects that deal with the development of such techniques and technologies can be found in [48] and [55].

As a consequence, classification concepts and tools are generally not integrated in technical frameworks although they can be considered as very important for assessing and retrieving (unstructured) data and information ([37] and [61]).

There are a number of interesting projects and frameworks with regard to the subject of this paper ([46], [53], [63], [66] and [67]). Although there are similarities between these projects and the approach that is proposed in this paper, there are in fact some basic differences. For instance, the employment of proprietary tools and concepts in [67] seems to be a limitation since the main objective, namely the classification, dissemination and reuse of multimedia content, can and should be achieved by incorporating existing Intranet tools and concepts. These tools and concepts can also be used to simplify and optimise the 'normal' administrative and paper work in schools and universities [29] and eliminate the necessity to switch between various applications and separated information sources.

Currently available ODL tools and frameworks such as TELSI, WebCT, Lotus Notes Groupware, Lotus Notes Learning Space and ProTo, which have been evaluated in [21] and [41], are not based on open standards which makes it difficult to collaborate and share course materials. Furthermore, these tools do not provide means to access, classify and exchange information on a broader level. In [3], the features and characteristics of some integrated distance learning environment such as FORUM, Virtual-U, Symposium, WebCT and First Class are evaluated against the Open and Distance Learning Information System (ODLIS), which can be used to "[...] provide virtual lectures, virtual conferences, collaborative work on projects which are shared among institutions, exchange of useful material [and] experience among teachers [...]" (see [3], p. 214). ODLIS pursues a broader ODL approach by supporting open standards but certain aspect such as the integration of existing information sources and classification concepts as well as copyright and licensing issues are disregarded.

The area of digital/electronic copyright protection and licensing is characterised by a number of recommendations, projects and prototypes (see [68] for an introduction to intellectual property). It seems however that current approaches such as the EU project CITED (Copyright in Transmitted Electronic Documents) and its follow-ups COPICAT (Copyright Ownership Protection in Computer Assisted Training),

COPEARMS (Co-ordinating Project for Electronic Authors Right Management Systems) and COPINET have not let to a commonly accepted solution (in terms of implementation and legal regulations). This is also true for hardware and software standards for electronic books such as the Open eBook Standard or Electronic Book Exchange [8].

The opposing positions of copyright holders, publisher and consumer were identified as a key problem in the report on copyright and digital distance education of the U.S. Copyright Office [34]. Recent developments such as the decision of the German *Verwertungsgesellschaften* [VG] to introduce a compulsory copyright fee for all PCs without co-ordinating this approach with the PC industry demonstrates the currently existing discordance in an even clearer manner [52]. Furthermore, ongoing legal actions against Napster and MP3.com, platforms to exchange copyright protected music, show that there is an urgent need for a commonly accepted and technically feasible solution to digital copyright issues.

The various online Electronic Bill Presentment and Payment (EBPP) systems fall into one or more of the following categories ([62] and [69]):

- Credit/Debit card schemes
- User-to-user account based schemes
- Virtual money schemes, including pre-paid cards
- Mobile commerce architecture which allows mobile users to make and receive payments
- Micropayment systems (aim at handling arbitrarily small amounts of money)

There are also various definitions of payment standards such as Secure Electronic Transaction (SET), Micro Payment Transfer Protocol (MPTP) by W3C and the Java Electronic Commerce Framework (JECF), which includes specifications for virtual money, smart-cards, etc.

To summarise, the following weaknesses and limitations of current ODL frameworks and tools can be identified:

- Lack of or insufficient support of open standards and/or platform-independent technologies
- KM concepts and tool are not considered
- Lack of or limited integration of (existing) information sources
- Lack of or limited facilities to assess and classify data and information
- Lack of copyright, licensing and billing concepts
- Reuse of courseware not possible or difficult

### **3. Logical Design of the Framework**

The proposed framework is based on existing concepts and Intranet technologies and aims at closing the gap between storing ODL content and courseware and

actually classifying and transferring this information in a way that enables pedagogues, management and other key personnel to reuse them. Based on knowledge management tools and concepts, pedagogues should be motivated and supported to reuse information and knowledge, instead of 'reinventing the wheel' by developing courses that already exist (see [24], p. 181). This is especially important since teaching is under financial pressure in nearly every country, which requires a careful planning of all ODL activities (the University of Oulu estimates the costs of a three year master program at 2.2 M Euro or approximately 2 M US\$, see [41], p. 126). Thus, it is even more important to disseminate relevant information and knowledge and, thereby, sharing costs through copyright fees. The financial aspect is an important reason for concentrating on Intranet technologies and open standards because, as mentioned before, these concepts can serve a broader purpose and require, in general, lower consequential costs. As open and distance learning activities are taking place in many different institutions and geographical locations, the framework must also allow for the distribution of pedagogical knowledge over the Internet. This requires the definition of a security concept, which minimises the potential security problems when accessing internal information and applications via the Internet. The proposed security concept focuses on a secure infrastructure, which comprises user authentication, data encryption and digital signatures.

The required IT skills to utilise the proposed framework are kept to a minimum which can be regarded as vital to its success since utilisation of ODL concepts means that "[...] teaching staff are being asked to simultaneously handle changes in the organisational environment in which they are operating and changes in the nature of the learning activities that they are expected to promote. This expectation is stressful and so it is unsurprising that many educators act defensively by avoiding those changes that can be avoided."([50], p. 3)

The main purpose is to support teachers and instructors in contributing, assessing and reusing concepts and content in a secure and controlled manner. Current frameworks rely on proprietary solutions, require a steep learning curve and handle administrative, managerial and copyright issues in an insufficient way (see [41], pp. 32). We believe that, in contrast to similar approaches, the usage of special purpose solutions and proprietary standards should be avoided.

In summary, the main objectives of the proposed framework are:

- Classification and reuse of ODL concepts and content
- Integration and authorised exchange/dissemination of information and knowledge
- Definition/Integration of a billing/licensing concept for copyright protected content
- User friendly design i.e. usage requires only basic IT skills
- Extendibility and flexibility
- Based on open standards and existing technologies

The envisaged user groups are:

- Teaching institutions (e.g. Universities)
- Teachers and Instructors
- Publishers
- Technical Personnel
- Management

The scope of the framework comprises the following components:

- Definition of a reuse policy, focusing on copyright issues
- Definition of a technical design
- Definition of system requirements

### **3.1. The Framework Structure**

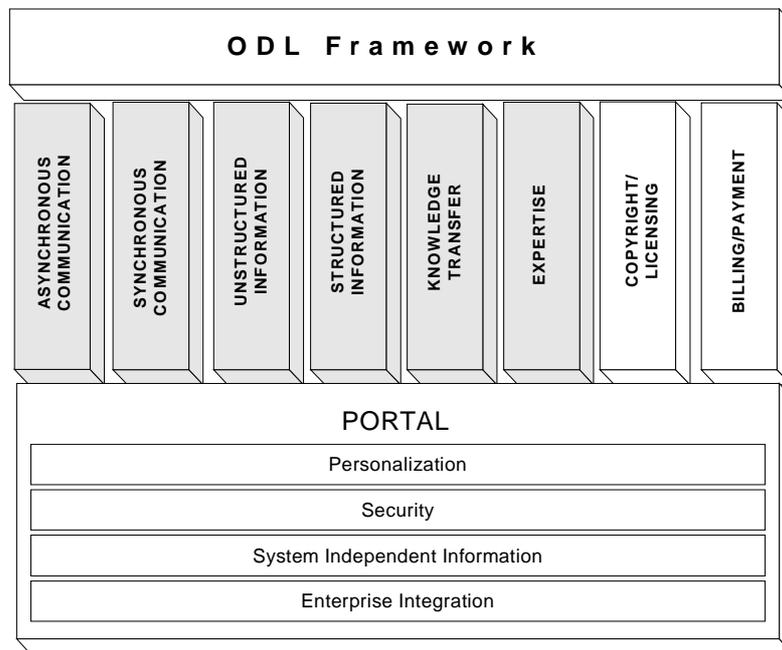
As depicted in figure 1, the basic layer of the logical design is based on Intranet technologies i.e. on Portals that establish the link between various and heterogeneous data sources and users. Portals have the potential to provide a 'single point of information access' and are considered as a technological basis for KM. However, due to a number of reasons, they have failed therein but, nevertheless, it is assumed that third generation portals or collaborative processing portals provide the necessary technical means to manage information and knowledge. The main aspects of KM are represented as grey boxes in figure 1 (see [23], p. 159). The boxes labelled asynchronous and synchronous communication refer to tools such as e-mail programs, discussion boards, chat programs and videoconferences. The unstructured information box comprises tools and concepts to store, retrieve, search and classify information in documents and images, for instance. By contrast, structured information is typically stored in data warehouses and is based on specific data models.

The box labelled learning comprises all tools to facilitate the transfer and exchange of information and knowledge (e.g. online tutorials). Finally, the expertise box provides information on 'who knows what' in an organisation. For instance, yellow pages, knowledge maps, etc can be utilised in this area. By adding copyright/licensing and billing/payment components, Portals can provide the technical basis for an ODL framework. It is however important to note that without the necessary organisational changes and management support, it is not possible to exploit the potential advantages.

The reason for using this architecture can be justified as follows:

First, institutions and organisations should have a single source of information in order to keep investment and maintenance cost at a minimum and data accuracy and availability at a maximum. For instance, access to index information on traditional media (e.g. books) should be provided within the same framework since they can and should be integrated in ODL courses as well (see [34], p. 14 and [41], p. 121 and p. 129). Because administrative, legal and financial processes require access to

structured and unstructured information anyhow (document workflow, electronic archives, etc.), there are potential synergies in terms of maintenance, consistency, etc.



**Figure 1:** Proposed structure for an ODL framework (see [23], p. 143)

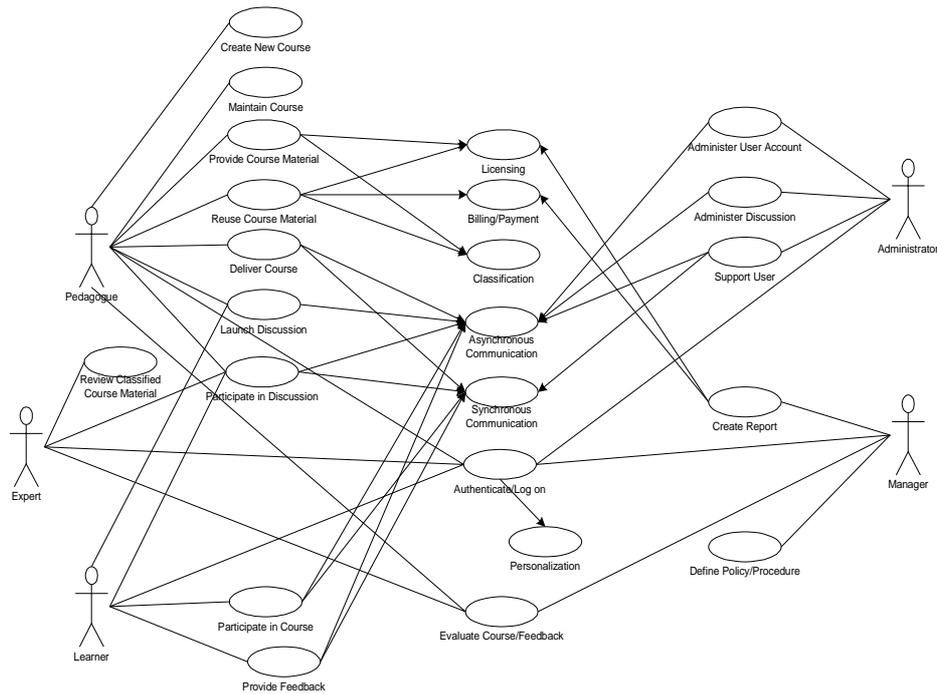
Second, they provide a unified and platform-independent interface to information and applications, thereby minimising the required user training. Third, Portals combine tools to filter and personalise information, which is a major requirement for KM, and migrate non-electronic information (e.g. high-speed scanner and Optical Character Recognition [OCR] modules). Finally, it is possible to integrate most forms of asynchronous (e.g. discussion boards, e-mail, etc.) and synchronous communication tools (e.g. videoconferencing).

The lowest Portal layer, labelled 'Enterprise Integration', represents the integration of all information/data sources, which is one of our main requirements. This might be difficult to achieve since, for instance, e-mails are normally processed and stored separately. System independent representation of information minimises dependencies on special software and hardware and allows the exchange of information between different platforms and applications. As mentioned before, XML can be used for that purpose. The security aspect comprises authentication, encryption and the highest Portal layer refers to the important ability to personalise one's view. A personalised view might contain just specific links and documents but also a configuration file for classification concepts.

The elements of KM, which are described in figure 1, can only be supported to a certain extent by the technical infrastructure. The transfer of knowledge, for instance, could be a ‘people-to-documents’ approach for explicit knowledge or a ‘people-to-people’ approach for tacit knowledge. This decision, of course, determines the support tools that have to be provided by the infrastructure (see [17], pp. 107).

### 3.2. Proposed Use Cases

Five main actors and about 17 directly related use cases have been identified, as depicted in figure 2, as well as the most important use relationships i.e. behaviour that is similar across more than one use case.



**Figure 2:** Proposed Use Cases of the ODL framework

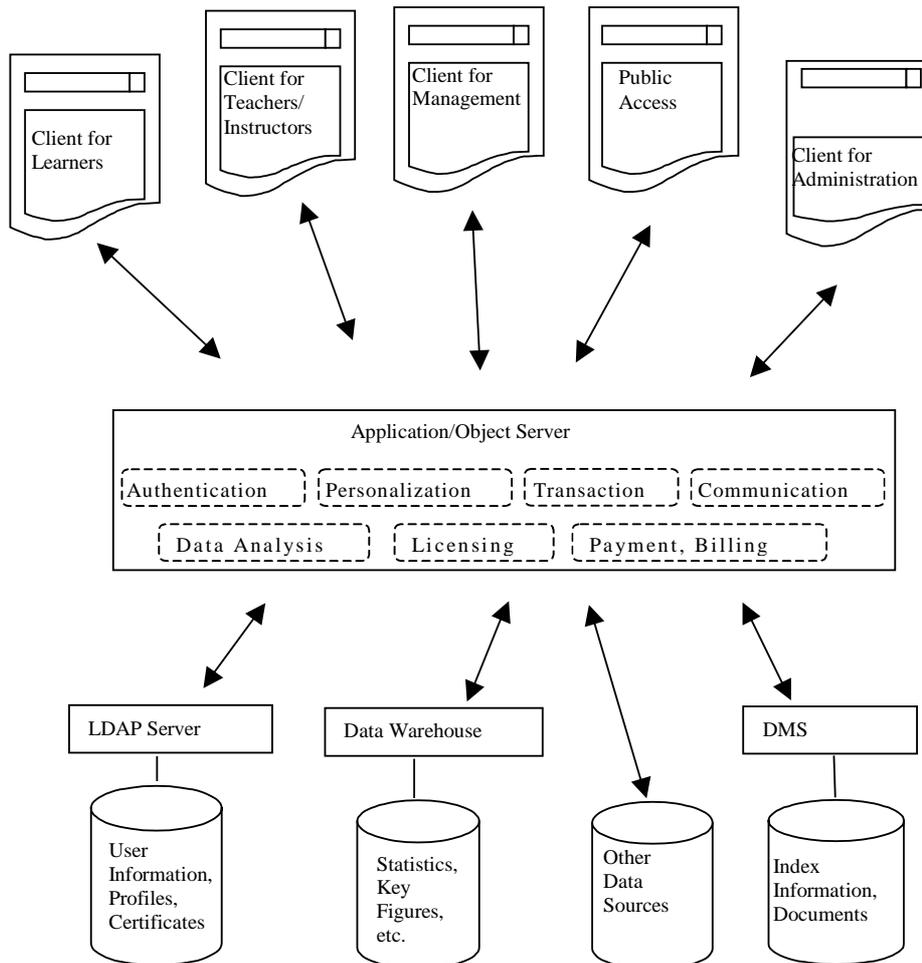
Figure 2 is conceived as a high-level description of the most important activities and common functions and identifies important relationships and dependencies. Note that special attention is given to the reuse aspect as well as the personalised view on information. Also the evaluation of feedback for quality assurance is an important use case (see [41], p. 126) and should be processed within the same framework using data warehouse technologies (see figure 3).

#### 4. Architectural Design

As shown in figure 3, a three-tier architecture is considered optimal because of its separation of presentation, application and data tier. The middle-tier, which is often called application server, is responsible for problem-specific data processing and provision of additional functionality such as transaction logic and security handling.

The advantages of using a three-tier design for the framework can be summarised as follows (see [32], pp. 27 and pp. 139):

- Integration of heterogeneous and distributed applications
- Scalability and Flexibility (automatic load balancing, new requirements can be easily integrated, etc.)
- Security (reduced number of potential vulnerabilities)



**Figure 3:** Simplified three-tier design of the ODL framework

With regard to the integration of legacy systems and distributed applications, CORBA is seen as a useful concept. However, because of its steep learning curve, one might also consider using JAVA's built-in mechanism Remote Method Invocation (RMI), which is much easier to use but restricted to the JAVA environment. In addition, it provides add-ons such as Java Database Connectivity (JDBC), authentication and authorisation (JAAS), JAVA Card technology, etc (see [13], pp. 25, [32], pp. 41 and pp. 139, [62]).

Both concepts facilitate the before mentioned Enterprise Integration through the provision of communication methods between heterogeneous and/or distributed applications.

The most important reasons for the approach described in figure 3 are:

- CORBA and JAVA are open platform-independent standards, which facilitate the integration of future data sources and applications
- Focusing on one standard reduces the number of dependencies on specialised knowledge
- Separation between representation, application logic and data structure
- Centralised authentication and transaction logic
- Integration of other open standards such as LDAP
- Integration of third-party products

## **5. Authentication, Security and Personalization Concept**

In general, the following technologies can be used to restrict access, authenticate the source of data and protect content (see [34], pp. 57):

- Password Protection
- Firewalls
- Filtering of IP Addresses and Domain names
- Public Key Cryptography (identification and authentication as well as encryption/decryption of data)
- Digital Signatures (mainly identification and authentication)
- Hardware Connections
- Physical Control

With regard to content, the following restriction and tracking methods can be used:

- Digital containers and proprietary viewers
- Streaming formats (no copy of the whole work is created on the user's PC)
- Low resolution data
- Digital watermarks

As mentioned before, it is suggested using LDAP based directory access systems for authenticating users, exchanging digital signatures and storing user profiles. The main advantages of supporting such systems are:

- Platform independent protocol (i.e. information is available cross-platform)
- Centralised information management (i.e. information can be accessed from a number of computers or applications)
- Mirroring and migration functions
- Personalization
- Skill management (important for selecting experts)
- Certificates management
- Supported by basically all web server and firewall products

User profiles in the LDAP database can be used as filter mechanism at a system level but also at an information level (e.g. classification parameters). Furthermore, it is possible to store several certificates per user in the Directory Information Tree (DIT), which can be utilised to reflect the different roles one person can have within an organisation (see figure 2). The possibility to replicate certain user information to the outside is seen as an important step to overcome the problem of identifying and contacting the owner of copyrighted work (see [34], pp. 41).

## **6. Copyright/ Licensing and Billing/Payment Concept**

As mentioned in section 1, there is no commonly accepted solution to the copyright and licensing issue. Because of the modular design of the proposed framework, it is possible to interface third-party copyright and licensing systems as long as they provide a generic interface (see [34], pp. 44). Also currently available Electronic Bill Presentment and Payment (EBPP) concepts can be easily integrated because these systems are specifically designed for the integration into web-based applications.

In general, the following three primary types of licenses are in use today (see [34], pp. 33):

- Transactional licenses for analogue uses (normally paid per student)
- Transactional licenses for digital uses (normally paid according to the usage)
- Site licenses (usage is allowed to a certain user/user group for a set length of time)

The proposed ODL framework must support all three types of licenses because of the mix of digital and traditional media in ODL courses. As mentioned before, one of the main problems is caused by the fact that courses may incorporate many different works, making it burdensome for faculty and librarians to identify and contact the owner of a single work. The provision of a generic method to provide and retrieve copyright information is therefore seen as an important part of the

framework. Otherwise "[...] many teachers may still prefer to create their own content for pedagogical purposes."([34], p. 38). A centralised user management that facilitates the identification of a copyright holder is necessary to overcome this problem. As for the cost of a license, one can assume that the increased usage of licensed work will lower the cost per license. Again, it can be assumed that LDAP based user management can be used to identify copyright holders and exchange, in combination with a commercial solution, keys and certificates to provide authorised access to courseware.

## 7. A Roadmap for Implementation

As stressed elsewhere in this paper, the proposed technical infrastructure can only provide the necessary means to design, develop and deploy ODL courses. It cannot induce the necessary organisational and managerial processes. The results of several evaluation reports indicate that it is vital to the success that the necessary organisational and managerial changes and strategies are planned in advance (see [41], pp. 122 and pp. 134) or to put in the words of Kuppinger and Woywode: "IT follows business" ([23], p. 91). A comprehensive description of the required organisational, administrative and pedagogical steps is provided, for instance, in [24], pp. 223. Since this paper emphasises on the technical aspects, only organisational aspects with regard to KM are mentioned here. In particular, it is important to consider basic questions such as:

- What kind of knowledge needs to be transferred?
- What kind of KM strategy should be pursued?
- What are the incentives for pedagogues to share their knowledge?

Figure 4 depicts the two basic KM strategies that are usually pursued by organisations. The codification strategy, which is for instance used by Ernst&Young, concentrates on the computer-based representation of explicit knowledge. In contrast to this approach, consulting firms such as McKinsey pursue a personalization strategy, which focuses on communication between people i.e. exchanging tacit knowledge.

The appropriate KM strategy depends on the kind of knowledge that is being transferred. In the ODL context, a shift to the 'people-to-document' strategy can be assumed whereas in traditional classroom situations the transition of tacit knowledge might be more important (see [17], p. 109). It is assumed that the framework should focus on the codification strategy with all its consequences in terms of IT structure, management and organisation but also provide means to support transfer of tacit knowledge.

The third question is representative for the psychological aspect of KM, which is summarised in the ten information facts of life by Davenport. In particular, fact seven states "if information is power and money, people won't share it easily" ([5], p. 44).

<b>Two Approaches for Managing Knowledge</b>		
<b>CODIFICATION</b>		<b>PERSONALIZATION</b>
Emphasise on reusing codified knowledge		Emphasise on channelling individual expertise
Reuse Economics Invest once in a knowledge asset and reuse it many times. People-to-Documents Develop electronic systems that codify, store, disseminate, and allow reuse of computerised knowledge. Heavy investments in IT: The goal is to connect people with reusable codified knowledge.	<b>Economic Model</b>  <b>Knowledge Management Strategy</b>  <b>Information Technology</b>	Expert Economics Provide highly customised solutions to unique problems.  Person-to-Person Develop networks for linking people so that tacit knowledge can be shared.  Moderate investments in IT: The goal is to facilitate conversations and the exchange of tacit knowledge.

**Figure 4:** *Codification vs. Personalization*

Thus, besides the strategic planning as to which ODL courses should be provided, the definition of an organisational strategy to foster knowledge/information exchange by providing incentives and accreditation is necessary. Beside the definition of a licensing and billing concept, it is also necessary to convince pedagogues of the usefulness of such an approach. As argued in [1], [41], p 115 and [23], pp 110, the proposed framework should be introduced with the support of upper management and the help of senior pedagogues to create the necessary level of trust and confidence. In reference to [24], it is also key to acquire the necessary pedagogical, technical and managerial in-house skills and expertise (e.g. through appropriate pre-service teacher education) to successfully utilise ODL concepts and tools.

## **8. Conclusion and Future Work**

Because of similarities between the area of ODL and Knowledge Management, this paper proposes using KM concepts and tools to foster the exchange of information and knowledge between pedagogues. The proposed framework does not aim at the creation of a new information system but the integration of existing technical infrastructures (e.g. Intranet) and existing applications (e.g. document management system, data ware house), using open standards. With reference to the involved players, the following advantages/improvements are expected, provided the necessary organisational and managerial structures are in place:

- Pedagogues: Encouragement to reuse existing ODL courseware, incentives to provide own courseware and share experience, one platform to access and classify information, flat learning curve, access to best practice examples

- Experts: Tools to access and classify information, possibility to share experience with pedagogues
- Learners: Profit by best practice examples, flat learning curve
- Management: Reduced investment/lower costs on the long run because of reduced maintenance and development costs, cost sharing by licensing courseware

The core parts of the suggested framework are currently being designed and implemented at the Provisional Technical Secretariat (PTS) of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organisation (CTBTO PrepCom) [60], an international organisation, which has its headquarters in Vienna, Austria. The Comprehensive Nuclear-Test-Ban Treaty provides for a global verification regime, including a network of 321 stations world-wide, a communications system, an international data centre and on-site inspections to monitor compliance. Due to the heterogeneous IT infrastructure (SUN Solaris, MS NT) at the PTS and the geographical distribution of experts and monitoring stations, web-based applications play an important role. In particular, a three-tier architecture that provides access to a Document Management System (DMS) and an Oracle Database Management System (DBMS) via Java Servlets and CORBA has been designed to provide web-based, secure access to documents, discussions and meetings. The main objective of this system is to provide world-wide access to relevant information in a secure manner, using platform independent solutions. The application layer of the communication solution is based on Oracle's Internet Application Server (iAS). The interface to the DMS has been designed in a way that allows future projects such as PTS's Intranet to reuse it. During the implementation specific problems with proprietary CORBA implementations (e.g. communication between Object Request Brokers from different manufacturers) and storing multiple certificates in LDAP have been encountered. The user authentication is realised via LDAP and part of a Public Key Infrastructure (PKI) project, which allows the authentication and encryption of seismic, hydroacoustic, infrasound and radionuclide data, which is being gathered in Vienna and transferred to information and, eventually, knowledge through various analysis phases.

The most important refinements of the proposed technical framework relate to the actual integration of a copyright/licensing and payment/billing concept as well as to the specific design of the security and classification requirements.

In addition, the definition and implementation of the appropriate pedagogical, organisational and managerial measures to exploit the technical framework need to be investigated. Such measures comprise, for instance, the handling of information and incentives for pedagogues to participate in the knowledge sharing process as well as the necessary organisational concepts in terms of hierarchical structures, managerial measures, communication processes, incentives, etc. In this context, existing KM concepts as well as best practice examples in the academic and commercial area should be considered [22].

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