

# Designing mobile access to DSpace-based digital libraries

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## ABSTRACT

Developing countries face serious problems on building and using digital libraries (DL) due to low computer and Internet penetration rates, lack of financial resources, etc. Thus, since mobile phones are much more used than computers in these countries, they might be a good alternative for accessing DL. Moreover, in the developed world there has been an exponential growth on the usage of mobile phones for data traffic, establishing a good ground for accessing DL on mobile devices. This paper presents a design proposal for making DSpace-based digital libraries accessible on mobile phones. Since DSpace is a popular free and open source DL system used around the world, making it accessible through mobile devices might contribute for improving the global accessibility of scientific and academic publications.

## Categories and Subject Descriptors

H3.7 [Digital Libraries]: User issues, dissemination, H.5.2 [User Interfaces]: User-centered design

## General Terms

Design, Human Factors.

## Keywords

Mobile digital libraries; DSpace, digital divide, developing countries

## 1. INTRODUCTION

The developing countries traditionally face serious problems on accessing printed publications. In Africa, for instance, where more than 50% of poorest countries in the World are located, the printed academic books are too expensive for the majority of students [1]. In fact, the traditional distribution mechanisms tragically failed the developing world [2]. In this context, the alternative seem to be the usage of digital libraries, which have the potential of making a great panoply of resources available theoretically anytime and from anywhere, as far as for instance, a computer with Internet access is available. However, building and using such libraries in these countries is also a serious challenge, since they face several other problems such as low literacy rates, lack of financial resources, low computer and Internet penetration rates, poor ICT infrastructures, etc. [3]. ITU statistics reveal that while the percentage of households with Internet and computer in

these countries are 20,5% and 24,5% respectively, there are about 76 mobile phones for each 100 people<sup>1</sup>. Thus, if digital libraries could be made available on these devices, they would theoretically reach a broader range of people!

By its turn, in the developed world, where these challenges are not crucial, digital libraries have promoted a particularly evident transformation on the accessibility of scientific and academic materials, making resources available in a very quick and reliable manner. In these countries, according to the same ITU statistics, the percentage of households with Internet and computer are 71.4% and 74,0% respectively, and there are about 118 mobile phones for each 100 people! Moreover, there is a strong trend towards the usage of mobile devices for Internet access. In 2009 for the first time, mobile phones were used more for accessing data than for making calls [4]. Thus, making digital libraries accessible over mobile phones seem also to bring important added value into the developed countries.

There has been some researches on making DL available over small screen devices [5], [6]. A substantial number of these researches has focused on extending the existing traditional libraries, by making additional services available on mobile devices. These researches have also indicated some of the major challenges related to making DL accessible over mobile devices: reduced screen space, content inadequacy for small screen, input constraints, device limitations, etc. Some authors have also identified key elements that should not be neglected when building mobile phone applications in general, and when making digital libraries available on mobile devices, in particular [5], [7]. Among these elements, there are at least four that are particularly relevant:

1. Before venturing into making a service available on mobile phones it is imperative to have a clear understanding on the potential users, on which equipments they use, on what their objectives are, etc.
2. On mobile devices, only a subset of the system functionalities should be made available, with a particular attention to an adequate interaction design. However, the results should always be the same, no matter if a desktop computer or a mobile devices is used.
3. A native mobile application is usually recommended when some mobile phone specific features are required, such as offline access, camera usage, user location, etc.
4. A specific web service should be created to provide data to the application instead of bundling images and metadata with the application.

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<sup>1</sup> [http://www.itu.int/ITU-D/ict/statistics/at\\_glance/KeyTelecom.html](http://www.itu.int/ITU-D/ict/statistics/at_glance/KeyTelecom.html), February 21st 2012

When building a digital library in developing countries, the usage of open source software is a must [2]. There are several open source digital library systems that are widely used even in these countries. Thus, in order to make digital libraries widely accessible over mobile devices, the usage of open source systems seem to be an effective mechanism. By building a mobile interface for a popular open source DL system, library resources might potentially reach a broader range of people.

This paper introduces an ongoing project on designing and developing a mobile phone interface for a popular DL system, as an alternative access mechanism for developing countries. The dynamic of the developed world on the usage of mobile phones for data traffic and the functionalities of the proposed system, make it also relevant for usage in the developed world.

## 2. DSPACE DIGITAL LIBRARY SYSTEM

When choosing a DL system, a questions that is often raised is: should we use an open source or a proprietary DL system? However, as mentioned above, in developing countries the usage of free open source digital library systems is indeed a must. There are several open source DL systems available: Archimede, DSpace, EPrints, Fedora, Greenstone, Invenio, Keystone, MyCoRe, OPUS, Streetprint, etc. Among them, DSpace is one of the most popular, with more than 1.160 installations around the world. It is OAI-PMH compliant and its interface is translated into more than 20 languages. DSpace can be installed on Windows, Linux, or Mac OSX. Apart from the Greenstone version for iPod-Linux and Android powered mobile phones, the majority of these existing open source DL systems do not have any specific interface for mobile devices.

The traditional DSpace interface is developed in JSP. Modifying it is difficult and expensive. However, besides this traditional JSP interface, DSpace is now also distributed with Manakin (XMLUI), which uses a modular interface layer to enable institutions an easy customization of the DL interfaces according to their own needs and requirements. The idea is separating the repository from the user interface and profit from all the advantages that this separation brings. This solution includes three major components [8]:

- Digital Repository Interface (DRI) - XML schema that provides an abstract representation of the repository page. It is an abstraction between the repository and the presentation, that enables Aspects and Themes to communicate.
- Aspects - used for developing Manakin extensions and for modifying or adding new features to the digital repository. Several Aspects are linked together in chains. Adding or modifying features would require Java development skills as well as Cocoon expertise. XSL, CSS, XHTML are also required.
- Themes - responsible for the look-and-feel of the repository, community or collection. Creating a new Theme requires the usage of XSL, CSS and XHTML.

Thus, when it comes to customizing the DSpace interface, and therefore when building a DSpace mobile Web interface, the usage of Manakin seems to be preferable when compared to the traditional JSP alternative.

## 3. MOBILE ACCESS DESIGN

Web and native applications bring specific sets of added value to the accessibility of digital libraries. While a native application can be installed on the mobile phone, enabling offline reading and the usage of specific device features such as camera and user location, a mobile Web interface for DL is theoretically accessible by any mobile phone that can navigate the Web, and does not need to be installed on the device. Therefore, it might reach a broader range of devices and users. Thus, in order to make DSpace-based digital libraries more widely accessible, both possibilities are considered: a specific DSpace native application is proposed, along with a mobile Theme for DSpace-based digital libraries. These two proposals are discussed in the upcoming subsections. However, designing such solutions necessarily requires understanding beforehand the user's needs and requirements.

### 3.1 Understanding the users

For enabling user access to a Web site through a mobile device or for developing a mobile application, it is crucial to know the users, to understand what their needs are, which devices they use, etc. [6], [7]. Thus, a user-centric design approach was adopted. Therefore, given the objective of making DSpace-based digital libraries available over mobile phones, especially in a digital divide context, a user study was conducted in a developing country scenario, characterized by difficulties on accessing printed publications as well as low Internet and computer penetration rates. This study was conducted at the University Jean Piaget, in Cape Verde, and aimed at finding the responses to the above mentioned questions in the process of developing a mobile interface, to DSpace-based digital libraries.

Cape Verde is a 10 islands archipelago with 491.875 inhabitants, 17,2% analfabetism rate<sup>2</sup> and a US\$3.737 GDP per capita. 30% of the Cape Verdean population has regular Internet access and 76% owns a mobile phone. However, computers are only available at 11% of the homes. The country faces serious problems on accessing printed publications, and there is no national network for book trade.

For collecting information on user requirements, devices and needs in a developing country context, a survey was conducted among the potential users at the University Jean Piaget of Cape Verde, where there were already a DSpace-based digital library available with the members of the University academic community as main target public.

The survey took place between January 24th and February 2nd 2012, and involved 312 potential users, among the University's 2.100 students and 200 lecturers. People from all the existing scientific areas at the University responded to the questionnaire that was divided into four main parts: (1) ICT access; (2) usage of mobile devices; (3) accessing online academic materials; (4) expectations. The key learnings from this survey are:

- Users do have computer, Internet and mobile phone access. iPhone is the most popular smartphone among them.
- The majority of users do not have smartphone, but within 6 months time, it is probable that at about 69% of them will have a smartphone, an iPod or a tablet.

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<sup>2</sup> <http://www.ine.cv>, April 9 2011 - 2010 national census

- The majority of the users don't have the habit of reading academic materials on their mobile phones due mainly to the unavailability of WiFi/mobile networks, slow connection speed, application unavailability and small screen size.
- Users would use a digital library available on mobile devices and would like the materials to be available on PDF, text, and HTML format, with offline reading possibility.

Apart from this survey, additional information on the DL usage was also taken into consideration so that a better understanding of the potential users could be reached: a previous user study on the existing DSpace-based digital library at the University [9], the updated DSpace usage statistics and the updated Google Analytics statistics on the DL. Such studies and information enabled a better understanding of the potential users. Thus, four personas were defined (two primary personas and two secondary personas). Some of the key characteristics and requirements of these personas are:

1. Bachelor student 1 - 21 years old; does not have Internet access at home; owns a smartphone; wants to search the DL and download materials for offline reading.
2. University researcher - 34 years old; has computer and Internet access at home as well as Internet connected smartphone; wants mainly to perform searches on single as well as on federate DSpace-based DL; is interested in receiving automatic reading suggestions and on indicating reading materials to students.
3. Bachelor student 2 - 24 years old; has computer and Internet access at home as well as smartphone; is mainly interested in searching thesis and dissertations for reading.
4. Foreign user - 24 years old; regular smartphone user for searching and reading materials on the go; wants a reading list of downloaded materials and the possibility highlighting texts and taking notes for each material that has been downloaded.

The proposed mobile system for accessing DSpace-based digital libraries is designed taking into account the characteristics of these personas.

### 3.2 Mobile application

The core idea of this mobile application for DSpace-based digital libraries is bringing the most important users functionalities of these libraries into a mobile phone, enabling offline reading, and bringing additional functionalities, according to the user needs and requirements. Since iPhone is the most popular smartphone among the personas defined in the previous section, this mobile application is developed specifically for this type of devices. However, considering that in 2011 the Android powered mobile phones had a 244% annual growth and represented 48.8% of smartphone shipments<sup>3</sup>, developing an application for android powered mobile phones seem to be a must. Therefore, an Android version of mDSpace should also be developed in the ambit of this

<sup>3</sup> <http://www.canalys.com/newsroom/smart-phones-overtake-client-pcs-2011>, February 17th 2012

project. Thus, taking into consideration the created personas, a set of functionalities was defined for the system. Figure 1 shows a concept map for the proposed mobile application, according to the requirements of the primary personas (red and green) as well as of the secondary personas (blue and brown). Therefore, the system should allow users to:

- Search for resources in one DSpace-based DL as well as in several libraries at the same time (federate search). This federate search on DSpace-based digital libraries should be accomplished using either DSpace REST API or Perl DEiXToBot scripts, on the server side.
- Download materials for offline reading. While reading offline, users should be able to highlight texts and take notes. This functionality requires the mobile device to have a local database of downloaded resources, including the corresponding metadata.
- Manage the reading list of downloaded materials, including rating, flagging and deleting.
- Send reading suggestions to other users as well as receiving automatic reading suggestions provided by the back-end service, according to the user profile and the usage statistics of available materials.

In order not to bring exacerbated computational overhead into the mobile phone, a back-end service should be developed and installed at DSpace server side. This service would receive connections from the mobile application, perform the requested operations and send the results back. Therefore, all interactions with the DSpace-based digital libraries should be performed by this back-end service. During the idle time, the back-end service should also convert the resources available in the DSpace-based digital library, into a format that is more user friendly on mobile devices. Figure 2 shows the mDSpace system architecture. All DSpace-based digital libraries might be searched using the federate search functionality, even if the back-end service is not set up alongside of the DSpace system. However, the automatic reading suggestions functionality, requires the back-end service to be set up beforehand. Thus, the user has two major options when using mDSpace:

1. Without logging in, he can simply choose (from an editable dropdown list) a DSpace server containing the back-end service up and running, and start using the system. In this case, no reading suggestion should be received since this back-end service does not know who the user is.
2. The user logs into a DSpace-based digital library (through the back-end service), before using the system. In this case, he can use the additional functionalities (such as reading suggestions), according to his profile. The user can choose whichever available DSpace-based digital library he wants, as far as this library has the mDSpace back-end service installed at server side. mDSpace allows him to sign up if he wouldn't have done it yet.

Taking into account the created personas and the defined specifications of the system, a low fidelity prototype for mDSpace was created. The system is still at design phase. The next stages will be a formative usability test, using a prototype that is under development using Objective C.

### 3.3 Mobile phone theme for DSpace

Apart from a native iPhone and Android application, a mobile Web interface for DSpace-based digital libraries is also proposed. With such interface, a broader range of users can use such libraries on their mobile phones, without the need of installing any specific native application. In order to accomplish this goal, DSpace Manakin interface should be used for building a mobile phone Theme.

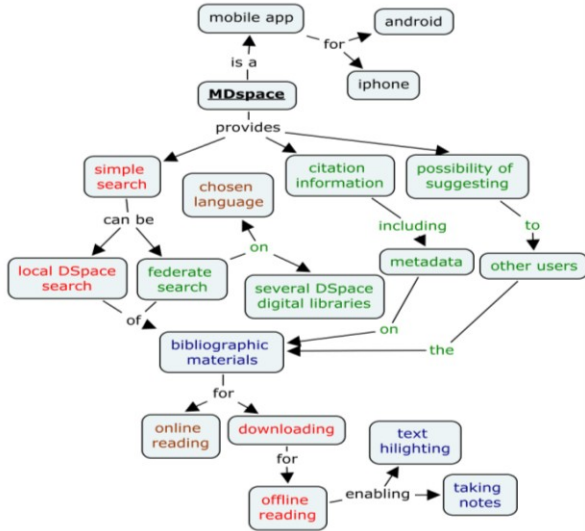


Figure 1. Concept map for mDSpace

The development process should focus at the Theme layer. Therefore, XSL, CSS and XHTML should be used. The interface would be at Manakin level which would then interact with the DSpace-based digital repository and send the results to the users devices. Therefore, if the native mobile application requires the back-end service to be installed alongside with DSpace DL system, the mobile Web interface requires Manakin and the developed theme to be also installed at server side. As mentioned before, the current DSpace version is already distributed with Manakin included. Figure 1 depicts the architecture of both, the proposed native application and mobile Web interface.

The resources available in the digital library are presented to the user on the same format as they are inserted into the DSpace database. However, if mDSpace back-end service is set up alongside with the DSpace server, the user should have the possibility of choosing between the original document format and a more mobile phone friendly format, since the back-end service would perform such conversion during the idle time.

### 4. CONCLUSION

This paper has proposed a design for an alternative mechanism of accessing DSpace-based digital libraries through mobile devices, using both, mobile Web and native application.

This mechanism should bring an important contribution to bringing library materials to the developing countries, which face on one hand, tremendous problems on accessing printed publications, and on the other, several challenges on accessing the existing digital libraries. Given the low computer penetration rates and high mobile phone penetration rates in these countries,

accessing digital libraries through mobile devices is a real alternative. Such access mechanism is also important for the developed world, where there has been a strong trend towards using mobile devices for accessing resources on the go.

The next stages of this ongoing project includes an evaluation on the level of acceptance and usage of this alternative access mechanism, in developing countries context. Thus, a better understanding should be achieved on the aspects that should be taken into consideration when making a DL accessible on mobile devices, as well as how they are perceived and accepted by users.

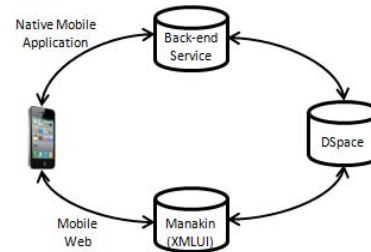


Figure 2. System Architecture

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