TECHNOLOGICAL CHALLENGES AND AUTOMATED LIBRARY SYSTEMS

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Abstract

This paper attempts to identify a set of ongoing trends and upcoming changes in automated library systems. The issues related with ongoing changes in library automation are discussed here in full length and are also linked with global recommendations on developing next generation library management software. It also attempts to predict the future of automated library systems with the advent of cutting-edge technologies that are going to influence the processes, procedures, architectures and platforms for integrated library systems.

Keywords: SOA architecture, Cloud-based library automation, Web-scale resource discovery, library management system, automated library system

Introduction

Libraries all over the world, right from 1970s with the advent of Personal Computer are increasingly attempting to automate activities for minimizing human clerical routines and thereby optimizing productivity and creativity of library staff[1]. Library automation is a generic term that denotes applications of Information Communications Technologies (ICT) for performing manual operations in libraries of any type or size. Automated Library Systems support three broad groups of library activities - i) housekeeping operations; ii) information retrieval; and iii) on-the-fly integration of library materials with open datasets. A decade wise analysis of developments in library automation[2] shows rapid upward changes in this domain.

- Pre-computer era (1950s): First was the pre-computer era of unit record equipment.
- Stand-alone era (1960s): The off-line computerization in 1960s and early 1970s
- On-line system (1970s): This was followed by the on-line systems of the 1970s.
- Micro-computer era (1980s): The 1980s saw the advent of microcomputers in the form of PCs, emergence of CDROM technology and Local Area Network (LAN).
- Web era (1990s): Internet revolution of 1990s paved the path of Web-enabled integrated library systems to support access and operations from anywhere at any time
- Open era (2000s): Emergence of open library systems powered by open source software, open standards and on-the-fly integration with open data and open contents[3].

The decade-wise development of library automation also termed as Integrated Library System (ILS), as discussed above, shows the effects of ICT on libraries and information centers. The path of developments is characterized by three fundamental factors:

- Mechanization – doing routine things with more efficiency;
- Innovation – experimenting with new capabilities i.e. introduction of new services and improvement of existing services through use of ICT; and
- Transformation – fundamentally altering the nature of the library operations and services through capabilities extended by ICT

Objectives

Automation of library housekeeping operations is considered as an especially critical area from which future benefits will emerge[4]. For example the non automated library can't take advantages contributed by ICT such as digitization, web-enabled library system, use of linked open data, remote library management, interactive user services, etc. Therefore, understanding the trends and future possibilities of library automation may help library professionals in selecting and implementing ILS, in demanding new features in ILS from vendor or developers (in case of open source software) and in customizing existing systems and services[5].

In view of the foregoing, this paper is reporting recent changes with probable futuristic possibilities of library automation at a global scale. This sketch is derived in a systematic way under five categories and fifteen-point checklist.

Architecture and Infrastructure

Library automation process is software-centric activities. The architectural design of ILS and corresponding infrastructural requirements are changing in following ways:

1. Service-oriented Architecture (SoA) in ILS

Service-Oriented Architecture (SOA) is an ICT architectural style that supports seamless flow of information irrespective of systems, platforms, software architecture, data structures etc. In other words, it supports sharing of services and datasets in heterogeneous information infrastructure. The term service-orientation indicates a way of thinking in terms of services, service-based development and the outcomes/deliverables of services. SoA is now established as a matured architectural style and the ILSs have started switching to this promising architectural style to provide end users innovative library services and opportunities to other libraries to utilize resources and services (through application program interface). The SoA is an essential attribute of an ILS to support Cloud Computing. It facilitates the effective use of the Cloud[6].

2. Cloud-based library automation

Cloud computing is network based computing facilities that support on-demand use of hardware and software resources[6]. Libraries can take advantages of cloud computing in the following ways – i) by using ILS available in remote server through web browser without any installation; ii) by hosting the Web-OPAC and staff interfaces in remote server without burden of local management of server and arrangement of IP address and domain name[7]; iii) by setting up own remote file storage and database system (with scheduled backups). The cloud computing mainly supports three facilities. These are Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service

(SaaS)[8]. The Cloud based library automation has following advantages – i) Resource pooling (cloud computing providers provides a vast network of servers and hard drives for use by client libraries); ii)Virtualization (libraries do not have to care about the physical management of hardware, software, user interface, data backup and hardware compatibility); iii) Elasticity (addition of storage space on-demand in hard disk or increasing server bandwidth can be done easily); iv) Geographical scalability (cloud computing allows libraries to replicate data to several branch libraries world-wide); v) Automatic resource deployment (libraries only needs to choose the types and specifications of the resources required and the cloud will configure it automatically); vi) Metered billing (library will be charged for only what they use). As a whole cloud-based library automation is quite useful and cost effective for small and medium sized libraries. Large-scale libraries may offer datasets on the cloud for use by small libraries (Data as a Service or DaaS)[6]. Table1 indicates some of the well-known cloud-based services while Table 2 listed the major cloud service providers and related services.

Table 1: Cloud platform, systems and services

Cloud platform	**Cloud systems**	**Cloud services**
Software as a Service (SaaS)	Server Virtualization, Open URL resolver, Application software	GoogleDoc, GoogleApps, OpenID, Adobe
Platform as a Service (PaaS)	Cloud based ILS, Inter Library Loan	LibLime, OSSLab, N-LARN project in India, Polaris, Exlibris
Infrastructure as a Service (IaaS)	Discovery services, Digital repository, Web hosting, Storage	Amazon Elastic Compute Cloud (EC2), Amazon Simple Storage Solution (S3), Dropbox Cloud storage

Table 2: Cloud providers and services

Cloud providers	**Types of services**
Amazon Web Services	IaaS, PaaS, SaaS
EMC	SaaS
Eucalyptus	IaaS open source Software
Google	PaaS (AppEngine), SaaS
IBM	PaaS, SaaS
Lincode	IaaS
Microsoft	PaaS (Azure), SaaS
Rackspace	IaaS, PaaS, SaaS
Salesforce.com	PaaS, SaaS
VMware vCloud	PaaS, IaaS

3. Web-scale library management

Web-scale library management service is essentially a cloud based solution developed by OCLC. In this service, OCLC member libraries are getting shared computing infrastructure and shared data from WorldCat. OCLC is successfully mixing four basic elements of cloud computing i.e. IaaS, PaaS, SaaS and DaaS (see cloud computing section above). There has been a change in trends of library automation. It is no longer about which library provides the largest collection but about which library can provide their community with the best means to access the materials they need, regardless of location[9]. Libraries can increase visibility at the global scale and accessibility to services at the wider scale by using the new Web-scale library management facility. The architecture of OCLC's Web-scale library management is given in Fig.1.

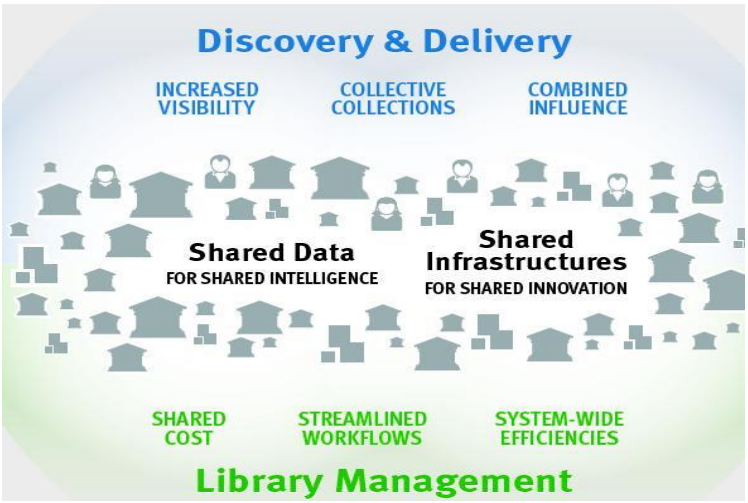

Fig.1: Web-scale Library System

(Source: OCLC (2011), Libraries at web-scale, Dublin, p. 23)

Software and Standards

Architectural design and infrastructural support provides a guideline in development of base line but not the product line. Software is the visible product to control the automation scenario in a library. Software based on standards and standards ensures interoperability. The emerging trends in this pivotal area of library automation are:

4. Increasing use of open source software

The domain of library and information science, right from the beginning of the open source movement, is benefited through structured effort and software philanthropy. We have matured ILSs like Koha (comparable to any global ILS), Evergreen, Emilda, NewGenLib; comprehensive digital library software like DSpace from the MIT, US (with support from HP), Greenstone Digital Library Software (or GSDL) from University of Waikato (presently supported by UNESCO). Use of open source ILSs are increasing all over the world because of the transparent use of library standards and scope of

customization to suite the specific requirements of a library. Moreover commercial ILSs are also utilizing open source components like MARCEdit & ISISMARC (MARC cataloguing tools), YAZ toolkit (Z 39.50 client and server), Lucene & Solr (Text retrieval engines), Unicode-compliant multilingual tools etc. The use of open source software in library automation ensures 3F – fund (as these are free of cost), freedom (as these are free to customize) and fraternity (as these are supported by International community's)[10,11].

5. Emergence of open standards

Open standards are available in public domain. These are the standards that anyone can incorporate into their software, service and system. MARC record standard is possibly the most visible open standard in the domain of library services. Library systems of any type or size are required to be compatible with global standards to achieve interoperability. Here lies the importance of open standards. These are developed, approved and maintained via collaborative process to facilitate exchange of datasets. These standards are available at no cost, well-documented, transparent and free from any kind of use restriction. ILSs are increasingly depending on open standards such as MARC-21 family of standards (Five standards), OAI/PMH, CCL (Common Command Language), ZING, Dublin Core metadata standard, SRU, SRW, OpenURL, MARC-XML, METS, MODS etc.[12,10].

6. Interoperability capabilities

Interoperability refers to communication between systems (external interaction) or system parts (internal interaction). Libraries are now operating in distributed information environment and many library systems communicate electronically with sources of bibliographic records (publisher or cataloguing agencies), book vendors, and users. They also now interconnect themselves with networked information resources outside of the library and deliver these through library-maintained interfaces; for example, inter library loan, distributed cataloguing, metadata harvesting, etc. ILS developers are aware of these facts and thereby supporting more and more interoperability standards in different modules of ILSs[10].

Organization and Processing

Library automation supports housekeeping operations and processes documents in different forms and formats for easy retrieval by end users. The ongoing changes in organization and processing of library materials through ILS are as follows:

7. New cataloguing standards

Document description models and standards are changing rapidly. We have now E-R (entity-relationship) based bibliographic data model known as FRBR (Functional Requirements for Bibliographic Records, developed by IFLA in 1998) in place of flat data structure of ISBD. Similarly FRAD ((Functional Requirements for Authority Data, developed by IFLA in 2009), FRSAR (Functional Requirements for Subject Authority Records, developed by IFLA in 2010) are now established data models for managing name authority and subject authority respectively. These changes call upon necessary data structures in ILSs to suite FRBR, FRAD and FRSAD. Both commercial ILS group

(e.g. Vitua ILS from VTLS group) and open source ILS group (e.g. Koha) are in the process of implementing the structural changes to address the improvements in cataloguing.

8. Digital media archiving module

The distinction between automated library system and digital library is blurring day-by-day. This is because of the fact that most of the ILSs are integrating digital media arching module or DMA (e.g. NewGenLib 3.0 onwards) to handle full-text discovery of documents in different formats. This trend of ILS is important in the sense that in future library can handle both automated and digital library systems through a single instance of ILS. Another advantage of DMA is the scope to integrate courseware in multimedia formats in case of academic libraries. Some ILSs are also achieving compatibility with OAI/PMH standard to support metadata harvesting in ILS (e.g. Koha version 3.10.1 onwards).

9. Multi-lingual records management through Unicode

Multilingual (including Indic scripts) information processing requires standard text encoding scheme (such as Unicode), which can store, process and retrieve regional language based documents. But creation of multi-script databases requires not only Unicode-compliant operating system (OS) and other application programmes such as Virtual Keyboards to enter multi-script records, Open Type Fonts (OTF) to support extended character sets and layout features, and Rendering Engines to display script specific conjuncts and ligatures properly[13]. ILSs are trying to support Unicode (especially UTF-8) to store native character sets, integrated virtual keyboard and supportive text retrieval engines to ensure processing and retrieval of multilingual documents.

Outreach and Integration

Web-centric ILSs allow libraries to go beyond the four-wall of libraries in both ways. First, they can extend library automation to support outreach activities like content management, community information services. And secondly, automated library system can easily use linked open datasets like VIAF, DDC, LSCH, etc. through suitable API (application program interface). The trends in this domain may be listed as below:

10. Community information services as outreach process

Community information services do support community members with the information originated in the community. The service includes three broad groups - survival information such as that related to health, housing, income, legal protection, economic opportunity, political rights etc.; citizen action information required for effective participation as individual or member of a group in the social, political, legal, economic process; and local information i.e. basic information concerning courses, educational facilities, government agencies, local organizations, fractional groups, health professionals etc. including a calendar of local events. Some ILSs are trying to include community information service module to extend their role and outreach services. For example, Vitua ILS and Koha are supporting MARC 21 community information format to handle community information resources.

11. Linked Open Data (LOD)

Linked Open Data (LOD) refers to publishing and connecting structured data on the Web for use in public domain. The three Key technologies that support LOD are – i) URI (Uniform Resource Identifier, a generic means to identify entities or concepts in the web), ii) HTTP (Hypertext Transfer Protocol, a simple yet universal mechanism for retrieving resources, or descriptions of resources over the web), and iii) RDF (Resource Description Framework, a generic graphical data model to structure and link data that describes things in the web). Linked Open Data (LOD) has two basic purposes – (a) to publish and link structured data on the Web; and (b) to create a single globally connected data space based on the web architecture.

Tim Berners-Lee advocated four rules for converting dataset to LOD. These are – 1) Use URIs as names for things; 2) Use HTTP URIs so that people can look up those names; 3) When someone looks up a URI, provide useful information, using the standards (RDF, SPARQL); and 4) Include links to other URIs, so that they can discover more things. W3C established Library Linked Data Incubator Group in 2011 "to help increase global interoperability of library data on the Web, by bringing together people involved in Semantic Web activities — focusing on Linked Data — in the library community and beyond, building on existing initiatives, and identifying collaboration tracks for the future." Libraries may utilize bibliographic data, authority data, classification schemes, and vocabulary control devices etc available as LOD for enriching existing library services and for introducing new information services. Some major examples of library LOD are - AGROVOC multilingual structured and controlled vocabulary, British National Bibliography (BNB) published as Linked Data, VIAF, LCSH, LC Name Authority File (NAF) provides authoritative data, MARC country, and language codes, Dewey.info etc. ILSs are taking advantages of integrating LOD available in library domain through appropriate APIs. For example, the cataloguing module of Koha can be linked with VIAF (Virtual Internet Authority File – a linked dataset of authority data from 21 major national libraries of the world) for getting authority data automatically to control name authority in local library catalogue[14,15].

12. Web 2.0 compliant ILS

The present web (often referred as web 1.0 in blogsphere) is progressing towards a User-centered entity with the support of an advanced set of technological tools that are collaborative, interactive and dynamic in nature. Radfar (2005)[16] identified following characteristics of web 2.0 – i) a platform enabling the utilization of distributed services; ii) a phenomenon describing the transformation of the web from a publication medium to a platform for distributed services; and iii) a technology that leverages, contributes, or describes the transformation of the web into a platform for services. ILSs are all set to take advantages of participative architecture of the web and introducing news services like user tagging of subject descriptors, user documents ratings of documents by users, RSS feed for search query, integration with web 2.0 services like read/write web, collaborative web, social networking tools and information mashup. This new trend of ILS is also termed as ILS 2.0.

Interface and Discovery

The success of an automated library system is measured against the user participation in the process. ILSs now use AJAX (asynchronous Java and XML) technologies to support collaboration, interaction and participation of end users. The trends are:

13. Interactive user interface: OPAC 2.0

Most of the ILSs now support web-OPACs. OPAC 2.0 is the next generation web-OPAC where users can interact, collaborate and participate in library workflows such as describing resources (folksonomy), tagging subject descriptors, rating of documents, creating personalized information environment, posting on library blog, suggesting new documents, commenting on library services, publishing book reviews, posting likes on facebook for library books and many such facilities. ILSs are increasingly taking advantages of web 2.0 technologies and services to convert static OPAC into dynamic OPAC 2.0.

14. Information mashup

Information mashup tools allow remixing of data, technologies or services from different online sources to create new hybrid services[17] through lightweight API. ILS uses information mashup in managing and integrating virtual contents distributed globally with local library resources. Information mashups are becoming popular application of Web 2.0 around the world such as KohaZon i.e. integration of Koha OPAC with Amazon services (Fig.2), WikiBios (a mashup where user can create on-line biographies of each other in a Wiki setup), LibraryLookup (integration of Google maps with library directory service in UK) and many more such instances.

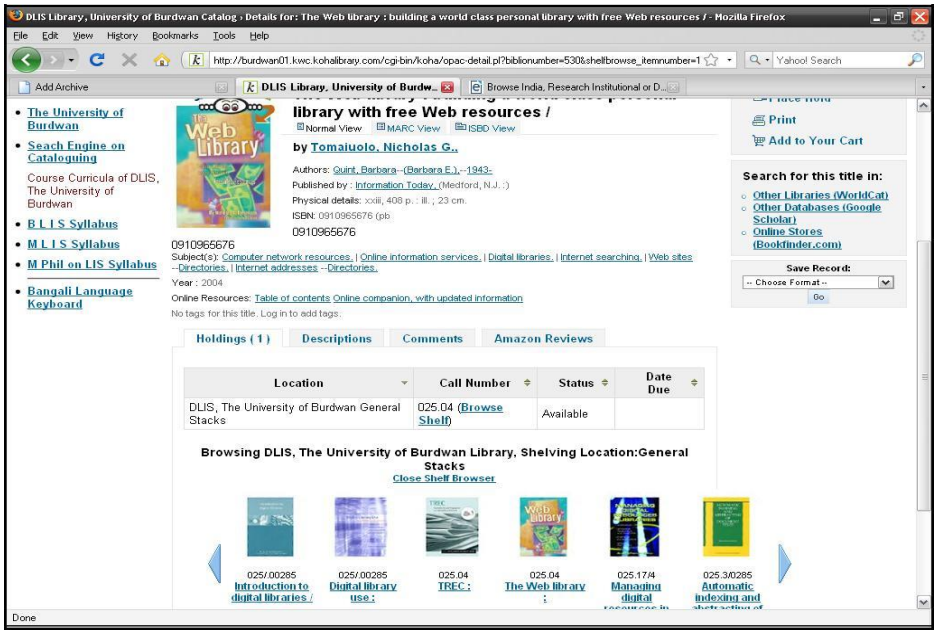

Fig. 2: KohaZon: Mashup of Koha with Amazon

15. Application of discovery tools

Uses of discovery tools are increasing in libraries. Discovery tools, powered by federated search mechanisms, allow library patrons to perform concurrent searching in the library catalogue (metadata level), journal articles (full-text level), electronic dissertations or theses, consortia databases, public web, open access repositories, union catalogues etc through a single-search interface with a set of feature-rich tools to support users. Discovery tools – i) can be integrated with existing library OPAC; ii) can import metadata into one index; iii) can apply one set of search algorithms to retrieve and rank results. As a result these tools support rich user experiences in terms of speed, relevance, and ability to interact consistently with results. Moreover, the unified interface is a big boost for users as they no longer need to choose a specific search tool to begin their search. These tools are available commercially like EBSCO Discovery Service and open source products such as VuFind, SOPAC, Blacklight, OpenBib, etc.

Conclusion

Predicting future is a risky path to travel. But at the same time right prediction leads to readiness and prompt decisions at the time of need. This paper can provide guidance – 1) to identify the future requirements for library automation; 2) to follow SoA architectural model for integrated library system; 3) to help in integrating automated and digital library system through digital media archiving; 4) to understand the future steps require for accomplishment of library automation; 5) to appreciate needs for standards in ILS and to recognize essential standards that need to be ensured; 6) to identify required features of ILS in rapidly changing technological environment. This paper also provides emerging global recommendations for developing ILS in the context of cutting edge technologies like cloud computing, linked open data and web scale library management.

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