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E-resource knowledge bases and link resolvers: an assessment of the current products and emerging trends

This article summarizes the findings of a study on e-resource knowledge bases and OpenURL-based link resolvers sponsored by the National Library of Sweden. The project involved soliciting detailed information from each of the providers of the major products in this genre, reviewing product information available on the web and in published articles, and conducting a survey addressed to libraries using these products. The report identified and presented comparative information on a top tier of products that includes KnowledgeWorks and 360 Link from Serials Solutions; SFX Global KnowledgeBase and the SFX link resolver from Ex Libris; LinkSource and the EBSCO Integrated Knowledge Base from EBSCO and the WorldCat knowledge base from OCLC. A second tier included TOUResolver from TDNet, Gold Rush from the Colorado Alliance of Research Libraries and GODOT from Simon Fraser University. Innovative Interfaces, Inc offers the WebBridge link resolver but does not produce a knowledge base. The library survey revealed relatively narrow differences in the statistical results. Serial Solutions emerged as more favorable in most categories except for end-user functionality where Ex Libris received higher ratings. The Global Open Knowledgebase project (GOKb) is noteworthy as a nascent community-based effort to produce a knowledge base. Key trends noted include less emphasis on knowledge bases and link resolvers as stand-alone products as they become integral components of comprehensive discovery and automation products.

Background

The National Library of Sweden commissioned the author to conduct a study to examine the major e-resource knowledge bases and their associated link resolvers. The study, carried out in January through April 2012, includes information collected from the providers of these products as well as data provided by the libraries that use them regarding their experiences of their quality and effectiveness. It focuses primarily on the knowledge bases, though it also examines the functionality offered in the link resolvers. In addition to these characterizations of the products, the report also provides observations regarding the role that these products play in the broader landscape of library automation and some of the trends currently in motion. A preliminary report was submitted to the sponsor in February 2012, with the final 100-page report completed in May 2012.[1]

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General findings

The project found the knowledge bases and link resolvers of Ex Libris, Serials Solutions and EBSCO to be as extensive and accurate as can be reasonably expected; each has seen significant commercial success and they received generally positive rankings from the libraries that employ them (see Table 1). The products of these companies have been sold both as stand-alone link resolvers and as components in broader product suites. OCLC's WorldCat knowledge base has similar capabilities, but follows a somewhat different approach and is specifically targeted now to those libraries involved with its WorldCat Local discovery service and its WorldShare Platform applications. OCLC has withdrawn

its previous link resolver. The knowledge bases produced by these organizations stand in close competition, with relatively minor points of differentiation in their comprehensiveness and quality. These four products currently stand as the top tier of products, above other commercial and community-based products such as WebBridge from Innovative Interfaces, the Gold Rush Link Resolver from the Colorado Alliance of Research Libraries, and the community-based GODOT/CUFTS project led by Simon Fraser University.

Category	Ex Libris	Serials Solutions	EBSCO	OCLC
Knowledge base	SFX Global KnowledgeBase	KnowledgeWorks	EBSCO Integrated Knowledge Base	WorldCat knowledge base
Year introduced	2000	2003	2003	Openly 1Cate 2001; 1Cate OpenURL 2003; WorldShare License Manager 2012
FTE involved in KB maintenance	29	12	29	8
Update frequency	Weekly (SFX V.4)	Monthly, but varies by resource	Continuously	Regenerated monthly through Pubget
Number of installations	2,350	974	Over 3,000	Not reported
Pricing	License fee or subscription. scaled to size of library	Annual subscription scaled to size of library	Annual subscription fee scaled by user FTE	
Deployment	Local or hosted	Hosted only	Hosted only	Hosted only
E-journal holdings	Yes	Yes	Yes	Yes
E-book holdings	Yes	Yes	Over 677,000 e-books represented	Yes
Chapter-level linking	Supported, but few sources provide data	Supported, but few sources provide data		Chapter-level metadata provided in KB
APIs	Full API set through SFX	Full API set through 360 Link	None	WorldShare Platform offers relevant APIs
Peer-reviewed materials	25,753 journal titles	No statistics available, but subscribers to Ulrichsweb can use API	Over 16,000 flagged as peer reviewed	No statistics available
E-Journal finding aid	A-Z listing built into SFX	Part of 360 Core	EBSCO A-to-Z	A-Z Listing integrated into WorldCat Local
Discovery products	Primo / Primo Central	Summon	EBSCO Discovery Service	WorldCat Local
Electronic Resource Management	Verde	360 Resource Manager	EBSCONET ERM Essentials	WorldShare License Manager
Library Service Platform	Alma	Intota	-	WorldShare Platform
MARC Record	Optional MARCit! service	Optional 360 MARC	EBSCO MARC Updates	Pilot project underway
KB available separately	No. Packaged with SFX	Packaged with 360 Core	Packaged with A-to-Z or other products	WorldCat knowledge base included with OCLC Cataloging Service; WorldShare License Manager priced separately
KBART involvement	KBART Phase I and II	KBART Phase I and II	KBART Phase I and II	KBART Phase I and II

Table 1. Summaries of top-tier knowledge bases and link resolvers

The Kuali OLE project and JISC have recently launched a joint project funded by the Andrew W Mellon Foundation to create a Global Open Knowledgebase (GOKb), a community-based knowledge base; however, this is not described as a replacement to commercial knowledge bases though it does seem positioned to serve as an alternative, with similar scope of e-content coverage (and an enhanced data model). It will become the knowledge base for Kuali OLE.

The study did not reveal any of the products in this top tier as entirely superior to its competitors. All four have strengths and weaknesses that will shape their appeal to any given library. The genre of link resolvers can be generally regarded as mature with each of the key commercial products having ample time to match the features and functionality of its competitors. Each of the knowledge bases addresses a similar quantity of materials and provides libraries with the ability to manage resources they hold not already present in the knowledge base.

The library survey responses included both positive and negative comments about each of the knowledge bases. Serials Solutions' 360 Link generally received the highest scores. It rated more positively in response to questions concerning general satisfaction, comprehensiveness of the knowledge base, quality of the knowledge base, responsiveness in making corrections, and ease of administration. Libraries using SFX from Ex Libris gave the highest scores when rating the effectiveness of end-user linking. For all of the survey questions, the spread of scores between highest and lowest among 360 Link, SFX, and EBSCO's LinkSource was relatively narrow. The survey revealed subtle more than dramatic differences. (See Table 2)

"One of the fundamental observations of this study involves the tremendous resources it takes to create and maintain these e-content knowledge bases."

One of the fundamental observations of this study involves the tremendous resources it takes to create and maintain these e-content knowledge bases. Such a project involves establishing procedural and technical arrangements with hundreds of content producers, having a very complex and scalable technology infrastructure, and programming automated processes to manage the in-flow of resource lists. In addition to such technical infrastructure, each organization devotes significant numbers of personnel (Ex Libris: 29; Serials Solutions: 12; EBSCO: 29; OCLC: 8). Despite bringing to bear such resources, the survey and its comments reflect that each of the knowledge bases continues to exhibit at least some level of errors. The second tier and community-based projects have more modest resources at their disposal.

We can expect that the knowledge base products will become less differentiated in terms of quantity of materials covered over time. As the KBART recommended practices[2] become broadly implemented, each of the knowledge base providers will have access to the same source data and from roughly the same set of content providers. Content providers will make

Survey results				
Category	Ex Libris	Serials Solutions	EBSCO	OCLC
Overall satisfaction	6.89	7.36	6.67	
End-user linking	7.26	7.09	6.61	
KB comprehensiveness	7.08	7.73	6.98	
KB quality	6.59	7.33	6.58	
Responsiveness	5.80	6.93	6.05	
Ease of administration	6.11	6.80	6.05	
Considering migration	18.40%	7.75%	13.04%	

Note: There were insufficient responses from libraries using OCLC products to be included in the main tables of the survey results.

Table 2. Responses showing subtle differences in 'scoring' of knowledge bases

their KBART-compliant source lists available to any interested knowledge base producer, ultimately resulting in some leveling of the quantity and quality of data available among knowledge bases.[3]

So far, community-based efforts at creating e-resource knowledge bases have not been able to result in alternatives to the commercial products. The CUFTS knowledge base created by the staff of Simon Fraser University offers a basic knowledge base, but with very limited coverage. The Gold Rush knowledge base and link resolver created by the Colorado Alliance of Research Libraries has created a somewhat more complete product. These two products fall into a tier of completeness, complexity and cost significantly below the mainstream commercial offerings. Yet, for libraries with more modest needs and budgets, these non-commercial products find a welcome niche.

GOKb, a joint project from Kuali OLE and JISC with the backing of the Andrew W Mellon foundation, may have some potential as a community-sourced knowledge base. This project, recently funded and just underway, aims to fill in some gaps that exist in the current products and can potentially tap the resources from the libraries associated with these two organizations to create and maintain a viable knowledge base. Yet, the resources anticipated for GOKb fall below what currently supports each of the commercial products with similar objectives and to which it aims to stand as an alternative.

Trend towards knowledge bases tied to broad strategic services

Link resolvers and their associated knowledge bases entered the market just over a decade ago as stand-alone products that operated largely independently of existing library management systems, online catalogs, or discovery interfaces. Today, knowledge bases are increasingly positioned as an integral component of a broader set of inter-related products from each vendor, including not only link resolution, but also federated search, electronic resource management, discovery, and as a key asset in next-generation library services platforms. Each of the top-tier companies offering linking and knowledge bases are involved in the development of new strategic discovery or automation platforms.

In the current dynamics of the library automation environment, link resolvers and their associated knowledge bases are positioned less as stand-alone products offered separately, but as part of the infrastructure of a company's strategic product suites. Using a third-party knowledge base in most cases will introduce redundant efforts of synchronizing the library's electronic holdings among multiple knowledge base or linking products. It remains possible to mix and match link resolvers and their knowledge bases with automation or discovery products from other providers, but such an arrangement comes with a higher burden of maintenance. Some libraries have already migrated away from link resolvers and knowledge bases previously in place to achieve better alignment with newly acquired discovery services. We can expect further migrations to take place associated with the implementation of Alma, Intota, WorldShare Management Services and other new-generation library services platforms.

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An overview of the top-tier knowledge bases and link resolvers

Ex Libris Global KnowledgeBase and SFX

Ex Libris ranks as one of the largest companies in the global library automation industry and specializes in software products for research and academic libraries. In addition to SFX and its Global KnowledgeBase covered in this report, Ex Libris offers two major library management systems, Aleph and Voyager, the Primo and Primo Central discovery products, Verde electronic resource management system, the Rosetta digital preservation platform, DigiTool digital asset management, and a variety of

other products and services. Recent development efforts have been focused on the creation of Alma, the company's new library services platform which is expected to be available in general release in mid-2012.

Ex Libris offers the SFX link resolver, based on the SFX Global KnowledgeBase it maintains on behalf of its customers, though it also relies on error reports from its customers as one of its channels for amendments and corrections. SFX stands as the original OpenURL link resolver, with initial development at the University of Ghent. Ex Libris acquired the rights to the technology in February 2000 and has offered SFX as a commercial product since 2001. The company facilitated OpenURL as the *de facto* method for context-sensitive linking and was a key participant in the establishment as a NISO standard. The SFX Global KnowledgeBase has expanded significantly in the course of the last decade and continues to be a core component of many of the products and services of Ex Libris.

Some form of what is now the SFX Global KnowledgeBase will become a component of Alma, the company's new library services platform. Having separate knowledge bases for its Verde electronic resource management system and its SFX link resolver has been somewhat problematic. With Alma, these two knowledge bases finally come together and will be one component of its Community Catalog.

Ex Libris steadfastly resists characterization of its knowledge base according to counts of the items it manages, since each of the knowledge base producers differs in how such counts are measured. The knowledge base has grown steadily over the decade it has been in production; Ex Libris reports about 10 percent growth each year. SFX has been implemented by libraries in 62 countries in different geographic regions. This broad international deployment helps shape the growth of the knowledge base. SFX provides tools for libraries to add any resources not in the global knowledge base to their local instance.

The SFX Global KnowledgeBase reflects the needs of Ex Libris' primary clientele of academic and research libraries oriented more toward scholarly publications (with less emphasis on popular and news-oriented materials).

Ex Libris has significant processes in place to maintain the quality of the knowledge base and to keep it up to date. It uses automated scripts to validate data before it enters the knowledge base and to test that it has been loaded correctly, and to check the entire database. Ex Libris also allocates personnel to the maintenance of the knowledge base. The company reports 29 FTE personnel involved with loading content into the knowledge base and dealing with quality assurance.

Ex Libris offers a comprehensive application programming interface (API) to its SFX link resolver that provides access to the data in its underlying knowledge base. This API has been used by projects such as Umlaut, originally developed at Georgia Tech, which entirely replaces the user interface of SFX. The company has a well-established track record of offering APIs for its automation products. Alma will likewise offer APIs that provide access to its data and services, including the central knowledge bases.

EBSCO LinkSource Integrated Global Knowledge Base

EBSCO Publishing ranks as one of the largest providers of content products to libraries. The company's EBSCOhost platform aggregates abstracting and indexing databases, e-journals, e-books and other resources. In addition to its flagship content offerings, EBSCO offers technology products that facilitate the access and management of electronic resources. EBSCO's deep involvement with the provision of content products provides a strong foundation for its product offerings in the broader realm of discovery and resource management.

EBSCO participates in the OpenURL linking arena primarily from the perspective as a publisher of aggregated databases delivered through its EBSCOhost platform and as a subscription agent for libraries. These two business activities provide a variety of synergies toward the development of knowledge bases of e-content holdings and for link resolution.

EBSCO initially launched its LinkSource link resolver in 2003 and has steadily expanded its portfolio of technology products related to linking, access and management of electronic resources. In addition to the vendor-neutral linking through LinkSource, EBSCO also provides a proprietary SmartLinks+ technology for creating direct links to full text available in its own EBSCOhost databases or EBSCO e-journals.

The EBSCO Integrated Knowledge Base serves as the basis for all of the company's discovery and management products. While the EBSCOhost and EBSCONET product families operate on separate platforms, they share the EBSCO Integrated Knowledge Base as their core knowledge base.

Unlike the knowledge bases of Serials Solutions and Ex Libris, EBSCO makes changes continually that become active immediately, rather than loading updates in periodic batches. EBSCO does not currently offer any APIs into its knowledge base or link resolver.[4] However, it does offer tools for exporting holdings data that can be imported into other products.

EBSCO does not reveal the exact number of implementations of any of its products or services. Until recently, LinkSource was licensed separately. It is now available to all libraries that have licensed the company's popular EBSCO A-to-Z product, which is currently in use in over 3,000 institutions.

Serials Solutions KnowledgeWorks

Serials Solutions operates as a subsidiary of ProQuest, which is part of the Cambridge Information Group. ProQuest ranks as one of the major companies producing content products for libraries, and has continually expanded since its founding in the 1930s as University Microfilms through creating new product lines and through the acquisition of other companies. In 2004, ProQuest acquired Serials Solutions, which offers a variety of products related to the management, access and discovery of library resources.

Serials Solutions, founded in 2000 by brothers Peter and Steve McCracken, traces its beginnings to the creation of lists and other resources to help libraries keep track of their e-journal holdings and has steadily expanded to include a wide array of products and services related to the access and management of electronic resources. In the last year, the company has further expanded its scope with the launch of a new platform, Intota, which will manage all aspects of a library's collection, including both print and electronic materials. The company launched its link resolver, initially called Article Linker, now known as 360 Link, in 2003. From its inception, Serials Solutions has based its products on its core knowledge base.

KnowledgeWorks lies at the center of all of Serials Solutions' product line and the company has created a sophisticated infrastructure to facilitate its maintenance. All the title lists received describing content products pass through a process that normalizes and corrects the data before it enters the knowledge base. The process relies on rule statements programmed to identify and correct known categories of errors, with new rules established as needed. Currently, over 100,000 rule statements have been established and around 200 new ones are created each month. Most databases are updated into KnowledgeWorks monthly, though the frequency varies according to the dynamics of each product.

Serials Solutions deploys all of its major products as a multi-tenant software-as-a-service, where all sites share a single instance of the software and data components with no software installed locally. All management of the resources and access is delivered through web-based interfaces. Libraries use the Client Center, a web-based tool provided by Serials Solutions, to configure and localize 360 Link to their specific holdings and customizations.

OCLC WorldCat knowledge base and WorldCat Local link resolution

OCLC operates as a global non-profit co-operative founded in 1967 that provides a wide array of services to its members and customers throughout the world. Its original activities were based on cataloging and other bibliographic services, which have steadily

expanded to include inter-library loan and other resource-sharing services, collection analysis, digital asset management products and end-user discovery services. OCLC has made a variety of strategic acquisitions of other organizations that provide bibliographic services and companies that produce library automation systems. Since 2009, OCLC has been developing its own library management services, currently known as the WorldShare Management Services and WorldCat License Manager, which operate on the company's new infrastructure, the WorldShare Platform.

OCLC became involved with OpenURL link resolvers and knowledge bases when it acquired Openly Informatics, which offered the 1Cate link resolver in January 2006. Openly Informatics was founded in June 1998 by Dr Eric Hellman. Following the acquisition of Openly Informatics, the 1Cate link resolver and its knowledge base became the basis for OCLC's WorldCat Link Manager, which was offered as a stand-alone link resolver.

Recently, OCLC has discontinued the WorldCat Link Manager product. WorldShare License Manger subsumes this functionality within its broad scope of electronic resource management. The WorldCat Local discovery service includes an OpenURL link resolution service based on the library's holdings set in WorldCat. OCLC offers OpenURL link resolution as part of WorldCat Local without additional costs, including an A-Z listing service for electronic resources. Libraries that previously licensed the WorldCat Link Manager have mostly migrated to new products, some to WorldShare License Manager and others to commercial products.

The WorldShare License Manger provides a suite of tools and services for the management of electronic resources. It includes a link resolution service and manages subscriptions, access policies, licenses, vendor, and rights management and relies on the WorldCat knowledge base.

OCLC offers the WorldCat knowledge base not as directly tied to any specific product, but as a data resource it can be tapped by any of OCLC's current or future services. The WorldCat knowledge base currently drives the OpenURL link resolution within WorldCat Local and the recently announced WorldShare License Manager. Within the confines of WorldCat Local, most links can be resolved entirely behind the scenes without the need to present users with a menu to invoke a link resolver.

Adopting a very different approach from that of Ex Libris, Serials Solutions, or EBSCO to populate and maintain its knowledge base, OCLC works with the organization Pubget to create an automated process for loading data into the WorldCat knowledge base. Pubget's primary product is a search engine for finding scientific papers. OCLC has partnered with Pubget to use their proprietary technology to retrieve holdings for each of the library's subscriptions. By providing the usernames and passwords for each of their subscribed resources, Pubget is able to automatically harvest all of the holdings available and record them in the WorldCat knowledge base. Where other methods rely on descriptions provided by content providers of what is expected to fall within a package, Pubget harvests what is actually available. OCLC reports that the WorldCat knowledge base is fully regenerated every month.

We place OCLC's WorldCat knowledge base in the top tier for products due to the fact that the scope of the resources covered and the process in place for maintenance are at the same level as those from Serials Solutions, Ex Libris and EBSCO. Yet, WorldShare License Manager has only been recently introduced and has not yet seen a large number of installations.

Second tier products and projects

TDNet Global KnowledgeBase

TDNet, a company based in Israel, offers a suite of products related to electronic resource management or access. Products include the TOUResolver, Electronic Resource Management, an A-Z product, all reliant on the TDNet Global KnowledgeBase. TDNet is a

business activity of Teldan Information Systems. Teldon also offers subscription services, distributes information products in the area of science and technology, as well as the TDNet products for access and management of electronic resources. The company did not respond to the questionnaire submitted for the study.

Gold Rush

Provided by the Colorado Alliance of Research Libraries, Gold Rush include several components, including A-Z listings, an OpenURL link resolver, electronic resource management and a utility for comparing content among content packages.

Gold Rush, with basic capabilities, can be considered a low-cost alternative to the more full-featured and significantly more expensive commercial products. There are currently around 75 libraries that make use of the Gold Rush Link Resolver

WebBridge

Innovative Interfaces, Inc offers the WebBridge link resolver, primarily to libraries that use its Millennium ILS. For the Library Journal Automation Marketplace 2011 survey, Innovative reported that 385 libraries have implemented WebBridge.

The WebBridge link resolver can make use of holdings data from third-party knowledge bases, or the library can populate its own. Innovative Interfaces, Inc does not maintain a global knowledge base on behalf of the libraries that use WebBridge. Innovative offers a product called CASE (content access service) that provides coverage data for WebBridge and electronic resource management. The company reports that CASE is based on data licensed from OCLC from the WorldCat knowledge base, so will not be discussed separately.

OLinks

OhioLink developed its own OpenURL link resolver called OLinks for its member libraries. Its knowledge base was populated primarily to represent the subscriptions of OhioLink. OhioLink will discontinue OLinks by the Fall of 2012. All members of OhioLink currently use OLinks and will transition to other products.

Community Source Projects

CUFTS (open source project launched at Simon Fraser University)

Simon Fraser University initiated the reSearcher product suite that involves the GODOT link resolver implemented as open source software and CUFTS, a community-developed open access knowledge base. reSearcher formerly included a federated search utility dbWiz, but when the Simon Fraser University Library implemented Serials Solutions Summon in 2011, support for this product was withdrawn.

Compared to the commercial knowledge bases, CUFTS is relatively limited. The CUFTS Open Knowledgebase currently contains around 475 resources. The knowledge base is managed by the Simon Fraser University Library, in collaboration with the community of libraries that also use the system. In December 2011 (the date of the last update), 12,336 journal titles were included. As of May 2012, 43 libraries use reSearcher.

Kuali OLE: Global Open Knowledgebase

The Kuali OLE project aims to create a new generation enterprise-level library automation platform for academic and research libraries through a community source development model. One of the key tenets of the Kuali OLE involves providing tools to manage all types of library resources, including print, digital and electronic. Following a one-year planning project, Kuali OLE is currently involved in a two-year process to build the software, an initial version of which is scheduled for completion of by the end of 2012.

A recently-added component of this project includes the creation of a knowledge base to support the management of electronic resources, called the Global Open Knowledgebase, or GOKb. As mentioned, this new activity has received funding from the Andrew W Mellon Foundation, and it has approved a grant proposal for a project to be carried out between April 2012 and March 2013. The proposal describes a collaborative engagement between JISC and Kuali OLE, with North Carolina State University serving as the lead institution. Susan Nutter, Vice Provost and Director of Libraries Administration at NCSU and Rachel Bruce, Innovation Director, Digital Infrastructure for JISC, serve as principal investigators for the GOKb project.

The GOKb project aims to create a community-supported knowledge base that can be used by multiple projects for the management of electronic resources. While the resulting knowledge base will initially target the immediate needs, the design and intellectual property arrangements will support other institutional and commercial uses. The data underlying GOKb will be made available under the Creative Commons 0 (CC0) public domain license, following the method described in the Science Commons Protocol for Implementing Open Access Data[5]. The technical infrastructure for the knowledge base will be created as open source software under the Educational Community License 2.0. The GOKb will be run as a shared service: one copy of the GOKb will reside within the Kuali OLE instance of OLE, with a mirror copy managed by JISC at a location to be determined (for example, a JISC national data center). The platform will also be created to deliver access to the data that comprises the knowledge base and relevant services through the exposure of open APIs, enabling third-party applications access using modern service-oriented methods.

The GOKb project has just begun its work as of April 2012 and will continue for the next year. After the funded grant period, the project is expected to be absorbed into Kuali OLE. A model for ongoing governance and sustainability will be developed as one of the project's deliverables.

One of the early tasks of the group will involve developing the best data models for the knowledge base. The data model will specify which data elements and structure will need to be part of the global knowledge base and which would be managed in local systems. It is intended that GOKb (Kuali OLE) and Knowledge Base+ (JISC) share the same data model to facilitate the exchange of data between the two.

GOKb proposes to use existing community-based data sources, such as GODOT, to help seed its own knowledge base.

With work just underway on this project, it is much too early to place it among the primary products covered in this report. The backing of the Mellon Foundation, the involvement of JISC and the Kuali OLE partner institutions, and the increasing availability of higher-quality resource listings through KBART and other initiatives, give reason to consider GOKb as having significant potential. This optimism is tempered through a comparison of the resources already being wielded toward the commercial products which still do not entirely meet library expectations. GOKb will allow libraries, such as those implementing Kuali OLE, to not have to rely on proprietary knowledge bases and link resolvers. It does seem positioned as an alternative, and to be successful needs to have similar standards for scope and quality.

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