Aslib Journal of Information Management

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Received 6 November 2014
Revised 6 November 2014
Accepted 18 January 2015

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Abstract

Purpose – The purpose of this paper is to describe a case study of developing a web service that will act as an intermediary between the Audio Library system for the visually impaired and the library management systems. The Audio Library is based on speech recognition and text-to-speech engines and it produces synthesized speech from various electronic materials. It has its own database with a limited number of books and textual materials. Web services described in this paper should enable access to a larger number of electronic resources provided by libraries.

Design/methodology/approach – In this paper, the author specified software architecture of a web service analyzing different approaches for search and retrieval.

Findings – Web service described in this paper is the first software solution addressing the problem of lending e-books in Serbia. It aggregates collections of different libraries in a single access point for the Audio Library system. In this way, users of the Audio Library system are provided with larger number of electronic resources.

Originality/value – Communication between the Audio Library and this web service is achieved by using standardized protocols for exchanging library data. However, those protocols did not fulfill all necessary requirements, so the authors propose some extensions to overcome those issues.

Keywords Visually impaired, Electronic resources, Library, Mediator web services, SRU protocol

Paper type Research paper

1. Introduction

Published material should be equally available to visually impaired people as to sighted people. Visually impaired people should be able to read a newspaper or a book like the sighted. They just should be provided with an appropriate format of the same material, so developing an efficient library service for print-disabled people is extremely important. In order to obtain written information, visually impaired persons can use Braille books, audio books that are recordings of books read out by human speakers or e-books made audible through text to speech-enabled devices.

The University of Novi Sad, Serbia, in cooperation with the company AlfaNum carries out the research and development of speech technologies for Serbian and other kindred South Slavic languages used in five countries of the Western Balkans (Delić *et al.*, 2010; Sečujski *et al.*, 2002). The Audio Library for the visually impaired is one of the results of that research (Pekar *et al.*, 2010). It is based on speech recognition (ASR) and text-to-speech (TTS) engines and it produces synthesized speech from various electronic materials. The Audio Library has its own database with a limited number of books and textual materials. Individual users of that system can access desired text,

The work is partially supported by Ministry of Education and Science of the Republic of Serbia, through project no. OI174023: "Intelligent techniques and their integration into wide-spectrum decision support."

Aslib Journal of Information Management
Vol. 67 No. 2, 2015
pp. 230-243

2050-3806
DOI 10.1108/AJIM-11-2014-0149

download it and have it converted to speech using a TTS engine. This system is used in the School for the Visually Impaired Children "Veljko Ramadanović" in Zemun, and also in five more organizations with all together about 400 users.

Since the Audio Library has a limited number of books, the idea of accessing collections of public libraries through the Audio Library system arose naturally. A large number of libraries in Vojvodina (autonomous province in Serbia) use the library management system (LMS) BISIS which is an integrated software solution fully meeting demands of libraries. LMS BISIS has been developed since 1993 also at the University of Novi Sad. LMS BISIS is used in public libraries, faculty libraries, and some specific-purpose libraries (archives, galleries, regional government of the province of Vojvodina). The current fourth version of the BISIS system is based on open source components and completely developed on Java platform. The main modules of LMS BISIS comprise cataloguing, bibliography reports, circulation, public web access (OPAC), bibliographic data interchange, and administration (Tešendić *et al.*, 2009; Boberić and Surla, 2009; Dimić and Surla, 2009; Milosavljević and Tešendić, 2010).

There are more than 10,000 persons in Serbia with a visual disability of some kind, and a much larger number throughout the region of the Western Balkans. In 2011, the provincial secretariat for science and technological development of the Serbian province of Vojvodina approved a project for connecting LMS BISIS and the Audio Library for the visually impaired. The idea behind this connection is to provide access to collections of libraries inside the library network BISIS for visually impaired using Audio Library. In this way, visually impaired people will gain access to a much larger number of textbooks and materials than they have now.

In order to integrate the Audio Library with libraries using LMS BISIS it is necessary to develop a software component that will act as a mediator between them. Communication between two systems is achieved using standardized protocols for exchanging library data. The main purpose of this intermediary component is to gather all libraries and to be a single access point for the Audio Library in order to search those libraries. By using this component, the Audio Library will make just one request for data instead of searching each library separately. The aim of this paper is to describe specification and architecture of that intermediary component and the way in which it gathers all libraries in a single access point. Also, this intermediary component must be designed in such manner to be independent of LMS BISIS in order to integrate the Audio Library with other LMS used by libraries in Vojvodina. In addition, since standardized protocols are applied, this component can be used by any other application that supports specified protocols, not just the Audio Library.

The presentation of this paper proceeds in seven sections. At the beginning of the paper, we give a brief overview of library services available to people with disabilities and describe the mechanisms for gathering libraries and fetching electronic materials at one place. We continue by laying out a plan of integration of LMS BISIS and the Audio Library, as well as protocols used for communication between them. Concluding remarks, as well as some plans for future works are presented in the two final sections.

2. Libraries and people with disabilities

Libraries have put a lot of effort to bring library services closer to people with disabilities. The International Federation of Library Associations (IFLA) and American Library Association (ALA) propose guidelines which should enable better inclusion of people with disabilities into libraries ("Library Services for People with Disabilities

Policy, 2001"; Irvall and Nielsen, 2005). Those guidelines specify requirements that libraries should fulfill. Some of them are easy and safe entrance to facility, appropriate library material formats (talking books, Braille books, e-books, etc.), usage of assistive devices (screen readers, Braille devices, etc.) and services for accessing library resources. However, people with disabilities still have problems to use libraries because they do not satisfy their needs entirely. For example, Wijayaratne and Amarasekara (2011) conducted a survey among the libraries of the national universities of Sri Lanka. Overall findings of that study reveal that provision for physical access, availability of facilities, resources and services and provision for web access are far below the satisfactory level.

People with disabilities may access library resources using various library services. Those services include books by mail, home delivery service, volunteer readers in the library as well as electronic services such as remote access to the OPAC and retrieval of library materials. With the development of information technologies electronic services gain on popularity. The World Wide Web Consortium (W3C) makes guidelines how to create Web content accessible to people with disabilities. Those guidelines are published as a standard named Web Content Accessibility Guidelines. The current version of this standard is WCAG 2.0 ("Web Content Accessibility Guidelines", 2014). Vandenbark (2010) made recommendations on how to implement this standard into libraries to make library materials more accessible for people with disabilities.

Another service that gains on popularity is retrieval of electronic materials from libraries because it does not require visiting the library. For example, audio books represent electronic material suitable for downloading by visually impaired people. One of the audio-books formats is DAISY format that has been created within the DAISY Consortium established in 1996. Books in DAISY format contain digital recordings and some document structuring that would allow easy navigation by the user. Bae *et al.* (2007) described a service called LG DTB Library that produces and distributes multimedia contents following DAISY format. This software supports ANSI/NISO Z39.86 standard and by applying this international standard, all kinds of players can read the talking books of the LG DTB Library. A similar approach was followed in the Dutch Public Libraries. Krikhaar (2014) presented their service for streaming daisy audio books.

However, many researches highlighted some serious drawbacks of audio books. First, the production of books in DAISY format or any other audio format is very expensive (Bae *et al.*, 2007). In addition to cost, the availability of materials is also a concern. According to Carey (2007) only 4 percent of printed material needs to be converted into audio format and those books are usually available around two years after their initial publication. So, the growth of the e-book market will solve many of the difficulties with access to printed content. The text of an e-book can be instantly made audible through text to speech-enabled devices.

Today, there are a lot of services for lending e-books. Usually e-books are hosted and facilitated by a secure lending platform. E-book lending platforms are software solutions that contain books from multiple publishers and enable users to search and checkout books. Libraries use those platforms to provide their users with e-books. Library lending policies are implemented through those platforms. For example, the lending period may vary from title to title, number of checkouts per user may be limited and so on, and those rules are implemented through those platforms. Different types of those platforms are available on the marketplace and some of them are Overdrive, Axis 360, 3M Cloud Library and LexisNexis Digital Library. Roncevic (2013) made an

exhaustive survey on 51 leading e-book platforms and gave some recommendations for choosing the platform that will best suit a library's needs.

Besides commercial e-book lending platforms, there are a lot of open-access and public domain platforms that provide free access to their content. Some of them are Directory of Open Access Books, World Public Library, Children's Books Online, etc. Those platforms provide a full text dissemination of open access books and provide services to publishers and libraries.

Also, there are examples of in-house software solutions for lending e-books. One example is the web site of China Digital Library for People with Disabilities developed by the National Library of China and the Information Centre of China Disabled Persons' Federation. This web site serves visually impaired juveniles aged from six to 16 providing accessible resources for them (Wei *et al.*, 2012). Libraries in Vojvodina also have some electronic materials that are in Serbian language, but there is no appropriate web service for downloading them. The main topic of this paper is the description of an in-house software solution that provides access to electronic materials available in libraries in Vojvodina for visually impaired people. Those materials will be retrieved and converted to speech in Serbian language by the Audio Library system.

3. Search and retrieval

The intermediary component described in this paper has to be a single access point toward all libraries searched by the Audio Library. Different approaches found in the literature to achieve that are analyzed in this section.

There are two approaches that can be applied to search and retrieve information from a number of systems in order to create a single access point for an end user (Cousins, 1999). One approach requires that all systems physically share a single common repository. That means that all systems must store their data in a single place. Examples of this approach are library union catalogues which physically contain all bibliographic records created by the participating libraries. A well-known, and also the largest physical union catalogue is the catalogue of Online Computer Libraries Centre (OCLC), today known as WorldCat ("OCLC WorldCat", 2014). WorldCat enables the search of many libraries at once for an item and then locates it in a library nearby.

The second approach assumes that there is one central component that will search all remote repositories and gather all obtained results at a single place. That approach is based on federate search, and communication with repositories is established using some standard communication protocols. During federate search, it is necessary to establish communication with all participating systems and to make parallel searches. In this approach the central component is responsible just for showing the result of a search, while data are still stored in the remote repositories. If the same data exists in numerous repositories, information about the repository that has that data will be included in the search result. This approach is applied in the development of library virtual catalogues. Some examples of library virtual catalogues are presented in the papers by Wong and Li (2009), Chellapandi *et al.* (2010), and Sarkar and Mukhopadhyay (2012).

Both approaches have their advantages and disadvantages, which have been the subject matter of many previous research studies (Lynch, 1997; Dovey, 2000; Gatenby, 2002; Hider, 2004). According to most of the authors, the first approach is faster because all data are stored in one place and there is no need to perform parallel searches as in the second approach. The response time of obtaining results during parallel searches will permanently increase with the addition of a new repository.

Furthermore, based on existing research studies, one consistent index and the authority control in systems sharing common repository, provide better recall and greater precision, but with an agreement on rules and policy to create and modify data in the repository. To achieve this with systems based on federate search, all participating repositories must provide uniform indexes and search functions, which is not always an easy task. On the other side, systems based on federate search are less politically difficult to establish because not every participating repository needs to adjust its work policy to others. In addition, research studies indicated that maintainability costs of systems based on federate search are lower in comparison with the costs of maintaining systems sharing a common repository. Also, systems based on federate search are more scalable because it is easier to join a new repository than to merge its data into a central common repository.

Libraries in Vojvodina, which will be searched by the Audio Library, are independent institutions and have different working policies. They do not want to adjust their working policies with each other. Also, making a central repository just for the need of the Audio Library is not their priority. According to those facts and previous analysis of approaches in creating a single access point, the second approach comes naturally in development of an intermediary component. In this paper, we describe the DigSrv component acting as a mediator between the Audio Library system and the LMS. This component applies federated search in order to retrieve data from all available libraries.

4. Integration of BISIS and the audio library

The web service that is responsible for integration of the Audio Library with LMS is called DigSrv. The DigSrv service is implemented as a SOAP web service using the CXF framework ("Apache CXF Framework", 2014) and the JAXB library for processing XML documents ("Java Architecture for XML Binding", 2014). The service is implemented as an independent software component in Java programming language using open-source solutions.

Service DigSrv is used by the Audio Library to retrieve electronic materials from libraries. The Audio Library for the visually impaired contains a client application with a graphical interface that is speech-enabled. It contains a screen-reader, an application attempting to identify and interpret what is being displayed on the screen as well as to communicate information on menus, controls, and other visual constructs. Searches by author name, genre and content are supported. Navigation through retrieved texts is intuitive and efficient due to a number of useful options. A screenshot of the Audio Library client application is shown in Figure 1. The Audio Library is responsible for creating and sending queries to DigSrv service. Also, this component will be responsible for converting the retrieved electronic materials into speech. Converting a text to speech is performed by TTS-based system anReader (Sečujski *et al.*, 2007), which is an integral part of the Audio Library system.

The role of the DigSrv web service in the process of integration of the Audio Library with libraries is presented in Figure 2. The DigSrv service has two main tasks. The first task relates to communication with the Audio Library. This service provides operations for search and retrieval of electronic materials and they are implemented as an independent SOAP web service using SRU protocol. Details regarding the implementation of this task are given in Section 5.

The second task of this service regards communication with libraries, performing searches and collecting obtained data in a single result. The DigSrv service is

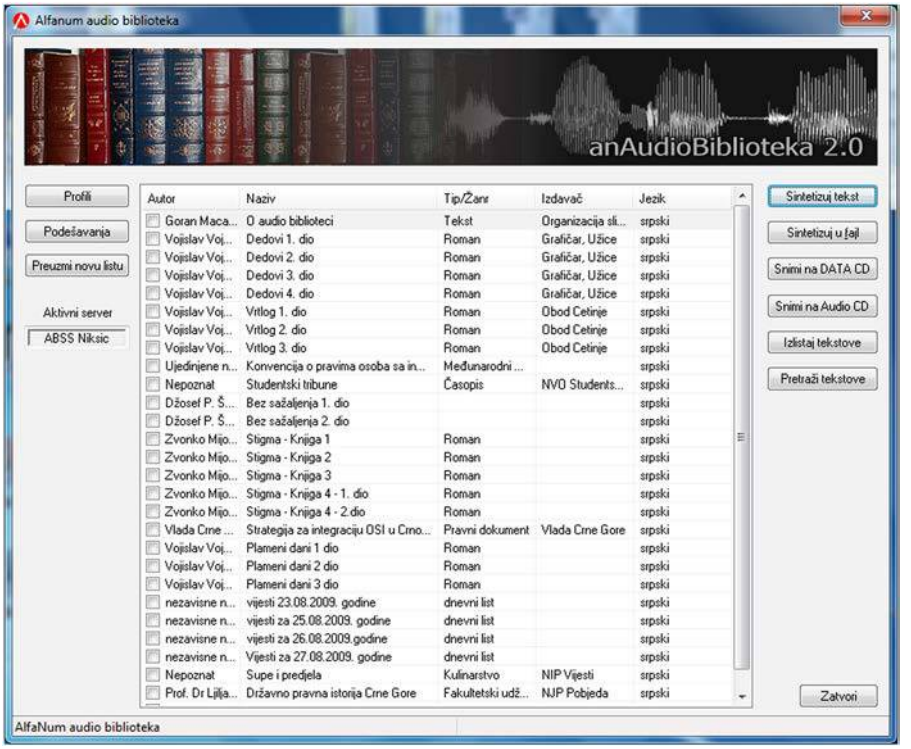

Figure 1.
Audio library-client application

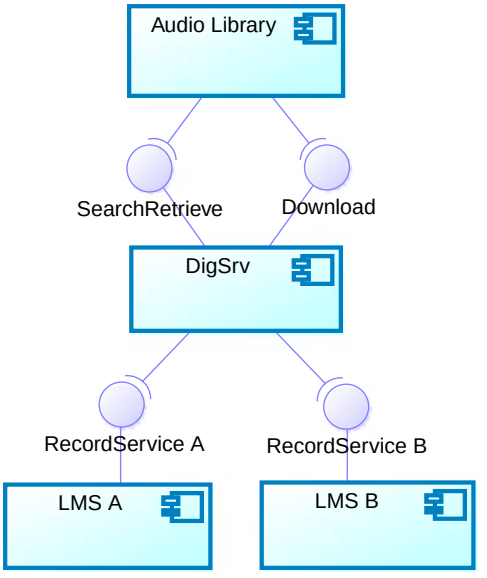

Figure 2.
Intermediary role of DigSrv service

responsible for establishing connections with each participating library and keeping those connections alive. When the Audio Library sends request for search, the DigSrv service transforms request in appropriate format supported by target system and simultaneously sends it to all libraries. After retrieving results from each library, the service will gather all results in a single result list and send it back to the Audio Library using SRU protocol.

The LMS components in Figure 2 represent library information systems. Currently, only communication of the DigSrv service with libraries that use BISIS system is implemented. However, in order to make this component less dependent on BISIS or any other library system, we designed the architecture of the component to be more flexible and to support communication with different library systems.

5. Communication between audio library and DigSrv service

This section describes the protocols and data formats used in the communication between the Audio Library and the DigSrv service. Search and retrieval of bibliographic data from libraries is implemented using the SRU protocol. The SRU protocol uses CQL query language for creating queries. The Specification of the SRU protocol defines that data about publications should be returned in XML format. In order to integrate the Audio Library and DigSrv service, it is chosen that data be exchanged as XML documents in accordance with XML schema of Dublin Core format.

However, DigSrv component must enable download of electronic materials from libraries and that functionality is not supported by the original SRU protocol. Regarding that, the SRU protocol is extended with a new Download operation supporting retrieval of electronic materials and our proposal of this extension is given in Section 5.4.

5.1 SRU protocol

Protocol SRU (Search and Retrieve URL Service) ("SRU Specification", 2014) is one of the most used protocols for exchange of bibliographic records and it is based on technologies that are widely used today (XML, SOAP, HTTP, URI). SRU protocol defines three operations: SearchRetrieve, Scan and Explain.

The SRU protocol can be implemented as REST (Fielding, 2000) or SOAP web service ("Web Services Architecture", 2014). The SOAP version of the SRU protocol is chosen for implementation of the DigSrv service. WSDL documents of the SRU protocol for the SOAP implementation of the service are available on the official web site of the protocol ("SRU WSDL documents", 2014).

The DigSrv service implements only the SearchRetrieve operation defined by the SRU protocol. The SearchRetrieve operation is responsible for searching and retrieving bibliographic data. The Audio Library sends a SearchRetrieveRequest message consisting of several parameters and one of them is a query that will be executed within the library system. The query that is sent is created in accordance with the CQL query language. The DigSrv service returns SearchRetrieveResponse message that contains the number of found records and the records that are in XML format. For each record, also information about the XML schema according to which the record is formed is given. For the purposes of the DigSrv service, records are formed in accordance with the Dublin Core XML schema.

5.2 CQL query language

Contextual Query Language (CQL) ("The Contextual Query Language, 2014") is a query language that is used to create queries when using the SRU protocol, regardless of the transport mechanism. CQL allows writing human-readable, intuitive queries.

The CQL query language introduces a concept called Context Set. Namely, all the indexes by which searching can be done are grouped in the Context Sets and those sets are registered within the Library of Congress ("CQL Context Sets", 2014). Each Context Set has a unique URI identifier and for each set can be defined a short name of the set. These abbreviations can be used in the queries. For example, if the short name of the defined Dublin Core Context Set is dc, then the query may contain index dc.title, which means that search should be performed by the index title that is defined in the Dublin Core Context Set. CQL Context Set ("The CQL Context Set version 1.2", 2014) and Dublin Core Context Set ("Dublin Core Context Set", 2014) are used in the implementation of DigSrv service.

The default Context Set, which is used in the CQL queries, is CQL Context Set and the abbreviation for this set is cql. If the Context Set is not explicitly defined for the indexes that appear within the query, it is assumed that they belong to the CQL Context Set. Implementation of the DigSrv service will use relations $=$, $<$, $>$, $==$, $<>$, $<=$, $>=$, as well as logical operators AND, OR and NOT from this set.

Search indexes are defined by the Dublin Core Context Set which abbreviated name is *dc*. Semantics of indexes and default values for the individual indexes are given at the official site of Dublin Core standard ("Using Dublin Core – The Elements", 2014). Indexes from this set, which will be used in the implementation of the DigSrv service, are provided in the Table I.

Examples of the queries in the CQL Query Language are given in following paragraphs.

Example 1:

CQL query: dc.title = Hamlet sortBy dc.date

Description: this query searches term Hamlet within the index title and it defines condition for sort according to index date. Indexes title and date belong to the Dublin Core Context Set, which is indicated by the abbreviation dc in front of the index.

Example 2:

CQL query: dc.creator = Shakespeare and dc.language = eng and (dc.publisher = Cambridge University Press or dc.publisher = Methuen)

Description: this is an example of a query which has more operands connected by logical operators AND and OR.

Index	Description
Title	Name of publication
Creator	An entity primarily responsible for making the content of the publication
Subject	Subject matter of publication
Publisher	An entity responsible for making the resource available
Contributor	An entity responsible for making contributions to the content of the resource
Date	Date associated with an event in the life cycle of the resource
Format	Physical or digital manifestation of the resource
Identifier	An unambiguous reference to the resource within a given context
Language	A language of the intellectual content of the resource

Table I.
Dublin core context sets indexes

Example 3:

CQL query: dc.subject = England and dc.format = aplication/pdf

Description: this is an example of a query that searches all publications that in the subject field have the word England and a format of the publication is pdf. The values for the index dc.format are defined by MIME types ("MIME Types", 2014).

5.3 Dublin core record format

Bibliographic records can be described using various bibliographic formats such as MARC 21, UNIMARC and Dublin Core. For the purposes of the DigSrv service, records are formed in accordance with the Dublin Core format ("Dublin Core Elements", 2014) represented through appropriate XML schema ("Dublin Core Record Schema", 2014). This format is chosen because it is simple and widely used for describing physical resources such as books.

In the implementation of the DigSrv service, each record is described with a single XML document and the root element of the document is the *dc* element. Each dc element consists of sub-elements that are defined by the Dublin Core format. An example of an XML document that contains a bibliographic record is given in the listing 1. This XML document describes a publication with the title Hamlet, by William Shakespeare. Beside other elements of the Dublin Core format, which describe the publication in more details, there are also the elements dc:format, dc:identifier and dc:source. The element dc:format states that the format of this publication is pdf. Element dc:identifier contains a record identifier while dc:source contains data about the library which posseses that record and those two elements are used in order to identify a record inside the library network.

Listing 1. XML document of bibliographic record

```
<?xml version="1.0" encoding="UTF-8" ?>
 <srw_dc:dc xmlns:srw_dc="info:srw/schema/1/dc-schema"
  xmlns:dc=http://purl.org/dc/elements/1.1/ ...>
  <dc:identifier>37232</dc:identifier>
  <dc:title>The Tragedy of Hamlet, Prince of Denmark</dc:title>
  <dc:creator>William Shakespeare</dc:creator>
  <dc:publisher>Pocket Books</dc:publisher>
  <dc:date>1958</dc:date>
  <dc:language>eng</dc:language>
  <dc:subject>Shakespeare</dc:subject>
  <dc:subject>Denmark</dc:subject>
  <dc:contributor>Virginia A. La Mar</dc:contributor>
  <dc:format>application/pdf</dc:format>
  <dc:source>City library of Novi Sad</dc:source>
</srw_dc:dc>
```

5.4 Extension of the SRU protocol

The DigSrv service must provide searching of the library's collections and SearchRetrieve, and the operation defined by SRU protocol described in Section 5.1 is suitable for that. By calling the SearchRetrieve operation, the client gets only bibliographic records. However, the DigSrv service beside search functionality must provide retrieval of electronic material linked to a bibliographic record. Currently, the SRU protocol does not support that functionality and our proposal of extension of SRU protocol in order to enable retrieval of electronic materials is given in this section.

We propose an extension of the official WSDL document of the SRU protocol with a new operation Download. Fragments of the WSDL document that describe this operation are given in listing 2. The Download operation has three input parameters: record identifier, library identifier and client's X.509 certificate. Record identifier and

library identifier are obtained from bibliographic record and they are necessary in order to identify the requested electronic document. The X.509 certificate is used to enable secure communication with the service. The Download operation returns the name of the file that is retrieved, encrypted file and encrypted session key.

Taking into account that the DigSrv service retrieves electronic materials which must be protected, hybrid cryptosystem is selected (Cramer and Shoup, 2004). Namely, an asymmetric algorithm is used for the distribution of keys used in a symmetric algorithm, and a symmetric algorithm is used for encryption of electronic material. By calling the Download operation, the client sends its X.509 certificate. This is defined in DownloadRequestMessage within the element publicKey, as shown in listing 2. This element publicKey is defined in accordance with XML signature schema ("XML Signature specification", 2014). The server generates a random session key for symmetric encryption and encrypts the document. That session key is encrypted by the client's public key and it is sent as a part of DownloadResponseMessage. The encrypted document is sent inside the same massage. Types of the return parameters file and sessionKey are defined within the XML Encryption schema ("XML Encryption Syntax and Processing", 2014).

Listing 2. SRU protocol extension

```
……
<message name="DownloadRequestMessage">
  <part name="recordId" type="xsd:string" />
  <part name="library" type="xsd:string" />
  <part name="publicKey" type="ds:KeyInfoType"/>
</message>
<message name="DownloadResponseMessage">
 <part name="fileName" type="xsd:string" />
 <part name="file" type="xmlenc:EncryptedData"/>
 <part name="sessionKey"type="xmlenc:EncryptedKey/>
</message>
……
<operation name="DownloadOperation">
 <input message="srw:DownloadRequestMessage" />
 <output message="srw:DownloadResponseMessage"/>
</operation>
……
```

6. Discussion and future work

When it comes to discussion on e-books, two main issues can be recognized. The first one relates to acquisition and ownership of the books and the second regards copyright policies.

Libraries can obtain books directly from publishers or they can use services from aggregators which host e-books from a variety of publishers. In both cases, libraries usually do not purchase books, but only lease them in accordance with terms defined by the publisher or aggregator. The process of leasing e-books is supported through e-lending platforms and terms of leasing are implemented inside those platforms. Those terms may relate to leasing period, number of checkouts per book, number of users accessing book at one time, etc. In this case libraries do not own the e-books, they just pay for access to the publisher's or aggregator's e-lending platforms containing those books. On the other side, libraries may have their own electronic materials which also need to be available online and accessible through e-lending platforms. For example, academic libraries may have their own issues published by institution to

which library belongs. Those publications may include PhD and master thesis, textbooks, proceedings from conferences, etc.

Described practice of using e-books has not been adopted in Serbia yet. Currently, publishers in Serbia are not interested in collaboration with libraries because usage of e-books is not widely spread in Serbia and publishing of e-books is not profitable for them. They have only a small number of e-books that they sell to end-users. So, libraries do not have the way to acquire e-books. On the other hand, libraries have users interested in borrowing e-books and visually impaired people are one of the interested groups. Libraries can supply those users just with open-access e-books which they posses. In this paper, we described a service for providing access to current libraries' collections of e-books primarily used by visually impaired people through the Audio Library. The main advantage of this service is that it aggregates collections from different libraries in a single access point for the Audio Library system.

Regarding copyright issues, publishers, copyright holders, and individuals usually use Digital Rights Management (DRM) technology in order to control the use of digital content. E-books are encoded with DRM software to limit copying, printing, and sharing of e-books and to define loan periods. Currently, the software solution presented in this paper does not use DRM technology. In our case we have two independent systems (Audio Library and DigSrv service) and it is necessary to provide secure communication between them. For this purpose, we used a hybrid cryptosystem, which means that keys are distributed using asymmetric algorithm and symmetric algorithm is used for encryption of electronic material. After receiving electronic material from DigSrv service, the Audio Library uses its own encryption system in order to control usage of electronic material. The Audio Library prevents end users to export, copy or print digital content.

We are aware that this software solution is far below today's standards relating e-lending. However, as it is previously mentioned, there are no services for e-lending in Serbia and this software solution would be a pilot project in this area. Reasons for shortage of e-lending services lie in current publishers' policy rather than in technology. The number of people reading e-books in Serbia is small and publishers have no interests in lending e-books. Visually impaired people are at this moment the most interested party for developing e-lending services. By implementing the presented software solution, we hope that the readership of e-books in Serbia will expand beyond visually impaired group of people. Consequently, publishers will recognize their interests in lending e-books and take the initiative to adopt some of the well-known business models for e-lending. Together with the development of e-lending in Serbia, our software solution will also evolve to support adopted standards and to fulfill requirements of visually impaired people and sighted people as well.

7. Conclusion

This paper presents a specification of the DigSrv service which enables communication between the Audio Library for visually impaired people and the LMS BISIS. By implementation of this service, electronic materials that libraries posses will become available to the visually impaired. The presented software architecture of the service is designed to primarily support communication between the Audio Library and libraries inside BISIS library network, and this is the main focus of the paper. However, by applying abstract factory pattern architecture of the service becomes more general and enables communication with other LMSs by implementing the appropriate interface for those systems.

This service is specified as an independent component based on standardized protocols for exchange of bibliographic data. The usage of protocols increases the interoperability of this service. Because of this, the service is also available to other applications that want to search the library's collections and retrieve electronic materials. The paper presents the communication with the Audio Library, but any other application that implements those protocols can use this service.

Currently, library collections in Serbia do not contain a lot of textual materials in electronic format, which is necessary for realization of e-lending service. Implementation of DigSrv service would stimulate libraries to purchase electronic books, allowing libraries to acquire new users and visual impaired people to access more textual materials.

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