e-Learning Resource Brokers

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ABSTRACT
There is an exponentially increasing demand for provisioning of high-quality learning resources, which is not satisfied by current web technologies and systems. E-Learning Resource Brokers are a potential solution to this problem, as they represent the state-of-the-art in facilitating the exchange of learning resources between multiple parties. These systems currently operate at a limited scale but their use is vastly increasing, especially in the context of multi-faceted educational organizations, such as virtual universities. This paper presents some of these systems that are extensively used in the e-learning market. It then moves on to provide an overview of the *ideal* functionality that e-Learning Resource Brokers should provide. Finally it discusses future trends in their development, within the context of global e-learning forces.

Keywords
e-learning resource broker, course broker, learning resource, metadata, learning technologies, e-learning.

1. INTRODUCTION
The Web offers a massive number of learning resources within reach of anyone with Internet access. A **learning resource** can be any digital asset of diverse granularity, which can be used to enable teaching or learning (IEEE LTSC, 2001). It may refer to many different types of resources from simple images or video clips, to complex quizzes, or to whole courses arranged in one or more sequences. The main critical issues concerning learning resources, are their ability to be updated, identified, utilized, shared and re-used. In order to address these issues, several, highly active, standardization initiatives are concerned with the specification of learning resources metadata, i.e. sets of attributes required to fully and adequately describe them (IEEE LTSC, 2001).

However, it takes more than the specification of metadata standards for learning resources to achieve the aforementioned goals. First, these metadata schemas are particularly complex to be simply incorporated into web pages and indexed by search engines; they need to be managed by special-purpose systems. Nevertheless, the systems that have indeed implemented these schemas, e.g. Learning Management Systems, focus on providing e-learning services in a limited, isolated fashion: their learning resources cannot be searched and accessed from other systems. This is why a new category of systems have emerged in this field, namely the e-Learning Resource Brokers (LRBs).

An LRB is an on-line system or portal that acts as an electronic marketplace for offering and demanding learning resources. In this sense, an LRB has two types of users: those who offer their products for sale (*providers*) and those who buy the offered products (*consumers*). An LRB facilitates the exchange of learning resources between providers and consumers, which can be either organizations or individuals. LRBs are not mere portals, i.e. gates of access to learning material (Duncan, 2002), but also offer the ability to discover a learning resource and put it to a new use. Thus the purpose of an LRB is not simply safe storage and delivery but reuse and sharing (Littlejohn, 2003). An LRB should be neutral to the pedagogic purposes of the material it offers, just as a library has no influence over how a book is read.

An LRB is particularly suitable to be used in the context of multi-party, distributed organizations, such as Virtual Universities. These organizations are comprised of smaller constituents, such as partner-institutes in several Universities, possibly from different

countries, and each such institute must deliver courses in joint programs of study. Subsequently there is a need to seamlessly offer courses from several institutes to the students who are possibly located themselves in different countries through a unified interface. In this case an LRB could be commissioned with the responsibility to do exactly that: provide services for partner institutes that offer courses, as well as students that wish to attend courses in a integrated and seamless fashion.

The aim of this paper is to present these systems, outline their functionality and discuss their potential. We first present a number of commercial and non-commercial systems that can be classified as LRBs. We then go on to elaborate on the functional requirements of an ideal LRB. We have examined several existing LRBs, composed a superset of their functionalities, and enriched them with more functionalities that we have thought desirable. We finally discuss on what could be the future of such systems, especially in the fashion of de-centralized LRBs, digital rights and quality assurance.

The structure of this paper is as follows: Section 2 briefly describes the set of LRBs that have been evaluated and analyzed in order to derive the functional requirements of these systems. Section 3 analyzes the functional requirements of an ideal LRB, through task analysis and use case diagrams. Section 4 concludes with a critical discussion of the trends in developing de-centralized LRBs.

2. LITERATURE REVIEW

In this section, we briefly present the set of e-Learning Resource Brokers that we have inspected in order to understand and formulate their functionality. The sources of this epigrammatic presentation are mainly white papers and specifications from their on-line documentation.

EducaNext Platform for Learning Resources: The EducaNext service (http://www.educaNext.org/) is a web-based LRB, which enables collaboration among educators by providing a range of services to support the exchange of Learning Resources. The EducaNext (former UBP) platform provides functionality for cataloguing and delivering both *educational materials*, which refer to sharable chunks of reusable learning content (electronic textbooks, recorded lectures and presentations, case studies, quizzes, lecture notes, problem statements, project assignments, etc.) and *educational activities*, which refer to distributed educational and training activities (lectures, tutoring sessions, synchronous group collaboration, complete on-line courses, etc).

World Lecture Hall: (http://www.utexas.edu/world/lecture/) It is one of the oldest LRBs that publishes links to university-level courses created by faculty worldwide who are using the Web to deliver course materials in any language. Some courses are delivered entirely over the Internet, and also provide university credit units to the students that pursue them. World Lecture Hall provides for free, not only updated extensive catalogues of these courses, but also advanced searching tools.

Online Learning Network: (http://www.onlinelearning.net/) It is an online supplier of continuing higher education, which provides courses for training programs, lifelong learners. It collaborates with higher education institutes like the University of San Diego and the University of California at Los Angeles (UCLA) in order to offer certification by accredited institutions to the learners. Except for learners it also provides a set of services for instructors, so that they can manage and offer courses through this LRB.

McGraw-Hill Learning Network (MHLN): MHLN (http://www.mhln.com/) provides services to students, teachers and the students' parents. Teachers can set up online courses by purchasing and assembling online content on multiple subjects. The students can go to an online class, get homework help, search through encyclopedias and dictionaries and play games. The parents can visit their child's online classroom, view progress reports, and take advantage of many free McGraw-Hill online resources.

Scottish electronic Staff Development Librafy (SeSDL): SeSDL (http://www.sesdl.scotcit.ac.uk/) is an on-line library of web-based resources designed to encourage the sharing and reuse of resources, mainly for teaching and learning. The resource center concentrates on materials, which can be delivered via the web and so can be used in a number of different flexible approaches to staff development.

IntraLibrary: (http://www.intrallect.com/) It is a digital repository for learning resources. It enables groups of trainers and content authors to store, share and re-use learning resources using a simple, web-based interface. IntraLibrary encourages content creators, such as university teaching staff or corporate training staff, to granularise their learning content into lots of smaller learning resources.

Health Education Assets Library (***HEAL):*** HEAL's (http://www.healcentral.org/) aims at providing educators with high-quality, free multimedia materials (such as images and videos) to augment health science education. In addition, HEAL collaborates with other organizations to establish a network of distributed databases of high-quality teaching resources. It thus uses web-based technologies HEAL to enable educators to efficiently search and retrieve teaching materials from a variety of sources.

Education Network Australia (EdNA): EdNA Online (http://www.edna.edu.au/) is a service that aims to support and promote the benefits of the Internet for learning, education and training in Australia. EdNA Online provides two key functions: a directory about education and training in Australia and a database of web-based resources useful for teaching and learning. It covers the entire higher education sector and facilitates the stakeholders into searching locating and using learning resources, as well as education and training programs.

Campus Alberta Repository of Educational Objects (CAREO): CAREO (http://careo.netera.ca/) is a project supported by Alberta Learning that has as its primary goal the creation of a searchable, Web-based collection of multidisciplinary learning resources for educators across the province and beyond. It facilitates indexers, educators and learners by providing indexing and searching tools, based on metadata standards.

MERLOT: MERLOT (http://www.merlot.org/) is a free and open resource center designed primarily for faculty and students of higher education. Links to online learning materials are collected along with annotations such as peer reviews and assignments. Community members help MERLOT grow by contributing materials and adding assignments and comments.

SMETE: SMETE.ORG (http://www.smete.org/) serves as an integrative organization and distributes pedagogical material through the establishment of a federation of digital libraries. Except for offering a dynamic online library, it also provides a set of services so that its users explore, share, discuss and of course learn online.

LearnAlberta Portal: (http://www.learnalberta.ca/) This is a portal aimed at students, parents, teachers and others from the Kindergarten to Grade 12 (K-12) community. It offers access to multimedia learning resources that directly relate to the Alberta programs of studies and are made accessible anywhere, anytime via linked databases and other portals on the Internet.

3. SYSTEM REQUIREMENTS FOR AN IDEAL SYSTEM

In this section we focus on the requirements that an LRB must satisfy. None of the LRBs that were presented in the previous section, provides all these functionalities, so they can be considered to be a superset of the functionalities of LRBs.

The requirements are grouped into *tasks* that the users perform through the system. The type of task analysis we have chosen is hierarchical and borrows ideas from several sources, including the one described in (Wigley, 1985). In a hierarchical task analysis, each task is analyzed by “breaking it into task elements or goals which become increasingly detailed as the hierarchy progresses” (Stammers et al., 1990). The most general information is placed at the top of the hierarchy, with the more specific information following on lower levels. Some figures that show part of the task analysis can be found in subsection 3.1. The major tasks that LRBs perform are analyzed in the following paragraphs.

3.1 The tasks

It is evident that every system should provide some way of browsing and searching for the offered resources. Therefore, we propose that an ideal LRB implements the following two general tasks: *Browse catalog of resources* and *Search resources*. Browsing should concern all resources on a specific (easily selected) area / category. As for searching, in addition to the simple text search, an advanced and customized search option should be also available. The results should be presented, after being sorted, either alphabetically, by relevance, by category, by last update or by any other meta-data information available for the resources.

When *viewing the details* of a selected resource, it is useful for the user to view, in addition to the meta-data available for the resource, some other indicative information. This includes some sample material or a summary / abstract of the resource, depending on each case. Users also seem to find useful, comments and ratings by other users that have used the same resource. The e-learning resource broker should also offer cross-reference to other resources that were also used by users of a given resource. This seems to provide the user with a very focused and high relevancy search option as illustrated by sites like "Amazon" and "Google" (with the option "Find similar pages").

In the case that an e-learning resource broker requires some form of *resource reservation* (as in brokerage platforms or providers of e-learning content), the system should provide the user with the option to view the "license agreement" under which the reservation (or purchase) of resources takes place, at any time (before, during or after the reservation takes place). The "license agreement" can be either specific to each resource (as in brokerage platforms, where resources have different providers) or common to all resources (as in providers of e-learning content, where the provider offers all resources). The user should have the "Reserve resource" option available, without being forced to commit to his/her choice, until the user is ready to proceed to the next step (resource delivery or payment).

Except for reserving a resource, the user should be also able to somehow *manage the reserved resources*. This option is not limited to viewing the resources reserved during the user's last transaction, but may (preferably) include all the reservations (that were actually committed) by the user in the past. This allows the user to manipulate this list by designating his/her favorite resources, recommend a resource for other users, rate a resource and comment (on usefulness, relevance to some topic, or any other useful criterion). The user can also categorize the resources to custom categories and manage the resources (actually links to the resources). This includes canceling an already reserved resource, or committing to the reservation (at which time the resource's provider should be notified and not prior to that time).

The ability to *buy a resource* is critical in e-learning systems that "sell" e-learning content online. Although the payment stage of a transaction can be carried out via alternative offline methods (e.g. telephone or mail order), we feel that since the rest of the transaction is completed online, so must the payment stage. The subtasks for implementing this requirement are well known and need not be discussed here. We should note, however, that the payment stage should be in accordance with the reservation of resources and the commitment requirement as explained above. Hence, the user should be allowed to reserve and cancel the reservation for any number of resources before committing and paying for them.

Regarding the *delivery of resources*, this can be implemented depending on the resource type, system category, terms of resource sharing (e.g. use once, unlimited use) and its digital rights, in general. This could include presenting the e-learning material onscreen, downloading the material to a local media or linking to a web site. In case an e-Learning Resource Broker contains a digital repository, it will be able to provide access to the e-learning content by itself. In any other case, it should provide just access details which should have been already given by the content provider as an addition to the standard learning resource meta-data.

Complementary to the resource delivery is the ability to *contribute a resource*. This is not required by all LRBs, but is necessary for digital repositories. When contributing a resource, the user should be able to either provide a link to the resource or upload the material to the system server, according to the desired functionality of the system. In any case, the user should be able to clearly define the intended viewers of the resource and the conditions under which the resource may be used, i.e. the digital rights. The system is responsible to uphold any constraints defined on the resources, provided that these comply with the system's policy.

A task that is complementary to resource contribution is the *management of the contributed resources*. In addition to viewing the resources contributed by a user-provider, the user should have the option to edit a contributed resource, or even cancel a contribution and withdraw the resource, again given that this complies with the system's policy. Lastly, the user has the option to make a contribution public and thus commit to his/her contribution.

The user should be able to *annotate a resource*, and store the annotations in an annotation repository. The user should be able to comment on the resource, using either free text or specific notations, e.g. the "star system" for rating the quality of the resource. There should be an authentication mechanism for each user since there can be two kinds of annotations: the private and the public ones. Each annotation resource should be accompanied by meta-data specifying the author, timestamp, the kind (e.g. "criticism", "praise" etc.). Additionally, other relevant sub-tasks are to filter and retrieve annotation sets based on their metadata.

The ability to create a *personal user account* is almost a necessity in e-learning resource brokers. This allows the system to keep personal user information (e.g. the reserved resources), to contact the user for updates and to adjust to each user's individual needs. The latter is important in order to provide a personalized and thus efficient and focused use of the system, since each user has unique expectations from the system.

Regarding the *update of notifications*, this should be provided upon user's request only and the user should be able to terminate it at any time. The information provided should be relevant to the user as possible, something that can be achieved by utilizing the user's personal preferences. The notification should be made both online (e.g. in the home page or some specific news page) and via email (e.g. mailing list or newsletter), according to the user's request.

The system should provide *informative material about the system*, which can take many different forms, including manual, FAQ, site map and glossary. The user should have the option to select the form with which he/she feels most comfortable with and believes it can most efficiently and accurately provide the needed information. It is also important that the information is presented modularly starting from help on the basic system functionality and moving to the more advanced functionality upon user request. Lists of steps that guide the user should be used whenever possible, instead of plain text.

The systems should also provide *company informative material*, that although not directly related to the system itself, may provide useful information to some users. This information should be clearly marked and accessible, but should not interfere with the system's functionality and documentation. The latter will result in confusing the user and blurring the system's indented goals and capabilities.

Besides reading precompiled help material, the system should also provide the ability to *contact the system personnel*. The user should be able to contact (via email, phone or online live chat, according to the importance of the request) the system personnel and get answers to specific questions or provide feedback about the system. Support and feedback should be preferably implemented via form completion. The structured input guides the user and allows for better processing of he information.

Multi-language support should be considered amongst the most important functional requirements of an e-learning system. A system that provides e-learning content should be able to also address the needs of foreign users that may not master the language of the system. This of course is not limited to providing multi-language resources, which is of course equally important. The entire system documentation and online information (except contributed resources) should be able to be translated to other languages. A clearly marked way should be provided to toggle between languages, appearing (preferably) on the home page (or every page) through icons (e.g. national flags).

The above cover the basic requirements of e-learning systems. In addition, some specialized requirements may also be present, depending on the system's goals. Such requirements include discussion forums, glossaries, etc. Although these requirements are not considered to be essential, when implemented and integrated correctly, they can advance a system's overall image.

3.2 Further Analysis of Tasks

Task analysis is a study of actions and/or cognitive processes that a user is required to do, in order to achieve a task. It gives an understanding of the current system and how information flows within it. In this section, we present indicative examples of how some tasks of an ideal e-Learning Resource Broker can be analyzed.

Initially, we give an overview of the main tasks of the system. In Figure 1, we present the process that a registered user (or a user that intends to register) should follow in order to take advantage of the whole system functionality. On the contrary, in Figure 2 we present the corresponding process for a non-registered user. Figure 1 and Figure 2 should be considered as the two alternative actions for the general system process task.

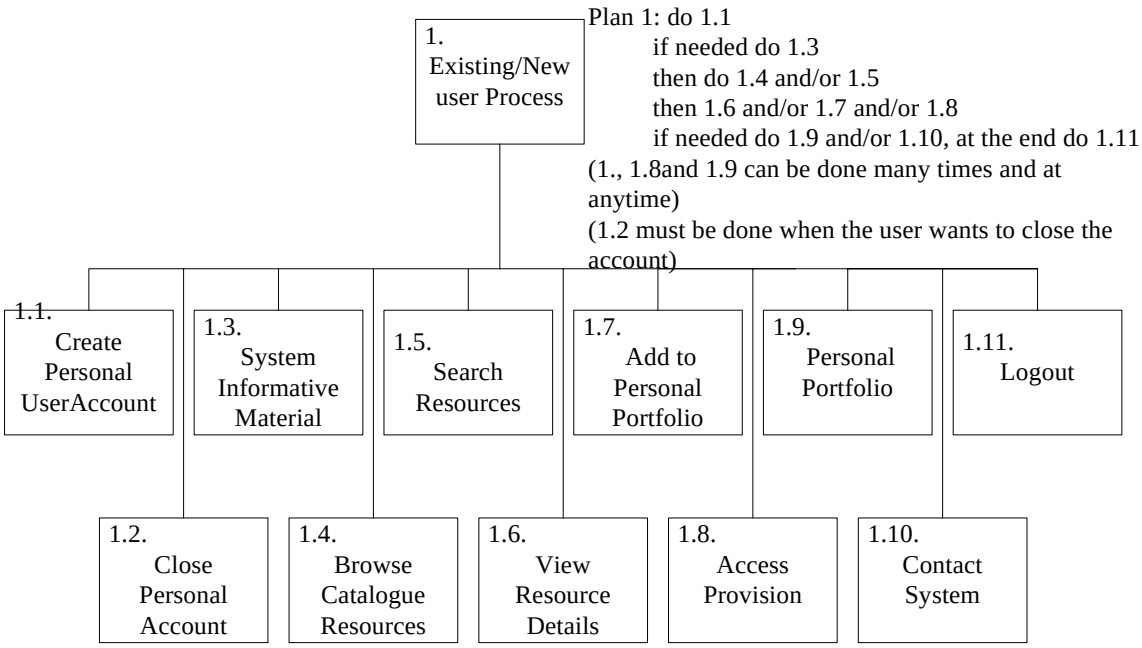

Figure 1: System process for a registered user

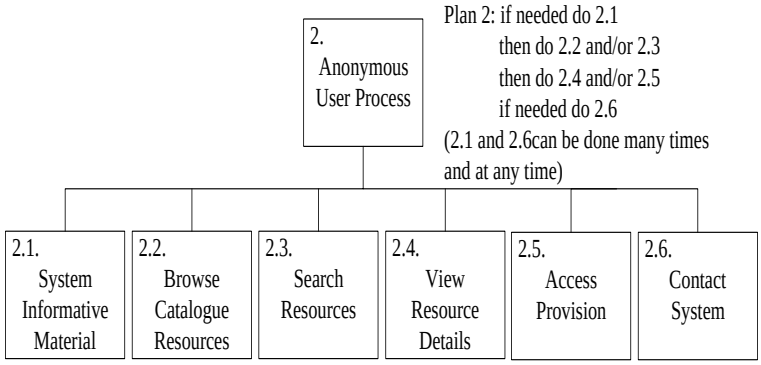

Figure 2: System process for a non-registered user

Figure 3 depicts the analysis of the "Search resources" task. As we have already described, either a simple text search or an advanced search form will accomplish the searching of the requested learning resources.

During action 3.1, the user, registered or not, fills in the search form. The most significant fields that a search form should contain are the scientific category, the subject, the language, and the access type of the resource, the last modification or updating date, the author or the publisher if the resource concerns articles. The result of this task will be the presentation of a result list. For each result, the user will be able to choose amongst three others tasks, the "View Resource Details", the "Access Provision" and the "Personal Portfolio". One more example of a task analysis concerns the "Personal User Account" task, depicted in Figure 4. A registered user can log on to the system and a new user can create his/her personal account.

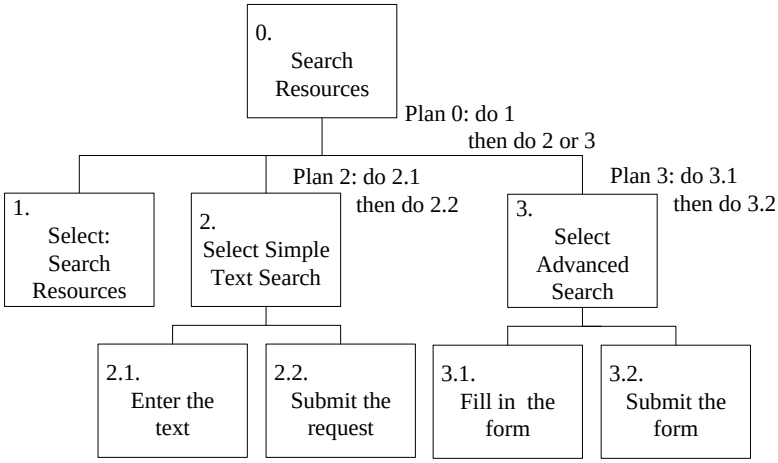

Figure 3: Analysis of the "Search resources" task

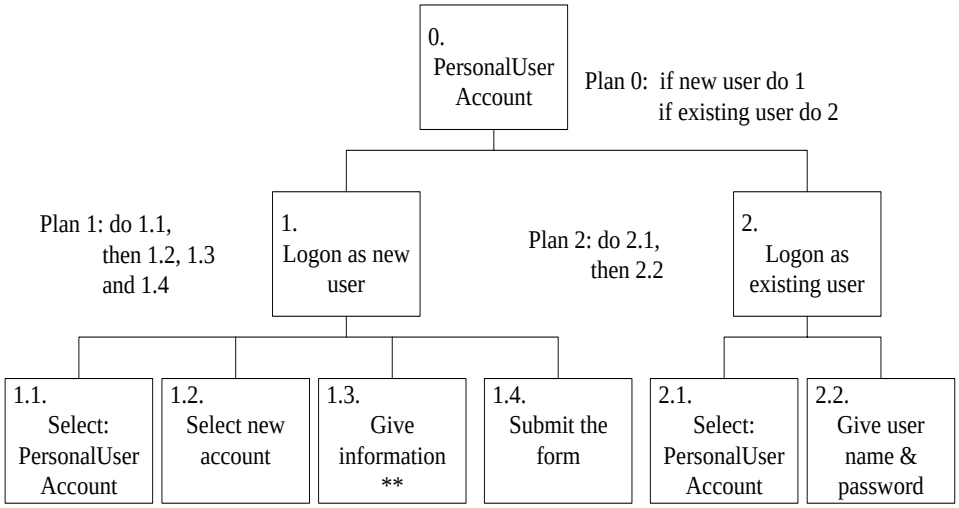

Figure 4: Analysis of the "Personal User Account" task

3.3 Use Case Diagrams

Use case diagrams can be used to describe the functionality of a system. Rather than merely representing the details of individual requirements of a system, use case diagrams can be used to show all of its available functionality. Use case diagrams show the relationships between external actors and use cases in a system.

In this subsection, we present some examples of use case diagrams. These diagrams combined with the task analysis we have described in the previous subsection, illustrate a significant part of the functionality of an ideal e-Learning Resource Broker. Similarly with the task analysis subsection, the first use case diagram given, contains the main use cases of the system operation. We give two different approaches (Figure 5 and Figure 6) for a registered and a non-registered user respectively. Figure 7 depicts the use case diagram that describes how a registered user can search for learning resources. Figure 8 presents the way that a user can access a learning resource that is presented in a result list.

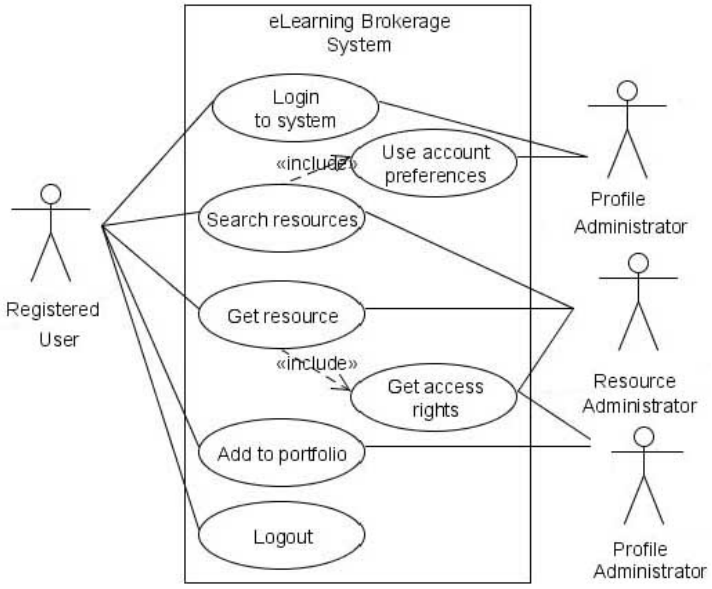

Figure 5: System process for a registered user

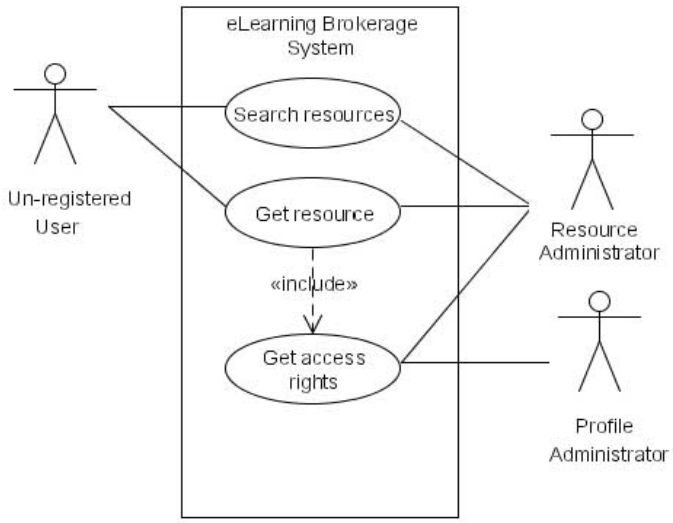

Figure 6: System process for a non-registered user

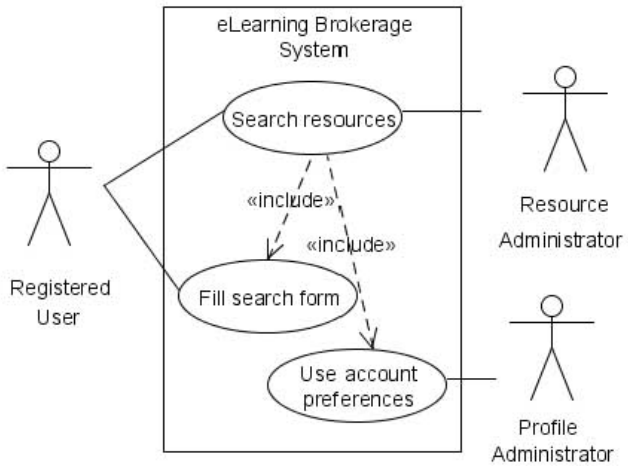

Figure 7: Search resources from a registered user

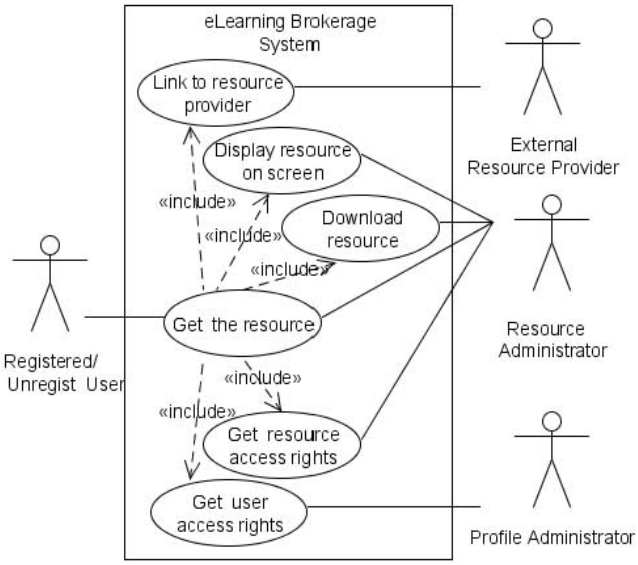

Figure 8: Access to a learning resource that is returned in a result list

4. THE FUTURE OF E-LEARNING RESOURCE BROKERS

According to IDC's bulletin *Worldwide Corporate eLearning Market Forecast and Analysis, 1999-2004* (IDC #B23904), worldwide revenues will grow beyond the $23 billion mark by 2004. This figure is extraordinary if we consider that the market was less than $2 billion at year end 1999. The huge market size will probably make the education and training industry the second largest economic sector in the US, next only to healthcare. Therefore, "killer applications" of the e-learning segments are expected to gain significant portion of the revenues.

LRBs have the potential of becoming such killer applications within the e-learning domain since they cover Content, Technology, and Services (Duval and Hodgins 2003). In order to reach this goal, and thus shift into the next generation, LRBs need to take into consideration the following research and development issues/trends:

- The current trend in developing LRBs is to move from centralized, non-distributed data repositories towards *distributed* architectures. Apart from offering a central data repository where the broker holds its own learning resources, the LRB is interconnected to several other repositories located in different places over the Internet. The trend is to use Peer-to-Peer (P2P) based approaches, which are more flexible than centralized ones, since content consumers, both teachers and students, can benefit from having access not only to a local repository, but to a whole network, making queries on metadata of distributed learning resources (Nejdl et al., 2002). This approach allows end-users to perform parallel queries for learning resources across LRBs. MERLOT, SMETE, eduSource, etc. have published specifications for APIs based on SOAP and WSDL, in order to achieve such interoperability.
- Issues of *copyright* and *intellectual property* need to be better addressed. If, for example, a company gets online and downloads an LR and sells it or uses it to make money, how will such issues be addressed? Several content providers are reluctant to channel their products through LRBs, precisely because such issues are mishandled. The Digital Rights Expression Languages (DREL) workgroup within the IEEE Learning Technology Standards Committee has published a draft document which identifies several such efforts on specifications, standards, and standards development efforts concerning digital rights in education and training.
- Finally *quality assurance* is a major issue. A procedure needs to be established that will ensure the high quality of learning resources posted and distributed via the brokers. Otherwise users are likely to lose trust towards the brokers and return to more traditional content providers. A peer review process similar to that of MERLOT can be effective in helping establishing high quality standards for learning resources. Furthermore, a special committee with content experts can be established that will be reviewing learning resources submitted and rating them according to their quality, following a pre-established set of criteria. Such criteria can be the following:
    - Appropriateness of the content for the level it is proposed (the language used, graphics, and other media attributes as they apply to the proposed context of use).
    - Accuracy of the data and information presented for the specific subject it covers (the information should be relevant to the subject, the level, and proposed context of use).
    - The organization of the material presented and its clarity (clear definition of the objectives, methods, procedures, and evaluation clearly defined).
    - The degree to which material provide a comprehensive coverage of the issue addressed in the learning resource.

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