

Open library systems – a new perspective

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A note of terminology

In the UK and some other countries the term library management system (LMS) is used more frequently than integrated library system (ILS). In the Higher Education (HE) sector these terms are being replaced by library services platform (LSP).

Open library systems – a new perspective

Over the last decade or so, open-source software became, for many, the chief factor in defining open library systems. This paper argues the need for a new, wider perspective on open library systems.

What is openness?

Aside from open source, the 21st century has seen the growth of several open initiatives that have particular resonance with libraries. They include Open Access, Open Research/Science, Open Data, Open Educational Resources (OER), open textbooks and open university presses. All these initiatives have gained traction in the last decade and are supported by a variety of open and proprietary technologies.

The open landscape is complex with multiple and potentially conflicting views about open systems. Technology journalist Larry Anderson recently distilled the definition down by stating that:

An open system provides maximum flexibility as a system evolves over time. In other words, an open system doesn't lock you in, or limit your choices. [...] Augmenting or expanding a system should be easy and manageable within an existing environment without extra disruption or expense.¹

In the present day, we see (non-open source) 'proprietary' solutions, including library systems, define themselves as open. The rationale lies typically around their use of open application programming interfaces (APIs)² and data standards. These are publicly available and often supported by not-for-profit communities rather than single commercial software vendors. They provide developers with programmatic access to a software application, enabling, as Anderson described the capability to easily augment or expand a system beyond its core functionality.

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Such systems are increasingly labelled 'platforms'. The term *library services platform* (LSP) was coined in 2011 by library consultant Marshall Breeding to describe a new generation of solutions and to differentiate them from older Integrated Library Systems (ILS)/Library Management Systems (LMS). In his view, a key justification for the new term was that 'they enable the library to perform its services, internally and externally through their built-in functionality, as well as exposing a platform of Web services and other APIs for interoperability and custom development'.³

What is open source?

Perhaps the most famous open-source initiative, the LINUX operating system, appeared in 1991.⁴ However, the term 'open source' did not gain wide currency until the end of the

1990s. The ‘Open Source Initiative’ (OSI) was founded in February 1998 to encourage use of the new term and evangelise open-source principles.⁵

For some, open-source software stands at the heart of the technology debate about openness. In his influential 2006 book, *The Wealth of Networks*,⁶ Yochai Benkler described free/open-source software as ‘the quintessential instance of commons-based peer production. An approach to software development that is based on shared effort on a non-proprietary model. It depends on many individuals contributing to a common project, with a variety of motivations’.

Licensing

In their 2021 book ‘Open Source Library Systems’, Robert Wilson and James Mitchell define open source as:

software whose licenses permit individuals or groups to copy, inspect, use, and improve upon it. Primarily, this distinction draws a clear line between OSS [Open Source Software] and proprietary software. Developers of proprietary software do not share the source for the software, and proprietary licenses prohibit attempts to reverse engineer the software.⁷

Open-source projects are collaborative. A ‘community’ that may include companies, not-for-profits and individuals work together to create or improve a product.⁸ However not all open source is the same. What users are permitted do with the software components, their obligations, and what they cannot do is determined by the way the code is licensed. This is analogous to open Creative Commons licences,⁹ which are primarily used to enable the free reuse of content such as documents and images. While there are over 200 types of open-source software licences, Wilson and Mitchell outline the two main categories that apply to library systems:

- Permissive licences: These minimise restrictions on reuse.
- Copyleft licences: These ‘prevent a person from modifying, changing and distributing copyleft software under different licensing terms than the original licence’.¹⁰

Permissive open-source licences, sometime referred to as ‘anything goes’, place minimal

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restrictions on how others can use open-source components, thus permitting use in proprietary solutions. For example, the proprietary TIND library system uses

elements from the open-source, MIT-licensed Invenio system.¹¹ The FOLIO library system is licensed under a permissive (Apache 2.0) licence and, like Invenio, might at some stage form the core of a proprietary offering.

The most popular open-source licence is GNU's General Public License (GPL).¹² It is a specific implementation of the copyleft concept.¹³ Richard Stallman, free software movement activist and programmer, created the GPL to protect GNU software from becoming proprietary. Any software based on any GPL component must be released as open source. The Koha library system is licensed under a GPL.

The commercialisation of open source

Most of the big name technology companies such as Google, Microsoft and Amazon are heavily invested in open source.¹⁴ Microsoft, historically known for its opposition to open-source software, has enthusiastically embraced the approach. The company open-sourced some of its code and made investments in Linux development, including the Linux Foundation and Open Source Initiative. In 2018, Microsoft acquired GitHub, the largest host for open-source project infrastructure.¹⁵ Open source has now become pervasive, especially since the shift to cloud and mobile computing – technologies powered to a large extent by open source. Along the way it has lost some of its commons-based peer production aura. Many open-source initiatives, including library systems, are now largely developed and funded by commercial companies.

Open-source library technology

Libraries engaged with open-source solutions from an early stage. In 1999 the open-source Koha library system was developed, with its first installation in 2000.¹⁶ In 2008, Jisc¹⁷ set up the Repository Support Project (RSP) to support and develop the UK network of institutional repositories (IRs). It ran until 2013 and helped many universities create their own IRs. These were typically managed by libraries and largely (though not exclusively) based on open-source solutions such as EPrints¹⁸ and DSpace.¹⁹

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Library systems

There are several open-source discovery and library management systems. In terms of discovery Blacklight was released in 2009, VuFind in 2010 and Aspen in 2019. More recently, the community open-source Project Reshare²⁰ is developing a solution for resource sharing. From a higher education (HE) perspective the most significant library management systems (LMS/ILS) are Koha and FOLIO.

Koha

Although Koha has been around since 1999/2000, it did not figure in the higher education library landscape in the UK or US until a decade later. This was largely because 'it lacked basic requirements (such as support for MARC records and record transfer through Z39.50), and it had only minimal capabilities for acquisitions, serials management, and other areas of

functionality'.²¹ These gaps were filled and, in the UK, Staffordshire University was the first to implement it in 2011.²²

Koha was a web-based system from the start, which gave it a competitive edge over some other ILSs. Nevertheless, in functional terms, Koha is a conventional library system with a focus on the management of print materials. Electronic resource management capabilities are generally supported by integration with the separate open-source CORAL system.²³ In terms of discovery, it does not support a central index (of typically ejournal content) so, where that is a requirement, libraries use it in conjunction with a proprietary discovery service such as EDS or Summon.

FOLIO

The alpha version of the FOLIO ('Future of Libraries Is Open') library system was released in January 2018. It claims to move 'beyond the traditional library management system to a new paradigm, where apps are built on an open platform'.²⁴ It is framed as a fundamentally

For some libraries a key attraction of an open-source library system is that it can give them software developed specifically to meet their own needs

new type of library platform, with 'open source software, modular components, and a microservices-based technical infrastructure'.²⁵ It can be considered the first open

source library services platform (LSP). The Open Library Foundation, an independent not-for-profit organisation, hosts the project and the software company Index Data developed the initial platform. The initiative received, and continues to receive, 'significant financial contributions' from for-profit EBSCO.²⁶

FOLIO followed the demise of the earlier Kuali OLE (Open Library Environment) project that was active from 2007 to 2016. The Kuali OLE software was only implemented in three institutions: University of Chicago, Lehigh University, and SOAS Library of the University of London. The Open Library Environment organisation, which managed the Kuali OLE project, has shifted its efforts from building its own software to supporting the FOLIO project.

Development

For some libraries a key attraction of an open-source library system is that it can give them software developed specifically to meet their own needs. Because the code is open, an enhancement can be made by a library (if it has the skills and resources), a third party developer or more usually one of the commercial companies supporting the system. Libraries may also adopt a model of sponsored development. Groups of stakeholders cooperate and financially support specific enhancements, which are then folded into the software to benefit all users. With a proprietary system, by contrast, customers may have to wait for their development request to rise to the top of the vendor's list of potential enhancements.

Furthermore, a shared community-development model means that, unlike a proprietary solution, vendors, companies and other open-source solution providers don't need to carry the full development costs of a library system. They can target their development resources on specific needs and/or focus on non-software development areas such as customer support.

Governance

Vendors of proprietary software have tight governance and control over how their solutions are developed and how they integrate with external solutions via documented, typically 'web services'²⁷ connectivity. Even the most aligned open-source community must be organised, and some degree of governance is essential. This can help ensure that bespoke developments are incorporated into the new release of the standard system. The Koha project, for example, 'is loosely governed by a committee formed by Horowhenua Library Trust'.²⁸ Loose governance can be attractive to many potential developers/stakeholders but can result in a lack of overall strategic direction.

The FOLIO open-source initiative recognises the need for a strategic roadmap. 'Although the FOLIO Project does not have direct influence over the work of external developers and teams, we will endeavor to include the goals and accomplishments of these external development efforts in the roadmap when possible'.²⁹ This approach is easier for FOLIO which, unlike Koha, is primarily targeted at academic libraries. The Technical Council considers which best practices will achieve the outcomes set out in the roadmap.^{30,31} FOLIO also has many special interest groups which bring in the domain expertise required.³²

The availability of commercial service providers was the key driver in the adoption of open-source library systems in HE

Service providers

You don't *need* a vendor to acquire or implement an open-source library system. You can download, install and run it yourself. Nevertheless, many open-source initiatives positively encourage for-profit vendors to get involved. In terms of library systems, the open-source service providers include non-profit organisations such as Equinox Open Library Initiative and for-profits including ByWater Solutions, EBSCO Information Services, Index Data and PTFS-Europe.³³

The availability of commercial service providers was the key driver in the adoption of open-source library systems in HE. They can respond to a formal Invitation-To-Tender (ITT) or Request-for-Proposal (RFP), which has been the way most university library systems are procured. In the US and Canada, almost all implementations of integrated library systems based on open-source software rely on commercial services from a vendor.³⁴ This is also true of the UK. Indeed, these service providers can look very much like a conventional

library system vendor and may also sell proprietary solutions alongside their open source offerings.

Companies such as PTFS-Europe and Bywater in the US provide support for implementation, including training, project management and development. In this way, they help mitigate the perception that open-source solutions require a library to have a high level of specialist technical and/or software development staffing to implement, manage and develop the system. Nevertheless, according to the 2022 Library Perceptions Survey, 'many libraries avoid open source products due to a perception that they would need more staff with technical skills'.³⁵

Market penetration

While proprietary software remains the dominant approach, a growing percentage of libraries are adopting open source library systems.³⁶ By 2020, open source accounted for over 7% of academic library implementations in the US.³⁷ In the UK, PTFS-Europe supported Koha implementations represent around 5% of the HE library systems market.

A changing library systems market

In part, open-source library solutions gained popularity in response to frustrations about the state of the library systems market. In 2007, a major UK library management system (LMS) study was commissioned jointly by Jisc and SCONUL (Society of College, National and

The conventional (ILS/LMS) library system did not successfully develop to encompass the management and workflows of new areas of library activity

University Librarians). The report was published in 2008³⁸ and painted a picture of a mature market dominated by four vendors with products that were not strongly differentiated.

In 2012, librarians from Princeton University Libraries and the College of New Jersey Library expressed their frustration and concluded: 'It is obvious that we are at the tipping point for a dramatic change in the area of library automation systems.'³⁹

In the same year, writing for NISO's Information Standards Quarterly on the future of library systems, Carl Grant commented: 'The amount of change we've seen, both in computer technology and in library management/operations, is so substantial that the best way to accommodate the change is to start with a fresh design that can take advantage of all of these changes.'⁴⁰

Moving beyond the ILS

The conventional (ILS/LMS) library system did not successfully develop to encompass the management and workflows of new areas of library activity. It remained print-focused in an era when most library spending went on electronic resources. Libraries need technology solutions that go way beyond the core functionality of an ILS to enable their growing supporting role for teaching and learning and especially research. It's now more appropriate

to think of a library technology ‘ecosystem.’ This may include a reading list solution, a system for archives, a digital preservation solution, repositories of various kinds and a research management system. There may also be a library-run university press.

Some research universities have library based ‘Open Research’ teams to facilitate ‘sharing research outputs (e.g. research protocols, methodology, code, data and publications) as early as possible in the research process in a way that enables access and reuse by others’.⁴¹ Such capabilities are beyond the scope of an ILS. The library at Liverpool University, a major research university in the UK, implemented its ‘Elements’ solution⁴² in 2016 ‘to help researchers manage information about their research and impact activity. It collects a range of data from multiple sources (including existing internal systems and web resources such as Scopus) and presents it all together within one single web-based interface’. It is based on the Elements research management system from Symplectic.⁴³ The ILS/LMS or even the LSP is increasingly marginalised in this environment, and its value is diminished.

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Addressing dissatisfaction and frustration with the library systems market

The growing frustrations with the library systems market have been addressed in two quite different ways.

Community, open-source responses

The Open Library Environment (OLE) project was launched in 2009 with a \$2.3 million grant from the Mellon Foundation and matching funds from the Quali OLE founding partners. In 2014 there was an additional grant of \$882,000. However even after a total investment by the Foundation of over \$6 million by 2016, the initiative failed.⁴⁴ Meanwhile, Koha did gain traction based on its open-source community appeal, functionality, a coherent web-based interface and support from a range of capable service providers. Nevertheless, some saw Koha’s architecture as limiting. FOLIO took a community open-source approach with a more modern architecture to move ‘beyond the traditional library management system to a new paradigm, where apps are built on an open platform’.⁴⁵ However, at the time of writing, the open-source core of FOLIO does not extend in functional terms far beyond a conventional ILS. Libraries will need to purchase additional, predominantly proprietary solutions to deliver a meaningful ‘ecosystem’.

Vendor, proprietary responses

Around 2009/2010, the first of a new generation of proprietary systems, exemplified initially by Ex Libris’ Alma, became credible. In 2011, OCLC launched its cloud-based WMS library services platform.⁴⁶ These were new systems built from the beginning as cloud-based, multi-tenant systems. These new systems allowed for more efficient, integrated workflows for electronic and print resources - what Ex Libris termed ‘Universal Resource Management’.⁴⁷

The underlying technology of these platforms differed radically from older systems. Within each multi-tenant environment, there is only one copy of the application software, one operating system and one database supporting multiple organisations on a single bank of servers. The vendor only has to deploy, develop, maintain and upgrade one copy of the software. The efficiency benefits of what is in effect one single global (or at least multi-

Many librarians and commentators make the point that choice of library systems has steadily narrowed over decades

national) library system has enabled software development to outpace older approaches. For example Ex Libris has added new applications including a reading list (Leganto) and a

research information management solution (Esploro) to what it now positions as a cloud-based platform for higher education. In the UK this approach enabled Ex Libris to increase its market share from 23% in 2008 to over 37% in 2020. The WMS cloud-based platform enabled OCLC to make a breakthrough into the UK HE market and establish a small but significant and growing market share.⁴⁸

However, other vendors such as SirsiDynix, Innovative Interfaces and, in the UK, Capita (now Education Software Solutions) balked at the task of creating new systems and continued with what they saw as an evolutionary approach to development. In the main these vendors have continued to lose HE market share. In the UK, for example, Capita/ESS's market share halved from 2008 to 2020, and SirsiDynix dropped from over 22% to 14% in the same period.⁴⁹

A consolidating market

Many librarians and commentators make the point that choice of library systems has steadily narrowed over decades. Mergers and acquisitions have reduced the systems available.⁵⁰ While some librarians are concerned by what they see as a lack of choice, Marshall Breeding suggests that competition remains, despite consolidation and the products implemented in the Association of Research Libraries reveal a more competitive environment now than there was a decade ago.⁵¹

Open library systems – a new perspective

Larry Anderson believes that it's wrong-headed to consider whether a system is fully open or closed. In reality it's a spectrum:

One might think that a system is either open or closed, but in fact, there are many degrees of openness, reflected by how many third party technologies are integrated and how easy the integrations are [.....] Open may not be completely open, and closed may not be completely closed.⁵²

From 'battle' to cooperation

In 2012 the divide between open-source and propriety library technology approaches was seen as a 'battle'.⁵³ A decade later, we see a more nuanced view emerging. Proprietary

library system platforms make use of open-source software inside their solutions and enable third parties (using proprietary or open-source approaches) to integrate to add functionality and reuse data. For example, OCLC publishes a range of its APIs on its developer network.⁵⁴ Ex Libris has a Developer Network,⁵⁵ a presence on the GitHub and an 'App Center' for publishing and searching for apps which extend the Ex Libris platform.

FOLIO takes a similar approach,⁵⁶ engaging both open-source, community and commercial software developers. For example, FOLIO libraries can use the open-source VuFind discovery solution developed by Villanova University in the US or, if they need a central index of electronic content (typically journal articles), the proprietary Ebsco Discovery Service (EDS).

Platforms and scale

Cloud-based platforms hide much of the complexity of the technology, whether open source or proprietary and have hastened what in 2012 Christian Reilly, Manager of Global Systems Engineering at Bechtel termed 'the dawn of infrastructure irrelevance.'²⁶ System librarians are a dying breed and 'should re-engineer themselves accordingly so that they will be able to support more critical issues in the library'.⁵⁷

Platforms work best at a large scale. A global platform can extend a partner's reach into new sectors and geographies. The more customers a platform has, the more likely open APIs and data standards will be developed.

Furthermore, data at scale delivers huge insights, and technologies such as artificial intelligence need

Whether based on open source or proprietary software, the elements of the ecosystem need to interoperate

considerable investment and work best with large volumes of data. Building these platforms requires a level of investment that only the largest, well-funded vendors or open-source communities can deliver.

Interoperability - a challenge for the library sector

Whether based on open source or proprietary software, the elements of the ecosystem need to interoperate. Achieving better integration means supporting and developing APIs and also enabling open data. Some progress has been made by vendors and through organisations such as NISO⁵⁸ and BIC⁵⁹ but Todd Carpenter of NISO remarks, 'fundamental advances in management of library information [...] have been slow to advance'.⁶⁰

For example, back in 2008 the Digital Library Foundation (DLF) ILS Discovery Interface Task Group (ILS-DI) published its Technical Recommendation for an API for effective interoperation between integrated library systems and external discovery applications.⁶¹ In 2022 libraries and vendors are still doing ad-hoc integrations that rarely achieve the full ambitions set out by those recommendations. Similarly BIC's Library Communications Framework (LCF) published in 2014 has made only modest progress.

Ambitions for open bibliographic data also remain thwarted. #biblios.net was unveiled just before the American Library Association Midwinter Meeting in 2008 with a data store containing over thirty-million records licensed under the Open Data Commons Public Domain Dedication and License.⁶² It has faded into oblivion. Initiatives such as ‘Plan M’ in the UK,⁶³ which started in 2018 as a project for ‘Exploring Supply and Demand Conditions in the Library Data Market’ is making slow progress in opening up bibliographic records for unfettered re-use. Recent initiatives such as Invest in Open Infrastructure (IOI) which aims to ‘collaboratively develop a shared roadmap and agenda for investment in open infrastructure for research and learning’⁶⁴ suggest some ways forward but much more needs to be done.

Conclusion

Libraries choose their technology solutions based on a combination of technical, cultural, and organizational factors, and most take a pragmatic business view. Solutions are almost always going to be some mix of open-source and proprietary technologies. All are based on a unified, integrated core, even though components of the core may differ. With a more dedicated focus on interoperability the next decade promises to be deliver an innovative, and competitive technology ecosystem for libraries.

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References

Links were current on 27th May 2022

- ¹ What is an open system? Larry Anderson. SourceSecurity.com. N.D
<https://www.sourcesecurity.com/insights/open-system-interoperability-rises-security-trend-co-8173-ga-sb.20393.html>
- ² Open APIs Wikipedia. https://en.wikipedia.org/wiki/Open_API
- ³ Library Services Platforms: A Maturing Genre of Products. Marshall Breeding. Library Technology Reports. ALA TechSource Volume 51, Number 4 2015. <https://journals.ala.org/ltr/issue/download/509/259>
- ⁴ History of Linux. Wikipedia https://en.wikipedia.org/wiki/History_of_Linux
- ⁵ Open-source software. Wikipedia. https://en.wikipedia.org/wiki/Open-source_software
- ⁶ The Wealth of Networks: How Social Production Transforms Markets and Freedom. Yochai Benkler. Yale University Press. 2006.. ISBN-13. 978-0300125771 http://www.benkler.org/Benkler_Wealth_Of_Networks.pdf
- ⁷ Wilson, Robert and Mitchell, James. Open source library systems: a guide. 2021. Rowman & Littlefield, Maryland; p.2–3.
- ⁸ Open Source Software. Navigating the ecosystem. Marshall Breeding. American Libraries. 1 November 2017. <https://americanlibrariesmagazine.org/2017/11/01/open-source-software/>
- ⁹ About CC Licenses. Creative Commons [website] <https://creativecommons.org/about/ccllicenses/>
- ¹⁰ Wilson, Robert and Mitchell, James. Open source library systems: a guide. 2021. Rowman & Littlefield, Maryland; p.3–4.
- ¹¹ Wilson, Robert and Mitchell, James. Open source library systems: a guide. 2021. Rowman & Littlefield, Maryland; p.42.
- ¹² GNU General Public License. <https://www.gnu.org/licenses/gpl-3.0.en.html>
- ¹³ Copyleft. Wikipedia <https://en.wikipedia.org/wiki/Copyleft>
- ¹⁴ Amazon, Microsoft, and Google are all ramping up open source work. By Mayank Sharma. TechRadar. 20 July 2021
<https://www.techradar.com/news/amazon-microsoft-and-google-are-all-ramping-up-open-source-work>
- ¹⁵ Microsoft and open source. https://en.wikipedia.org/wiki/Microsoft_and_open_source
- ¹⁶ Koha (software). [https://en.wikipedia.org/wiki/Koha_\(software\)](https://en.wikipedia.org/wiki/Koha_(software))
- ¹⁷ Jisc. A not-for-profit UK higher, further education and skills sectors' organisation for digital services and solutions. 'Who we are and what we do' [Website] <https://www.jisc.ac.uk/about/who-we-are-and-what-we-do>
- ¹⁸ EPrints. <https://www.eprints.org/uk/>
- ¹⁹ DSpace. <https://duraspace.org/dspace/>
- ²⁰ Project ReShare is designing an open source, highly-scalable platform that supports discovery, fulfillment, and delivery workflows. <https://projectreshare.org/>
- ²¹ Adoption Patterns of Proprietary and Open Source ILS in U.S. Libraries. Marshall Breeding. Computers in Libraries 35(8):17-2. October 2015 <https://librarytechnology.org/document/21505>
- ²² McGarvey V, Staffordshire University's Koha journey: taking an integrated approach to supporting an open source library management system, Insights, 2018, 31: 21, 1–7; DOI: <https://doi.org/10.1629/uksg.411>
- ²³ 'CORAL is an electronic resource management system initially started by the University of Notre Dame's Hesburgh Libraries'. CORAL website <http://coral-erm.org/>
- ²⁴ FOLIO. <https://www.folio.org/>
- ²⁵ 2020 Library Systems Report. Fresh opportunities amid consolidation. Marshall Breeding. American Libraries. 1 May 2020 <https://americanlibrariesmagazine.org/2020/05/01/2020-library-systems-report/>
- ²⁶ FOLIO. A New Open Source Initiative. Marshall Breeding. ALA Techsource. Vol 53, No 6 (2017) <https://journals.ala.org/index.php/ltr/article/view/6408/8458>
- ²⁷ A web service is a software system designed to support interoperable machine-to-machine interaction over a network. Wikipedia. https://en.wikipedia.org/wiki/Web_service
- ²⁸ Wilson, Robert and Mitchell, James. Open source library systems: a guide. 2021. Rowman & Littlefield, Maryland; p.32.
- ²⁹ FOLIO Roadmap Process. <https://wiki.folio.org/display/PC/FOLIO+Roadmap+Process>
- ³⁰ Open systems and library analytics. Webinar from Research Information sponsored by EBSCO Information Services. 13 Oct 2021 <https://communities.ebsco.com/posts/open-systems-and-library-analytics>

-
- ³¹ The FOLIO Open Source Library Services Platform. Tamir Borensztajn. EBSCO 2021. <https://www.researchinformation.info/sites/default/files/content/white-paper/pdfs/The%20FOLIO%20Open%20Source%20Library%20Services%20Platform%20%282%29.pdf>
- ³² Special Interest Groups. FOLIO Product Council. <https://wiki.folio.org/display/PC/Special+Interest+Groups>
- ³³ 2021 Library Systems Report. Advancing library technologies in challenging times By Marshall Breeding. 3 May 2021. <https://americanlibrariesmagazine.org/2021/05/03/2021-library-systems-report/>
- ³⁴ Library Strategies in a Consolidated Industry. by Marshall Breeding. Library Technology Newsletter February 2022. <https://librarytechnology.org/document/27081>
- ³⁵ Library Perceptions 2022: Results of the 15th International Survey of Library Automation by Marshall Breeding, 17 April 2022. <https://librarytechnology.org/perceptions/2021/>
- ³⁶ Open Source Software. Navigating the ecosystem. Marshall Breeding. American Libraries. 1 November 2017 <https://americanlibrariesmagazine.org/2017/11/01/open-source-software/>
- ³⁷ 2020 Library Systems Report. Fresh opportunities amid consolidation. Marshall Breeding. American Libraries. 1 May 2020 <https://americanlibrariesmagazine.org/2020/05/01/2020-library-systems-report/>
- ³⁸ JISC & SCONUL Library Management Systems Study: An Evaluation and horizon scan of the current library management systems and related systems landscape for UK higher education. March 2008 <http://www.webarchive.org.uk/wayback/archive/20140615073047/http://www.jisc.ac.uk/media/documents/programmes/resourcediscovery/lmsstudy.pdf>
- ³⁹ The Next Generation Integrated Library System: A Promise Fulfilled? By Yongming Wang and Trevor A. Dawes. Information Technology and Libraries. September 2012 <http://napoleon.bc.edu/ojs/index.php/ital/article/viewFile/1914/pdf>
- ⁴⁰ The Future of Library Systems: Library Services Platforms. By Carl Grant. NISO. Information Standards Quarterly. Fall 2012. Vol. 24. Issue 4. ISSN 1041-0031 http://www.niso.org/apps/group_public/download.php/9922/FE_Grant_Future_Library_Systems_%20isqv24n04.pdf
- ⁴¹ Open Research. Welcome to the Library's Open Research service. Liverpool University [website] <https://www.liverpool.ac.uk/open-research/>
- ⁴² Case Study: Elements Implementation at The University of Liverpool. Symplectic [Website] <https://www.symplectic.co.uk/case-study-elements-implementation-at-the-university-of-liverpool/>
- ⁴³ Elements research management system. Symplectic (part of Digital Science) [Website] <https://www.symplectic.co.uk/theelementsplatform/>
- ⁴⁴ Marshall Breeding. Kuali OLE (Defunct) ALA Techsource Vol 53, No 6 (2017) Chapter 4. <https://journals.ala.org/index.php/ltr/article/view/6407/8456>
- ⁴⁵ FOLIO website. <https://www.folio.org/>
- ⁴⁶ OCLC Technology. <https://www.oclc.org/en/about/technology.html>
- ⁴⁷ The URM Vision. Ex Libris [website] [https://knowledge.exlibrisgroup.com/Alma/Product_Documentation/010Alma_Online_Help_\(English\)/010Getting_Started/010Alma_Introduction/020The_URM_Vision](https://knowledge.exlibrisgroup.com/Alma/Product_Documentation/010Alma_Online_Help_(English)/010Getting_Started/010Alma_Introduction/020The_URM_Vision)
- ⁴⁸ Library System market overview. Higher Education Library Technology [website] https://helibtech.com/library_systems_market_overview
- ⁴⁹ Library System market overview. Higher Education Library Technology [website] https://helibtech.com/library_systems_market_overview
- ⁵⁰ 2021 Library Systems Report. Advancing library technologies in challenging times By Marshall Breeding. 3 May 2021. <https://americanlibrariesmagazine.org/2021/05/03/2021-library-systems-report/>
- ⁵¹ Library Strategies in a Consolidated Industry. by Marshall Breeding. Library Technology Newsletter February 2022. <https://librarytechnology.org/document/27081>
- ⁵² What is an open system? Larry Anderson. SourceSecurity.com. N.D <https://www.sourcesecurity.com/insights/open-system-interoperability-rises-security-trend-co-8173-ga-sb.20393.html>
- ⁵³ BIC's battle of the library systems! Open v Proprietary. Book Industry Communication. 28th November 2012. <https://www.bic.org.uk/files/pdfs/Speaker%20biogs.final.pdf>
- ⁵⁴ OCLC Developer Network. OCLC APIs <https://www.oclc.org/developer/api/oclc-apis.en.html>
- ⁵⁵ Ex Libris Developer Network. <https://developers.exlibrisgroup.com/>
- ⁵⁶ Folio Developers. <https://dev.folio.org/>

⁵⁷ Supporting the Next-generation ILS: The Changing Roles of Systems Librarians. Ping Fu. Journal of Library Innovation. Volume 5, Issue 1, 2014

https://www.researchgate.net/publication/299458119_Supporting_the_Next-generation_ILS_The_Changing_Roles_of_Systems_Librarians

⁵⁸ "NISO is where content publishers, libraries, and software developers turn for information industry standards that allow them to work together." NISO website. <https://www.niso.org/>

⁵⁹ For example: "This LCF standard is recommended by BIC as the best way to implement communications between systems within a library, for example between a Library Management System (LMS/ILS) and an RFID Self-Service Solution." Library Communications Framework (LCF). Book Industry Communication (BIC) website. [https://bic.org.uk/114/Library-Communications-Framework-\(LCF\)/](https://bic.org.uk/114/Library-Communications-Framework-(LCF)/)

⁶⁰ Out-of-Date Systems Are Holding Libraries Back. Todd Carpenter. NISO. June 2021.

<https://www.niso.org/niso-io/2021/06/out-date-systems-are-holding-libraries-back>

⁶¹ DLF ILS Discovery Interface Task Group (ILS-DI). Technical Recommendation. An API for effective interoperation between integrated library systems and external discovery applications. Revision 1.1. December 8, 2008. https://old.diglib.org/architectures/ilsdi/DLF_ILS_Discovery_1.1.doc

⁶² biblios.net Emerges, a New Opportunity for Catalogers (and Competition with OCLC)? Norman Oder. Library Journal 27 January 2009

<https://web.archive.org/web/20120505123159/http://www.libraryjournal.com/article/CA6632425.html>

⁶³ Plan M: streamlining the bibliographic metadata marketplace. Jisc <https://www.jisc.ac.uk/rd/projects/plan-m>

⁶⁴ Invest in Open Infrastructure (IOI) is "an initiative dedicated to improving funding and resourcing for open technologies and systems supporting research and scholarship" IOI website. <https://investinopen.org/about/>