Collaborative Resource Sharing for Computer Networks Education Using Learning Objects

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***Abstract*—The digital repository of learning objects for computer network education is presented. The repository was designed to enable sharing localised study materials among Czech instructors of Cisco certification programmes. The repository works as a digital library, with the set of metadata elements used for tagging and rating learning objects.**

I. INTRODUCTION

Cisco certificates are computer networking certificates that are valid and accepted by employers worldwide. The relevant training is provided by specialized centres, often as part of university study programmes. Cisco Systems Company provides official learning materials to instructors and learners through Cisco Networking Academy Program (NetAcad), online learning system.

The objective of our paper is to describe LORENA, the shared repository of localised NetAcad learning materials for Czech students to explain how the repository can be integrated with the learning management systems.

II. NETACAD

NetAcad was founded in 1997 as a partnership between Cisco System and educational, business, government and other communities all over the world with a vision to train new network professionals. The educational program uses e-learning and related tools such as instructors and students training, web portal, network simulators, testing exercises, study materials, collaborative tools, network simulation and exercises in laboratories. The goal of this effort is to teach students how to create and manage real computer networks. More than 2 million students studied in more than 10 000 academies in 165 countries worldwide [2], including the Faculty of Informatics and Management, University of Hradec Králové (FIM UHK).

The computer network education at FIM UHK is based on combination of distance study hours in virtual education environment and following practices in laboratories. There are many supporting tools, out of which very important is Packet Tracer – the network simulator that enables students to simulate network topology, set parameters for active parts of computer network etc.

For theoretical preparation and study process support there are two environments available at UHK: NetAcad provided by Cisco Systems Company and e-learning system Web-CT/Blackboard which is used at FIM UHK for delivering online learning materials in most study programmes and courses.

NetAcad program is considered as the Global Learning Network. This network is a collection of hardware and software that creates international distance learning system containing the following parts:

- Content management system,
- Content distribution system,
- Web server,
- Cisco Learning Institute Virtuoso,
- System maintenance tools.

Cisco headquarters is interconnected with local centres (academies). Every academy is allowed to use its own web server to distribute the content from central servers. There is no need to download the whole content of central server, only relevant parts can be used. These adjustments improve the performance and increase efficiency of learning process. The content distribution system is responsible for transferring units of educational data to students. The Cisco Learning Institute Virtuoso is a set of tools used for creating multimedia content. If there were more information required, the system finds and displays this it including the most effective way of data distribution.

Following functionalities are available in NetAcad [2]:

- Course study materials,
- Hands on labs,
- Continuous (chapter) tests,
- Final exams,
- Practice exams,
- Tools.

Although there are English NetAcad learning materials available, in numerous countries the localized study resources are prepared and enhanced. Instructors tend to define their own guidelines and have their own best practices that make the learning process more efficient. Sharing these resources is highly preferred, typically among educational institutions with the same or similar structure of computer network study programmes, the same organization of the academic year etc.

III. COMMUNITY OF NETACAD INSTRUCTORS

The NetAcad community involves computer network instructors from secondary schools and universities. The academies were organized hierarchically, with the regional academy on the top. At the moment of preparation of this paper, the hierarchy of academies is under reconstruction. The academies are planned to be

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associated with the Academy Support Center and the instructors will be taught at the Instructor Training.

For instructors, there is the iPortal where any kinds of problems related to the computer network training can be discussed and news, workshops proposals, competitions etc. can be announced. The digital content at the iPortal is well organized on blog principles. The main group for Czech instructors is called „CZ.All“, with 216 instructors from 77 academies. Thanks to the strong community of Czech instructors who are willing to cooperate, new events and activities are organized frequently. For example, the competition Networking Academy Games was prepared by instructors from over ten academies. Another important activity is the preparation of localized learning materials: Czech resources extend the amount of study materials for Czech students and lecturers. To share these resources, the repository of learning objects was created.

IV. LEARNING OBJECTS

Learning object is defined by IEEE as "any entity, digital or non-digital, that may be used for learning, education or training" [1]. Chiappe defined learning object as "a digital self-contained and reusable entity, with a clear educational purpose, with at least three internal and editable components: content, learning activities and elements of context. The learning objects must have an external structure of information to facilitate their identification, storage and retrieval: the metadata."[11].

Metadata descriptions of learning objects were standardized by several initiatives. The standards enable further exchanges of learning objects among learning systems, including their automated processing. One of first metadata standardization initiatives, Dublin Core (DC), defined essential metadata elements that are necessary for description of any resource. There were 15 core elements defined in the scope of DC. Their specification is flexible and no element is obligatory, their meaning can be precised. The Dublin Core specification does not define the syntax, XML format is used frequently to achieve the portability of metadata records [5].

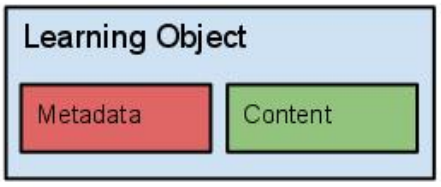

Figure 1: Learning object scheme

The DC specification itself is too general, therefore impractical for describing the learning objects. The more usable standard is LOM, the IEEE Standard for Learning Object Metadata no. 1484.12.1. This standard defines 58 metadata elements in 9 categories:

- General,
- Lifecycle,
- Metametadata,
- Technical,
- Educational,
- Rights,
- Relation,
- Annotation,
- Classification.

As well as DC, the LOM elements are not obligatory, therefore also learning objects with no description are LOM standard compatible. For practical use, the application profiles have to be specified. Typically the profile are designed for regional or institutional usage, e.g. UK LOM Core for Great Britain, CanCore for Canada, ARIADNE for European academic institutions etc. The LOM standard supports three notations [5]:

- Resource Description Framework (RDF),
- Extensible Markup Language (XML),
- ISO/IEC 11404 (standardized abstract data type language).

Other IEEE projects (1484.12.2-4) are focused on standardization, too.

Not only metadata descriptions, but also learning objects have to satisfy standards to simplify further reuse and interoperability. One of these standards is ADL – SCORM (Sharable Content Object Reference Model) produced by Advanced Distributed Learning Initiative. From 1997, ADL provided standardized format that interconnected the isolated formats used by particular providers of learning objects. The main task of ADL was to interlink the American consortia (IMS, IEEE, AICC) with providers of standards (W3C, ISO). The results of this effort is SCORM, enabling the interoperability built on XML. The latest SCORM version is from 2004 [9].

V. LEARNING OBJECTS REPOSITORIES

Numerous repositories of learning objects were built. Most of them are defined as Learning Object Repositories (LOR), or more generally Digital Libraries. LOR are accessible for registered users who can full-text search for learning objects, browse the tree of categories etc. Precise metadata description of the stored content increases the usability of the repository.

In article [7] are comparison of the following Digital Libraries described.

Fedora – it is a flexible system based on principles of service oriented architecture. Nevertheless, flexibility is concerning only to content of the repository, Fedora is capable to store and access any digital content – this does not stand for flexibility of whole information system. Fedora does not contain user interface.

DSpace – is complex system that contains repository including user interface. Nevertheless, DSpace is not flexible system – it is not possible to customize certain parts and behaviour of the software.

Greenstone – supports distributing collections via removable media. In this paper we discuss service oriented architecture, process based approach etc. – nevertheless contemporary technologies do not allow creating applications, which are based on these principles, which are multiplatform and which supports running from removable media.

EPrints – is primarily intended for scientific publications (digital objects are not modified very often). This system uses statically generated pages of user

interface. EPrints supports multiple archives under one instance (logical libraries).

CDS Invenio – is a complex and flexible system, which uses third party products for certain use cases. Customization of the system is complicated and may be expensive. There are strong dependencies on other products, which can cause problems with incompatibility between different versions.

DILLEO – is primarily intended for educational purposes. It is typical three-tier architecture with thin client. The application consists from set of components producing tight coupled relations. DILLEO – similarly to the most of other digital library systems – does not support service oriented architecture and does not stand for flexible system.

Most of presented systems are specific oriented (e.g. EPrints or CDS Invenio), whereas usually respect needs and requirements of institutions, where were created. There are a few digital library systems, which are complex; nevertheless the solution is not optimal and sufficient enough. Table 1 contains comparison of architecture and features of selected digital libraries systems.

In article [7] the following results of comparison from perspective of architecture of information systems are summarized:

Table 1 – Comparison of digital library systems

	Fedora	DSpace	Greenstone	EPrints	CDS Invenio	DILLEO
User interface		*	*	*	*	*
Dynamically generated pages	*	*	*			*
Customizable searching					*	
Customizable metadata formats	*				*	
Flexibility of the system	*				*	
SOA principles	*					
Process based approach		*				
Removable media (DVD, CD…)			*			

In general, flexibility of described digital library systems is very low. Only Fedora is based on SOA principles, CDS Invenio is a flexible system, nevertheless customization is relatively complicated. None of these systems (except DSpace) support process based approach, typically for the approval process. Very problematic is also customization of searching algorithm and modifying of used metadata format. Any customization and modification of these systems may be complicated and represents high costs for an institution.

VI. LORENA System requirements

LORENA is a **L**earning **O**bject **Re**pository for **N**et**A**cad. The basic requirements for the repository are as follows:

- Well structured internal organization of learning materials according topics, themes, last update, rating etc.,
- Web access without the need to install any special applications,
- Simple interface for uploading and downloading materials,
- Rating system for measuring the quality of materials,
- Support of sharing multimedia,
- Support of threat discussion related to particular learning materials,
- Advanced search,
- Tag support,
- RSS support.

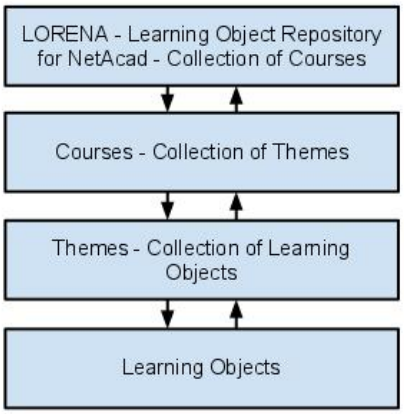

Figure 2: Logic hierarchy of the repository LORENA

The metadata description of the learning object should consist of:

- Name of author,
- Document type – text, image, audio, video, configuration file etc.,
- Description of the content,
- Last update,
- Ranking assigned by users,
- Related chapters, modules or collections where the object is reused.

In the case of requirements, customizable metadata formats and high flexibility of the systems are highly recommended. Fedora seems to be adequate to the requirements. The main advantage of Fedora is that Fedora is based on principles of service oriented architecture (SOA). Service oriented architecture is a concept for building and integration of information systems and applications. Fedora provides repository service exposed as web services with well-defined application interfaces via REST or SOAP protocols. The key feature of Fedora is that repository can store all types of digital content and its metadata [4]. Due to service

oriented architecture Fedora provides high level of flexibility of content (not whole system). Fedora does not contain the user interface (presentation tier). An institution should implement the user interface by other means [7].

Reusing Learning Objects from LORENA is presented on Fig.4.

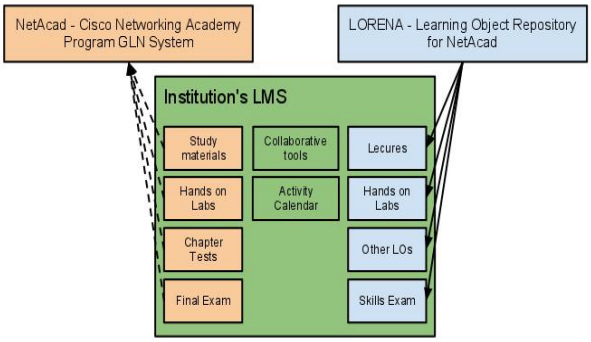

Figure 3: Reusing Learning Objects from LORENA and links to NetAcad environment in institution's LMS

Particular learning object can be exported from the repository and reused in LMS of the educational institution (Blacboard in case of UHK). The advantage of that the e-course in the LMS enables defining sequences of learning objects with links to the NetAcad. Thanks to the interest and enthusiasm of instructors, the quality of materials should be high.

VII. Conclusion

Czech universities prefer either open source e-learning systems (Moodle), or licensed products (Blackboard). In the scope of the computer network courses, students of informatics are motivated to obtain certificates. Official study materials are available, but the experienced instructors prefer their modified and localised resources.

Acknowledgment

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References

[1] Learning object – IEEE definition (2002) Learning Technology Standards Committee, p45

[2] Bodnárová, A., Soběslav, V., Horálek, J., Feltl, M. (2009) Implementation of Career Certification in higher Education Process. In Emerging e-learning technologies and applications : 7th international conference. Elfa, Košice, Slovakia, pp327-330, ISBN 978-80-8086-127-8.

[3] DSpace, Digital Archive Project, http://dspace.org

[4] Fedora, Flexible Extensible Digital Object and Repository Architecture, http://www.fedora.info

[5] Drášil, P. et al: Relevantní standardy v oblasti e-Learningu, Technická zpráva CESNETu číslo 24/2004, aviable at: http://www.cesnet.cz/doc/techzpravy/2004/elearning/elearning24.pdf

[6] Neven, F., Duval, E. (2002) Reusable learning objects: a survey of LOM-based repositories, Proceedings of the tenth ACM international conference on Multimedia, December 01-06, 2002, Juan-les-Pins, France

[7] Kokorceny, M., Bodnarova, A. (2010) Comparison of digital libraries systems. In Advances in Data Networks Communications Computers - 9th WSEAS International Conference on Data Networks, Communications, Computers (DNCOCO 10), Faro Portugal, pp150-152, ISBN 978-960-474-245-5

[8] Nash, S. (2005) Learning Objects, Learning Object Repositories, and Learning Theory: Preliminary Best Practices for Online Courses. In: Interdisciplinary Journal of Knowledge and Learning Objects, 1, pp217-228.

[9] http://www.adlnet.gov/capabilities/scorm

[10] Mikulecký, S. (2005) Digital library of learning objects, University of Hradec Králové.

[11] Chiappe, A. (2007) Toward an instructional design model based on learning objects, In: Educational Technology Research and Development, Springer, Boston, pp671–681.

[12] Olševičová, K., Mikulecký, S. (2003) The possibility of semantic searching in educational e-resources. In: DEL2003, Prague.