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Comparison of Selected Software Systems for Creation of Digital Libraries

from the Field of Open Source for the Needs of the NRGL STL

This document contains detailed characteristics and orientation comparison of software systems used to build digital libraries. It was produced for the National Technical Library (NTK) within the project National Repository of Grey Literature (NRGL). It describes and compares these systems: CDS Invenio, DSpace, Eprints, Fedora and Greenstone. There were selected, more or less intuitively well-known systems widely used abroad as well as in the Czech Republic. They have their origin in the area of Open Source, i.e. an area with an open source code. The openness means also legal availability of the source code for users under certain conditions and therefore a cheap alternative to obtain quality software. However, open source does not mean software free of charge, attention also must be paid to the continuity of development, availability of support services, software development and so on. This document only presents basic features of the systems selected and compares them on a more general level. Nevertheless, it does not substitute for the competitive bidding documentation for the software system for the NRGL; it was only written as a supporting material for the purpose of the competitive bidding.

CDS Invenio

CDS Invenio (formerly CDSWare) is a highly modular system to store bulk amounts of library records and make them accessible. It was created and is being further developed in the Swiss CERN. The development started in 1993 primarily for internal needs of this renowned scientific institution as institutional repositories, from 2000 it includes the support of multimedia, OAI-PHM and so on and it is licensed under the GNU GPL also outside CERN. Now it represents a suite of applications, which is being developed in cooperation with École Polytechnique Fédérale de Lausanne (EPFL), for general administration of documents, institutional repositories or a large-sized library system. It has been localised to eighteen (18) languages including Czech and Russian. It enables to define its metadata schema, having the internal naming convention MARC21 as its underlying standard. It supports OAI-PHM standard.

The CDS Invenio system is very elaborated and flexible, and it can be customized in several ways for various uses, but it is relatively complicated. However, it has the most formalised support from all of the systems evaluated when installed and during operation, provided for a consideration on the basis of an agreement (its level of services and support is close to the system Eprints). Apart from the system itself we can also expect that some of the services will be localised to Czech, or Slovak.

CDS Invenio consists of several more or less independent modules with precisely clearly defined functionality. They are as follows:

BibCheck is a tool for the administrator and library cataloguers for automation of various kinds of tests on the metadata quality such as integrity rules, formats and the field length and so on.

BibClassify allows automatic extraction of the keywords from the documents on the basis of the frequency of a term contained in a dictionary.

BibConvert allows metadata conversion from any structured format to other format. It works similarly as the XSLT processor. Input and output formats are fully configurable, definitions of common formats are provided in the distribution.

BibEdit enables to edit the metadata via a web interface.

BibFormat permits to format bibliographic data in numerous ways. It enables to separate the data content administration and the formatting layout, therefore it can be done as a batch task or invoked on fly, or it can pre-format outputs that are often used.

BibHarvest is a harvester compatible with OAI-PMH, allows harvesting of metadata from other repositories supporting OAI-PHM and the administration of the repository. It is built directly in the database and it includes a manager module which allows to perform administration of the repository aside from the principal data administration. The repository can be completely or partially open for harvesting within the scope of the OAI-PHM protocol. The data is provided in raw form, where individual tags are named according to MARC21 naming convention.

BibIndex indexes metadata, links (references) and text files. It creates two types of indexes – a word index and a phrase index. It is possible to define several logical indexes (author, title and so on). The indexes consist of two parts – the forward and reverse index. This indexing enables quick search.

BibMatch filters input XML files against the database contents and enables search of records according to various criteria, e.g. to prevent duplicated records.

BibRank permits to set various ranking to the criteria to be used later in search, e.g. by frequency of occurrence of a particular word, or the number of downloads of a document and so on. BibRank is independent from the module BibIndex.

BibSched is a task scheduler that as a central module of the system allows other modules to access the database in a controlled manner, thus preventing sharing violation threats during access to the database and assuring coherent execution of the database update tasks. It allows the administrator to monitor and control the task queue.

BibUpload allows uploading of new data to the database. The entry must be a properly formatted XML file that complies with the selected metadata schema.

ElmSubmit is a gateway for automated upload of documents from trusted sources via e-mail. Web submission or harvesting of files is usually preferred to acquire files.

MiscUtil is a collection set of miscellaneous tools that other modules use.

WebAccess is a module that provides access of users to the system. It uses the RBAC technique (Role-Based Access Control – access according to roles) where users belong to several groups according to their roles and authorisation in the system. Each user group can only perform certain operations in the system.

WebAlert provides the users of the system with alerts about events in the system, e.g. occurrence of a new document meeting specific criteria. The criteria correspond to typical user queries. The alerts are sent to the users by e-mails, or stored in their baskets.

WebBasket enables the users to store documents in their personal basket, similarly as in an internet shop the goods items is stored. One user may have several baskets. A basket can be either private or public. A public basket enables to share documents in a group of users.

WebComment is a community tool to rank the documents and to share comments about the documents by the readers. Integrated with the group tools WebBasket, WebGroup, WebMessages tools and WebComment it is the heart of the social network features for group communication in the CDS Invenio system.

WebHelp represents a global documentation of the CDS Invenio system for users and administrators. The specific documentation for individual documents is a part of each particular module.

WebMessage permits communication among (possibly anonymous) users of the system via web message boards, e.g. for invitations to discussion groups and so on.

WebSearch is a module used by the users to enter queries to the system to search certain words or phrases in the database. It enables two types of queries search: a word search or a phrase search. Further it allows complex Boolean operators, regular expressions search, or combined search in the metadata and their files. Its users also have the possibility to browse the records according to indexes. If no direct match had been found, the system proposes alternative matches and help with search. The metadata in collections are directly accessible to be browsed similarly as in the popular concept of *Web Directories.* Orthogonal views of the documents are arranged in virtual collections, and the documents can be classified according to various criteria. This flexible arrangement enables to create well-arranged navigation schemas for its users.

WebSession is a manager of sessions and users, that permits to differentiate between users and to personalize the user interface such as personal baskets and so on.

WebStat is a configurable system that permits to collect data and statistics about the system itself and its usage.

WebStyle is a design-related library of modules which defines design and look and feel of the CDS Invenio system.

WebSubmit is a comprehensive system which allows authorised users to submit individual documents into the system. The system offers flow-control mechanisms, conversion of various formats of documents and extraction of bibliographic data.

Find more information at http://cdsware.cern.ch/invenio

DSpace

DSpace originates as most system for digital libraries in the area of Open source, from the university environment. Its development was commenced by the library Massachusetts Institute of Technology (MIT) and the company Hewlett-Packard; its first version is from 2002. Now there are other universities and organisations participating at the project, there are altogether 500 organisations from 60 countries. Its development is financially secured by DSpace Foundation, Massachusetts, a non-profit organisation. The development and error reporting are secured by the SourceForge technology (sourceforge.net), its development has clearly defined rules and each user of the community can contribute to it with new functions.

DSpace is software to be used to build digital repositories of various documents for various types of organisations. At present it supports the metadata scheme Dublin Core, it uses the CNRI handle system to assign the persistent identifiers and it supports the OAI-PHM 2.0 as a data provider. It also supports the standard OpenURL, it allows export of the data to the simple XML format or to the METS format.

The data is stored in the system in the form of digital objects with a unique identifier that contain also metadata. Further there are also structures to divide the records logically to sets and collections. The object can further be part of more than one logical structure. DSpace supports creation of user accounts, grouping of users, assigning access rights and basic system of user authentication.

In the DSpace system it is possible to search by means of the metadata as well as in the files themselves, the system enables indexing of not only plain text files, but also other formats, such as PDF and Microsoft Word.

On the whole a quality user interface consists of web technology of Cascading Style Sheets (CSS) and it can be relatively easily customized. A current novelty is the Manakin system, a second version of the user interface of the DSpace system, where it is possible to work with templates. Its user interface offers the users all the basic functions, browsing and searching of records for users and storage of the records for the manager of content.

On the level of contents upload there can be defined working procedures which include various levels of contents approval before it is stored in the database.

The DSpace system has quite a wide and lively community of users and is easy to operate. However it has a limited functionality, its modifications must be usually programmed and it also has specific requirements for the operating system – UNIX and other operating parts.

Further information is at
http://www.dspace.org and http://www.ics.muni.cz/dspacecz

EPrints

It is a complex system widely used all over the world and it also originated in the university environment, it has been developed by the University of Southampton in Great Britain, and it is available under the GNU licence. The whole system is based on the web technologies; its primary purpose is to build institutional repositories for various types of documents, such as common literature, scientific research literature and student's theses as well as other types of documents including multimedia with primary focus on scientific data. Although the whole system is easy to configure and it is possible to create a general repository when it is deployed, its primary orientation on the scientific area can limit and restrict such effort. When installed and operated, it also offers paid services, such as training, management of implementation project, technical support and so on, everything in English.

In the field of standards it supports the system EPrints OAI-PHM, the metadata have their own inner format. The system allows importing of data from the XML format and some external resources (PubMed and so on). Export is possible in a number of formats, XML, RSS, DublinCore, METS.

Its inner architecture does not use the notion digital object, but Item. The item encapsulates the metadata as well as the files. Within one installation it allows to build more repositories also for different organisations, or more than one separated collection for one organization with a different design and structure. It is secured by more instances of the web server Apache.

The system Eprints supports administration of user accounts, but assigning of user rights is less elaborated because initially it was aimed only at publishing scientists. The system offers three types of user accounts – administrator, editor and user. Even a user can upload very detailed data to the system, mainly on the level of the metadata. A final upload and storage must be approved by a user with the editor profile.

The system Eprints provides a similarly complex user interface as the DSpace system, based on the web technologies. The interface is easy to configure; a part of the interface are the static pages in HTML which the system generates for added items – it is not programmed for a daily upload of a bulk amount of records.

It enables search via the interface as well as in the metadata as well as data, the system indexes text files as well as other common formats (PDF). It also allows browsing the logical tree structures, its intro structure is the same as in the Library of Congress of the USA, but it can be modified. The interface further enables registration of new users, to inform them about news and to provide them with feeds and e-mail alerts to keep them up to date. Administrator interface allows configuration and control of the whole system. The whole system is very sophisticated, upload of individual items is very complex, but difficult to use and time-consuming; it mainly aims at publishing researchers who upload a small number of items with great volumes of information attached to each. This feature makes the building of general repositories more difficult.

Further information at http://www.eprints.org

Fedora

The Fedora system (Flexible Extensible Digital Object Repository Architecture) was again created in the university environment – at Cornell University and University of Virginia. It all started as a research project in 1997 which result was published on the web of Cornell University in 1998. In 2001 both universities started to cooperate and received financial contribution for further development from the Melon Foundation with the assignment to develop a universal digital library on the basis of the web services and XML. In 2007 both universities established an organization Fedora Commons, which now takes care of the development of the joint system.

The Fedora system is a digital repository which allows, in fact, upload and storage of any digital object. Nevertheless, it only offers services of a repository in the form of a core, which allows storage and maintenance of the digital objects plus programmer's libraries of functions and service alerts, which enable the developers to manage the repository.

The Fedora system does not have its own user interface; it must be created for each deployment of the system separately. Although Fedora system is a repository of a good quality meeting the basic theoretical knowledge in the field of building of digital libraries, the fact that the system is not complex and the user interface must be programmed after installation prevents its usage in projects where the operation must be started immediately and where they do not have the developmental capacity.

A basic part of the architecture of the system is a digital object, similarly as in any other system, however, it is not only an object in the sense of a stored record, but the system differentiates three types of objects:

- Data Object which contains data and metadata, or a unique persistent identifier, providing a link to other data in another repository, (the system allows versioning – saving of different versions of the same document),
- further the Behaviour Definition Object, definition of services, linked to a to a particular file (e.g. displaying of data of a particular type); these services are also encoded in the WSDL and thus secure platform independence for another type of object
- Behaviour Mechanism Object (e.g. software which enables to display the data), these services can be in fact written in any programming language

The Fedora system supports various standards, OAI-PHM, exports to METS formats and its own internal format FOXML, the descriptive metadata are stored in the Dublin Core format.

Although the core of Fedora system is very advanced, at present it is not a complex library system ready-to-use. It is only a platform that further has to be programmed at quite a higher cost and with great effort. When operated, the higher cost must be taken into account due to the platform independence of the system, because it is more demanding for hardware sources than other systems.

Further information at http://www.fedora.info

Greenstone

The system Greenstone (Greenstone Digital Library Software) has more exotic origin than other systems. However, it is also a university product – it has been developed since 1995 at the University of Waikato in New Zealand, its development is supported by the UNESCO. It is available under the GNU GPL licence. Despite its exotic origin, the system is, apart from other languages, localised partially to Czech as well.

In the field of standards the system supports the Dublin Core metadata scheme, OAI-PHM protocol and it supports Z39.50 protocol for two-way search of catalogues of other libraries, as the only one from all systems evaluated, however the configuration for this support is not part of the standard configuration and has to be compiled in order to start its operation.

The basic unit to be stored to the system is a document, (the system supports various formats of digital objects), which is stored to previously prepared collections with defined information which documents they will contain and these collections then will be linked to the libraries. To process individual types of documents, the system has to contain programming support, the so-called plugins. Its architecture has higher requirements for the system configuration than other more complex systems. When the file is stored to a previously defined collection in the internal XML format, it generates a unique identifier in its own format.

User interface is separated from the repository itself (it is a separate application), the repository as well as user interface communicate via their own internal protocol, which can be substituted by the CORBA protocol and this way connect the application itself to the system. It is possible to configure the user interface for each collection in a different way; based on web technologies.

It can be used to browse and search collections. The search of collections is based on categorising of similar documents to the same folder that can be hierarchically linked and in this way create a logical search structure.

The system contains management of users and assigning of user rights, but this support is not developed too well. It is limited to the assigning of rights to administrators and content managers, but it does not take into account activities of other users.

The system is functional, it also has services available provided by the organisation DL Consulting in New Zealand, but it is not easy to use and is limited to organisations, where the data upload cannot be performed by other users than the content managers.

Further information at http://www.greenstone.org

Information table

	CDS Invenio	DSpace	EPrints	Fedora	Greenstone
Year of creation	1993	2002	2000	1997	1997
Development provided	Yes	Yes	Yes	Yes	Yes
Development organisation	CERN, Switzerland	DSpace Foundation, Massachusetts, USA (MIT/HP)	University of Southampton, Great Britain	Cornell University, University of Virginia, USA	University of Waikato, New Zealand
Programming language	Python (PHP, Common LISP)	Java	PERL	Java	PERL, GDBM, MG
Operating system, operation	Unix, Python/Apache	Unix, Apache… (Windows/XP)	Unix, Apache, PHP …	Unix, Apache	Unix, Linux, Windows …
Database	MySQL	PostgreSQL Oracle	MySQL	MySQL, Oracle …	Not necessary
OAI-PMH	Yes	Yes, provider	Yes	Yes	Yes
Z39.50	No	No	No	No	Yes
Metadata format	MARC21, flexible	Dublin Core	Dublin Core	Dublin Core, METS …	Dublin Core
Identifiers	their own	CNRI Handle	their own	their own	their own

Basic evaluation of the system focused on the following areas:

- **Content Management**– Tools and procedures that support upload of content to the digital library and control of this process of submitting and versioning. In this category the systems did not show any problems, only Fedora system does not provide formalised support for content upload, on the other hand it allows storage of various versions. CDS Invenio is the most complex in this field.

- **Content Acquisition** – Import and export of content, support of various formats of documents
    - in this category none of the system shows any weaknesses, Eprints and CDS Invenio are systems having the most complex support in this category.

- **Metadata** – Support of various metadata formats is important for indexing, upload of content, making it accessible and content protection. Most of the systems in this category support only some metadata standards, mainly the Dublin Core and MARC21. However, Fedora also supports some less used formats (METS); CDS Invenio allows mapping of any metadata format to its inner structure, represented by the name convention MARC21.

- **Search Support** – It applies to numerous searching and browsing functions, search in the metadata, full text search, hierarchical browsing and so on. It is an important category and all of the systems offer basic search functions. Fedora fails to have the user interface, CDS Invenio offers a very advanced search and hierarchical browsing. None of the systems offers proximity search.

- **User Management and Privacy Protection** – User management and privacy protection includes administration of passwords, user accounts with access rights with the possibility to retrieve forgotten passwords and so on. CDS Invenio offers the most sophisticated support in this category, mainly in the area of user passwords with the possibility to assign passwords by the system, to choose your own password and to retrieve a forgotten password. The system Greenstone is the least elaborated in this category.

- **Support of Reports and Queries** – This criterion deals with evaluation of the digital library and possibility to monitor the patterns of users' behaviour to improve the services provided and the usage of user activity logs for billing purposes. Greenstone has the best support here. Fedora also offers user statistics, but it does not offer the possibility to edit the output messages. Eprints and CDS Invenio do not provide too many complete reports. CDS Invenio, mainly in the module WebStat offers an option to create reports about usage of the system.

- **Sustainability, Data Protection** – Protection of the metadata, consistency and integrity of the database, backup, possibility to support the migration of data. All systems offer the migration by means of export to various formats, mainly XML.

Fedora is a very elaborated system in this field, DSpace as the only system primarily uses the CNRI Handles, the Greenstone system uses persistent identifiers in its own format; Fedora and CDS Invenio systems are set to cooperate with any other system of persistent identifiers.

- **Interoperability** – It allows two-way cooperation with other distributed systems on the level of the metadata, search and acquisition and providing of documents, OAI-PHM support, Z39.50 – Z39.50 is supported by the system Greenstone only, OAI-PHM is supported by all of the systems in a different form, DSpace supports it only as a data provider.

- **User Interface** – This category only deals with the support of more languages and allows adapting of the user interface according to various needs of users or different implementations. Fedora is the weakest system in this category because it has simple testing interface, and the user interface has to be further programmed. DSpace has a good concept of the user interface – cascade styles and the Manakin templates; CDS Invenio offers very good tools for both individual users and group communication. CDS Invenio and partially Greenstone provide Czech localisation; DSpace has a wide user community, which is also active in this field.

- **Standards Compliance** – Standards are important for sharing and long-term storage of digital content. It is a wide range of standards, from metadata to interoperability and formats of the stored documents. See the description of individual systems – basic necessary standards are supported by all of the systems, Z39.50 only by Greenstone. Only DSpace has a native support of CHRI Handles.

- **Automation Tools** – This category deals with tools for automated acquisition of contents, harvesting, generating of the metadata, maintenance and so on. In this field the systems Greenstone and CDS Invenio are the best, Fedora and Eprints do not provide good support of automation. DSpace ranks between these two groups in its quality.

- **Support, Services** – An important aspect of all software systems. Numerous good digital libraries come from the area of Open Source, where this aspect must be taken into account in particular. Important services are: documentation, helpdesk, collection of requirements to improve it, discussion forums and so on. CDS Invenio and Eprints provide a formalised paid support on the basis of an agreement; the system Eprints probably has the largest installed database in the world, DSpace has a very lively user community and support by means of SourceForge.

The evaluation of the systems aforesaid is relatively subjective mainly in respect to the limitation to assess some of the systems in the Czech Republic. In the table below there are approximate figures of individual systems listed in categories on a scale from one to ten.

	CDS Invenio	DSpace	Eprints	Fedora	Greenstone
Content Management	10	8	8	5	9
Content Acquisition	10	9	10	8	9
Metadata	6	5	5	7	5
Search Support	8	6	5	4	7
User Management	8	6	8	4	5
Support of Reports	6	6	4	6	10
Sustainability, Data Protection	8	8	7	10	6
Interoperability	6	6	6	7	8
User Interface	8	8	7	5	7
Standards Compliance	9	9	9	9	10
Automation Tools	9	7	5	5	8
Support, Services	9	7	8	6	6
Total	97	85	82	76	90

Should the given systems be evaluated only according to their functions disregards to the possibility to use them in our conditions, Greenstone and CDS Invenio are the best systems, followed by the DSpace system. Fedora is not a complete system and its further programming would be laborious and costly. The system Eprints is aimed to be used for one purpose for smaller amounts of daily acquisitions of described scientific documents in detail.

From the point of view of services availability and language localisation, it is advisable to use the system CDS Invenio in the Czech Republic because it also offers a lot of functions and is flexible, although it is relatively complicated and difficult to operate.

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