Research on Open Platforms and Open Application Programming Interfaces

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Abstract

Open platforms and open application programming interfaces represent a novel methodological framework enabling libraries in open science environments to facilitate data transmission for integrated open data applications and linked open data. This study delineates user requirements and practical implementations of open platforms and APIs, systematically examines open systems issues within library and information science, and discusses relevant policies concerning licensing and information content management. Finally, it synthesizes two research directions: API standards and user behavior in specialized domains.

Full Text

Research on Open Platforms and Open APIs

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Abstract

Open platforms and open Application Programming Interfaces (APIs) represent a novel approach for libraries to enable open data integration and linked open data applications within open science environments. This article describes end-user needs and the practical implementation of open platforms and APIs, systematically reviews open system issues in the field of library and information science, and discusses relevant policies including licensing and information content management. Finally, it identifies two key research directions: API standardization and user behavior in specialized domains.

Keywords: Open architecture; Open source software; Mashup; Tag cloud; User profiles

1. The Necessity of Open Platforms and Open APIs for Libraries

Three major transformations driven by information technology are reshaping the network environment. First, the communication infrastructure supporting network services—including bandwidth, storage, and computing devices—has become increasingly affordable. Second, information access hardware such as personal computers, mobile phones, and Personal Digital Assistants (PDAs) has achieved widespread penetration. Third, the proliferation of electronic journals, e-books, and Web 2.0 content has diversified both the types and channels of academic resources.

These changes have given rise to new user behaviors and demands. Confronted with an excess of information sources, overwhelming volumes of data, and slow information filtering processes, users now seek to spend less time accessing systems (reducing the number of platforms), less time filtering information (minimizing manual searches), and less time obtaining information (fewer operational steps), while simultaneously demanding more reliable information and more relevant recommendations. Addressing these needs requires solutions at multiple levels, with common challenges centering on content portability and system interoperability.

Media infrastructure portability represents a multi-layered industry challenge. First, developers must optimize initial code to create multimedia products for smartphones, media players, and gaming consoles. Second, most code written in assembly language must be rewritten for each distinct hardware platform, making integration and programming time-consuming and costly for media infrastructure development. Solving this problem requires action at three levels [**?**]: (1) application developers need portable APIs that can operate across platforms to control high-level media functions; (2) system integrators require standards for media component integration, advanced data routing, and robust synchronization across vendors, which involves open platform universality; and (3) software component suppliers and chip vendors need reliable methods to accelerate different codecs, particularly cross-platform API specifications that provide complete media infrastructure portability. Such engineering represents a novel research area that balances complex user needs with streamlined universal design.

For libraries and information science, meeting these new user demands requires digital library systems to achieve integrated services for software applications and information content across different media carriers. Open platforms and open APIs offer a problem-solving model that encompasses communication architecture, hardware devices, and software content, making them critically important for next-generation library services.

2. End-User Perspectives on Open Platforms and APIs

User-centered design represents a new trend in the service-oriented computing era. Individual users, who function as both information producers and consumers, and end-user model upgrades (encompassing not just system upgrades but also the information, technology, and financial support that end users can provide) are creating new types of services [**?**]. In this process, adopting open platforms and APIs enables both information service consumers and suppliers to benefit from a cheaper, faster, and better service delivery process.

From the end-user perspective, two notable approaches are tag indexing and classification, and data mashups with browsing. For instance, applying folksonomy to detect expert search and spam requires examining the rich interactions among users, objects, and tags, and proposing a unified continuous model to integrate these functions and interactions [**?**]. Such online collaborative tagging systems for annotating content and vocabulary can be viewed as a form of open platform, though their effectiveness still depends on understanding and applying user behavior. On the other hand, users struggle to efficiently locate needed information within the vast expanse of online data, while semantic mashup collaborative browsing platforms can integrate heterogeneous information and collect various open APIs to help users identify appropriate collaboration partners [**?**]. These API services can be built upon existing systems or implemented in new open platforms after data migration.

Security concerns represent a primary reservation regarding openness. As enterprises and their application requirements continue to expand, many have established extensive network infrastructure for communication. However, security issues in open platforms have grown exponentially alongside this expansion and openness. Research on routers and security mechanism design provides valuable support for developing secure software, as routers represent clear targets for network attacks and are therefore critical components of any security deployment [**?**]. Mesh-enabled smartphones functioning as mesh routers can implement mesh gateways or even serve as internet gateways themselves during forwarding processes [**?**]. These security measures and methods can help avoid security vulnerabilities and usage pitfalls in open systems.

3. Approaches to Implementing Open Platforms and Open APIs

There are two primary approaches to implementing open platforms: developing complementary components around the platform to create an API product market and service ecosystem, or relinquishing control of the platform itself to establish a fully open development platform [**?**]. The former typically involves hardware manufacturers with proprietary technologies opening value-added applications to expand market reach, while the latter usually involves software vendors with significant market share abandoning control over everything except core kernels and architectures to extend into hardware markets. However,

these are not absolute rules and should be determined based on specific circumstances.

Abandoning control of the platform does not mean abandoning management; rather, it requires even more prudent management mechanisms. Since web services are considered an effective means to achieve interoperability among heterogeneous workflows, they can provide information on how to interact with clients based on web service signatures, thereby mobilizing relevant applications and information. For example, Amazon's Strawberry application in e-commerce services combines integration and detection technologies, automatically deriving behavioral protocol simulations from web service signatures based on data type analysis, and performing consistency checks in corresponding web service implementations [**?**]. This approach differs significantly from most open development that centers on complementary components around existing platforms.

Development focused on complementary components around original platforms emphasizes practical application effects and simple development methods, making mashups highly popular. Mashups combine third-party data and services with open APIs (such as Google Maps and Flickr) and internal data to create an interconnected ecosystem supporting complex users. Research shows that a small number of APIs serve as the foundation for most mashup APIs; mashups have evolved from functional modules to address increasingly complex application interfaces, and the growth of mashup ecosystems follows a ladder-shaped data growth pattern based on complementary relationships among open APIs [**?**]. In other words, the positions of data suppliers and mashup API suppliers in the ecosystem are mutually reinforcing.

Users expect to access the internet anytime and anywhere for voice chat, messaging, information searching, service requests, and blog management, with increasingly high expectations for location-based functions in mobile environments. Major companies such as Microsoft, Google, and Apple have entered the mobile platform market, introducing open platform and open API operational mechanisms. Open APIs allow developers to design more user-friendly services for mobile devices. However, application development is often constrained by requirements during the development stage, necessitating the use of appropriate models during the modeling phase so that code generation can undergo reliability verification before proceeding to full development [**?**, **?**]. In other words, while anyone can develop, not everyone should develop; selecting appropriate open methods based on actual needs yields results closer to expected goals.

4. Current Application Issues in Library and Information Work

For library and information institutions, key application areas for open platforms and open APIs include the development of electronic academic journals, conflicts between content providers and consumers, open utilization of library catalogs, integrated application of educational resources, and capture and anal-

ysis of user behavior.

Electronic academic journal websites provide text and data mining services (and their links), whose full realization depends on interconnectivity between websites. Publishers often exclude smaller publishers due to partial exclusion or differentiation motives when choosing between open platforms and bilateral versus multilateral interconnection [**?**]. Consequently, in multilateral interconnection scenarios, open platforms yield smaller benefits than profit-oriented platforms. This has led many library professionals to recognize market imbalances.

In web services, APIs enable interaction between various systems, achieving the goal of accessing all information within systems on a single platform and enabling special information analysis or chart presentation. This cross-platform openness can leverage mashup models to automate and digitize the enrichment of content by linking bibliographic information, related reading lists, user comments, e-bookshop reviews, and podcast reviews [**?**].

For library users, similar "open laboratories" can be developed, allowing students to practice and experiment with open-source integration and network location translation service skills anytime and anywhere through remote multi-user platforms, addressing resource-intensive space limitations and overcoming geographical and temporal barriers to provide a low-cost, high-efficiency computer technology experimental environment [**?**].

Furthermore, if cross-platform service mechanisms are established, user behavior can be captured relatively completely. Systems can create tag clouds based on user behavior, enabling users to intuitively understand information importance, relevance, and evolution depth, and alerting them to important information previously overlooked. User profiles can be established based on behavior records to filter and select appropriate information. User models can be built according to interest profiles and mapped into virtual spaces through avatars for informal information exchange between users. Information ratings can be conducted based on user behavior, feedback, opinions, and informetric results [**?**].

With the development of mobile communication and computer technology, Short Message Service (SMS) has rapidly become an ideal platform for convenient information queries due to its low cost, easy deployment, scalability, and high security, emerging as a new service platform for libraries [**?**]. However, the struggle between content providers and content consumers has intensified in recent years. Suppliers, holding assets based on copyrighted material ownership, remain skeptical of new open platform technologies, while consumers reject closed technologies, prompting countless format wars and technological competitions in the industry. In the music industry, we can observe how flawed business models failed to keep pace with technological advancement. Cloud computing platforms, such as management programs, virtualization, hardware abstraction, and data center automation, originally had the capacity within the ecosystem to reduce costs and develop new channels and services through API positioning, but have not fully realized their potential [**?**].

For libraries themselves, if library catalogs can communicate with other platforms, they can serve readers more effectively. This involves collaboration between libraries, between libraries and telecommunication operators, and between libraries and service providers, requiring software architecture and model design different from traditional library systems, particularly regarding module deployment and operational mechanisms for open platforms and open APIs.

5. Future Open System Issues in Library and Information Work

Beyond current applications, library and information institutions should incorporate new application modes such as remote consultation, 3D visualization, mechanical engineering applications, social science applications, educational support, and cross-domain collaboration.

For the healthcare industry, an open platform supporting multiple functions such as real-time transmission, event notification, and data accumulation can allow medical professionals to provide health monitoring services anytime and anywhere using portable medical sensors and mobile networks based on network and multimedia subsystems [**?**]. Past e-health applications and technical solutions typically lacked interoperability, but current telemedicine can rely on a universal system architecture to integrate independent telemedicine devices within smart homes [**?**].

These open platforms and open APIs can serve as references for library and information institutions in remote consultation. Considering development costs and other more expensive resources, the introduction of remote pathology and medical resources is gradually moving away from traditional closed systems toward open platforms and open APIs. The Telepathology Center at the University of Basel in Switzerland aggregates remote pathological diagnoses provided by pathologists from around the world, offering diagnostic consultation and pathological education [**?**]. They connect digital cameras to computer microscopes to generate pathological slides and transmit digital images, supporting regions lacking pathologists to avoid diagnostic delays and errors while developing their own telepathology capabilities. This win-win technological application approach merits emulation.

Additionally, open platforms for visualizing 3D medical data benefit interdisciplinary research groups by providing opportunities to try new methods and ideas using virtual reality and feedback in medical applications, independent of hardware and operating systems [**?**]. Similar products include ISReal, an interdisciplinary 3D web research platform that combines semantic web models to simulate e-commerce transaction networks, analyzing their usage degree and betweenness centrality to generate new research methods for large-scale e-commerce systems through open APIs and social network analysis [**?**, **?**]. Such research is currently emerging, and the role of libraries lies not in analyzing business models but in analyzing academic information exchange patterns.

In educational support applications, the "MIT-UPV Exchange"initiated a decade ago is a collaborative learning project between the Massachusetts Institute of Technology (MIT) and the Universitat Politècnica de València (UPV), serving as an interactive website connecting students from both locations. This open platform enables registered students to interact through text messages (including built-in chat functions) and upload/download multimedia files (videos and graphics created by students), achieving cross-national, cross-cultural, and cross-linguistic communication [**?**]. Using open platforms, computer-assisted language learning systems can also be established, where users create learning lists and share various functions based on open APIs, while the system tests users' cognitive abilities through cognitive diagnosis modules to create dynamic personalized learning programs and evaluate user performance in learning modules [**?**].

In mechanical engineering applications, the most cutting-edge scientific research explores "Augmenting Human Evolution" or "Human Augmentation" (HA) technology—a technical means to promote human evolution without biological evolution, expanding human capabilities through information technology (such as cloud computing and big data) to form a socio-ecological system combining humans and machines [**?**]. However, this requires conditions for non-biological devices and improved system interaction design through open standards and open APIs. Although this is distant from library development, as an advanced information and communication technology (ICT) approach, we should consider how to achieve "knowledge evolution" applications.

In cross-industry collaboration, open platforms and open APIs have entered the automotive and home domains. The automotive infotainment industry must adapt to rapid changes and diverse forms across different manufacturers. Adopting an open platform can reduce costs for designing dedicated platforms for each brand and model while enabling third-party applications (mobile devices like Google Android) for end users [**?**]. Currently, cross-industry collaborative development has become another hot research topic. In smart homes, the small size of RFID tags allows embedding in every smart appliance, drawing on experience from RFID applications in cargo management, vehicle management, and medical equipment to develop open resource sharing platforms supporting JVM applications, enabling users to manage homes through ICT [**?**]. These application models merit attention from library and information institutions regarding future development.

6. Issues Involving Science and Technology Information Policy

Notably, licensing and information content management issues related to open platforms and open APIs are often overlooked. Entrepreneurs typically rely on Intellectual Property (IP) to obtain returns on their innovations and are willing to provide some standards and proprietary components of a shared technology platform. Research shows that among 13 voluntary Standard Setting Organizations (SSOs), patent litigation rates are relatively high because, following market

rent-seeking logic, once specialized technology suppliers are incorporated into an open platform, they defend their intellectual property more aggressively [**?**].

Most enterprises and independent software vendors currently widely adopt software-intensive systems that combine an Open Architecture (OA) with multiple open APIs as Open-Source Software (OSS) components or parts. While this approach realizes many benefits of openness, the challenge lies in each component being subject to different copyright or intellectual property licenses [**?**]. Therefore, personnel with both technical capabilities and information policy research backgrounds are needed to conduct license analysis programs to identify key performance OSS licenses.

Open APIs are useful tools for developing popular and useful web applications, achieving seamless integration of social media services, mobilizing third-party systems, and establishing data interoperability on social media platforms. However, the sharing and participation pathways provided by open APIs, as a means for social media companies to achieve market dominance, also create problems regarding contextual integrity, data security, privacy, user autonomy, and freedom. Interoperability specifications for open APIs require long-term summarization and analysis of sharing conditions, technical characteristics, and social impacts of large-scale online services (such as Facebook, Google, YouTube, MySpace, and Twitter) to develop safer, more controllable, and more user-practice-friendly social network services not constrained by commercial applications [**?**].

Newspapers and television were once important tools for creating the national public sphere (Habermas' s concept) [**?**]. The current network environment involving citizen participation and mobilization is actually immature, with many claims about network democratization and social media being overly optimistic. Online content often tends toward partial viewpoints rather than broad dialogue and critical discussion (the essence of the public sphere) [**?**]. The issue is not how to balance open participation and content review, but how to provide a comprehensive and inclusive social framework on the network. Public institutions should expand their participation in various online platforms, and as trusted media brands, Public Service Media (PSM) can help establish an inclusive public domain, enhance citizen participation, and build a harmonious society.

7. Future Research Directions

Open APIs are a way to rapidly create new network services on network platforms, providing richer web applications for end users. The standardization of Next Generation Network (NGN) architecture and protocols has made significant progress, such as supporting multiple traffic types, diverse services, rich protocols, high-capacity and high-performance core networks, and edge networks with rich interface capabilities, as well as new terminals acceptable to users [**?**]. Open API standard organizations remain worthy of continued attention.

On the other hand, the Internet, telecommunications, and third-party suppliers

have initiated a Web 2.0 paradigm for public services in the form of open APIs. Smart devices (such as iPhone and Android) have made user participation more active, meaning a single network service may be insufficient to fully meet users' various goals. Integrating network services is one method to address this issue, with open platforms and open APIs as its foundation. Increasing numbers of APIs enable users to not only be service recipients but also service creators or service combiners [**?**]. However, the environment for practicing this is not yet fully mature—for example, users still find it difficult to locate open APIs in given situations. The collective intelligence created through user-driven services can create end-user types and develop various converged applications based on user experience and perception.

In the foreseeable future, new user-driven composite services will emerge. In summary, two directions warrant continued attention: API standards and user behavior research in specialized domains. However, are open platforms and open APIs sufficient for library and information institutions to address the constantly changing needs of researchers? Further research will be needed to deeply explore the revolution in academic communication.

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Note: Figure translations are in progress. See original paper for figures.