### **Information Technology Standards for Libraries**

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The general view is that standards tend to reduce chaos, enhance the credibility of compliant organizations, and often foster creativity at the individual level. On one hand, it has been argued that there are too many standards-making bodies and too many standards, and that the proliferation of standards often does no more than serve the interests of specific industries and markets. On the other hand, the proponents of standards and the standards-making process contend that while standards intended for different uses or different constituencies tend to cause conflict at the edges, the same standards reflect the varied and often deep needs of the domains to which the standards are applied, and that the standards process, in its emphasis on procedure, creates a desirable orderliness that engenders beneficial efficiencies and makes interoperability possible.

Information technology standards, which have been an important part of librarianship in the United States for more than 75 years, are more important than ever. In the digital era, the environment in which such standards arise grows increasingly complex, as the technical concerns of librarians and archivists intersect with the communities formulating technical standards for computing, networking, and digital publishing in general. In this essay, which assumes that the benefits of technical standards far outweigh any liabilities in the library marketplace, the nature of standards and basic aspects of the standardization process are described, key standards-making organizations are identified and their roles are assayed, and the various benefits of information-oriented technical standards are assessed.

#### **INTRODUCTION**

With the rise of digital libraries and the emergence of digital documents as the primary means of composition and publication, technical standards have become more important than ever for libraries and other information services. In fact, information technology standards may be viewed properly by librarians and archivists as blueprints for survival, because the interoperability of systems that is derived from standards is now essential to the continuation of high-quality library and archival services.

Technical standards have been an important part of librarianship in the United States since 1939, when the American National Standards Committee Z39, the forerunner of the current National Information Standards Organization (NISO), was formed. Today, the environment in which technical standards bearing on libraries are formulated is complex, as the rise of the Internet and the World Wide Web, the emergence of compound documents, and the perceived need to reimagine the basic library services like cataloging engage a wide array of organizations and interests in the development, revision, and use of technical standards. The technical concerns of librarians and archivists have intersected, moreover, with those communities formulating technical standards for computing, networking, and digital publishing. So, in the early twenty-first century, organizations like the Internet Engineering Task Force (IETF), International Organization for Standardization (ISO) and the World Wide Web Consortium (W3C) also play prominent roles in the development of technical standards that have significant effects on digital libraries and archives, and on digital publishing.

As Lynch noted, technical standards “are the basis for making many exciting and empowering things happen – like connecting one system to another, producing files on one system that can be transferred to another, and saving users money when a different manufacturer’s less expensive component can be connected to their system.”[[1]](#endnote-1) Or, to cite another view, “without standards no one can use intelligent machines very effectively, equipment cannot interoperate, and all the information people are so busy creating would stay locked in files and archives, largely inaccessible.”[[2]](#endnote-2) Perhaps even more to the point, Lynch has written:

We are beginning to recognize that standards documents are really a form of “public good,” reflecting and recording achievements of intellectual consensus among a broad community of developers, rather than representing acts of individual creative authorship. They serve as a social construct and intellectual record.[[3]](#endnote-3)

Looking ahead, it is clear that as the need for interdependence and interoperation grows, technical standards will only increase in importance. It is also clear that the development of open technical standards like those developed by NISO, ISO, IETF, and W3C are critical factors in the broader advance, penetration, and benefits of information technologies. As has been observed throughout the Internet era, open standards yield the highest levels of interoperability and confer greater benefits, both technical and economic. From the perspective of libraries, archives, and many other information organizations, that open technical standards tend to be leveling in effect — in other words, their benefits flow to organizations independent of their size, status, or affluence — is a matter of considerable, if not crucial import.

#### **THE NATURE OF STANDARDS**

What is a standard? How are standards developed? How specifically are information technology standards developed? These are important questions, inasmuch as understanding standards and the role of standards requires an understanding of the nature of such specifications and the processes leading to their acceptance.

A number of relevant definitions are available. According to the ISO, a standard is “a document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.” The ISO stipulates further that standards should be based on the consolidated results of science, technology, and experience, and aimed at the promotion of “optimum” community benefits.[[4]](#endnote-4) The general view is that “a standard is the deliberate acceptance by a group of people having common interests or background of a quantifiable metric that influences their behavior and activities by permitting a common interchange.” In addition, it is held that a standard represents the belief of its authors that its specifications will be “understood, accepted, and implemented by the market,” and that standards are formulated with the expectations of substantial effect on the markets that they address.[[5]](#endnote-5)

The British Standards Institution (BSI) states that:

... a standard is an agreed, repeatable way of doing something. It is a published document that contains a technical specification or other precise criteria designed to be used consistently as a rule, guideline, or definition. Standards help to make life simpler and to increase the reliability and the effectiveness of many goods and services we use. They are intended to be aspirational – a summary of good and best practice rather than general practice. Standards are created by bringing together the experience and expertise of all interested parties such as the producers, sellers, buyers, users and regulators of a particular material, product, process or service.[[6]](#endnote-6)

(The idea that standards should be aspirational is essential. In many instances, the creation of technical standards is not merely about codifying good or best practices, but rather about using such practices as the basis for envisioning an even better way of pursuing an important operational objective.)

With specific reference to information technology standards, the ISO stipulates that the “purpose of IT standardization is to ensure that products available in the marketplace have characteristics of interoperability, portability and cultural and linguistic adaptability,” and that standards should therefore reflect the following “Common Strategic Characteristics”: repeatability; interoperability; portability; and cultural and linguistic adaptability.[[7]](#endnote-7)

The notion of open standards looms large in the standards-making process. While there is no single definition or interpretation of what constitutes an open standard, it is generally regarded as a standardized specification that is publicly available, has various rights of use associated with it, and is often linked to an open development process. The ambiguities arise mainly in the meaning of “open.” The definitions emphasize different and various aspects of openness, including the openness of the resulting specification, the openness of the drafting process, and the ownership of rights in the standard.

Perhaps the best available example of a specific commitment to the idea of open standards is embodied by a group known as OpenStand. Organized in 2012 by the Institute for Electrical and Electronics Engineers (IEEE), the Internet Society (ISOC), the World Wide Web Consortium (W3C), the Internet Engineering Task Force (IETF), and the Internet Architecture Board (IAB), OpenStand defines open standards in terms of a set of “principles,” which are:

* Cooperation
* Adherence to the five fundamental principles of standards development: due process; broad consensus; transparency; balance; openness.
* Collective Empowerment
* Availability
* Voluntary Adoption

OpenStand contends that standards developed on the basis of these principles “serve as building blocks for products and services targeted to meet the needs of markets and consumers,” and that such standards drive innovation and contribute to the creation of new markets and the growth and expansion of existing markets.[[8]](#endnote-8)

#### **TYPES OF STANDARDS**

There are several types of technical standards, including conceptual and implementation standard and process and product standards. The first type of standard is the conceptual standard. Conceptual standards usually constitute the detailed articulation of a proposal to produce a new technology or induce a revolutionary change in the way in which a process is conducted. For example, the IEEE 802.3 Ethernet standard, which was conceived so that individual computer users might have access to remote facilities such as printers, is rooted in problems of effectiveness and efficiency and predicated on the idea that facilitating communications between computer users and systems resources affords a basis for maintaining high levels of both performance and service at acceptable costs. Although implementation of this conceptual standard led more or less directly to the development of the local area network and an array of technologies necessary to support specific aspects of the service envisioned in the standard, the standard itself is conceptual in nature.

The second type of standard is the implementation standard. Implementation standards are typically evolutionary as opposed to revolutionary in nature, and tend to reinforce existing industry patterns. Efforts aimed at ensuring that a programming language which exists in various versions, e.g., JavaScript, is implemented properly are an example of this type of standards work.[[9]](#endnote-9)

Today, the notion of the implementation standard extends to digital document formats, such as the Portable Document Format (PDF) and the Open Document Format (ODF). In the case of the PDF, after more than 15 years of proprietary development, Adobe Systems decided in 2007 to release the PDF specification to the Association for Information and Image Management (AIIM), with the understanding that AIIM would work with and through the ISO to establish PDF as an open standard. PDF had become a *de facto* global standard for information exchange and archival storage (and Adobe had already worked within the ISO process to deliver specialized subsets of PDF as standards for specific industries and functions), but Adobe decided that the most effective way to continue to advance this particular technology was to make the underlying specification an open standard, so that other developers had a readily available reference standard in implementing PDF writers, readers, and other applications. The standard, ISO 32000-1:2008, specifies “a digital form for representing electronic documents to enable users to exchange and view electronic documents independent of the environment in which they were created or the environment in which they are viewed or printed.” The standard also specifies that “it is intended for the developer of software that creates PDF files (conforming writers), software that reads existing PDF files and interprets their contents for display and interaction (conforming readers) and PDF products that read and/or write PDF files for a variety of other purposes (conforming products).” PDF/Archive (PDF/A) and PDF/Exchange (PDF/X) are ISO standards.[[10]](#endnote-10) [[11]](#endnote-11)

The Open Document Format is a file format for electronic office documents, such as spreadsheets, charts, presentations, and word-processing documents. The specifications were originally developed by Sun Microsystems and the standard was further developed by the Open Office Extensible Markup Language (XML) technical committee of the Organization for the Advancement of Structured Information Standards (OASIS) consortium. Based on an XML format originally created and implemented by the OpenOffice productivity suite, the purpose of the ODF is to establish a basis for the creation and exchange of formatted documents based on open standards and without reliance on any specific application.

The standard was published as an ISO/IEC international standard, ISO/IEC 26300:2006 Open Document Format for Office Applications (OpenDocument) v1.0. Development of the Open Document Format continues. [Version 1.2](http://docs.oasis-open.org/office/v1.2/cs01/OpenDocument-v1.2-cs01.html) was published in 2011 and adopted by ISO in 2015. (Version 1.3, also known as “ODF-Next,” is a working draft at this writing.) Its importance was reinforced and expanded in 2007, when Microsoft announced that beginning with Microsoft Office 2007 Service Pack 2 native support for the ODF would be included.[[12]](#endnote-12) [[13]](#endnote-13) Microsoft’s commitment to the Open Document Format, though it was coerced by the European Union, heralded a new and even more productive era for digital text, since the use of ODF as a format for documents generated under the widely used Microsoft Office productivity suite enhances interoperability at the document level.

A third type of standard is the product standard. Typically, a product standard described an existing product or service and establishes the characteristics of the product or service as a model for other products of the same type within a specific industry.[[14]](#endnote-14) Product standards, *de facto* or *de jure*, are commonly derived from products that dominate specific markets; recent examples of de facto product standards include the file formats supported by popular computer applications like Microsoft Excel or a widely used peripheral device such as a Bluetooth mouse.

Finally, there are process standards, which are concerned with the transformation of a need into a solution, but not with the products that produce the transmutation. In other words, process standards are generally device independent specifications. An example of such a standard is ISO 8879: Standard Generalized Markup Language (SGML), a meta-language providing a standard syntax for defining descriptions of classes of structured information and rules to structure information that led to the development of the Hypertext Markup Language (HTML), which is, in its various forms, an SGML document type definition (DTD), and which shares a number of SGML constructs.[[15]](#endnote-15) Under SGML, a set of DTDs is established, and then segments of a document (e.g., the title statement, the bibliography, or illustrations) are labeled in accord with the DTDs, thus dividing the document into named, logical elements. The advantage of using a standardized language for describing documents in structural terms is that a single source document may be processed by a wide array of applications, where those applications are capable of interpreting SGML, thus liberating the interchange of electronic documents from the realm of specific applications and proprietary document structures.

Today, SGML has been superseded by XML, which is a simple text format derived from SGML (ISO 8879). Originally designed to meet the challenges of large-scale electronic publishing, XML is also playing an increasingly important role in the exchange of a wide variety of data on the Web and elsewhere.[[16]](#endnote-16)

#### **HOW STANDARDS ARE MADE**

The process under which standards are made varies from organization to organization, but the development process employed by NISO is, in general terms, representative.

NISO uses a three-dimensional structure to categorize the different types of information standards-related activities. The structure is intended to help the standards community understand the landscape in which NISO operates and prioritize and align NISO’s work with the information community at large. The NISO Strategic Framework Committee defined three functional categories, entities, services, and activities, to indicate and describe the problems that standards address and the services standards support, as well as define the context of the standards and aspects of the information chain to which they apply.

A useful perspective in considering this structure is to look at Entities as nouns in a sentence, Services as the verbs, and Activities as the “how” (adjective, adverb, etc.) of the interaction. A standard’s Activity explains how someone or something performs a specific activity within the scope of trying to accomplish a particular goal.[[17]](#endnote-17)

New standards are proposed by one of NISO’s Topic Committees as a “work item,” when it can be demonstrated that the proposed standard is relevant to NISO’s purposes, that its development is feasible, and that it warrants the requisite investment.

Each topic committee works with the community it serves to develop and maintain the plans necessary to sustain an active standards program for its area. This may include a research and learning plan, a standards development plan, and an implementation plan for its area of work. It then manages the work necessary to carry out those plans.[[18]](#endnote-18)

Under a strategic framework adopted in 2007, the NISO topic committees are the Business Information Topic Committee, the Content & Collection Management Topic Committee, and the Discovery to Delivery Topic Committee. NISO also maintains an Architecture Committee that is responsible for providing strategic direction for the organization, oversight and leadership for standards development in areas new to NISO, and coordinating the work of the topic committees.[[19]](#endnote-19)

A proposed work item includes a working group charter, a description of the proposed standard, a suggested timeline for development, and a description of related standards. In the second phase of the process, if the work item is approved, a working group is recruited and then approved by the topic committee. (Approval of a work item requires that 10% of the NISO membership votes in favor of the item.) In the third phase, a work plan, timeline, and budget are created and approved by the topic committee. The work plan is then implemented, with the plan typically divided into a data-gathering phase and the development of the draft standard. In the fifth phase, assuming support by two-thirds of the working group, the draft standard is forwarded to the topic committee, with the recommendation that NISO release it as a Draft Standard for Trial Use or for ballot. If two-thirds of the topic committee approve, the trial use period runs from 6 to 18 months. A standard ballot is issued if and when a draft standard secures the approval of the topic committee, the Architecture Committee, the majority of the NISO Board of Directors, the direction of NISO’s managing director, or a petition from 5 or more voting members of NISO. Once the standard “goes to ballot,” there is a 60-day public review period, followed by a 45-day voting period. If a majority of the “voting pool” casts ballots and two-thirds of those votes are in the affirmative, the draft standard is approved. (Comments must be addressed and resolved before the standard is officially published.) In the next phase, the standard is submitted to American National Standards Institute (ANSI) for approval, under a nine-stage process administered by ANSI. Once ANSI approval has been secured, NISO establishes a maintenance agency or a standing committee, in either instance assuming responsibility for changes, clarification, and interpretation.[[20]](#endnote-20)

#### **THE BENEFITS OF TECHNICAL STANDARDS**

Technical standards offer several important advantages. First, the process of developing technical standards affords a structured basis for exchanging relevant ideas and information. In addition, technical standards offer what has been termed a collaborative advantage, meaning that developers, particularly the developers of standards that are prospective in nature, often have a substantial amount of time in which to investigate the implications of a new standard or a revision of an existing one. Of equal importance, open standards create a more competitive environment, and that usually provides consumers with a wider array of choices and lower prices. For organizations such as libraries and archives, standardization has been a crucial factor in making computing and networking economically feasible. In summary, technical standards help to ensure compatibility between products and their compliments, reduce production costs, dispel confusion for customers, and lower the risks associated with the supply and/or use of complimentary products

## **STANDARDS-MAKING BODIES**

Who makes standards? The realm of standards making is a complex one, ironically lacking a high degree of standardization. Industry or inter-industry groups, treaty organizations, professional organizations, government agencies, and ad hoc vendor groups each make standards.

On the international scene, the ISO is the primary standards making body, but other organizations, such as the International Telecommunication Union (ITU) also play important, sometimes crucial, roles in the development of technical standards.

In the United States, the principal standards-making body is the ANSI, which charters committees and accredits other groups to formulate standards. NISO is one of the bodies that ANSI accredits for the purpose of developing standards in a specific area. Standards of the Federal government, not necessarily inconsistent with the standards devised by ANSI and its allied organizations, are developed by the National Institute of Standards and Technology (NIST), with considerable influence from other federal agencies, including regulatory agencies such as the Federal Communications Commission and the nation’s largest consumer of goods and services, the U.S. Department of Defense. Some unaccredited standards bodies, such as the IETF and Internet Architecture Board (IAB), are also highly influential. The IAB supports the development of documents that define standards for the Internet protocol suite. The IAB has developed these standards in order to coordinate the evolution of the Internet protocols. The majority of Internet protocol development and standardization activities takes place in the working groups of the IETF. Protocols that are to become standards in the Internet go through a series of steps: proposed standard, draft standard, and standard. Each step in this process involves increasing amounts of scrutiny and experimental testing. At each step, the Internet engineering steering group of the IETF must make a recommendation for advancement of the protocol and the IAB must ratify it for the process to move forward. If a recommendation is not ratified, the protocol is returned to the IETF for review and further development. It is a general practice of the IAB that no proposed standard can be promoted to draft standard without at least two independent implementations and the recommendation of the Internet engineering steering group. Promotion from draft standard to standard generally requires operational experience and demonstrated interoperability of two or more implementations, as well as the recommendation of the Internet engineering steering group.

#### **THE AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)**

The ANSI is a private, nonprofit organization that approves national standards and coordinates a system for voluntary standardization. Founded in 1918, ANSI is also the U.S. representative to the ISO and the International Electrotechnical Commission (IEC). Its membership includes “nearly 1,000 U.S. businesses, professional societies and trade associations, standards developers, government agencies, institutes and consumer and labor interests.”[[21]](#endnote-21)

ANSI is the official U.S. representative to the ISO and, via the U.S. National Committee, the IEC. ANSI is also a member of the International Accreditation Forum (IAF). At the regional level, ANSI is the U.S. member of the Pacific Area Standards Congress (PASC) and the Pan American Standards Commission (COPANT). It is also a member of the Pacific Accreditation Cooperation (PAC) and Inter American Accreditation Cooperation (IAAC). ANSI’s mission is:

To enhance both the global competitiveness of U.S. business and the U.S. quality of life by promoting and facilitating voluntary consensus standards and conformity assessment systems, and safeguarding their integrity.[[22]](#endnote-22)

The ANSI standards-making process is governed by the ANSI Essential Requirements, which guarantee, among other things, that “participation shall be open to all persons who are directly and materially affected by the activity in question,” and the development process “shall not be dominated by any single interest category, individual or organization,” with the goal of “achieving balance” in the formulation of new standards or the revision of existing ones.[[23]](#endnote-23)

#### **THE NATIONAL INFORMATION STANDARDS ORGANIZATION (NISO)**

The NISO is accredited by the ANSI to develop voluntary technical standards for libraries, publishers, and the information industry. Its mission is to foster “the development and maintenance of standards that facilitate the creation, persistent management, and effective interchange of information so that it can be trusted for use in research and learning.”[[24]](#endnote-24) In addition, NISO serves as the expert technical advisory group to ANSI on international standards concerning information sciences, documentation, and libraries, as developed by the ISO/technical committee 46.

NISO is supported by a number of organizations, ranging from the American Library Association, the American Society for Information Science and Technology and the Modern Language Association to the Library of Congress, Online Computer Library Center (OCLC), the U.S. Government Printing Office, Reed Elsevier, and Recording Industry Association of America. At present, NISO has more than 75 voting members, who assist in the development of new standards and review all the standards developed by NISO.

In addition, the Library Standards Alliance, which has 130 members, has been established in order to provide libraries a role in NISO’s activities. The members of the Library Standards Alliance include Boston College, the British Library, Columbia University, Harvard, the Library and Archives Canada, the NIST, Ohio State, Princeton, Stanford, the Universities of Chicago, Florida, Maryland, and Notre Dame, and the World Bank.

Throughout its history, NISO has been concerned with the formulation and implementation of standards that address the needs of libraries and archives, information services, publishing, and the book trade in a series of areas, including information transfer, forms and records, identification systems, publication formats, transliteration, preservation of materials, and library equipment and supplies. Today, NISO’s mission includes identifying areas in which standards are needed; developing, writing, and maintaining voluntary technical standards; reviewing and updating current standards; and representing national interests in the development of international standards.

More than 50 NISO projects have standards that are currently in print, and a substantial number of other standards are being developed or revised at this writing. Standards produced to date include specifications for bibliographic information interchange, such as the Dublin Core Metadata Element Set, the construction and formatting of indexes, a Common Command Language (CML), interlibrary loan data elements, patron record data elements, international standard numbering for both books and serials, the OpenURL Framework for Context-Sensitive Services, Specifications for the Digital Talking Book, Syntax for the Digital Object Identifier (DOI), and Permanence of Paper for Publications and Documents in Libraries and Archives. Each NISO standard is reviewed as a matter of policy after five years in force.

In the past, NISO has been largely reactive in its dealings with the library community, and has not been engaged in the “incubation or early development of standardization efforts.” In recent years, however, NISO has begun to work on standards-related activities that go beyond its traditional portfolio of Z39.xx standards and its relationship with ISO. According to strategic plans established in 2005, in the future NISO will be engaged in the development of other outputs, including “recommended practice documents; tools, plugins, or Web services definitions; white papers investigating and educating on new technologies; registries in support of identifiers and other processes; and creation of “living documents.” Under the new framework, another goal is to accelerate the standards-making process by compressing both the incubation and testing periods for draft standards, so that the process which begins with a concept and culminates in final approval of a standard typically requires less than two years. (“Final approval” in this case is a majority vote of NISO members, not the full consensus needed for approval of an ANSI Z39-track standard.)[[25]](#endnote-25) Under NISO’s previous system, the initial phase of standards development in the NISO environment took 2-3 years. At the end of this period, a draft of the proposed standard entered into a round of comments and revisions that could take another 12–18 months, followed by a vote of the NISO membership. If the proposed standard was approved, a resolution phase followed, during which the changes necessary to achieve consensus are sought in order to finalize the standard. Finally, ANSI reviewed and approved the new standard prior to publication. It was not unusual for this process to span a period of 5–8 years, given that acceptable, useful standards must be clear and reflect consensus, neither of them being qualities that are easily achieved.[[26]](#endnote-26)

#### **CURRENT NISO STANDARDS**

Some of the key NISO standards have been in place for years. Examples include the Information Interchange Format, ANSI/NISO Z39.2, which is the basis for the MARC (Machine-Readable Catalog) record and the standard for serial numbering, ANSI/NISO Z39.9. Of the newer standards, several are likely to be of critical importance, including ANSI/NISO Z39.88, the OpenURL Framework for Context-Sensitive Services, which defines an architecture for an open framework for information services in networked environments; ANSI/NISO Z39.29, which establishes rules, guidelines, and examples for bibliographic references; ANSI/NISO Z39.85, the Dublin Core Metadata Element Set, defining metadata elements for resource description in cross-disciplinary information environments; and ANSI/NISO Z39.93, the Standardized Usage Statistics Harvesting Initiative (SUSHI) Protocol, which defines an automated request and response model for the harvesting of electronic resource usage data within a Web services framework.

The SUSHI Protocol is a good example of how standardization advances library analysis and management. Approved as an ANSI/NISO standard in 2014, the SUSHI Protocol is designed to provide an automated method for retrieving standardized usage statistics reports, using the Simple Object Access Protocol (SOAP) and a machine-processable XML container. It is designed to accommodate any customized usage report that conforms to the protocol’s requirements. Specific types of reports, including COUNTER (Counting Online Usage of Networked Electronic Resources) reports, are addressed through the use of an extension to the general protocol. (COUNTER was established in 2002, as a result of a collaborative effort by librarians, publishers, and full-text aggregators to ensure that librarians had access to usage statistics that are “consistent,” “comparable,” and “credible.”[[27]](#endnote-27) The original aim of SUSHI development was to create a standardized reporting framework for COUNTER.) The XML formatted data can be collected in spreadsheets, databases, electronic resource management systems, or any other repository that the user establishes for that purpose.

In this instance, COUNTER is the driving force — the most recent release of its Code of Practice employs new metrics, such as using record views and result clicks for databases, as opposed to relying on searches and sessions, and Code of Practice for Usage Factors, now in development, will use article-level data to develop a usage- based measure of journal impact.[[28]](#endnote-28)[[29]](#endnote-29) But SUSHI is an essential aspect of the process, affording a standardized format for the reports generated by COUNTER and other, similar efforts and thereby creating a basis for shared understanding how library resources are being used.

NISO also fosters the development of recommended practices, which are newer than standards, are typically more “lightweight” than standards, and where compliance is less rigorous. Recommended practices are usually deployed for emerging areas. The areas in which NISO has lately developed recommended practices include knowledge bases and related tools (KBART), the Open Discovery Initiative (ODI), and Open Access Metadata And Indicators (OAMI).[[30]](#endnote-30)

In the case of the KBART initiative, there are many opportunities for link resolvers operating under the OpenURL to fail. KBART provides a metadata exchange format that includes where and how information should be placed and when to update the information, and its been expanded to include metadata for consortia, open access journals, e-books, and conference proceedings.[[31]](#endnote-31) ODI addresses issues raised by library discovery platforms and their services, defining ways for libraries to assess the level of content providers’ participation in discovery services, streamlining the process by which content providers work with discovery service vendors, establishing models for “fair” linking from discovery services to publishers’ content, and determining what usage statistics that should be collected.[[32]](#endnote-32) The OAMI working group is concentrating on the development of a specific format for bibliographic metadata that describes the rights of the reader for a single scholarly work.[[33]](#endnote-33)

#### **THE INTERNATIONAL STANDARDS ORGANIZATION (ISO)**

On the international scene, about 100 countries have national standards bodies that bring together experts from industry and universities to develop standards. In addition to ANSI, prominent standards-making bodies include Deutsches Institut fuer Normung (Germany), the British Standards Institution, Association francaise de normalisation (France), Nederlands Normalisatie instituut (Netherlands), Standards Australia, Norges Standardiseringsforbund (Norway), Dansk Standard (Denmark), and the ITU. The International Organization for Standardization (ISO) is the organization that coordinates the activities of national standardization bodies at the international level. (The origins of the ISO can be traced back to 1946 meeting at the Institute of Civil Engineers in London, when delegates from 25 countries voted to create a new international organization “to facilitate the international coordination and unification of industrial standards.” In 1947, the new organization, by then known as the International Organization for Standardization, officially began operations.) Together with the IEC, ISO concentrates its efforts on “harmonizing” national standards all over the world. The results of these activities are published as ISO standards.

ISO has members from 162 countries and more than 3,300 technical bodies, in this instance meaning organizations that are responsible for setting and/or maintaining standards domestically. Under ISO’s charter, there are three categories of membership. Full members, or member bodies, participate and vote in ISO technical and policy meetings, correspondent members, which are from countries without their own standards organization, observe the development of ISO standards and strategy by attending ISO technical and policy meetings as observers, and subscriber members, which are from countries with small economies, keep up to date on ISO’s work but cannot participate in it. At present, there are 38 correspondent members, including, for example, Albania, Haiti, Lesotho, and Zambia, and 5 subscriber members, including Belize, Honduras, and the Lao People's Democratic Republic. The ISO’s Central Secretariat, which coordinates the system and consists of a staff of approximately 150 employees, is located at Geneva, Switzerland.

As a matter of policy, ISO standards are developed on the basis of consensus, taking into account the interests and views of manufacturers, vendors and users, consumer groups, testing laboratories, governments, engineering professions, and research organizations. ISO standards are intended to be global solutions that address and satisfy the requirements of industries and consumers on a worldwide basis. Finally, ISO standards are voluntary, and their promulgation is based on the view that international standardization is and should be a market-driven process.

#### **ESTABLISHING ISO STANDARDS**

There are three principal phases in the ISO standards development process. In the first phase, the need for a standard is articulated, usually within an industrial sector, and then communicated to a national member body. The national member body then proposes the new work item to ISO. If the need for an international standard is recognized, the technical scope of the proposed standard is defined, usually by a working group of experts from countries interested in the subject matter of the proposed standard. (ISO standards are developed by panels of experts, operating within the framework of a technical committee. Once the need for a new or revised standard has been established, the relevant panel meets to discuss, negotiate, and prepare a draft standard.)

Once agreement has been reached by the working group on the technical aspects to be covered under the proposed standard and a draft version of the proposed standard has been created, the second phase of the process begins, during which the detailed specifications of the proposed standard are reviewed and revised by representatives of the member bodies. It is during this phase of the process that the consensus building necessary for the eventual approval of the proposed standard occurs. In the final phase of the process, the draft standard is taken to ballot, with formal approval requiring affirmation by two-thirds of the ISO members that have participated actively in the standards-development process and 75% of all members voting on the draft standard. Following formal approval, the text of the standard is published as an ISO International Standard. (Most standards require periodic revision, owing to factors such as technological evolution, new methods and materials, and new quality and safety requirements. Consequently, ISO mandates that all standards should be reviewed at least once every five years.)

At this writing, ISO has published more than 20,500 standards, including the metric system of units, international stationery sizes, rules for technical drawings, electrical connectors, security regulations, computer protocols, file formats, bicycle components, ID cards, programming languages, international standard book numbers (ISBN), barcode symbology, and RFID.[[34]](#endnote-34) According to the ISO, its goal in standards-making is sustainability:

Sustainability is the goal of sustainable development. It refers to any state of the global system in which the needs of the present are met without compromising the ability of future generations to meet their own needs. The concept of sustainability is continually evolving. Understanding and achieving a balance between environmental, social and economic systems, ideally in mutually supporting ways, is considered essential for making progress towards achieving sustainability. The achievement of sustainability is now recognized as one of the most important considerations in all human activities.[[35]](#endnote-35)

Within the ISO, the ISO/IEC Joint Technical Committee 1, which is maintained in collaboration with the IEC, deals with information technology. The ISO/IEC Joint Technical Committee 1 was formed in 1987 by merging ISO/TC 97 (Information Technology) and IEC/TC 83, with IEC//SC 47B joining later, thereby establishing a single approach to information technology standardization by and for the two parent organizations. Its mandate is to develop, maintain, promote, and facilitate information technology standards in the following areas:

* Design and Development of IT Systems and Tools
* Performance and Quality of IT Products and Systems
* Security of IT Systems and Information Portability of Application Programs
* Interoperability of IT Products and Systems
* Unified Tools and Environments
* Harmonized IT Vocabulary, and
* User-Friendly and Ergonomically Designed User Interfaces.

Membership in the ISO/IEC Joint Technical Committee 1 is open to any national body within either of the parent organizations. Other organizations may participate as liaison members.

#### **ISO STANDARDS RELEVANT TO LIBRARY AND INFORMATION SERVICES**

Although the ISO is engaged in the development of standards in many different areas, most of the ISO standards that are applicable to libraries and related information services are standards addressing specific issues in computing and networking. There is, for example, the Linux Standard Base (LSB), a joint project by several Linux distributions under the organizational structure of the Linux Foundation to standardize the software system structure used with the Linux operating system. The LSB, which is based on the POSIX (Portable Operating System Interface) specification, the Single UNIX Specification, and several other open standards, was submitted for approval as ISO/IEC 23360 in 2008. Another recent example is the PDF. Developed by Adobe Systems for document exchange and in widespread use since the mid-1990s, PDF was officially published as an open standard in 2008, as ISO 32000-1:2008. PDF encapsulates a complete description of a fixed-layout two-dimensional document (and, with Acrobat 3D, embedded 3D documents), including the text, fonts, images, and vector graphics which comprise the document. Last but not least, there is ISO 8879: 1986, which describes the SGML, a format for storing documents together with their logical structure and layout information in a standardized scheme and the basis for the HTML, and which is effectively the precursor of contemporary documents standards, such as ISO/IEC 29500-1-4:2008, which defines a set of XML vocabularies and other conventions for representing word- processing documents, spreadsheets, and presentations, based on the Microsoft Office 2008 applications, and ISO/ IEC 26300:2006 Open Document Format for Office Applications (OpenDocument) v1.0, which defines an XML schema for office applications and its semantics in more expansive terms.

An ISO standard more directly relevant to the interests of libraries (and illustrative of the conditions that influence the evolution of technical standards) is ISO 23950, also known as ANSI/NISO standard Z39.50. Designed as a protocol for searching and retrieving information, usually from bibliographic records, Z39.50 specifies procedures and formats for a client to search a database provided by a server, retrieve database records, and perform related information retrieval functions.

Z39.50’s design predates the World Wide Web, relying on now largely outmoded connection oriented, program-to-program communication. As a result, substantive work aimed at updating and revising the protocol has been under way since 2000, leading thus far to the development of two new protocols, SRU (Search and Retrieve via URLs) and SRW (Search/Retrieve Web Service), and a synthetic query language, the Contextual Query Language (CQL), intended to support their implementation. (The CQL is a formal language for representing queries to information retrieval systems. The language represents an effort to combine the qualities of more powerful, more expressive query languages such as SQL, PQF, and XQuery with simpler, more intuitive languages, such as the CCL and Google’s search syntax.) The suite encompassing SRU, SRW, and CQL was originally called “Z39.50 Next Generation,” and then later it was known as “Z39.50 International Next Generation” (ZING). Today, neither designation is used. Development of SRW/SRU/CQL began in 2000. An experimental version, 1.0, was released in 2002, and the first official version, 1.1, in 2004. The most recent revision is [SRU 2.0](http://www.loc.gov/standards/sru/sru-2-0.html), which became an OASIS standard in 2013.[[36]](#endnote-36)

SRU is based on Representational State Transfer (REST), a collection of network architecture principles that specify how resources are defined and addressed, and enables queries to be expressed in URL query strings. SRW uses SOAP, the Simple Object Access Protocol, a specification for exchanging structured information within the framework of Web services, as the basis for the expression of queries. SRU and SRW address the same information retrieval problems that Z39.50 confronted, each of them relying on XML as their message and results format.[[37]](#endnote-37)

The OASIS Search Web Services Technical Committee continues to develop a unifying model for Web-based search and retrieval services that incorporates SRU/CQL, with the expectation that other protocols will be integrated into this model at a later date.[[38]](#endnote-38) One of the goals of this effort is to lower the barrier to entry for developers through a reliance on existing Web services technologies. SRW/U is being deployed as the search API for the DSpace initiative, and it is under consideration as the standard search API by a number of communities, including the meta-searching and geospatial searching communities.[[39]](#endnote-39) The SRW/U Open Source project offers software that implements both the SRW Web Service and the SRU REST model interface to databases, including interfaces that support DSpace and Lucene repositories.[[40]](#endnote-40)[[41]](#endnote-41)[[42]](#endnote-42)

Other, library-oriented ISO standards include: ISO 15511:2003 Information and documentation—International Standard Identifier for Libraries and Related Organizations (ISIL); ISO 9230:2007 Information and documentation—Determination of price indexes for print and electronic media purchased by libraries; ISO/TR 21449:2004 Content Delivery and Rights Management: Functional requirements for identifiers and descriptors for use in the music, film, video, sound recording, and publishing industries; and ISO 11620:2008 Library performance indicators.

#### **WORLD WIDE WEB CONSORTIUM (W3C)**

The World Wide Web Consortium (W3C) was established in 1994, as an industry consortium dedicated to building consensus around Web technologies through the creation of relevant standards and guidelines. Tim Berners-Lee, who invented the World Wide Web in 1989 while working at the European Organization for Nuclear Research (CERN), was one of the founders and has served as the W3C Director since its inception.

Since 1994, W3C has published more than 110 such standards, called W3C Recommendations. The goal of the W3C is to maintain and promote “Web interoperability.” For the World Wide Web to reach its full potential, the basic technologies must be device and platform independent, vendor neutral, and fully compatible with one another. The W3C works to avoid the fragmentation of the Web by developing and publishing open, nonproprietary standards for Web languages and protocols. According to Berners-Lee:

W3C is where the future of the Web is made. Our Members work together to design and standardize Web technologies that build on its universality, giving the power to communicate, exchange information, and to write effective, dynamic applications—for anyone, anywhere, anytime, using any device.

As of December 2015, the W3C has more than 407 member organizations from more than 40 countries. W3C’s operations are supported by a combination of dues, research grants, and other sources of public and private funding.

The Consortium's primary operations are hosted by three institutions: the Massachusetts Institute of Technology, the European Research Consortium in Informatics and Mathematics (ECRIM), and Keio University in Japan. These institutions provide for W3C administration on a joint basis. In addition, the W3C maintains regional offices around the world, to promote W3C technologies in local languages, broaden its geographical base, and encourage international participation. Regional W3C offices have been established in 17 locations, including Australia, China, Hong Kong, Israel, India, Korea, and the United Kingdom and Ireland, with new offices planned for the near future in Latin America and Africa; each office has the mission of promoting adoption of W3C standards among developers, application builders, and other standards setters; and of encouraging stakeholder organizations to participate in the development of future W3C standards.[[43]](#endnote-43)

A main focus of the activities of the W3C is to make the World Wide Web and its services “available to all people, whatever their hardware, software, network infrastructure, native language, culture, geographical location, or physical or mental ability.” Work in areas such as Web accessibility, internationalization, device independence, and the so-called mobile Web is emphasized.[[44]](#endnote-44) In addition, the W3C is committed to fostering “technologies that enable a more collaborative environment, a Web where accountability, security, confidence, and confidentiality are all possible, and where people participate according to their individual privacy requirements and preferences.”

The W3C follows processes that are based on consensual approval, including the members of the working group that develops a draft recommendation, W3C members at large, and the public. Proponents of the W3C processes believe that it promotes fairness, responsiveness, and progress.

How specifically are W3C Recommendations formulated? According to the W3C, the process begins when there is sufficient interest in a topic, as evidenced by member submissions. Where such interest exists, it is monitored within and without the W3C and often leads to the organization of a workshop for the purposes of discussing and assessing the area of interest. Following a successful workshop and/or discussion on an Advisory Committee mailing list, the formal development of a proposal is initiated for one or more Interest Group or Working Group charters, depending on the breadth of the topic of interest. The proposed charters are reviewed by the W3C membership, and when there is enough support within W3C to warrant investing resources in the topic of interest, the charter is approved and the work begins.

There are three types of Working Group participants: member representatives, invited experts, and team representatives. Team representatives contribute to the technical work and help ensure the group's proper integration with the rest of W3C. The Working Group charter sets expectations about each group's deliverables, e.g., technical reports, test suites, and tutorials. Working Groups generally create specifications and guidelines that undergo revisions and reviews as they advance to W3C Recommendation status. The W3C process for producing the associated technical reports includes review by both members and public, and at the conclusion of the process, the W3C Advisory Committee reviews the technical report, and if there is sufficient support, W3C publishes it as a formal Recommendation.

#### **W3C ACTIVITIES**

W3C activities are organized into groups: Working Groups (for technical developments), Interest Groups (for more general work), and Coordination Groups (for communication among related groups). The groups, made up of participants from Member organizations, the Team, and Invited Experts, produce technical reports, including Web standards, open source software, and services. These groups also ensure coordination with other standards bodies and technical communities. At this writing, there are 43 working groups and 14 interest groups.[[45]](#endnote-45)

#### **MAJOR W3C ACHIEVEMENTS**

W3C’s most important achievements fall into four broad categories. First, there are the specifications that relate to digital documents, including Cascading Style Sheets, HTML, the Document Object Model (DOM), XML, and Compounds Document Formats. Second, there are the metadata standards, RDF and OWL. These technologies, which have been designed to support the Semantic Web by providing structured descriptions and addressing ontological issues, respectively, provide a standardized framework for asset management, enterprise integration, and the sharing and reuse of data on the Web. Third, there are the access-oriented initiatives, including the Web Accessibility Initiative (WAI), the Mobile Web Initiative, the Internationalization Activity, and the development of standards supporting multiple, simultaneous modes of interaction. Finally, there are the coordinating efforts aimed at providing the infrastructure necessary to realize the goals embedded in Berners-Lee’s notion of the Semantic Web. An example of this sort of activity is the work done by the Technical Architecture Group.[[46]](#endnote-46)

#### **DEVELOPMENT OF HTML5 AS A STANDARD FOR WEB MARKUP**

The development of HTML5 is a cautionary tale. It revealed the limits of the role of the W3C, the contentions, both political and technical, surrounding it, and, in a more general sense, the complexities of the standards making process in the digital age. After the release of HTML 4.01 in 1998 W3C's HTML Working Group (HTMLWG) announced it would transfer its attention to the development of what became known as XHTML.[[47]](#endnote-47) This effort started with a reformulation of HTML4 in XML, known as XHTML 1.0. The first version of XHTML, which was completed in 2000, added no new features except serialization.[[48]](#endnote-48) After XHTML 1.0, the W3C's focus turned to extending XHTML, under the banner of XHTML Modularization, and working in parallel on a new language, XHTML2, that was not compatible with the earlier HTML and XHTML languages.

The W3C's advocacy of XHTML was eventually viewed as an impediment to the further development of the Web, because its integration of XML beyond a shared syntax was limited and unsuccessful and on account of the lack of backward compatibility, which many developers believed to be an essential aspect of any plan for evolving HTML into a more sophisticated language. But the larger problem, which persisted even after the W3C renewed its interest in the development of HTML — in 2003, in an effort to update the technology for Web forms, the W3C renewed its interest in the development of HTML, citing "the realization that XML's deployment as a Web technology was limited to entirely new technologies (like RSS and later Atom), rather than as a replacement for existing deployed technologies (like HTML)" — was the deliberate pace at which the W3C operates. The segment of the development community represented by WHATWG wanted to move ahead much more rapidly in order to keep pace with developments and requirements in mobile computing.[[49]](#endnote-49) [[50]](#endnote-50)

The Web Hypertext Application Technology Working Group (WHATWG), a group of software developers, including Apple, Mozilla, and Opera, was formed in order to address those issues.[[51]](#endnote-51) The WHATWG is dedicated to the creation of what its members called a living standard, which would become known as HTML5. (According to Wikipedia, a living document is a document "that is continually edited and updated."[[52]](#endnote-52) An example of a living document is an article in Wikipedia, whereas an article from an edition of the Encyclopædia Britannica is a "static" document. Under the WHATWG's notion of a "living standard," the standard is updated more or less continuously in view of feedback received from Web designers, browser vendors, tool vendors, or other interested parties. The documents reflecting the standard evolve through incremental changes to the standard and new features added "at a rate intended to keep the specifications a little ahead of the implementations but not so far ahead that the implementations give up.")[[53]](#endnote-53)

In contrast, the W3C's approach is much more conservative and much slower than the one advocated by WHATWG. The W3C reserves the name "standard" for specifications that emerge from the "consensus process, have wide community support, are stable, have demonstrated interoperability, and patent commitments behind them.”[[54]](#endnote-54) The W3C process tends to be a long one — for example, a representative of the W3C recently estimated that it might take another decade to establish and approve a final version of HTML5 — and this has created considerable tension within the community of developers concerned with the continuing development of HTML and the deployment of new versions thereof.

Beginning in 2004, the WHATWG began working on HTML5. In 2009, the W3C allowed the XHTML 2.0 Working Group's charter to expire and eventually began to work with the WHATWG on the development of HTML5. In 2012, WHATWG and W3C agreed to a separation of efforts on HTML5, with the W3C continuing to work on a single definitive standard and the WHATWG renewing its commitment to the ideas of HTML5 as a “living standard,” and under which a single standard would be developed by the W3C as a "snapshot.” In 2012, W3C designated HTML5 as a Candidate Recommendation — the criterion for advancement to W3C Recommendation is "two 100% complete and fully interoperable implementations" — and in 2014, the specification process was completed and HTML5 was released as a W3C Recommendation.[[55]](#endnote-55)

In response to the criticisms of its process and pace of development, the W3C has committed itself to a greater reliance on modularity, meaning that aspects of HTML5, such as Canvas, WebRTC, and WebVTT, will be advanced as separate specifications, and that some specifications originally developed as standalone items, including SVG and MathML, will be adapted as HTML5 extensions or features by reference.[[56]](#endnote-56),[[57]](#endnote-57),[[58]](#endnote-58),[[59]](#endnote-59),[[60]](#endnote-60) In addition, W3C has elected to employ a similar strategy in the development of Level 3 of the Cascading Style Sheet specification, also known as CSS 3.0.[[61]](#endnote-61)

Despite the years of effort devoted to reconciling differences between the Web Hypertext Application Technology Working Group and the World Wide Web Consortium, HTML5 is fraught with problems, including issues of browser compatibility – at this writing, only Google and Opera come close to providing full support, and many important features have thus far received only mixed and/or partial support from other Web browsers such as Internet Explorer, Firefox, and Safari – security concerns, since HTML5 tends to reveal technical details of the presentation layer and “business logic” of the information producer, and performance issues related to HTML’s native support for animation and audio and video playback; for example, Microsoft’s Internet Explorer 11 affords no support at all for a wide array of HTML5 features, including the WebM and Ogg/Theora video formats.[[62]](#endnote-62),[[63]](#endnote-63) Finally, there is the issue of support for the Web Content Accessibility Guidelines (WCAG), one of the most important of the W3C’s projects.[[64]](#endnote-64),[[65]](#endnote-65) The evidence of sites like html5accessibility.com suggest that WCAG compliance is generally improving, but remains unacceptably low.[[66]](#endnote-66)

In the end, both WHATWG and W3C lost in the HTML5 controversy. But W3C had more at stake, given its leading and highly visible position in directing Web development, and it had more to lose, because WHATWG’s interests were always much more limited. The essence of the controversy was, at least as viewed from afar, a matter of innovation versus stability, and there are many Web developers who believe that the W3C’s stance throughout the process was not sufficiently supportive of new, innovative approaches to HTML and its uses, and more than a few who believe that the results reflect compromises that will make the ongoing development of HTML5 more difficult, though, in fairness, the differences between the WHATWG and W3C specifications are not regarded as great or unbridgeable. (The W3C’s corporate responses have not made the situation better. There has been a modest degree of internal re-organization, but the principal response has been fall back in public on the commitment to openness, in the form of the Open Web Platform and W3C’s founding role in OpenStand, a stance its critics would argue was undermined, if not betrayed in the process of negotiating the HTML5 Recommendation.[[67]](#endnote-67)) The almost certain result is that in the years ahead the W3C will have a weaker hand in directing the development of the World Wide Web.

From the perspective of the library community, this may indeed be cause for concern. The library community’s investment in HTML5 is indirect. How libraries are affected will depend largely on how publishers elect to use HTML5, and at this point that is not altogether clear, though there is reason to believe that important journal publishers are interested in the possibility of HTML5 supplanting PDF as the preferred format for presentation of articles and papers. What is clearer is that more unsettled technical circumstances could make it considerably more difficult to not only use resources arrayed across the Web, but also more difficult to carry out the curatorial and preservation-related tasks that will surely form a growing part of the professional agenda for librarians and archivists.

#### **THE IMPORTANCE OF TECHNICAL STANDARDS IN LIBRARIANSHIP**

Standards are important to any organization that proposes to connect technologies of different types and made by different manufacturers, but they are especially important to organizations like libraries, since neither libraries nor librarians are able to exercise great influence over the creation or design of the many of the technologies on which so much of their future now clearly depends. (It is important to note that the library community’s contribution to the body of standards bearing on information interchange has been significant, but those standards, while often of on-going importance to libraries and archives, are of marginal consequence in the larger spectrum of information technologies that form the basis for the Internet and the World Wide Web. For example, it may be argued compellingly that the on-going development of HTML5 is likely to be far more important to the future of the electronic journal and the experiences of the readers of electronic journals than efforts to standardize the identification and presentation of those resources.) With the emergence of digital libraries, the reliance on standards and the scope of the standards process have expanded, including not only hardware and software, but also digital documents, metadata, network-based services, and schemes for accounting and management of related information activities. Perhaps more to the point, a generation of documentation has been built on the basis of various standardized digital document formats, including the Microsoft Office formats and the Portable Document Format, as well as the open HTML and XML formats, and much of what is feasible and problematic in the interrelated realms of digital curation and digital preservation will depend on the extent such standards can be maintained.

As we look to the future, there is reason to believe that the work of the W3C and other organizations interested in the standardization of compound document formats will become increasingly important, as various agencies work to make digital documents richer, more informative, and more useful. The key issue has been and will continue to be interoperability, which is defined under ISO/IEC 2382 Information Technology Vocabulary as “the capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units.”[[68]](#endnote-68) From a systematic perspective, interoperability assumes that the objects of interaction, including metadata, can be exchanged across systems, that as a result an aggregated content layer may be constructed on the basis of resources drawn from a distributed system of digital libraries. For libraries and librarians, the technological standards enabling different kinds of interoperability, including more traditional approaches geared toward library metadata interoperability, such as Z39.50, the harvesting methods based on OAI-PMH (Open Archives Initiative-Protocol for Metadata Harvesting), and Web service-based approaches, will continue to be critical elements in achieving and maintaining this capability.

#### **THE FUTURE**

As always, the future is uncertain. However, if recent history is a sign, it is likely that more and more standards bearing on information technology in general and libraries in particular will be formulated and promulgated. The reasons will be many and varied, but in the end the proliferation of standards (and standards-making bodies) will constitute a collective, rational response to the increasing complexity of the information environment, as well as an expression of the need for continuity, both diachronically and synchronically.

It seems reasonable to imagine, too, that the standards-making process itself will be a matter of even greater interest, particularly as the economic benefits of standards in information technology and allied areas are more clearly understood.[[69]](#endnote-69) Such trends will intensify the longstanding debate over the speed and complexity of the standards-making process, as exemplified by the problems that arose in the development of HTML5, and especially when it is coupled with the growing sense that the responsibility for maintaining information technology and library standards has become too diffuse and perhaps too chaotic.

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39. DSpace. Accessed December 6, 2015. http://www.dspace.org. [↑](#endnote-ref-39)
40. DSpace is an open source repository software package used for creating open access repositories for scholarly and/or published digital content. Recent versions of DSpace also support faceted search and browse functionality using Apache Solr, which is the search platform based on Apache’s Lucene technologies. [↑](#endnote-ref-40)
41. Apache Lucene is an open-source information retrieval software library. It is supported by the Apache Software Foundation and is released under the Apache Software License. [↑](#endnote-ref-41)
42. Apache Lucene. Accessed December 6, 2015. http://lucene.apache.org. [↑](#endnote-ref-42)
43. As part of the internationalization of the Web, the W3C instituted changes to its fee structure in 2005 to encourage the participation from organizations in developing countries. [↑](#endnote-ref-43)
44. The goal of W3C’s Mobile Web Initiative (MWI), which was launched in 2005, is to make Web access from any kind of device as simple, easy, and convenient. [↑](#endnote-ref-44)
45. World Wide Web Consortium Process Document; 2015. Accessed December 5, 2015. http://www.w3.org/2015/Process-20150901/#GAGeneral. [↑](#endnote-ref-45)
46. Architecture of the World Wide Web, Volume One. W3C Recommendation December 15, 2004. Accessed February 7, 2015. http:/ www.w3.org/TR/webarch/. [↑](#endnote-ref-46)
47. W3C HTML Media Extensions Working Group. World Wide Web Consortium (W3C). Accessed December 6, 2015. http://www.w3.org/html/wg/. [↑](#endnote-ref-47)
48. Serialization is the process of converting an object into a stream of bytes in order to store the object or transmit it to memory, a database, or a file. Its main purpose is to save the state of an object in order to be able to recreate it when needed. [↑](#endnote-ref-48)
49. WHATWG (Web Hypertext Application Technology Working Group). Accessed December 6, 2015. http://whatis.techtarget.com/definition/WHATWG-Web-Hypertext-Application-Technology-Working-Group. [↑](#endnote-ref-49)
50. This effort would result in the development of XForms. XForms is a set of models based on a model–view–controller (MVC) approach. The models describe form data, constraints upon that data, submissions, and view, with the view describing in turn what controls appear in the form, how the controls are grouped, and how the controls are bound to specific data, typically using CSS for formatting. In addition, XForms can be designed to validate user data against XML Schema data types, require specific data, disable input controls, change sections of the form depending on operational circumstances, enforce particular relationships among data, input variable length arrays of data, output calculated values derived from form data, populate entries using XML source documents, respond to actions in real time, and modify the style of each control depending on the display device. See The Forms Working Group, <http://www.w3.org/MarkUp/Forms/>; and HTML5: a vocabulary and associated APIs for HTML and XHTML. W3C Recommendation 28 October 2014. http://www.w3.org/TR/html5/introduction.html.) [↑](#endnote-ref-50)
51. Web Hypertext Application Technology Working Group. Accessed December 6, 2015. https://whatwg.org. [↑](#endnote-ref-51)
52. "Living Document." Wikipedia, the Free Encyclopedia. Accessed December 6, 2015. http://en.wikipedia.org/wiki/Livingdocument. [↑](#endnote-ref-52)
53. See WHATWG Wiki. Accessed December 6, 2015. https://wiki.whatwg.org/wiki/FAQ#Whatdoes.22LivingStandard.22mean.3F) [↑](#endnote-ref-53)
54. Jaffe, Jeff. "Web at 25, W3C at 20: An Opportunity to Reflect and Look to the Future." IEEE Internet Computing 4 (2014): 74-78. [↑](#endnote-ref-54)
55. HTML5 is not an outright rejection of XHTML. It is instead an effort to incorporate the most important features of HTML 4.01 and XHTML, such the simple doctype, separation of content and style (that effectively compel the use of CSS for formatting), the stricter traditions of coding, validation support, and a higher degree of integration with programming languages such as JavaScript and PHP, under which CSS supports visual layout, JavaScript provides for client-side programming, and PHP or another server-side language facilitates server-side controls and interactions with databases. The prevailing view of HTML5 is that while HTML remains the core language of the Internet, HTML5's design distributes control to other languages, and in so doing facilitates the inclusion of new capabilities emerging in other, related technologies. [↑](#endnote-ref-55)
56. The Canvas element supports the dynamic, scriptable rendering of 2D shapes and bitmap images under HTML5. [↑](#endnote-ref-56)
57. WebRTC (Web Real-Time Communication) is an API definition that supports browser-to-browser applications for voice calling, video chat, and P2P file sharing without the need of either internal or external plugins. [↑](#endnote-ref-57)
58. WebVTT (Web Video Text Tracks) is a W3C standard for displaying timed text — the presentation of text media in synchronization with other media, such as audio and video — in connection with the HTML5 <track> element. [↑](#endnote-ref-58)
59. Scalable Vector Graphics (SVG) is an XML-based vector image format for two-dimensional graphics, with support for interactivity and animation. The SVG specification has been under development by the W3C since 1999. The latest version is [Scalable Vector Graphics (SVG) 1.1 (Second Edition)](http://www.w3.org/TR/SVG/), which was issued as a W3C Recommendation in 2011. [↑](#endnote-ref-59)
60. MathML, the Mathematical Markup Language, is an application of XML for describing mathematical notations in terms of both structure and content. It is part of HTML5 and is also an ISO standard, ISO/IEC DIS 40314, which was adopted in 2015. [↑](#endnote-ref-60)
61. Unlike CSS 1.0 and CSS 2.0, which are single specifications defining various features, CSS 3 is divided into separate documents that referred to in the process as "modules". Each module adds new capabilities or extends features defined in CSS 2, preserving backward compatibility. Due to the modularization, different modules have different stability and statuses; for example, the modules concerned with selectors, colors, and media queries have achieved the status of W3C Recommendations, whereas the modules dealing with backgrounds and borders, the cascade and inheritance, multi-column layout, and fonts, respectively, remain Candidate Recommendations. [↑](#endnote-ref-61)
62. WebM is a video file format. It is intended to offer a royalty-free alternative for use in conjunction with the HTML5 video tag. The development of the format is sponsored by Google, and the corresponding software is distributed under a BSD license. [↑](#endnote-ref-62)
63. Theora is a lossy video compression format that is used in concert with the Vorbis audio format and the Ogg container, which can multiplex a number of independent streams for audio, video, text, and metadata. The technologies are available under a BSD-style open source license. [↑](#endnote-ref-63)
64. The Web Accessibility Initiative is based on the idea that the Web should provide equal access and equal opportunity to people with diverse abilities and capabilities and the idea, as articulated in the UN Convention on the Rights of Persons with Disabilities, that access to information and communications technologies, including the World Wide Web, should be regarded as a basic human right. See United Nations Convention on the Rights of Persons with Disabilities. From the Final report of the Ad Hoc Committee on a Comprehensive and Integral International Convention on the Protection and Promotion of the Rights and Dignity of Persons with Disabilities. 2006. http://www.un.org/disabilities/convention/conventionfull.shtml. Last accessed December 6, 2015. See also "Web Accessibility Initiative (WAI) - Home Page." World Wide Web Consortium (W3C). Accessed December 6any udingrg/TR/WCAG20/#conten, 2015.; which assumes that the benefits of technical standards far outweigh the liabilities in the libr [↑](#endnote-ref-64)
65. The Web Content Accessibility Guidelines, which are part of the larger Web Accessibility Initiative (WAI), are based on four principles; namely, that content is perceivable, meaning that information and user interface components must be presented to users in ways they can perceive; that pages and sites are operable, meaning that must be able to operate the interface, that the interface cannot require any interaction that a user cannot perform; that the interface must be understandable; and that the content must be robust, meaning that it can be interpreted fully and reliably by a wide variety of user agents, including assistive technologies, and that the content should remain accessible as the technologies underlying its presentation advance.While the main goal of the Web Accessibility Initiative is social inclusion for people with disabilities, it also supports the needs and requirements of other groups, including older people, people living in rural areas, and people in developing countries. There is, too, a business case to be made for Web content accessibility. Accessibility intersects with the issue of best practices in other areas, including mobile Web design, device independence, multi-modal interaction, general usability, and search engine optimization, and case studies indicate that accessible Websites produce many benefits, including better search results, reduced maintenance costs, increased audience reach and compliance with legal and policy requirements. The current version, WCAG 2.0, was adopted as a W3C Recommendation in 2008. See “Web Content Accessibility Guidelines (WCAG) 2.0." World Wide Web Consortium (W3C). Accessed December 6, 2015. <http://www.w3.org/TR/WCAG20/#contents>; and See World Wide Web Consortium. Developing a Web Accessibility Business Case for Your Organization: Overview. Accessed December 6, 2015. http://www.w3.org/WAI/bcase/Overview. [↑](#endnote-ref-65)
66. HTML5 Accessibility. Last accessed December 6, 2015. <http://www.html5accessibility.com>. [↑](#endnote-ref-66)
67. The Open Web Platform refers to the collection of open, royalty-free technologies developed under guidelines formulated by the World Wide Web Consortium. See http://www.w3.org/wiki/Open\_Web\_Platform. [↑](#endnote-ref-67)
68. ISO/IEC 2382:2015. Information technology -- Vocabulary. Last accessed December 6, 2015. https://www.iso.org/obp/ui/#iso:std:iso-iec:2382:ed-1:v1:en. [↑](#endnote-ref-68)
69. Tiemann, Michael. 2006. An objective definition of open standards. Computer Standards & Interfaces 28 (5): 495-507; Neus, Andreas, and Philipp Scherf. "Opening minds: Cultural change with the introduction of open-source collaboration methods." IBM Systems Journal 44, no. 2 (2005): 215-225. [↑](#endnote-ref-69)