Process-Driven, Context-Sensitive Resource Discovery Systems: Design Concepts and Implementation Methods (Postprint)

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Abstract

[Purpose/Significance] Amidst tremendous changes in the library information service environment, this study provides ideas and specific operational methods for constructing a process-driven, context-sensitive resource discovery system. [Method/Process] Analyze the characteristics and changes in the application environment and requirements of domestic information service institutions; investigate the current application status of domestic resource discovery systems; summarize the deficiencies in user permission control functions and service process design of resource discovery systems adopted by domestic information service institutions; propose ideas for constructing a process-driven, user-role and context-sensitive resource discovery system, and introduce specific implementation methods. [Results/Conclusion] The ideas and methods introduced in this paper have been successfully applied in the application environment of Guangdong Provincial Science and Technology Library, providing valuable reference for domestic institutions with similar application environments and requirements to construct practical resource discovery systems.

Full Text

Preamble

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The Design and Implementation of Workflow-Driven and Context-Sensitive Resource Discovery Systems

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Abstract

[**Purpose/Significance**] In today's rapidly evolving library information service environment, this paper aims to provide design concepts and practical implementation methods for constructing workflow-driven, context-sensitive resource discovery systems. [**Method/Process**] We analyzed the characteristics and changes in the application environment and demands of domestic information service institutions, investigated the current application status of resource discovery systems in China, and summarized the shortcomings of imported resource discovery systems in terms of user authority control functions and service workflow design. We then proposed a design concept for building workflow-driven, user role- and context-sensitive resource discovery systems and introduced specific implementation methods. [**Result/Conclusion**] The design and methods introduced in this paper have been successfully applied in the integrated service environment of the Guangdong Science and Technology Library, providing a valuable reference for similar institutions in China that need to build practical resource discovery systems.

Keywords: resource discovery system; system integration; workflow-driven; context-sensitive; authority control
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Introduction

Since Serials Solutions released Summon, the world's first web-scale resource discovery system, in 2009, resource discovery systems have attracted global attention in the library and information science community as a revolutionary academic information discovery tool. With their "simple, fast, user-friendly, and effective" search capabilities, innovative resource organization methods, and new business models, these systems have transformed traditional library service concepts and provided users with entirely new experiences. Research and application of resource discovery systems have continued to receive widespread attention from libraries and information institutions worldwide. By the end of April 2018, over 16,000 libraries and information institutions globally had adopted index-based discovery service products such as EDS, Primo, and WorldCat Local [1].

After more than a decade of continuous development, resource discovery system technology has become increasingly mature and feature-rich. However, their primary goal remains helping users quickly and conveniently find and access

the highest-quality content for optimal research experiences. To achieve this goal, libraries and other information institutions must conduct extensive system implementation work after introducing resource discovery systems, including localization deployment and resource configuration, functional integration with existing library systems, fusion with third-party data, and development of personalized search services to continuously improve user experience and meet evolving service demands.

2. Research Status of Resource Discovery Systems

International research and application of resource discovery systems began relatively early. Ex Libris Group started developing Primo in 2006 [2], and Serials Solutions released Summon in 2009. Subsequently, OCLC launched WorldCat Local, Ex Libris introduced Primo, and EBSCOhost company launched EDS. International library and information science research has primarily focused on overview descriptions of resource discovery systems, comparative studies, usability testing, and usage surveys. For example, M.B. Hoy elaborated on the basic principles and implementation methods of web-scale discovery systems [3]; R. Rowe conducted detailed comparisons of Summon, EDS, and WCL [4]; A.D. Asher et al. performed qualitative and quantitative analyses of the search effectiveness of EDS, Summon, Google Scholar, and traditional library retrieval systems [5]; T. Sadeh conducted usability testing and research on a pre-release version of Primo before Primo Central integration [6]; D.J. Comeaux studied the usability of Primo and Primo Central [7]; J. Gross and L. Sheridan performed usability evaluations of the website featuring Summon at Edith Cowan University in Perth, Australia [8]; S. Fahey, S. Gordon, and C. Rose described usability testing studies of WorldCat Local implementation at Memorial University in Canada [9]; and S.C. Williams and A.K. Foster described usability assessments of EBSCO EDS at Illinois State University [10]. As resource discovery systems have matured and become more widely applied, international libraries have gradually shifted their focus to changes in user behavior, expectations, experiences, and information literacy during system usage, as well as exploring value beyond the systems themselves [8, 11-13].

Domestic research and application of resource discovery systems started slightly later than abroad, with research hotspots focusing more on functional comparisons, system evaluation and selection, system implementation, and solutions to problems encountered during usage. For instance, Zheng Wen conducted in-depth comparisons and analyses of the faceted filtering functions of three foreign discovery systems—EDS, Summon, and Primo [14]; Wang Yuechen compared and analyzed the functions of four major Chinese discovery systems from perspectives such as resource integration, knowledge discovery, knowledge association and prediction, document access convenience, and personalized services [15]; Li Yunhua et al. investigated the development and application of academic resource discovery systems domestically and internationally and provided recommendations for pre-selection testing and evaluation [16]; Qin Hong and Zheng

Wenyi detailed implementation points for discovery systems using the deployment of Primo at the University of Electronic Science and Technology Library as an example [17]; Dou Tianfang et al. introduced the implementation experience of Tsinghua University's resource discovery platform—"Shuimu Search" [18]; and Zhou Yigang addressed issues encountered in promoting Peking University's "Weiming Academic Search," such as Chinese word segmentation, Chinese retrieval, and unstable full-text links, proposing corresponding solutions [19].

As research and application of resource discovery systems have deepened, domestic libraries have developed higher functional requirements. The domestic library community is no longer satisfied with discovery at the "carrier" level of resources but demands discovery at the "content" level, hoping to achieve resource association organization, semantic retrieval, and intelligent services. Zeng Jianxun proposed the concept of building a national scientific and technical information discovery service system in China, emphasizing the application of knowledge organization tools such as ontologies and thesauri in the semantic knowledge organization of literature resources to form a semantically linked data resource system, promoting system functions from single resource-level discovery services to knowledge services such as citation analysis and research entity identification [20]; Yu Li explored the role and limitations of Superstar Discovery System in library knowledge services through theoretical analysis and empirical research, and proposed development ideas for semantic, mobile, and collaborative discovery systems [21].

3. Characteristics of Mainstream Resource Discovery Systems and Their Application Status in China

Currently, four resource discovery systems are widely used in China: Summon from Serials Solutions, Primo from Ex Libris, EDS from EBSCOhost, and the domestic product "Superstar Discovery System." The three foreign systems excel in foreign language resource discovery, while "Superstar Discovery" is strong in Chinese resource discovery. Among the three foreign products, each has its strengths: Summon and EDS, originating from digital resource providers, are content-rich with relatively comprehensive metadata, while Primo, starting as a system integrator, has technological advantages and is slightly superior in deep integration with OPAC [17]. Due to insufficient coverage of Chinese resources and suboptimal relevance ranking for Chinese literature in foreign resource discovery system products, some domestic libraries and information institutions (such as libraries at the University of Electronic Science and Technology, Xi'an Jiaotong University, and Sun Yat-sen University) have adopted a "dual discovery model," namely "foreign discovery system + Superstar Discovery System," focusing on providing discovery services for foreign language and Chinese resources respectively [17].

Most domestic libraries and information institutions directly utilize the functions and services of resource discovery systems after introduction, performing only simple resource integration and configuration before launching services. A

few institutions have conducted localized secondary development on this basis, achieving data and functional integration between resource discovery systems and existing institutional application systems, integration and mashup with third-party resources, and personalized service functions.

During the construction of the "Shuimu Search" resource discovery system by introducing the Primo system, Tsinghua University Library focused not only on maximizing the data and platform advantages of Primo itself but also on achieving data integration management of Primo Local and the connection between Primo and existing library systems [19]. The system integrates OPAC system data and service functions, enabling the display of collection information and real-time circulation information for Chinese and foreign language literature, multimedia CDs, e-journals, e-books, dissertations, and other resources in the resource discovery system, and providing real-time circulation functions such as direct renewal and reservation [22]. Tsinghua University Library also utilized Primo's Web 2.0 features and the openness of Wikipedia, using 3 million Wikipedia entries downloaded locally and collected academic profiles of Tsinghua scholars as independent data sources, and employing MASHUP technology to associate Wikipedia entries and Tsinghua scholar profiles with search results at the display layer of the resource discovery system [18].

After introducing Summon, Peking University Library achieved integration between Summon and the unified authentication system through secondary development: users can successfully log in using either their campus portal password or the library's OPAC password. After a single login, identity information can be carried to OPAC, interlibrary loan, dissertation submission, and Summon's library catalog; it also achieved integration between Summon and real-time circulation information of collections (RTA), enabling the display of call numbers, copy numbers, shelf status, return dates, collection types, and collection locations in Summon, as well as online circulation functions such as book reservation [19]. Shanghai Jiao Tong University Library, after introducing the PRIMO system, built the "Siyuan Discovery" system through localized deployment and secondary development. According to the library's service needs, it integrated other library systems, including unified identity authentication and OPAC service functions, enabling book reservation operations in the resource discovery system. It also conducted extensive secondary development of third-party resource information mashup, achieving mashup functions for book and journal covers (Google Books, Superstar covers, Douban covers), book reviews (Douban, Amazon), search term encyclopedias (Wikipedia), and book and journal tables of contents (Douban, self-built information databases), as well as personalized search functions such as customized database search and subject-based resource ranking [22].

The University of Electronic Science and Technology Library selected the Primo system to build a one-stop resource discovery and acquisition system—Cheng Dian Search. Through API implementation, OPAC functions were embedded and integrated into Cheng Dian Search, deeply integrating real-time circulation

information and collection location information of print collections. Table 1 summarizes the integration of resource discovery systems with existing application systems and the implementation of user authority control in some typical domestic information service institutions after introducing resource discovery systems, based on our literature and network investigation.

Table 1 Integration and Authority Control of Resource Discovery Systems in Typical Domestic Institutions

Institution	Discovery System	ILS Name	OPAC Data Integration	OPAC Service Integration	Unified Authentication & Authority Control (User Type Segmentation)	Remote Access System Integration	Document Delivery System Integration
Tsinghua University Library	Primo	Aleph	√ [23]	√ [23]	× [23]	× [23]	× [23]
Peking University Library	Summon	Aleph	√ [24]	√ [24]	√ [24]	× [24]	× [24]
Wuhan University Library	Find+	Sirsi	√ [25]	√ [25]	× [25]	× [25]	× [25]
Nanjing University Library	Superstar Discovery	—	√ [26]	× [26]	× [26]	× [26]	× [26]

Institution	Discovery System	ILS Name	OPAC Data Integration	OPAC Service Integration	Unified Authentication & Authority Control (User Type Segmentation)	Remote Access System Integration	Document Delivery System Integration
Guangdong University of Foreign Studies Library	Superstar Discovery	—	√ [27]	× [27]	× [27]	× [27]	× [27]
Guangdong Science and Technology Library	Primo	Aleph	√ [28]	√ [28]	√ [28]	√ [28]	√ [28]

Note: ILS refers to the Library Automation Management System. "OPAC Data Integration" refers to the unified revelation and discovery of print collection resources in the resource discovery system. "OPAC Service Integration" refers to providing direct services such as renewal and reservation in the resource discovery system. "Unified Authentication & Authority Control (User Type Segmentation)" refers to the integration of the resource discovery system with unified authentication systems, achieving unified identity authentication and authority control with remote access and document delivery systems, enabling user type segmentation to control full-text access permissions. "Remote Access System Integration" refers to authorized users being able to transparently invoke the remote access system when accessing the resource discovery system from outside the library to directly obtain library-licensed full text. "Document Delivery System Integration" refers to users being able to submit document requests directly from the resource discovery system to the document delivery system without repeated login or copying and pasting bibliographic information.

4. Changes in Domestic Resource Discovery Service Application Environment and Process Improvement Needs

Initially, institutions that introduced resource discovery systems were large university libraries with the following application environment characteristics: relatively homogeneous user types, relatively concentrated IP ranges, and relatively simple database service models, with most databases controlling access rights by IP range and providing the same permissions to all users within the IP range. Therefore, most university libraries directly utilized the original service processes of resource discovery systems after introduction to meet their needs for unified discovery and acquisition of resources within their IP ranges: resources with full-text permissions could be accessed immediately upon discovery, while resources without full-text permissions were indicated with extended full-text links or links to document delivery systems.

In recent years, an increasing number of other types of institutions, including public libraries, large research libraries outside universities, large enterprises, and library consortia, have begun to introduce and apply resource discovery systems. These institutions have the following application environment characteristics: (1) diverse user groups and types; (2) dispersed user IP locations, with a considerable or majority portion of digital resource users located outside the institutional IP range; (3) diverse database procurement and service models, with different service methods and access scopes for different databases: IP-limited subscription databases are only accessible within the institution; IP-unlimited subscription databases allow authorized users to access full text from outside using account passwords; usage-based billing databases authorize external users and internal users to directly access full text. The application environment of university libraries has also changed, with many beginning to provide information services to external users, serving user types beyond their own faculty and students, and extending services beyond the campus IP range. Like public libraries, university libraries also need to address the needs of faculty and other user types to use resource discovery systems from outside campus, provide resource discovery and delivery services with different permissions based on user type segmentation, and achieve one-stop service from resource discovery to acquisition.

This requires libraries and information service institutions to seamlessly integrate resource discovery systems with existing unified authentication systems, remote access systems, and document delivery systems while providing unified resource discovery services. This integration adapts to these service institutions' resource service environments, satisfies the diverse service models of subscribed databases, enables flexible authority control through user type segmentation, and provides remote full-text services for authorized users within the intellectual property rights framework, thereby improving resource discovery and acquisition service processes to achieve workflow-driven, context-sensitive one-stop resource discovery and acquisition services.

5. Design Ideas for Building Workflow-Driven, User Role- and Context-Sensitive Resource Discovery Systems

5.1 Resource Discovery System Service Flow Framework

The current service flow framework of resource discovery systems introduced by domestic libraries and information institutions (using Primo as an example) is shown in Figure 1 [Figure 1: see original paper]:

The most important component in this framework is the SFX server, a context-sensitive reference linking solution based on OpenURL launched by Ex Libris. As shown in Figure 1, after the resource discovery system frontend receives a search request from the user (Figure 1), it sends a search request to the backend (Figure 1), receives search results from the backend (Figure 1), and obtains detailed metadata information and related links (such as OPAC collection links and special resource original text links) from the metadata repository (Figure 1). The system frontend then sends an OpenURL request to the SFX server (Figure 1). The SFX server parses the OpenURL, searches and calculates in the activated knowledge base, obtains matching resources (subscribed resources Figure 1 -1, OA resources Figure 1 -2), dynamically generates corresponding full-text links (Figure 1), and finally returns context-sensitive resource acquisition service links to the user (Figure 1).

This flow has several shortcomings: (1) it provides the same process and permissions for all users, unable to flexibly control access permissions based on different user types; (2) it cannot provide context-sensitive full-text service links for different IP ranges; (3) it cannot provide remote access functions for users outside the library; (4) for resources without library permissions, it cannot directly submit requests to the document delivery system.

5.2 Resource Discovery System Authority Control and Process Optimization Ideas [30]

To address these shortcomings in authority control and process design, we improved the process during the localization deployment of the resource discovery system at Guangdong Science and Technology Library. The improved system flow framework is shown in Figure 2 [Figure 2: see original paper]:

The improved framework integrates unified authentication, remote access, and document delivery systems. After users locate desired resources from search results returned by the resource discovery system, the frontend sends an OpenURL request to the SFX server with additional user information (IP address for unlogged users, user group information for logged-in users) (Figure 2). The SFX server parses the OpenURL, searches the activated knowledge base, obtains matching resources (subscribed resources or OA resources Figure 2 -1), or returns document delivery system links if no accessible resources are available or the user lacks authorization (Figure 2 -2), then dynamically generates corresponding full-text links or document delivery requests (Figure 2 -1). Based

on user IP and login status, it determines whether to invoke the remote access system to convert to a remote access address (Figure 2 -2), ultimately providing context-sensitive resource acquisition links (Figure 2). During this process:

(1) When users locate print collection resources, Primo obtains print resource metadata and collection link information by harvesting OPAC system data and returns parsed results containing this information to the resource discovery system frontend (Figure 2), enabling users to access print collection metadata, collection location, and circulation status information. Ideally, after user login, Primo can also interact with the ILS system based on user identity and permission information provided by the unified authentication system (Figure 2 -1) to provide relevant service operations for print collection resources, such as renewal, reservation, and viewing personal borrowing history.

(2) When users locate electronic resources for which the library has full-text permissions, Primo and the SFX server return resources matching user permissions based on the user's IP address or user identity and permission information (group) returned by the unified authentication system (Figure 2 -1) (Figure 2 , Figure 2 -1). The resource discovery system frontend provides corresponding full-text acquisition links for authorized users, who can directly access full text by clicking the link; for unauthorized users, it returns direct call links to the document delivery system based on the document delivery system's interface (Figure 2 -2), allowing users to submit document requests directly by clicking the link.

(3) When authorized users access library-subscribed full-text resources from outside the library, they need to authenticate their identity through the unified authentication system. The SFX then invokes the integrated remote access system to return remote full-text access links to the user (Figure 2 -2). The remote access system is also integrated with the unified authentication system, allowing authorized users to remotely obtain full text by clicking the link.

The improved process solves the problems of flexible authority control through user type segmentation, remote full-text acquisition, and direct submission of document delivery requests. It provides corresponding full-text services based on different user roles and network environments, achieving a smooth one-stop service flow from resource discovery to acquisition.

6. Methods for Building Workflow-Driven, User Role- and Context-Sensitive Resource Discovery Systems

In 2015, Guangdong Science and Technology Library introduced the Primo-SFX system, which supports localized deployment and extended development. During system localization deployment, we seamlessly integrated the resource discovery system with existing library application systems (OPAC, unified authentication, remote access, document delivery, etc.), achieving secure infor-

mation sharing, unified identity authentication, and authority control among systems, and optimizing the system service process. The specific integration and deployment methods are as follows [30]:

6.1 Integration with OPAC System

Integration between resource discovery systems and OPAC can be divided into two levels: data-level and service-level integration. Data-level integration refers to regularly harvesting OPAC collection metadata into the resource discovery system to achieve unified revelation and discovery of print collection resources and other electronic resources. Service-level integration includes not only OPAC collection metadata but also OPAC service functions such as renewal and reservation, enabling online service functions like direct renewal and reservation for print collection resources in the resource discovery system.

Guangdong Science and Technology Library achieved data-level integration between Primo and OPAC through the following methods: (1) Adding a data view in the ILS to write MARC data into the view when ILS bibliographic data is added or modified; (2) Adding a script in the resource discovery system to read MARC data from the ILS bibliographic view table via SQL statements and convert it into MARC-XML format files; (3) The resource discovery system regularly harvests newly generated MARC-XML format files, loads them into the Primo local metadata repository, and rebuilds the index.

6.2 Integration with Unified Authentication System

The unified authentication system of Guangdong Science and Technology Library uses the open-source CAS system (Central Authentication Service), a lightweight single sign-on (SSO) system developed by Yale University. Figure 3 [Figure 3: see original paper] shows the basic CAS authentication protocol process [31]:

The specific methods and steps are as follows: (1) Deploy CAS Server: Deploy a CAS Server on the server, configure a user information table under the CAS Server directory as the CAS unified user authentication center, synchronize user information from other application systems requiring unified authentication to this user information table via certain methods, and set the CAS authentication method to database verification. (2) Deploy CAS Client: All application systems requiring unified authentication are configured as CAS Clients. For systems that natively support CAS authentication (such as Primo), simply configure the CAS method in their authentication module and add the CAS Server address parameter. For systems that do not natively support CAS authentication (such as document delivery systems), add corresponding interfaces and interception functions in their login and authentication modules, then configure the CAS Server address. (3) Set full-text acquisition permissions and integrate with unified authentication: Configure full-text resource authorized user groups in SFX—based on database service methods and scopes, configure a series of

user groups (institute) in SFX, each corresponding to different database (group) access permissions. These user groups correspond to user groups in the CAS Server's user authentication center (representing different user types and corresponding full-text access permissions).

Figure 4 [Figure 4: see original paper] shows the institute configuration interface in SFX. The system sets up cndb (Chinese general database group), stlib (Chinese and foreign language general database group), userau (foreign language general database group), and a default Default group for off-campus anonymous users with full-text access permissions for self-built and OA databases. Other user groups' permissions all include the Default group's permissions.

Activate databases in SFX and assign corresponding user groups: For different database resources, specify their authorized access user groups. **Figure 5** [Figure 5: see original paper] shows the activation and full-text access permission configuration interface for an OA database, with institute set to DEFAULT, indicating that the Default user group (off-campus anonymous user group) has full-text access permission for this database. **Figure 6** [Figure 6: see original paper] shows the configuration for a Chinese database, with institute set to DEFAULT (off-campus anonymous user group), cndb (Chinese general database group), and stlib (Chinese and foreign language general database group), corresponding to the user groups set in Figure 4.

Add user group information in Primo: When readers log in through the authentication system and need to obtain full text, Primo passes the user group information obtained from the unified authentication system along with the OpenURL to SFX. SFX then determines which databases the user can access based on the user group (institute) and generates corresponding full-text acquisition links.

Improve the display method of full-text acquisition status in Primo: By default, Primo determines full-text acquisition status for all library-accessible resources and cannot differentiate by reader type. Guangdong Science and Technology Library conducted localized development of the Primo system, using AJAX technology to call SFX's RS IAPI in the background. Based on the "found" or "not found" status returned by the API, it displays "Online Full Text" or "Document Delivery" links.

Through the above integration and configuration steps, seamless integration among the resource discovery system, other library application systems, and the unified authentication system has been achieved. Users need not repeatedly log in to other systems after logging in to one system. This enables user type-segmented full-text authority control and user role-sensitive full-text acquisition services (displaying "Online Full Text" links when users have full-text permissions for located resources, and "Document Delivery" links when they do not).

6.3 Integration with Remote Access System

To enable authorized users to remotely access resources discovered and located through the resource discovery system from outside the library, remote access control settings must be configured for different databases in SFX (Proxy set to YES or NO). For example, subscribed databases can be set to YES (invoking remote access system), while OA and self-built databases can be set to NO (no need to invoke remote access system).

6.4 Integration with Document Delivery System

The specific implementation method for integrating resource discovery systems with document delivery systems is as follows: (1) Add a document request interface in the document delivery system. (2) Add a document delivery type Target in SFX, passing required metadata parameters of the literature according to the document delivery system's request interface requirements. (3) When Primo determines that a reader lacks full-text permissions, it redirects the request to the document delivery Target in SFX. (4) Add links and functions to invoke the resource discovery system in the document delivery system.

After completing the above deployment, the following effects are achieved: For resources discovered and located in the resource discovery system, if users lack direct download permissions, they can click the "Document Delivery" button to directly submit requests to the document delivery system without repeated login or copying and pasting bibliographic information. Meanwhile, in the document delivery system, users can directly invoke resource discovery system functions to discover and locate needed literature. For literature with full-text permissions, they can directly download and browse; for literature without permissions, they can directly submit document delivery requests.

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Shen Fucheng: Research ideas and framework design, paper revision and finalization;
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Li Zhen: Provided content on system integration methods, paper revision and improvement;
Wei Dongyuan: Research ideas and framework design, paper revision and finalization;
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