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Electronic Scientific Journal-Management Systems

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Abstract—In this article, the authors present modern information systems for the automatization of the full cycle of electronic scientific journal creation and publishing. The advantages of using open-access journal systems are shown. The choice of the Open Journal System (OJS) as the platform for creating an electronic base of scientific journals is substantiated. The authors present the structure of an electronic scientific journal-management system and describe the features of its implementation within the framework of the pilot system of the e-Government of the Republic of Tatarstan.

Keywords: integration of electronic resources, information systems of automatization for creating and publishing electronic scientific journals, digital libraries, Open Journal System

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INTRODUCTION

Currently, information communication technologies (ICTs) are used at almost every stage of scientific and educational activities and electronic forms of presenting scientific materials are gradually replacing paper forms. Moreover, conversance with new scientific results and communication occur more frequently over the Internet. New methods of information processing, storage, and transmission based on digital technologies are being created and made widely available. The difficulty of electronic scientific information processing occurs due to not only to the constant growth of the number of scientific publications, but the fact that scientific and educational electronic journals and resources are becoming dissolved in the total electronic-information flow.

The traditional approach to electronic publication storage and access through the interface of full-text search systems is most common today; however, due to the growing volumes of electronic information and features of the electronic publication life cycle, the use of the standard services and search tools of the Internet that relate to electronic scientific information has become less effective. The problem of electronic data integration, which includes scientific and educational content in a one entire information space, is very topical. To some extent this problem can be solved through the creation of special information systems.

Integration of information resources is traditionally one of the basic functions of research libraries; until recently it played the role of the single repository of scientific information. In the Internet age when publishers provide online access to scientific contents, the role of research libraries is changing. In addition, there are legal issues of the preservation and provision of access to digital research resources; copies of articles are not available if it is impossible to get them in a publishing company. One of the methods for providing access by libraries to the newest scientific content is the execution of publishing functions by libraries themselves [1, 2]. In particular, a survey that was conducted by Library Publishing Services confirms this fact [3, 4]. Thus, the world's leading research libraries and publishers are taking part in the creation of a scientific-communication system and establish a new integration system of scientific literature using the network infrastructure.

One of the powerful effects of the information society and, in particular, of the automatization of the library information field, is the appearance and development of a new kind of IT system, the digital library (DL) [5], which is a distributed information system that provides the opportunity to store and effectively use the various collections of electronic documents, which are accessible to end users through a wide area network. The components of digital libraries are specific electronic collections of information resources.

D-library technology is widely used in the field of information storage (for example, [6]) and can be used for journal information systems. The modern scientific journal and publication management system is a specific class of digital library management systems (DLMSs) (according to the terminology in [7]). It can use advanced and widely used digital library technologies that take the specifics of the business processes of scientific publications into account.

The aims of this article are a review of existing open-source projects for electronic publication man-

agement and their analysis in the context of the evaluation technique of the DLMS developed in the framework of the European DELOS project (http://www.delos.info). The authors also noted the specific features of the use of digital library technology for editorial process automation in scientific journals using the example of the Open Journal System (OJS).

INFORMATION AND COMMUNICATION TECHNOLOGIES IN INFORMATION AND PUBLISHING ACTIVITIES

Using information and communication technologies in information and publishing activities allows leading modern publishing companies not only to organize the anticipation of the release of the electronic versions of scientific journals, but also provides new information services for authors, readers, editorial boards, and editorial staffs. For example, almost all modern management information systems for scientific and educational information provide services of scientometrical data reception, on which the analysis of the publication activity of employees of scientific institutions and universities is performed and the most perspective directions for the development of scientific research are identified.

The world's largest scientific publishing companies were among the first that started to use ICTs. They created their own electronic book-publishing systems and are constantly developing them. Examples include the information system of the Springer publishing company (www.springer.com), the Science Direct platform (http://www.sciencedirect.com) of Elsevier (www.elsevier.com), and the electronic publication system of the scientific archive arXiv.org (http://arxiv.org/). Two Russian projects, viz., eLIBRARY.ru (http://elibrary.ru) and the mathematical portal Math-Net.Ru (www.mathnet.ru) are innovative for a number of such solutions [8, 9]. We also note the project for the automation of the electronic journal *Lobachevskii Journal of Mathematics* (www.ljm.ru), in the framework of which the process of research-material review by an editorial board became fully automatic (and the editorial board became a network), including automatic selection of reviewers from a database of experts, notification system support, and the control of terms [10, 11]. For the first time in an electronic mathematical journal the conversion of incoming papers and their storage in the MathML format were organized, which allowed the creation of the search system by formulas [12].

Scientific publishing and the creation of electronic educational and scientific collections are an integral part of the research and educational activities of any research institute. A number of scientific journal and publication management systems were created in 2004–2008 to provide these activities. The greatest practical interest lies in those that are open source. Due to open source there is an opportunity to improve the system and give it the required functionality. The presence of a development team who develop new modules, which are often innovative, using advanced ICT is important.

An important component of the modern scientific journal management system is services that control the review and provide for the collective editing of electronic documents. Such services must provide editorial processes: classification, annotation, parceling-out data definitions, publishing, long-term storage, converting, distribution, participations, usage statistics, harvesting, association with collection, relationships with institutional repositories, access control, subscription, notification delivery, and new arrivals. As well as the remote viewing of articles in scientific journals and their further processing for final publication, information journal systems provide access to generated content and advanced searches (by author, title, keyword, and other types) in electronic collections, in other words, they fully implement the functionality of digital libraries. From this point of view, an electronic scientific journal can be viewed as a scientific digital library, using the articles in a journal as information objects. Therefore, well-developed digital library technologies can be used for the creation of electronic scientific-publication management systems. As well, approaches of formation of conceptual models, which generalize the gathered experience in the field of creation, and the use of digital libraries, in particular, the Digital Library Reference Model, (DLRM) [7], which was designed in the framework of the DELOS project, can be used for analysis of such systems.

ELECTRONIC JOURNAL-MANAGEMENT SYSTEMS AS A SPECIAL CLASS OF DIGITAL LIBRARY MANAGEMENT SYSTEMS

The DELOS DLRM model includes three different levels of conceptualization of the digital library concept:

- *Digital library*: a certain digital library with its content, users, rules, etc.;
- *Digital library system*: software on whose basis digital libraries are created;
- *Digital library management system*: software for the creation and management of digital library systems, with digital library functionality.

The professional roles played within the digital libraries of the DELOS DLRM model are chiefly described in terms of end users, designers, administrators and software developers, so four user form levels are made. As well, the model consists of six core concepts, each of which has its own properties: architecture, content, functionality, users, policies, and quality. These concepts can be used as criterions for evaluation and due to their universality they can be used to analyze almost any information system.

An electronic scientific journal is the storage of articles with software for storing, collecting and access provision to information objects. A scientific journal management system is a kind of digital library-management system. It also has a user role model and uses metadata to create journal and article descriptions. Their peculiarity is that an electronic journal-management system must have a more difficult publishing process for information objects that reflect the real activities of a scientific publishing company.

A comparative analysis of current electronic scientific journal management systems that is made taking the DELOS DLRM criterions of estimation into account is given below.

ELECTRONIC JOURNAL-MANAGEMENT INFORMATION SYSTEMS

The majority of scientific journals are placed on the Internet; periodicals have web sites with independent control systems or are part of unified information systems (for example, a university or a publishing company system). As a rule such independent systems not only have limited functions and do not provide the automatization of all electronic-journal business processes, but also are created on a simplified model of a certain journal. We will not analyze such systems, only non-commercial and open source platforms; moreover, preference was given to developing a project with actual or planned Russian locations.

In the analysis of such systems the results in [13–15] were used; the comparison was conducted using a set of parameters such as basic software, the number of successful installation, and the fullness of the technical documentation. As well, we used [4], which contains the results of the survey of more than 100 universities using publishing platforms. As a result, the following scientific journal-management systems were chosen.

The Open Journal System (OJS) (http://pkp.sfu.ca/?q =ojs) is an open-source software for the management of peer-reviewed academic journals that has been developed in the context of the Public Knowledge Project (http://pkp.sfu.ca/about) in Canada by the partnership among the Simon Fraser University, the University of British Columbia, the Ontario Council of University Libraries, and in the USA the School of Education at Stanford University, the University of Pittsburgh and California Digital Library.

OJS was released under the GNU General Public License. The project is always developing, new versions appear, and a stable full version is available for installation. Currently, OJS is used by more than 12000 journals worldwide, some of which are registered on the project site (http://pkp.sfu.ca/ojs-journals). Some Russian journals also use the OJS platform, for example, the *Russian Journal of Herpetology* (http://www.folium.ru/rjh/index.php/rjh), several electronic journals of the St. Petersburg State University (http://ojs.spbu.ru/), and *Vestnik MGSU* (http://vestnikmgsu.ru/). We note that OJS is embedded into the Ukraine scientific-publishing infrastructure as the national platform of scientific periodicals [16].

OJS supports a wide range of access options and business models, from full open access to browsing of short annotations, and commercial subscriptions. It allows one to use the OJS as a single platform for managing a group of electronic publications (for example, of a research or educational organization).

OJS has a cloud software configuration and can be installed and controlled locally; all business processes are configured by the editors of each publication. OJS provides special tools for reading and viewing of publications in the PDF and HTML formats; some functions are available for working with bibliographic data, metadata, etc.

OJS has a modular architecture and is well documented, which allows not only the use of existing functions, but creates one's own classes and modules. The system has the MVC structure (Model–View–Controller), so data storage, user interfaces and control functions are divided into different levels of interaction. Despite its apparent complexity, this architecture provides fault tolerance, performance, flexibility, and scaling of the entire system.

The OJS is a platform-independent system and can be installed both on Windows and Unix-like operating systems. It uses open-source components: the PHP scripting language (from Hypertext Preprocessor), which was created for generating HTML pages on Web servers and for database operation, the cross-platform Apache server, and DBMS (MySQL, PostgreSQL). The installation is standard for content management systems. It is also important to note that OJS has multi-level documentation.

OJS has Russian-language support. The standard installation package includes a number of libraries and extensions that provide various functions: dealing with citations and displaying articles in PDF or HTML, phpMyVisites (a Web traffic analyzer), METS (data exchange gateway), adding an OpenURL descriptor to an article, the WYSIWYG page editor, etc.

OJS works correctly not only on a PC, but also on smartphones and other mobile devices. This is important due to the IT orientation to BYOD (Bring Your Own Device). It is also possible to connect payment module that provide paid access to resources.

OJS has a role-based access control and multistage publishing process, which supports all the life cycle stages of an article: from the initial download of its author's edition to online accommodation of the final version and the creation of indexes and references. The functionality of the system allows online interaction between the participants of the editorial process. OJS interface modules are implemented as sets of Smarty templates (http://smarty.php.net),

which allows one the flexibility to change the user interfaces of the system. The interface and functionality of OJS can be customized and adapted to the business process of a specific scientific publication.

We emphasize again that the OJS capabilities and methods of operation are presented in a large number of manuals and publications. One advantage of OJS as a basic platform is the tested method of its use (see http://pkp.sfu.ca/ojs-journals). The presence of a constantly updated plugin gallery (http://pkp.sfu.ca/support/forum/viewforum.php?f=28) is also an important factor that allows one to consider the peculiarities of scientific publications and not to try to unify publishing work in full (currently, this is hardly possible and, in our opinion, is not necessary). The technology of software module creation is based on open-source software that allows one to include services considering the specificity of certain scientific publications into the system.

The ePublishing Toolkit (ePubTK, https://dev.livingreviews.org/projects/epubtk#) is a publishing software package of tools that were developed by the Max Planck Society (https://dev.livingreviews.org/projects/epubtk/) to control a family of online scientific open access journals from the Living Reviews publisher (www.livingreviews.org). There is no final installation package for this software; however, the latest sources are available in an on-line repository of developers. The absence of versions does not allow one to make a conclusion about the frequency of updates and the real development plans of the system.

The information space of ePubTK consists of a family of journals, which in turn is divided into separate journals. Each journal is a container for publications. Almost all of the functionality of ePubTK is connected with journals. When creating each journal, one installation of ePubTK is assigned with a unique identifier that is used further in different scenarios.

The ePubTK architecture consists of several components that can operate independently. Each component has a set of functions to work with a class of system objects. The basic functions that are required by many components are made in the form of shared libraries. A separate component is responsible for creating the publications of the source material (pubBuilder) and submission on the Web. The refdb component is used to control the links. The back office of the management of the lifecycle and business processes of the publishing company is provided with the EIMS (Editorial Information Management System) special management subsystem, which also is a separate component of the ePubTK (http://www.carpet-project.net/en/catalogue/detail/eims-editorial-information-management-system-workflowsupport-living-reviews/).

The flexibility of the ePubTK configuration for various journals is achieved through the use of XSLT templates, on whose basis it is possible to generate web pages, letters, etc.

The maximum compliance to open standards, such as OpenSearch, OAI-PMH (Open Archives Initiative Protocol for Metadata Harvesting), unAPI, and OpenID authorization has been declared.

As well, ePubTK has a role-based access control model and a multi-stage publishing process, which supports all the life cycle stages of an article: from the initial download of a draft copy to the accommodation online of its final version, which is adapted to the Living Reviews processes.

As well, ePubTK can be installed on MS Windows (win32) and Linux operating systems, it is necessary to install Python (version 2.3 (or higher) and some of the Python packages (https://dev.livingreviews.org/projects/epubtk/wiki/Requirements), which makes the installation process quite time consuming. System setup requires highly qualified personnel.

The Digital Publishing System (DPubS, http://dpubs.org/) is an open-source software system that was developed for the online publishing of scientific and educational journals, monographs and conference proceedings. The DPubS was developed in 2004–2008 by Cornell University and the Pennsylvania State University. The Euclid Project (www.projecteuclid.org) was developed and used by the Cornell University Library on the basis of this system. There has been no further updating of the system since 2008. At this moment about ten projects, which are associated with the organizations–developers of the system, are performed on the basis of the DPubS.

One major issue of the DPubS is that it was conceived by the Cornell University Library (for the purpose of creating an electronic publishing system) and not by the scientific and educational communities. This had an effect on the peculiarities of the system's functionality. In particular DPubS is designed to consider the problems of ensuring the safety of information resources and resiliency, which are critical to all electronic libraries. In addition there is support for publishing software and repositories of information objects (institutional repositories), such as DSpace or FEDORA (Flexible Extensible Digital Object Repository Architecture).

The DPubS is a set of interrelated services and has a modular architecture. Functionally the DPubS consists of a Collection service, an Editorial Service, an Index Service, a Query Mediator Service, a Referral Service, a Repository Service, a Subscription Service, a User Interface Service and an Admin Service.

The Editorial Service provides initial uploading of articles and transfer to the reviewing phase, the further preparation and publication of journal issues, and their final loading to the DPubS storage . As well, role-based access control is performed. Both paid and free access to resources are available.

The system documentation does not match the actual released version of the system, the functionality of some modules is not described fully, and there is no user manual.

The DPubS installation process requires considering the peculiarities of the architecture and internal interaction between elements. The lack of updates since 2008 and actual documentation make the installation and use of this system a very non-trivial task.

GAPWorks (http://gapworks.berlios.de/) is an online publication system that was developed in the GAP project (German Academic Publishers, GAP), which was funded by the Deutsche Forschungsgemeinschaft (DFG). GAPworks provides the necessary infrastructure for online publishing (including a peer-reviewing process) and online management of people, roles, and other elements of the publishing process.

GAPWorks is based on PHP and the database PostgreSQL. It provides a peer-reviewing process, management of users, OAI-PMH support, and has a customizable set of templates. Despite the fact that the installation package of GAPWorks is available for downloading, there is no information about the system development since 2006; the data on these projects are also missing.

The Ambra Publishing System (Ambra, http://www.topazproject.org/trac/wiki/Ambra) is a system for electronic publishing that was developed by the Topaz nonprofit organization (www.topazproject.org) on the basis of the eponymous platform; it is related to the Public Library of Science (PLOS) at www.plos.org. Ambra is a web application that has a service-oriented architecture, for the publication of research materials from all fields of science. It is intended to help to revive published scientific articles; the system allows users to evaluate, annotate, and comment on a publication, which allows the community of authors and readers to have a rapid exchange of new scientific ideas. The Ambra system is also used as a platform for the accommodation of some of the PLOS journals.

The Ambra information model is based on the Topaz platform; a specially configured FEDORA repository (www.fedora-commons.org) and the Mulgara DBMS (open source RDF database, www.mulgara.org) are used for data storage. To characterize Ambra it is necessary to describe the Topaz platform, on which it is built.

Topaz is a library of object-management programs that uses the object-relational mapping technology and allows the development of one's own stored classes and objects in accordance with the paradigm of object-oriented programming. All application data is stored using RDF; Java classes are used to describe display RDF objects. As well, the library supports special blob storage for storing blob data. Mulgara is used for object metadata storage, for blob data (articles, text, photo, video, and other items), the FEDORA repository is used.

One major feature of Ambra is the use of object-relational mapping technology for the system development and a non-relational database management system for storage of information. Since the interaction between certain Ambra modules is performed via TCP, the structure of the system can be distributed. The boot process of publications is simplified and consists of just two steps (user uploading and confirmation by the administrator); there are no specific roles for editors and reviewers. All articles are stored in the FEDORA repository and are connected with the information objects of this repository in Ambra; thus, in fact, all the functions of FEDORA API, for example OAI-PMH support, are available to the Ambra system.

The Ambra Web application can be installed on Windows and Unix-like operating systems, but the installation package does not include the installation wizard, which is why the process of its installation is not easy. The latest release of the system is dated 2009; thus, to make conclusions on the further development of the project is difficult.

The Drupal E-Journal (http://drupal.org/project/ejournal) is a specially designed control module for electronic journals that was created for the well-known Drupal content-management system. Initially, this module was developed as an analogue of OJS for Drupal. It provides the functions of journal control, their release, and articles; as well, it supports user roles and access control. Since the Drupal E-Journal is architecturally a separate Drupal module, it can be used together with other Drupal add-ins and modules.

Currently the module has not finished, so it is impossible to speak of the full-function control system of electronic journals. The last version was released in 2011; a stable form via the 5.x and 6.x versions is also available.

HyperJournal (http://www.hjournal.org) is a project that was initiated in 2004 by the Groupement de Recherche Europeen (GDREplus) and supported by the Centre National de la Recherche Scientifique (CNRS); currently it is under development by volunteers with the support of the Dipartimento di Scienze della Politica, at the University of Pisa.

The HyperJournal system is installed under Linux and requires additional installation of PHP and MySQL. The installation package is available at http://sourceforge.net/projects/hyperjournal/.

The analysis of electronic scientific journal-management systems allows one to make the following conclusions:

• almost all of the systems related to electronic journals and electronic publishing companies (OJS, ePubTK, DPubS, Ambra) were created in the period from 2004 to 2008 and were designed to ensure the functioning of specific electronic publications; this has led to substantial differences in the architecture of the systems and their functionality;

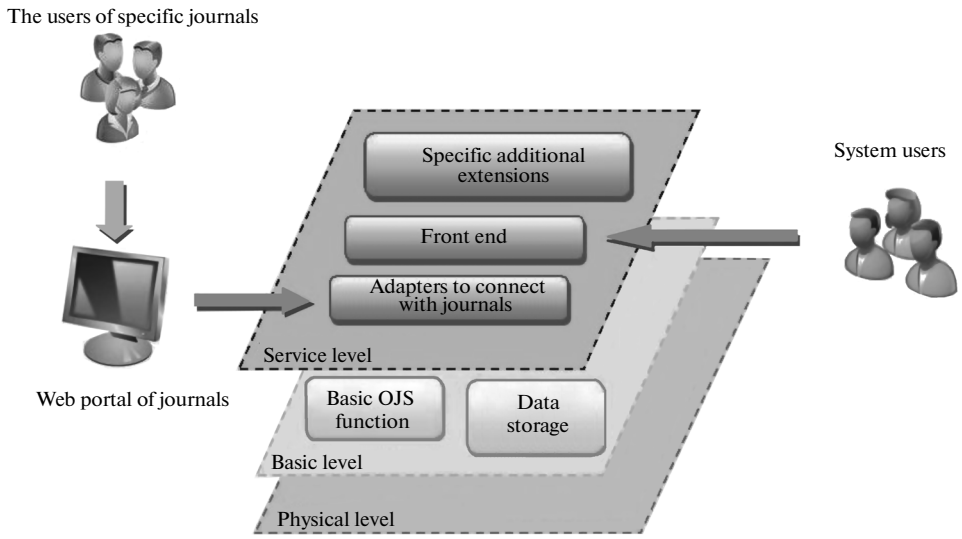

Fig. 1. The architecture of electronic journal-management systems.

• there is no universal model of an electronic journal-management system that describes specific requirements and services; developers of such systems often took the experience of the creation of a specific digital library management system as a basis and didn't use the results that have been achieved in the field of digital libraries in full;

• almost all of the electronic journal-management systems that were considered above support the generally accepted standards in the field of data integration and data exchange;

• currently most of the projects considered above have not received further substantial development; the only exception is the one actively developing project, viz., Open Journal Systems.

Thus, in order to provide the storage and support of the life cycles of both individual articles and journals as a whole it is advisable to use the OJS platform as the core of an electronic journal-management system. Its architecture is shown below.

THE ARCHITECTURE OF THE ELECTRONIC SCIENTIFIC JOURNAL-MANAGEMENT SYSTEM

The architecture of the system includes three levels, viz., the physical, base, and service levels (figure).

The physical level describes the hardware component of the system, ensuring the functioning of upper levels, and contains the system and applied software. All these components must be provided with technical support using virtualization and cloud computing, although its implementation is possible without the use of virtual machines.

The basic level is responsible for providing basic services of electronic scientific journal management, which provide, in particular, author and user registration, reception, and initial articles processing, including automatic checking of the implementation of revision and review rules. It should also have the control of compliance with deadlines of consideration of articles, reviewer assignment, and distribution of various notifications, services of remote communication and collaboration, searching in electronic storage, automatic metadata extraction, and structuring of incoming information. As well, the support of user management, differentiation of access rights, and the possibility of the organization of paid access to contents are needed. At the basic level there is the OJS, using which all the business processes of the electronic publishing company and content storage are performed.

The service level has additional components and functions, which take into account the specifics of a scientific journal. For example, it is very important for mathematical journals to have services for the conversion to specialized formats (TEX, MathML, etc.). In this case the system's front-end interactions with end users are performed.

Interaction with the electronic scientific journal-management system can be arranged either through its own web portal, or through special software adapters from the site of a certain journal, which place its content into the system storage.

The first method of interaction occurs when a registered user has access to all the journals placed in the system and the web portal is a single entry point. This method is the most convenient for new journals that do not have their own sites on the Internet.

The second method for interaction is more reasonable for journals that have a history and maintain their own websites. In particular, it allows one to save jour-

nal URLs and their history with the maximum automation of editorial processes.

In 2013 an electronic scientific journal-management system was under creation on the basis of this architecture in the Republic of Tatarstan. Currently, the system works technically, the system web portal (www.science.tatarstan.ru) has been created, and a number of scientific journals have been transferred to its control. The system is also being tested for further integration into a unified scientific and educational environment.

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