LINKING VISUALLY IMPAIRED PEOPLE TO LIBRARIES

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Abstract - This paper describes communication between the application for the visually impaired people (Audio Library) and the library management system BISIS. By integrating these two systems, visually impaired people will be able to access electronic materials that libraries possess. Communication is achieved through the web service which is implemented within the LMS BISIS. This paper gives a specification of that web service used for exchange messages and files between BISIS system and Audio library system.

1. INTRODUCTION

Published material should be equally available to visually impaired people as to sighted people. Visually impaired people should read a newspaper or a book like sighted people do that. They just should be provided with appropriate format of that 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 or audio-books that are recordings of books read out by human speakers.

One of the audio-books formats is DAISY format which is created inside DAISY Consortium established in 1996. Books in DAISY format contain digital recording and some document structuring that would allow easy navigation by the user. Authors of the paper [1] described service called LG DTB Library which produces and distributes the 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.

However, many researches highlighted some serious drawbacks of audio-books. Firstly, production of books in DAISY format or any other audio format is very expensive [2]. In addition to cost, the availability of materials is also a concern. According to paper [3] only 4% of printed material is converted in 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. Text of an e-book can be instantly made audible through Text to Speech-enabled devices.

The University of Novi Sad, Serbia in cooperation with the company AlfaNum carry out the research and development of speech technologies for Serbian and other kindred South Slavic languages used in five countries of the Western Balkans [4,5]. As a one of the results of that research is Audio library for the visually impaired (ABSS) [6]. ABSS system is based on speech recognition (ASR) and text-to-speech (TTS) engines and it produces synthesized speech from various electronic materials. ABSS has its own database with limited number of books and textual materials. Individual users of that system can access desired text, download it and have it converted to speech using a TTS engine. This ABSS system is used in the School for the Visually Impaired Children „Veljko Ramadanović“ in Zemun and five more organizations with all together about 400 users.

Public libraries have increased acquisition of electronic materials with development of internet technologies and since ABSS has a limited number of books, the idea of accessing library collections through ABBS system arose naturally. A large number of libraries in Vojvodina use library management system BISIS also developed at the University of Novi Sad. Library management system BISIS is integrated software solution fully meeting demands of libraries and it provides modules for cataloguing, circulation, reporting and acquisition [7-10].

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 Western Balkans. In 2011, Provincial secretariat for science and technological development of Serbian province of Vojvodina approved project for connecting LMS BISIS and Audio library for the visually impaired. The idea standing 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 text books and materials than they have now.

This paper presents a specification of DigSrv service which enables communication between the Audio library and the BISIS system. Communication between two systems is achieved using standardized protocols for exchanging library data. The paper describes only connection of Audio library with BISIS system. However, since standardized protocols are used, proposed architecture can be extended to allow connections of Audio library with other library systems too. On the other hand, client for DigSrv service can be any other application that supports specified protocols, not just the Audio library. Architecture of DigSrv service is presented in the section 2. SRU protocol is used for searching and retrieving bibliographic data from BISIS system. SRU protocol is a standardized protocol that is mostly used for that purpose and a brief description of the protocol is given in the third section. SRU protocol uses CQL query language for creating queries and CQL is described in the section 4. Specification of SRU protocol defines that data

about publications should be returned in XML format. For the purpose of presented integration, it is chosen that data are described in accordance with XML scheme of Dublin Core format which is described in the section 5. Section 6 describes extension of SRU protocol. The last section contains summary of the paper and future plans for further development.

2. DIGSRV SERVICE

DigSrv service plays a role of an intermediary between the Audio library and the network of libraries that use BISIS system. DigSrv service is used by the Audio library to retrieve digital materials from BISIS libraries. DigSrv service is implemented as an independent web services that implements operation of SRU protocol described in the section 3, as well as operation described in the section 6. Beside DigSrv component, in the Figure 1 are also given other components involved in the process of searching, downloading and converting electronic material to the speech.

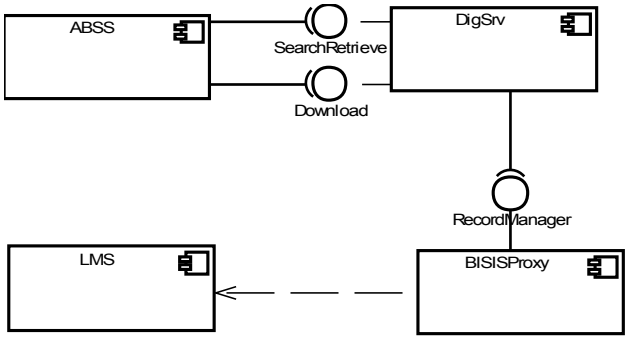

Figure 1. Component diagram

ABSS component presents Audio library. Audio library contains client application with a graphical interface which 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. In the Figure 2 is shown screenshot of the Audio library client application

In order to integrate the Audio library with BISIS system, ABSS component will be 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 [11] which is an integral part of the Audio library system.

DigSrv service accepts queries and forwards them to a BisisProxy component. The BisisProxy is responsible for communication with the library systems in the BISIS network. This component is also responsible for transformation of the received query to a query supported by BISIS system, as well as for transformation of bibliographic records from BISIS into Dublin Core XML format. After transformation of the query, component BisisProxy will simultaneously forward that query to all systems in the BISIS network. After the search is complete, it will return results to DigSrv component. In addition, BisisProxy component enables retrieval of electronic materials for selected record.

LMS component represents a library information system. Currently, only communication of DigSrv services with libraries that use BISIS system is defined. Integration of DigSrv service with other library management systems can be realized by implementation of appropriate proxy components for those systems.

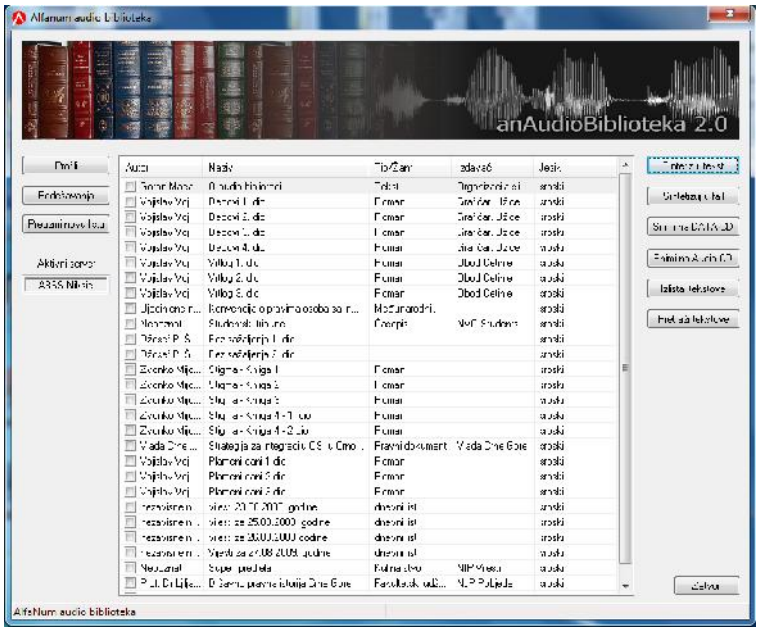

Figure 2. Audio library - client application

The following sections describe the protocols used in the communication between ABSS and DigSrv components. Description of the BisisProxy component is beyond the scope of this paper.

3. SRU PROTOCOL

Protocol Z39.50 [12] was one of the most used protocols for exchange of bibliographic records in the past twenty years. However, it is noticed that it has some drawbacks besides all its advantages and because of that users of Z39.50 protocol start up many different initiative in order to make Z39.50 more useful for a larger number of users. One of the projects which aim is to reduce the complexity of Z39.50 protocol, but still to save its basic functionalities is SRU (Search and Retrieve URL Service) protocol [13].

SRU protocol is based on technologies that are today widely used - XML, SOAP, HTTP, URI. SRU is a protocol that defines two transport mechanisms. One mechanism involves transmission of messages using HTTP GET or POST methods, while the second mechanism involves the exchange of messages over the SOAP protocol. SRU protocol defines three operations: SearchRetrieve, Scan and Explain.

The SOAP version of the SRU protocol is chosen for implementation of the DigSrv service. WSDL documents of the SRU protocol are available on the official website of the protocol [14].

The DigSrv service will implement only SearchRetrieve operation defined by SRU protocol. SearchRetrieve operation is responsible for searching and retrieving bibliographic data. Namely, ABSS component sends a message *SearchRetrieveRequest* and it receives corresponding message *SearchRetrieveResponse* from DigSrv component. Message *SearchRetrieveRequest* consists of several parameters and one of them is a query that will be executed within the library system. The query that is sent using SearchRetrieveRequest message is created in accordance with the CQL query language. After receiving SearchRetrieveRequest message, component DigSrv forwards the query to BisisProxy component which processes the query and returns results. Component DigSrv returns *SearchRetrieveResponse* message that contains the number of found records and the records in XML format. For each record, it is also given information about the XML schema according to which the record is formed. For the purposes of the DigSrv service records will be formed in accordance with the Dublin Core XML schema.

Regarding the fact that SRU protocol does not provide exchange of electronic material, for implementation of DigSrv service, this protocol is extended with a new operation which will support retrieving electronic materials. This extension of SRU protocol is described in the sixth section.

4. CQL QUERY LANGUAGE

CQL (Contextual Query Language) 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.

CQL query language introduces 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 [15]. 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* [16] and *Dublin Core Context Set* [17] are used in the implementation of DigSrv service.

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 *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 [18]. Indexes from this set, which will be used in the implementation of the DigSrv service, are provided in the Table 1.

Table 1. *Dublin Core Context Sets indexes*

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

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

Example 1:

CQL query: dc.title = Hamlet

Description: This query searches term Hamlet within the index title. Index title belongs to the Dublin Core Context Set which is indicated by the abbreviation dc in front of the index.

Example 2:

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

Description: This query searches term Hamlet within the index title and it is defined condition for sort according to index date.

Example 3:

CQL query: dc.creator=Šekspir and dc.language=eng and (dc.publisher =Prosveta or dc.publisher =Prometej)

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

Example 4:

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

Description: This is an example of a query which searches all publications that in the subjects 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 [19].

Example 5:

CQL query: dc.publisher =Prosveta and dc.date > 2005

Description: This is an example of a query which searches all publications published after 2005 and by the publisher *Prosveta*.

5. DUBLIN CORE RECORD FORMAT

Bibliographic records can be described using various bibliographic formats such as MARC 21, UNIMARC and Dublin Core. Implementation of the DigSrv service uses the Dublin Core format for creating records. As discussed in the Section 3, component DigSrv returns bibliographic records in the form of XML documents. Therefore, records will be formatted in accordance with the XML schema of the Dublin Core format [20].

This XML schema can also be used to describe the collection of records. In that case, one XML document contains all records and the root element of the document is *dcCollection*. This element contains a sequence of *dc* elements, each representing a single record. In the implementation of DigSrv service each record is described with a single XML document and therefore the root element of the document is *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 title Hamlet, by William Shakespeare. Beside other elements of the *Dublin Core* format, which describe the publication in more details, there are also elements *dc:format*, *dc:identifier* and *dc:source*. Element *dc:format* states that the format of this publication is *pdf*. Element *dc:identifier* contains record identifier while *dc:source* contains data about library which posses that record. Those two elements are used in order to identify record inside the BISIS 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>Hamlet</dc:title>
   <dc:creator>Šekspir, Vilijam</dc:creator>
   <dc:publisher>Prosveta</dc:publisher>
   <dc:date>1981</dc:date>
   <dc:language>scc</dc:language>
   <dc:subject>Šekspir</dc:subject>
   <dc:subject>Danska</dc:subject>
   <dc:contributor>Pandurović, Sima
   </dc:contributor>
   <dc:format>application/pdf</dc:format>
   <dc:source>Gradska biblioteka Novi Sad
   </dc:source>
</srw_dc:dc>
```

6. EXTENSION OF SRU PROTOCOL

Use of SRU protocol for the purpose of search and retrieval bibliographic records is described in the third Section. However, DigSrv service beside search functionality must provide retrieval of electronic material linked to a bibliographic record. Currently, SRU protocol does not support that functionality and proposal of extension of SRU protocol in order to enable retrieval of electronic material is given in this section.

Official WSDL document of SRU protocol is extended with a new operation *Download*. Fragments of WSDL document which describe this operation are given in the listing 2. *Download* operation has three input parameters: record identifier, library identifier and client's X.509 certificate. As a return value, *Download* operation returns name of file which is retrieved, encrypted file and encrypted session key.

Taking into account that DigSrv service retrieves electronic materials which must be protected, hybrid cryptosystem is selected for that purpose. Namely, asymmetric algorithm is used for distribution of keys used in symmetric algorithm, and symmetric algorithm is used for encryption of electronic material. While calling *Download* operation, client sends his X.509 certificate. This is defined inside *DownloadRequestMessage* within the element *publicKey*, as it is shown in the listing 2. This element *publicKey* is defined in accordance with XML signature scheme [21]. Server generates random session key for symmetric encryption and encrypts document. Used session key is encrypted by client's public key and it is sent as a part of *DownloadResponseMessage* as a SOAP attachment. Inside the same massage, also as SOAP attachment encrypted document is sent, too. Types

of the return parameters *file* and *sessionKey* are defined within the XML Encryption scheme [22].

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>
……
<binding… >
……
<operation name="DownloadOperation">
<soap:operation soapAction="" style="document"/>
 <input>
   <soap:body use="literal" />
 </input>
 <output>
  <mime:multipartRelated>
   <mime:part name="body">
    <soap:body parts="fileName" use="literal" />
   </mime:part>
   <mime:part name="attach">
     <mime:content part="file"
       type="application/octet-stream" />
   </mime:part>
   <mime:part name="sessionKey">
     <mime:content part="sessionKey" type =
              "application/octet-stream" />
   </mime:part>
  </mime:multipartRelated>
 </output>
</operation>
</binding>
```

7. CONCLUSION

This paper presents a specification of the DigSrv service which enables communication between the Audio library for visually impaired people and the library management system BISIS. By implementation of this service, electronic materials that libraries posses would become available to the visually impaired. Currently, library collections in Serbia do not contain a lot of textual materials in electronic format which is necessary for realization of such an idea. Implementation of this kind of service would stimulate libraries to purchase electronic books, allowing libraries to acquire new users and visual impaired people to access more textual materials.

The DigSrv service is specified as an independent component which will allow connection of the Audio library with any library management system. This paper describes just connection between the Audio library and LMS BISIS. The DigSrv service can communicate with other LMSs by implementing the appropriate interface for those systems.

In order to achieve interoperability with systems that use the DigSrv service, specification of the DigSrv service is based on standardised protocols that are used in communication with library management systems. Because of this, DigSrv service is also available to other applications that want to search the library collections and retrieve electronic materials. The paper presents the communication between the Audio library and DigSrv service, but any other application that implements those protocols can use DigSrv service. Due to the fact of increasingly use of electronic materials nowadays, this service could have widespread usage.

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