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Building the Ubiquitous Library in the 21st Century

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Abstract

On the basis of web-based library information architecture, this paper outlines the ubiquitous library's most relevant concepts and features tied up with the internet platform. Utilizing successful library projects and applications from the real world, this paper explores primary technical solutions for the ubiquitous library in the digital age, which could be utilized to transform the concept of "Ubiquitous Library" into a real "dynamic engine for the knowledge and information society." Also discussed is the future of web-based ubiquitous library information architecture. This paper intends to draw a clear road map for librarians, instructors, IT specialists, managers, executives, and other professionals to utilize cutting-edge technologies and emerging technologies to design, develop, integrate, enhance, and implement ubiquitous library services and projects in the 21st century.

Introduction

Since the 1990s, the Internet has become the primary platform for libraries to access, organize, retrieve, storage, deliver, and disseminate information resources, services, and instructions. With the assistance of the Internet and the World Wide Web, today's libraries have already possessed capability of reaching library users outside the library buildings. The rapid development of cutting-edge technologies and emerging technologies has provided libraries with new ways of delivering and disseminating information resources and services in the digital age. Facing up with the new information explosion, librarians, instructors, and library executives are eager to find out quality leading technology solutions how to deliver seamless, dynamic, and interactive information resources and services just one click away for global users.

The purpose of this paper is to explore key issues about how to transform the concept of "Ubiquitous Library" into real "Dynamic Engines for the Knowledge and Information Society." With the web-based library information architecture, this paper intends to explore new features of the ubiquitous library in the 21st century. Utilizing various successful real world examples of ubiquitous library projects, this paper analyzes different technology solutions of building the high quality ubiquitous library in the digital age.

This paper is composed of six parts. Part I is the introduction. Part II outlines the primary concepts and features of the ubiquitous library in the digital age. Part III overviews primary principles and three ways of selecting best technology solutions for building the ubiquitous library. Part IV categorizes real world examples for building the high quality ubiquitous library. Part V discusses the future web-based ubiquitous library information architecture. Part VI summarizes the new mission of the ubiquitous library, plus the implication of cutting-edge technologies, emerging technologies, copyrights, and global economy on the further development of the ubiquitous library in the 21st century.

Ubiquitous Library: Concept, Architecture, and Features

According to the Oxford English Dictionary (O.E.D. 2nd Ed.), the ubiquity is described as "the capacity of being everywhere or in all places at the same time." The basic concept of the ubiquitous library is the library accessible from anywhere at anytime. With the emergence of the Internet and the World Wide Web, the dream of the ubiquitous library has already become a reality.

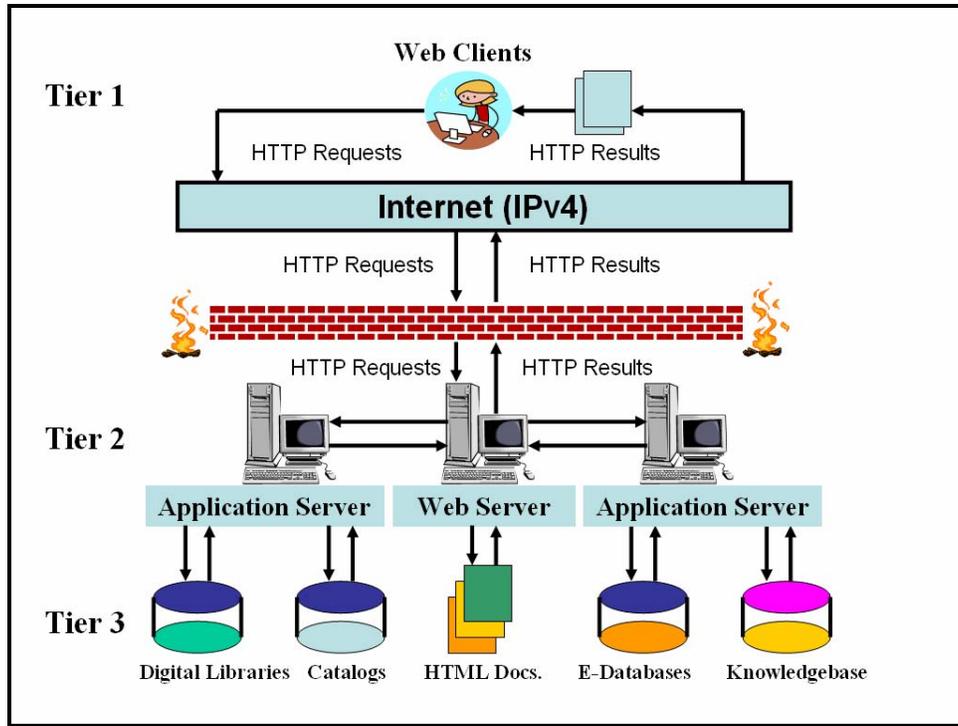


Figure1. The Current Web-based Library Information Architect

From this web-based three-tier client/sever academic library information architecture, we can clearly see how today's libraries have become information gateways of delivering and disseminating specific information resources, services, and instructions, such as bibliographic instructions, catalogues, data warehouses, digital libraries, distance learning services, e-databases, government documents, guides, interlibrary loans and document deliveries, library workshops, special collections, virtual classrooms, virtual references, virtual tours, and other specific programs as well as services, etc. via the Internet and the World Wide Web.

The Tier 1 (also called the frontend) represents library users getting access to library information resources and services via different web browsers, such as Internet Explorer, Netscape, FireFox, Opera, and Safari, etc. The Tier 2 is the Middleware, which contains Web Servers, Application Servers, and many other business rules. The Tier 3 (also called the backend) is the data repository containing different data objects, such as HTML based documents, web forms, databases, data warehouses, and so on.

Based on the web-based library information architecture above-mentioned, we can easily find out that the Internet and the World Wide Web are basic platforms for the future evolvement of the ubiquitous library. Technically speaking, we are so proud to declare that the ubiquitous library has been finally transformed from a paper concept to a reality. With the rapid development of cutting-edge technologies and emerging technologies, the evolving modern ubiquitous library is showing up its six new features in the digital age:

1. Web-based -- The modern ubiquitous library is web-based. It means that the ubiquitous library utilizes the Internet and the World Wide Web to deliver and disseminate its information resources and services.
2. 24x7 -- The modern ubiquitous library is accessible for 24x7 without any time and geographic limitations.
3. Open Access -- Since the Open Source Software is the current developing trend for the software engineering and IT solutions in the digital age, the Open Access should also become one of key features for the ubiquitous library in the 21st century, too. In addition to providing specific library users with password-protected information resources, services, and instructions, the ubiquitous library should also provide global users with an open access to its information, especially the scholarly information from open access journals. Without this feature, the ubiquitous library will lose its primary attraction to global users in the 21st century.
4. Multiformats -- The modern ubiquitous library should deliver and disseminate heterogeneous information dynamically and seamlessly. Modern web technologies have provided libraries with dynamic ways of delivering and disseminating information at multiple formats, such as texts, Portable Document Format (PDF), images, slides, audio, and video via the Internet platform.
5. Multilanguage -- The modern ubiquitous library should commit to provide the multilanguage support for global users with different cultural backgrounds so that they can access information without any difficulty, no matter whether or not they can read, speak, and write English effectively and efficiently. Moreover, the mission of the ubiquitous library is to serve as a dynamic engine for the knowledge and information society, which naturally includes providing the multilanguage support.
6. Global – The ubiquitous library in the 21st century should become the information gateway for the world's knowledge and information. It also means that the ubiquitous library will serve for global users without regard to their age, sex, gender, color, race, religion, language capability, computer skills, and library literacy, etc.

Selecting Best Technology Solutions

Based on the discussion about the ubiquitous library's six primary features in the previous section, we can now focus on selecting best technical solutions of building the high quality ubiquitous library in the 21st century. These technology solutions will range from cutting-edge technologies and emerging technologies, such as Broadband Network, Digital Communication, DOM (Document Object

Model), Human-Intelligence, Internet (IPv6), Machine-Translation, Object Relational Database Management Systems (ORDBMS), UltraBand Wireless Network, Voice Recognition, VOIP (Voice Over Internet), Web Services, WiMax, XML (Extensible Hypertext Markup Language), and so on.

In the process of searching best technology solutions for building the ubiquitous library, the basic principle is that the best technology solution will always depend on three conditions: (1) specific user needs; (2) web-based distributed library information architectures; and (3) allocated funding supports. The best technology is always relative, which is based on the balance among user requirements, the web architecture, and the operating budget. Technology solutions are only means for us to reach our goals. We should pursue end user satisfaction, instead of pursuing various fancy technologies. We want to commit our user satisfaction missions in use of best technology solutions at lowest operating costs.

Currently, there are three ways to apply best technology solutions to building the ubiquitous library. The first way is to directly purchase worldwide leading vendors' advanced technology solutions, such as computerized integrated library systems, digital library tools, e-databases, and other necessary library automation products, to build distributed ubiquitous library information infrastructures. It is the most common technical approach for general libraries to enhance and upgrade their web-based distributed library information systems.

The second way is to utilize current mature computer network technologies and web technologies to build the web-based library distributed information systems. Most of libraries are using this technical approach to design, develop, enhance, and maintain their specific web-based library information applications, such as web portals, bibliographic instructions, e-sources, information literacy projects, knowledgebases, learning commons, user surveys, virtual classrooms, and so on.

The third way is to collaborate with leading industrial pioneers, such as Adobe, Google, Microsoft, and Yahoo, to design and develop most advanced leading ubiquitous digital library projects. This approach is the best option for academic research libraries and national libraries. With millions of books and other printed materials, audio/video recordings, manuscripts, maps, and photographs, their collections naturally become primary information and knowledge resources for designing and developing pioneer ubiquitous library projects, such as the Google Printed Library Project and the proposed European Digital Library Project.

Strictly speaking, general libraries do not possess sufficient operating funds and qualified technology power to independently design, develop, and implement large-scale ubiquitous library projects. In the process of selecting most appropriate technology solutions of building the high quality ubiquitous library,

librarians, instructors, IT specialists, managers, and executives should carefully assess and evaluate their specific user requirements, particular web-based infrastructure, and allocated operating budgets before they make a hasty decision.

Limited by sufficient funding and technology supports, most of general academic libraries and public libraries might as well follow the first two ways above-mentioned to build their specific distributed ubiquitous library information systems. These are most practical technology approaches for them to enhance and upgrade their information resources, services, and instructions to meet requirements of the ubiquitous library in the 21st century. For leading academic research libraries and national libraries, they can collaborate and coordinate with industrial giants to initialize cutting-edge ubiquitous library projects. With sufficient funds and strong government supports, they are pioneers to build leading ubiquitous library projects in the digital age.

Real World Examples for Building the Ubiquitous Library

The following successful library projects will provide us with high quality technical solutions how to utilize cutting-edge technologies and emerging technologies to build the ubiquitous library. Based on different ranges of user services, these successful technology solutions for the ubiquitous library projects are grouped as follows:

A. University-based Ubiquitous Library Solutions:

In the academic learning environment, it is always a huge challenge for the university and the university library to provide high quality information services to assist academic students effectively and efficiently adjust themselves into a new learning environment. However, University of Memphis in USA set us a very successful example how to dynamically combine CRM (Customer Relationship Management) software with academic library information services:

- Ask Tom -- Powered by the customer relationship management software solutions provided by RightNow Technologies, the University of Memphis in January 2004 initialized its first student-centered jointed information service project called Ask Tom (http://asktom.custhelp.com/cgi-bin/asktom.cfg/php/enduser/std_alp.php), which integrates the information consulting services and customer help desks via multiple student interactive channels, including Web, interactive voice, email, chat, and regular telephone. Ask Tom made it possible for the University of Memphis and the university library to integrate and upgrade their information services under one successful user interface.

B. System-Wide and Consortium-wide Ubiquitous Library Solutions:

For a large university or a consortium, it is always a big challenge to provide various users at various locations with dynamic and seamless services. The

following successful system-wide and consortium-wide library technology projects will give us some instructive tips:

- GIL Universal Catalog and GIL Express:
The GIL Universal Catalog (<https://giluc.usg.edu/>) -- The GIL (GALILEO Interconnected Libraries) Universal Catalog is a centralized union catalog functioning to multidatabase library consortia settings. Developed by the Endeavor Information Systems (<http://www.endinfosys.com>), the GIL Universal Catalog connects all 35-member libraries within the University System of Georgia (<http://www.usg.edu/>). With the total collection of over nine million bibliographic records, the GIL (GALILEO Interconnected Libraries) Universal Catalog is the one of the most powerful academic information resources and services offered for students, staff, and faculty from the University System of Georgia (USG) to access all eligible circulating materials from all 35 USG member libraries.

GIL Express – The GIL Express is the resource sharing service designed and developed on the basis of the GIL (GALILEO Interconnected Libraries) Universal Catalog. All students, staff, and faculty within the University System of Georgia (USG) will be able to access the GIL Express either from the on-site service or from the remote requesting service. Compared to the regular Interlibrary Loan Services, the GIL Express is much faster. Since they can directly review and select circulating bibliographic information from member libraries directly, GIL Express users can usually obtain books they ordered within the next two to three business days. In the future, the GIL Express will be able to deliver periodical materials ordered by GIL Express users.

- The Center for Research Libraries (<http://www.crl.edu/>) -- As a consortium of North American universities, colleges, and independent research libraries, the Center for Research Libraries (CRL) is a membership organization to acquire, preserve, and promote traditional and digital resources among its current 212 member institutions. The collection of the Center for Research Libraries ranges from 16,000 newspaper titles in print and microform, 800,000 doctoral dissertation titles from universities outside the U.S. and Canada, government documents and publications, thousands of journals in English and other languages, archives, and other traditional and digital information resources. All these rich and diverse information materials are available to member institutions via traditional interlibrary loan services and electronic document delivery services.
- Open Content Alliance (<http://www.opencontentalliance.org/>) – The Open Content Alliance (OCA) consists of a group of culture, technology, education, non-profit, and governmental organizations in the world. The mission of the Open Content Alliance (OCA) is to build a comprehensive digital archive collection for free global access and reuse via the Internet.

Information resources offered by the Open Content Alliance (OCA) have covered archive of digitized materials, including texts, images, and multimedia. The contributor will offer donated services, facilities, tools, or funding to the Open Content Alliance (OCA) separately. To compete with Google Incorporated, Yahoo and Microsoft have declared separately to support this project. Microsoft's MSN Search Division also paid \$5 million to scan 150,000 books for the Open Content Alliance.

C. Global Ubiquitous Library Solutions

With the strong support from governments and industry-leading IT giants with quality technical solutions, it is the only practical approach for research libraries and national libraries to implement global ubiquitous library projects. The following examples will give us a lot of inspirations how ubiquitous library projects could be successfully initialized and implemented:

1. Google Library Project (<http://print.google.com/googleprint/library.html>) – Definitely, the Google Library Project is the world's most ambitious technology project for the ubiquitous library in the 21st century. Claiming to be an enhanced card catalog for the world's books, the Google Library Project threw out a nuclear bomb towards the global publishing industry. Declared in December 2004, several leading academic universities – Harvard University, Stanford University, the University of Michigan at Ann Arbor, and the University of Oxford in England, as well as the New York Public Library – started working with Google to scan 15 million books for the Google Library Project. If it can break the blocks of copyright issues, the Google Library Project will definitely make a great contribution to promote the global information literacy, which will also have wide and far-reaching implications on authors, copyrights, global users, intellectual property protection, librarians, printings, publications, ubiquitous libraries, and so on.
2. Google Scholar (<http://scholar.google.com/scholar/about.html>) – The Google Scholar (Beta) is the world's first successful Web Search Engine for scholarly literature. Although the Google Web Search can provide users with large amount of information – usually more than millions or ten millions of search records, it is impossible for users to review all scholarly literature from such large numbers of web records before they finish scan over millions or over ten millions of web search records. Utilizing cutting-edge technology, the Google Scholar can filter peer-reviewed papers, theses, books, abstracts and articles from academic publishers, professional societies, preprint repositories, universities and other scholarly organizations for web searchers, which is the real value for the ubiquitous library. With the Multilanguage support, no doubt, the Google Scholar will become the world's first scholarly Web Search Engine for the ubiquitous library in the 21st century.

3. Microsoft Windows Live Academic Search (<http://academic.live.com/>) -- As a counter attack to the Google Scholar, Microsoft, Inc. announced on April 11, 2006 that it has released the Window Live Academic Search (beta version) to assist academic students and faculty to access various peer-reviewed journal information provided by the publishers of scholarly journals. Also, the Microsoft Windows Live Academic Search does provide users with multiple formats – PS (Postscript File), HTML (Hypertext Markup Language), and PDF (Portable Document Format) -- to access scholarly journal information filtered by its web technology.
4. The European Library (<http://www.theeuropeanlibrary.org>) -- The European Library is the central information gateway that offers free access to its 45 national libraries of Europe via the Internet. The mission of the European Library is to “open up the universe of knowledge, information and cultures of all Europe's national libraries.” As a consortium of 45 national libraries from different European countries, the collection of the European Library includes printed and digital-format books, magazines, journals, and other resources. Currently available is a searching engine to access the cataloging information from the fifteen full-participating national libraries of European countries ranging from Austria, Croatia, Denmark, Estonia, Finland, France, Germany, Italy, Latvia, Netherlands, Portugal, Serbia, Slovenia, Switzerland, and the United Kingdom. The relevant cataloging information from other 30 basic-participating European national libraries will be included in the future. In addition, the web site of the European Library provides its users with 12 European languages to access its information resources and services.
5. The European Digital Library Project -- As a challenge to the leading status of Google which claims its mission is “to organize the world's information and make it universally accessible and useful,” six European countries -- France, Germany, Hungary, Italy, and Poland -- proposed to initialize the European Digital Library Project in Paris on April 28, 2005. Nineteen European Libraries have already declared to support this ambitious project. The projected European Digital Library is a web portal to access a collection of over 6 million books, films, and photos. On the current Internet platform of the European Library, the projected European Digital Library aims to provide free public services to the European Union's 25 member nations by 2010.

The Future Web-based Ubiquitous Library Information Architecture

The traditional n-tier information architecture is still evolving in the digital age. The rapid development of cutting-edge technologies and emerging technologies has already shaped the future web-based ubiquitous library information architecture as follows:

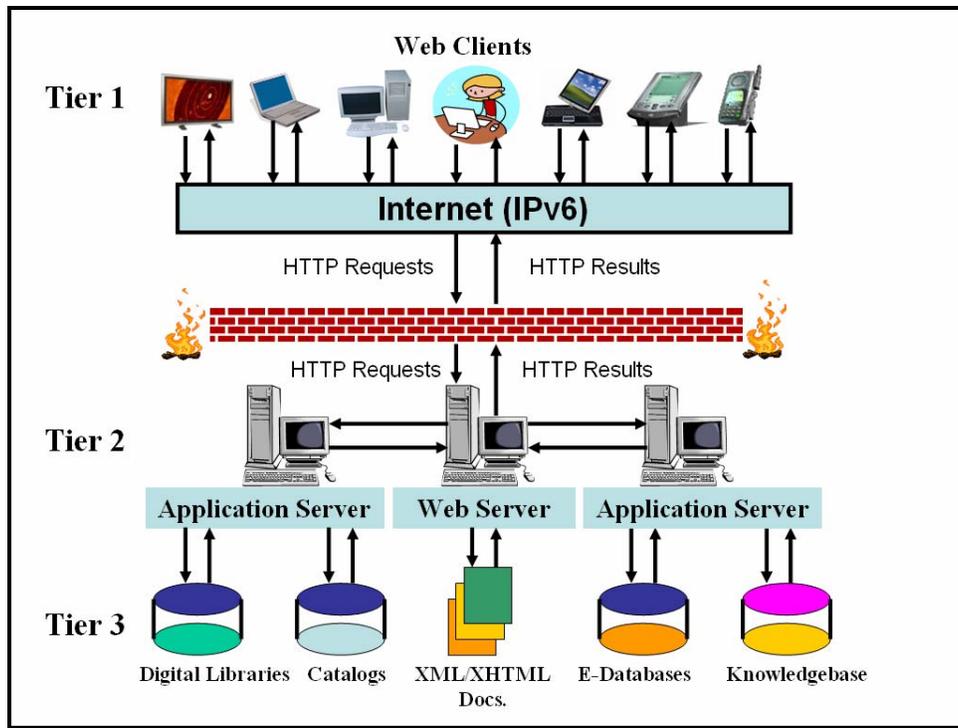


Figure2. The Next Generation Web-based Library Information Architecture

Obviously, the next generation of the Internet (IPv6), the UltraBand Network, and the WiMax Technology will lay down solid backbones for the ubiquitous library to deliver and disseminate its information resources, services, and instructions to global users at faster speed via more dynamic channels. In addition to regular Desktop computers, Notebooks, Tablets, PDAs (Personal Digital Assistants), Handheld computers, HDTVs (Hi Definition Televisions) and Cell Phones could also be used to access, locate, convert, and disseminate the ubiquitous library information resources, services, and instructions via the future Internet platform.

Working with JavaScript, XSL (Extensible Stylesheet Language), and XHTML (Extensible Hypertext Markup Language) at the frontend (Tier 1), XML (Extensible Markup Language) will be widely used to define web page contents, data manipulation and management from Object Relational Database Management Systems (ORDBMS) located at the backend (Tier 3). At the Tier 2, the middleware such as Web Services and DOM (Document Object Model) will handle server-side processes. In addition, the UltraBand Network, which can transmit data at 5-40 megabyte per second, and the WiMax, which represents the 802.16 wireless metropolitan-area network standard, will make it possible for ubiquitous library users to access ubiquitous library information resources, services, and instructions dynamically and remotely within city or suburb areas.

Summary

In one word, it is the fact that the ubiquitous library has been in existence. The significance of the ubiquitous library is no longer in its physical existence today. Instead, the real power of the ubiquitous library is to become “Dynamic Engines for the Knowledge and Information Society.” The mission of the ubiquitous library in the 21st century should assist global users to access, locate, transform, and disseminate heterogeneous information at multiformats in multilanguage support via the Internet and the World Wide Web.

The further development of cutting-edge technologies and emerging technologies will provide the ubiquitous library with new innovative ways of delivering its information resources, services, and instructions. For the ubiquitous library, however, copyright issues are still major blocks of transforming and disseminating information. The final result of legal dispute between Google and publishers will have a great impact on the future direction and the developing process of building the ubiquitous library. Finally, the long-term stable world peace and the consistent development of global economy will greatly promote the further evolution of the ubiquitous library in the 21st century.

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