Fourth Generation Libraries

Saji Gopinath*, Ashok Pathak*, Manoj Kumar*, M.G. Sreekumar*

Abstract

Information Technology has dramatically changed the nature of business of modern day libraries. The conventional set up of brick and mortar libraries that store information within a constrained physical space have given way to digital multimedia in information store houses that integrate data resources around the globe through effective deployment of Information Technology, without straining the tight financial resources. This has virtually eliminated the lack of geographical proximity to the information sources and ensured quick delivery of the information anywhere in the world. With the fast development of technology, it is becoming increasingly difficult for the modern day libraries to leverage on physical facilities to store and disseminate information in a relevant manner. The concept of Lean and Agile libraries that streamline information supply is gaining popularity all over the world as evident from the plethora of e-archives, digital libraries and on-line info-store houses mushrooming the Net. The spread of the Internet, coupled with the platform independent database connectivity and applicability of CORBA architecture is increasingly making development of library portals and web libraries more and more effective.

These Third Generation Electronic Libraries have the capability to work round the clock and provide access across the globe. However the time and space utility these libraries claim to provide is not realized to the full potential due to lack of communication infrastructure. In countries like India, where networking is still in its infancy, digital libraries are plagued by last mile problems. The hilly terrain of the country also makes a wired environment conducive for electronic information distribution an uphill task, limiting the spread of such ventures. These lacunae make it necessary to develop the libraries that leverage on wireless technology. In this paper we have discussed issues in developing such mobile libraries which we refer as Fourth Generation Libraries

Introduction

Libraries are mainly entrusted with a host of pre-determined tasks, viz., acquire, organise, preserve, retrieve, and disseminate pertinent information to their clientele. From the Guttenberg's press to the Global Information Infrastructure age, a library's role as an information intermediary has always been so and would continue to be the same in future. This necessitates the libraries to acquire the skills of the day quickly to perform their tasks effectively. To be more specific to the needs of the hour, their role is to help access of information irrespective of its location, and also to disseminate the same regardless of distance and time. Libraries[1] are rightly called the "store houses" of valuable knowledge,

* Indian Institute of Management, Kozhikode

in the form of invaluable books, journals and other information material. With the rapidly growing advancement in every field, more and more documents are becoming available the world over in printed and machine readable forms. Looking at the other side of the spectrum, the user expectations are very much on the increase and highly demanding.

Information technology and computers have been playing a substantial role in library resource enrichment and dissemination services ever since its inception. From the conventional role of static storehouse of information, it has matured into the proactive model of information generation and effective dissemination. The revolution in computer, information and telecommunication technologies is registering significant changes in all types of libraries in India. Availability of powerful computers at affordable cost, spread of telecommunication networks to even remote areas, advent of the Internet, increasing interest in creating digital content are some of the significant forces accelerating the pace of changes in the functioning of our libraries. Even the limitations like lack of space, poor logistic services for delivering print material, difficult terrain, etc. are proving as pressing factors for libraries to migrate into the e-world. However, with the closing gap of various disciplines, the demands of clientele is becoming multi faced making libraries to become store houses of wide variety of information. The information explosion has direct impact on libraries as they have to device ways of performing their tasks better and a faster even when the volumes are increasing at a huge pace.

Intensive development and use of modern information and communication technologies (ICT) entailed a large-scale digitization of information accumulated by mankind and, accordingly, the creation of a large number of new electronic information resources. This new form of information representation makes it possible to produce, to store and to distribute information at qualitatively better levels. To ensure public (including remote) access to information resources has become one of the priorities for those providing service to science, culture and education. Today it is obvious that the most effective way to achieve this is to create digital libraries (DL), distributed information systems ensuring reliable storage and effective use of various collections of electronic documents (text, graphics, audio, video, etc.) via global telecommunication networks in a way convenient for the end-user.

Library resources and services in institutions of higher education must meet the needs of all their stake holders, viz., faculty, students, and academic support staff, wherever these individuals are located, whether on a main campus, off campus, in distance education or extended campus programs, or in the absence of a campus at all; in courses taken for credit or non-credit; in continuing education programs; in courses attended in person or by means of electronic transmission; or any other means of distance education[2] .

Thanks to the host of technologies, today the vast and invaluable resources and services of a library are accessible to the outside world at the stroke of a button. The convenience of time and space which these libraries offer are unparalleled, propelling their unprecedented growth in the past few years.

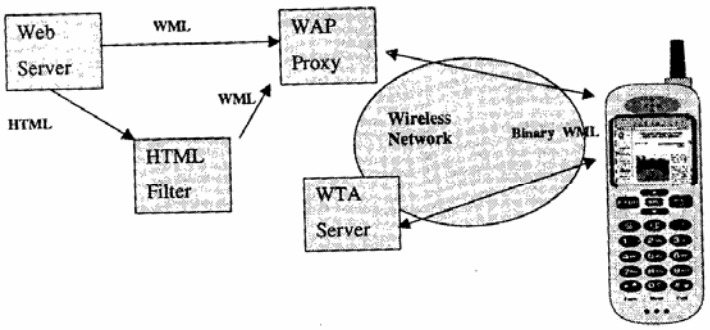
Evolution of libraries

The increasing demand from the users coupled with proactive actions of visionary librarians have seen radical changes in the libraries over the past. The First Generation had only text and pictographs as their major resources, while the Second Generation had the hybrid approach of having the print as well as digital information in varying degrees. The front office operations of these libraries were streamlined leveraging on the state-of-the-art information technology means to provide the users faster access to library resources and minimizing non-value adding time spent in the library. That advent of the SGML and the most appreciated HTML along with the TCP/IP - HTTP communication protocols paved way for the hypertext world of the Third Generation libraries. These libraries virtually eliminated the need for users' physical presence in the library, while the library resources have increased multifold, due to reciprocal linkages with leading libraries elsewhere in the world. The Third Generation libraries had streamlined supply chains of information[3] making them lean and agile. The virtual libraries which minimized the physical infrastructure of information store houses emanated during this period. However, the scope of these libraries were limited because of last mile problems of communication and need for specific computing device at the user end. Thus, virtual libraries have limited acceptability among user community and a large chunk of users especially in developing countries like India could not make the best use of sun rise technology developments in library and information science. It is in this context that the birth of the fourth generation libraries that virtually eliminates the infrastructure overhead from the users' shoulders by leveraging on the advancements in the wireless technology. These mobile libraries are expected to radically transform the conventional library set ups and empower the users with the power of information at their finger tips without having the drudgery of using large personal computers.

Wireless Libraries

The WWW has brought to us the best of both the wired and the virtual world in a record span of time. Still the Web centered around computers, its connecting networks, and the Internet Service Providers (ISP). Take away the wire and the computer, and soon we will be left in the Web-free zone, the pre-WWW era. But, if the manufacturers of information appliances have their way, the desktop and laptop computer may become irrelevant for consumer-side Web publishing, and this is a fast developing area, especially in the world of small information appliances.

Many libraries put their catalogs on their web server for outside users to access. That's easily handled by wireless. However, if libraries wish to serve CD/DVD and other high-bandwidth files, a wireless connection at this juncture won't suffice. In the wake of the VSNL's and BSNL's recent announcements and a number of corporates entering the ISP market, Libraries / Institutes may take PRI, BRI, ISDN or any other high bandwidth connectivity. The required wireless access protocols will have to be properly enabled and



WAP Network

the recommended languages and standards duly incorporated by the libraries in order to make them ubiquitous and wireless accessible.

The world of electronic information continues to advance at a rapid rate, presenting numerous opportunities and challenges for information professionals. New ways of accessing and applying information are here, and more improvements continue to be introduced. In turn, this raises questions about the obligation, if any, to offer end-user access support and the means to provide it.

Wireless applications have been struggling to get a foothold in the information industry for a number of years. The conventional view of these devices as pure voice carriers and lack proper architecture protocols could be the reason for the same. However, with the development of technology, the time is ripe for these information appliances to have a critical mass of wireless users who can create an impact on the market.

If you decide to provide wireless access to your library systems and databases soon, you're already ahead of the expected demand and can take time to decide on a measured plan of action. Therefore, now is the time to decide whether this is a form of access that you'll offer, keeping in mind that security issues are not yet totally resolved for most forms of wireless access.

A number of library applications could be translated to wireless such as information retrieval, renewal, reserve, and overdue transactions. The convenience of being able to execute library transactions via PDAs and other Internet appliances opens up another area for better communication and service between the library and its clients.

Wireless OPAC

There are a number of ways in which wireless OPAC access can be accomplished. The wireless world demands brevity. Translating your database from MARC to WAP (or another evolving format) will require a data-conversion project much like the one used to transform card catalogs to MARC. Of course, having a standard MARC format means machine-to-machine translation. This will enable a much faster project timeline than your

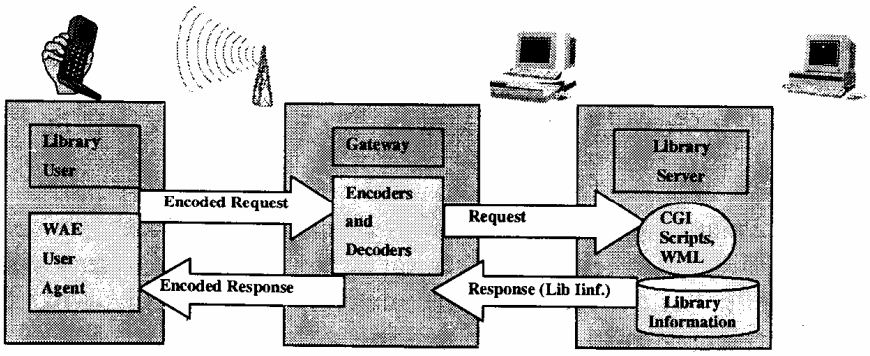
earlier conversion, and the WAP format data can be stored alongside your original MARC record. The cost of storage space has come down so much that this is a viable option. Perhaps another path to take, other than undergoing a database conversion, is to have queries from wireless devices automatically truncated by the system when they reach the database. The database would signal that abbreviated information is being used to execute the search and that the system should look for special matching algorithms. This method wouldn't require an expensive database conversion but would on the other hand require development effort on the part of the automation system vendor.

Wireless Search and Retrieval

Keeping issues in mind such as brevity, strength of signal, and screen design of wireless appliances, it's probably best (at least initially) to limit the search type, combination of keywords, and types of fields being searched. The most wireless-friendly OPAC access points would be call number (the subject classification number) and author's last name, followed by a truncated title search.

Just as important as getting your database ready for wireless access, and perhaps even a more intriguing challenge, is sending back meaningful search results to the end user's wireless device. How will results be formatted for the small screen? Can enough vital information be placed within 50 / 80 characters so that the user doesn't have to scroll through information every time he retrieves search results? Can the user know whether he has a good hit within such a stringent limitation, or will multiple hits tend to look too much alike to be useful? How will users be able to choose among multiple hits? - are some of the basic questions coming to one's mind, and which needs to be addressed.

The host of emerging languages, protocols and standards such as the XML Document Navigation Language, NaVigation Markup Language (NVML), Annotation of Web Content for Transcoding, WAP Binary XML Content Format, POIX: Point Of Interest eXchange Language Specification, Compact HTML for Small Information Appliances, HDML - Handheld Device Markup Language, i-MODE, SMS, and related technologies give a great deal of promise to the information access and interactivity of Small Information Appliances



WAP Model for Library Information

(SIA) such as the Mobiles, PDAs and Handhelds.

Compact HTML (cHTML)

The Compact HTML[4] is a well-defined suoset of HTML 2.0, HTML 3.2 and HTML 4.0 recommendations, which is designed for small information appliances. cHTML focuses on small information appliances. Small information appliances have several hardware restrictions such as small memory, low power CPU, small or no secondary storage, small display, mono-color, single character font, and restricted input method (no keyboard and mouse). The browser for cHTML proposed in this document can be implemented in such a restricted environment. Once such a subset of HTML is defined, contents providers and information appliance manufacturers can rely on this common standard. It is envisaged that cHTML definitely contributes to the rapid growth of small information appliance market.

Compact HTML does not depend on the underlying network protocol. In the typical cases, the transport protocol for Compact HTML is assumed to be HTTP over TCP/IP. However, current wireless communication networking for cellular phones is low band and low speed. In this area, the transport protocol should be defined as light protocol for better performance on the physical packet layer. It also seems useful to compress HTML contents so that most of HTML data can be stored within one packet data.

Compact HTML is defined so that all the basic operations can be done by a combination of four buttons; *Cursor forward, Cursor backward, Select*, and *Back/Stop* (Return to the previous page). The functions which require two-dimensional focus pointing like "image map" and "table" are excluded from Compact HTML.

The major features which are excluded from Compact HTML, are as follows.

- JPEG image
- Table
- Image map
- Multiple character fonts and styles
- Background color and image
- Frame
- Style sheet

The cHTML document type is defined as follows;

<!DOCTYPE HTML PUBLIC "-//W3C//DTD Compact HTML 1.0 Draft//EN">

Benefits of Compact HTML

The Compact HTML, an HTML-based approach, guarantees that small information appliances can connect to the open WWW world. Compact HTML keeps the advantage of HTML features and solves the problems arising from the restrictions of small information appliances.

The Compact HTML specification can be referred to by the tools like HTML authoring systems. In addition, the client-specific web services for such small devices can be realized by using user agent attributes. That is, the server can do the content filter for Compact HTML.

HDML (Handheld Device Markup Language)

There may be another approach which is NOT based on HTML standards. The approach of a new language may be accepted in a certain closed service. For example, a language named HDML is proposed for the mobile handheld devices. The goal of HDML is very similar to the one of Compact HTML. It seems useful for a class of handheld devices. However, the disadvantage of special language approach can be said that everything such as contents, authoring tools, server software, client software, and textbooks have to be prepared. Especially thinking about a product line from high-end PDAs to low-end cellular phones, the consistent HTML-based approach would make sense.

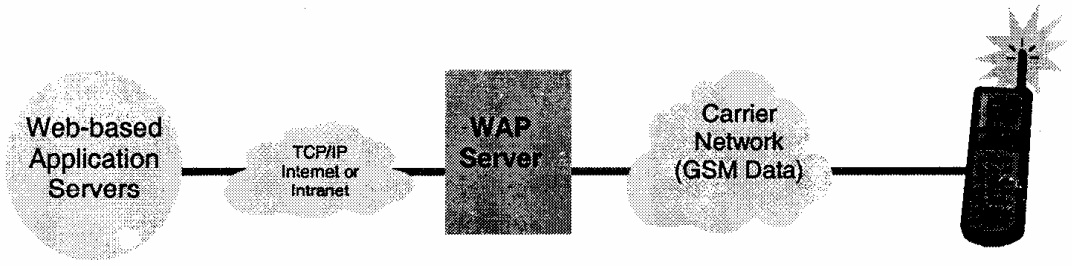
Bluetooth

Bluetooth[5] wireless technology is a specification designed to enable wireless communication between small, mobile devices. The inspiration behind this technology was the concept to eliminate the need for proprietary cables, which are currently required to enable device connectivity. Bluetooth is a global de facto standard for wireless connectivity. It enables seamless voice and data transmission via wireless, short-range radio. Bluetooth allows users to connect a wide range of devices including mobile phones, laptops and other portable devices easily without any cables. Being a radio-based link, Bluetooth doesn't require a line-of-sight connection in order to establish the communication. Bluetooth is likely to be standard in tens of millions of mobile phones, PCs, laptops and a whole range of other electronic devices.

WAP Technologies

WAP stands for Wireless Application Protocol. WAP is not a single entity, but a list of protocols and specifications. It is an open global standard for communication between mobile devices and the Internet or other computer applications, defined by the WAP Forum[6]. The objective of this standard is to serve Internet contents and services to wireless clients, WAP devices, such as mobile phones and terminals. The WAP Forum is an industry consortium of over 350 vendors that are defining the technical specifications and interoperability guidelines for the WAP protocol. The WAP Forum was originally founded by Nokia, Ericsson, Motorola and Phone.com. The current membership includes a vast majority of mobile device manufacturers, as well as a majority of the global mobile carriers (majorities defined in terms of aggregate market share).

The WAP is more than just the Internet. The Web started with the Internet, but quickly expanded to include Intranets and Extranets. WAP is about access to relevant information and content, wherever it resides.



WAP provides a new channel for existing services and the possibility for totally new services that can reach customers 24 hours a day wherever they are. It provides the same technology to all vendors regardless of the network system. It allows operators and companies to select from a wide range of products and encourage manufacturers, application developers and content providers to invest in developing WAP compatible products.

Following are some of the benefits of WAP:

- Customers receive convenience and timely access to important data by a mobile phone or device.
- The telecommunications industry avoids overlapping investments thanks to the open platform and tool for wireless messaging.
- Operators differentiate themselves by launching new and intriguing services.
- Developers and content providers can access all protocols and carriers using a single set of protocols.

Key WAP Application Categories Include:

- Wireless access to personal information (email etc.)
- Wireless access to Internet content (using WAP devices)
- Wireless access to Corporate Information Systems
- Wireless Vertical Market Solutions
- M-Commerce
- Library & Information Services

The main components of a WAP solution include: Content, Content Server, TCP/IP, HTTP, WAP Gateway, Bearer, and WAP Device, Wireless Markup Language (WML) and Microbrowser. Content - The important information one needs to access when he/she is away from his/her computer and the office LAN. Content Server - This takes the content (information) and formats it into the WML (Wireless Markup Language) Cards that the WAP Device can understand. WML Cards are very similar to the HTML Pages we use on the Web. A content server functions similar to an HTTP proxy server, except that a different set of protocols is used for communication with the mobile device. Device requests are converted into HTTP requests by the server, and are relayed to standard web servers. Some Content Servers are dedicated to a certain role such as Infinite InterChange that can be used immediately to provide WAP access to E-mail mailbox. Other Content Servers use

general-purpose Web Servers such as IIS or Apache. These require the customer to build their own custom applications, such as the "Query Order Status" application mentioned above.

TCPIP / HTTP - The WML Cards are carried across a TCPIP network (the company's Intranet, or the public Internet) in the same way as Web pages. WAP Gateway (or "WAP Proxy") - The WML Cards cannot be delivered directly to a WAP Device. Instead they must pass through a WAP Gateway, which translates them into a compressed "byte-code" format that the WAP Device understands. This compression helps to get the best performance from the WAP Device. Personal WAP users are likely to use their Mobile Operator's WAP Gateway. Corporate users and WAP Content providers such as Banks are likely to need better control and / or security. Bearer - The Bearer is the communications path between the WAP Device and the WAP Gateway. The three most common Bearers are:

- SMS - Available on most mobile phones, but performance can be unpredictable.
- CSD - (Circuit Switched Data). Very similar to dialing from a home PC to an ISP. Its disadvantage is that while it is used, you cannot make or receive voice calls.
- Packet - The ideal solution, but not yet widely available.

WAP Device - This usually includes a WAP Mobile Handset and Personal Digital Assistants and Terminals.

New digital CDMA (Code Division Multiple Access) cell phones have changed the rules, making it trivial to connect notebooks to the Internet. Now, one can just plug a cable from the phone manufacturer between the cell phone and the notebook's serial port, and after a brief software setup let the Windows' standard dial-up networking dial a special code instead of a regular phone number. A few seconds later the notebook will be on the Internet, able to surf the Web and run a secure VPN Tunnel into the corporate Intranet so that user can read Email or access any other service available on the Intranet. This CDMA digital data is not, yet, "high speed", however.

There's an intriguing technical difference between this and the way it used to work; now, there's no modem involved at all! The digital signal from the notebook goes through the cell phone and its digital CDMA data stream, through the cell phone company's Internet gateway, and out onto the Internet, without ever going through a pair of modems' digital-analog-analog-digital gentle ministrations. There is no further need to dial the normal dial-in ISP, because the cell phone network puts the user right on the Internet! U.S. CDMA cellular systems may be able to support ISDN-speed data within a year or so.

Wireless Markup Language (WML)

The language that is used to produce pages of information that can be displayed on a mobile phone or other mobile device. WML has roots in HTML and XML, but is better designed for constrained devices. WML stands for Wireless Markup Language and is what

HTML is to a web browser. It is based on XML (eXtensible Markup Language) or it is an XML application. Just like HTML and XML, WML is read and interpreted by a browser built into the WAP device.

For WAP devices, the official WML specification is developed and maintained by the WAP Forum, an industry-wide consortium founded by Nokia, Phone.com, Motorola, and Ericsson. This specification defines the syntax, variables, and elements used in a valid WML file. The actual WML 1.1 Document Type Definition (DTD) is available for those familiar with XML[7]. A valid WML document must correspond to this DTD or it cannot be processed.

There are many other reasons for using WML in the WAP environment instead of HTML. The most important reason is that WML requires very little bandwidth resources compared to HTML. Other important reason is that WML requires relatively less processing power on a wireless device compared to HTML, resulting in longer lasting batteries. Finally, HTML really requires larger displays than the display on a mobile device such as a mobile phone. It's of course possible to have large displays on mobile devices, but the larger the device is, the less mobile it will be.

Microbrowser

This is the software built into the WAP device that presents a user interface allowing users to interact with WAP-compatible applications, content and services. The software is commonly called a microbrowser, indicating that its capabilities are somewhat limited. These capabilities are of course also limited to the capabilites of the WAP device in which it lives. WAP-compatible applications, content and services send WML pages to a device in order to interact with the user through the WAP microbrowser built into a device.

The Dublin Core

From the cataloguing point of smart data organisation and information retrieval, the Dublin core assumes a great deal of significance. The Dublin Core Metadata Initiative (DCMI) is an international standard for describing information resources. The DC Qualifiers build upon the DC Metadata Element Set, which provides 15 categories to describe resources on the Web. Known as the Dublin Core, the metadata model has become the de facto standard for description of information on the Internet. The deployment of Dublin Core in various projects around the globe, in addition to the World Wide Web Consortium's (W3C) impending finalization of a metadata[8], Resource Description Framework (RDF), has spawned widescale discussions about the future for this flexible and robust standard. Although Dublin Core can be used to describe materials in traditional formats, its developmental thrust has been as a means to adequately describe Internet resources. In fact, one of the most controversial uses of Dublin Core would be as a replacement to MARC.

Into the Future

For the next generation libraries, it will be an interoperable document object world as envisaged in Sun Micro Systems' Jini[9] technologies, which will be playing substantial role in information access and delivery. Technology will get perfected to the extent that information will be pertinent, precise and pin pointed and the same will be delivered by gadgets which are not conventional information appliances. The mode of delivery of the information will also need not be digital and multimedia through these conventional appliances. It will be an assemblage of photonic, digital and multimedia through a number of gadgets such as the TV, refrigerator, two-in-one, or any other forthcoming device capable of delivering the information in a number of ways. With this convergence, the one-device one-world paradigm will emerge. Will this radical change redefine the role of information scientists and professionals is a matter of major concern to all knowledge workers. The convergence of user and the service provider may be an off-shoot of this paradigm shift creating a catch 22 situation to the modern librarians or the cybrarians. Information professionals will be effective when they empower users for autonomous information services which makes their existence. How to come out of this vicious circle will be or should be a major area of studies and we end this paper with the hope that several such studies will be initiated in the near future.

Acknowledgement

The authors would like to place on record the encouragement and support received from Prof. A.H. Kalro, Director, IIM Kozhikode.

Further Readings

1. Developing Library Network (DELNET - formerly, Delhi Library Network) (http://delnet.nic.in/)
2. Association of College and Research Libraries, Distance Learning Section (http://www.ala.org/acrl/guides/distlrng.html)
3. Sreekumar, M.G. and Gopinath, Saji Supply Chain Management of Information. Proceedings of the Seventh National Convention for Automation of Libraries in Education and Research - Caliber 2000, Chennai, 16-18 Feb. 2000: 1.214-1.222.
4. http://www.w3.org/Mobile/
5. Anywhereyougo (http://www.anywhereyougo.com)
6. WAP Forum (http://www.wapforum.org)
7. XML (http://www.wapforum.org/DTD/wml_1.1.xml)
8. ONLINE (special issue) January, 1999.
9. Jini technology (http://www.sun.com/jini/)