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Information technology — Big data reference architecture —

Part 5: Standards roadmap

Technologies de l'information — Architecture de référence des big data —

Partie 5: Feuille de route pour les normes

Reference number
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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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Contents

Page

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/IEC JTC 1, *Information technology*.

A list of all parts in the ISO/IEC 20547-series can be found on the ISO website.

Introduction

There is broad agreement among commercial, academic, and government leaders about the remarkable potential of big data to spark innovation, fuel commerce, and drive progress. big data is the common term used to describe the deluge of data in today's networked, digitized, sensor-laden, and information-driven world. The availability of vast data resources carries the potential to answer questions previously out of reach, including the following:

— How can a potential pandemic reliably be detected early enough to intervene?

— Can new materials with advanced properties be predicted before these materials have ever been synthesized?

— How can the current advantage of the attacker over the defender in guarding against cyber-security threats be reversed?

There is also broad agreement on the ability of big data to overwhelm traditional approaches. The growth rates for data volumes, speeds, and complexity are outpacing scientific and technological advances in data analytics, management, transport, and data user spheres.

Despite widespread agreement on the inherent opportunities and current limitations of big data, a lack of consensus on some important, fundamental questions continues to confuse potential users and stymie progress. These questions include the following:

— What attributes define big data solutions?

— How is big data different from traditional data environments and related applications?

— What are the essential characteristics of big data environments?

— How do these environments integrate with currently deployed architectures?

— What standards are in place to support big data and how does big data affect existing standards?

— What are the central scientific, technological, and standardization challenges that need to be addressed to accelerate the deployment of robust big data solutions?

This document is focused on providing at least some portion of the answers to the last two questions.

Information technology — Big data reference architecture —

Part 5: Standards roadmap

1 Scope

This document describes big data relevant standards, both in existence and under development, along with priorities for future big data standards development based on gap analysis.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 20546:—[1], *Information technology — Big data — Definition and vocabulary*

3 Terms, definitions and abbreviations

For the purposes of this document, the terms and definitions given in ISO/IEC 20546 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Terms defined elsewhere

3.1.1
big data
extensive datasets — primarily in the characteristics of volume, variety, velocity, and/or variability — that require a scalable architecture for efficient storage, manipulation, and analysis

[SOURCE: ISO/IEC 20546:—[1]]

3.2 Terms defined in this document

3.2.1
standard implementer
component that enables the provision of services based on the standards

Note 1 to entry: For example, a developer who need to comply with SQL commands would be an implementer of that standard.

1) Under preparation. Stage at the time of publication: ISO/IEC DIS 20546:2018.

3.2.2
standard user
person or component that interacts with a service via the standard or that accepts/consumes/decodes data represented by the standard

3.3 Abbreviations

ANSI	American National Standards Institute
AP	Application Provider layer
BDRA	Big Data Reference Architecture
BSI	British Standards Institute
DC	Data Consumer layer
DIN	Deutsches Institut für Normung e.V. (German Institute for Standardization)
DMTF	Distributed Management Task Force, Inc.
DP	Data Provider layer
ISO	International Organization for Standardization
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
INF	Infrastructure Layer
INT	Integration Layer
ITU-T	International Telecommunication Union – Telecommunication standardization sector
JISC	Japanese Industrial Standards Committee
MGT	Management Layer
OASIS	Organization for the Advancement of Structured Information Standards
OGC	Open Geospatial Consortium
OGF	Open Grid Forum
OSS-Association	Open Security Standards Association
PL	Platform Layer
PR	Processing layer
SAC	Standardization Administration of China
S&P	Security and Privacy Layer
SDO	Standards Development Organization
W3C	World Wide Web Consortium

4 Rationale

Identifying and locating relevant standards developed by ISO/IEC and other organizations and determining their applicability to big data and the BDRA (Big Data Reference Architecture) is a continual process. This roadmap provides standard implementers and users the pointers and links to other standards which would apply to or inform their implementation of the BDRA.

5 Relationship to BDRA

The Big Data Reference Architecture (BDRA) specified in ISO/IEC 20547-3 describes multiple viewpoints of the big data paradigm and how those viewpoints fit together. Because the big data paradigm integrates a wide variety of existing technologies, it is useful to identify the standards behind those technologies.

6 Standards development organizations

Big data has generated interest in a wide variety of multi-stakeholder collaborative organizations, including those involved in the de jure standards process, industry consortia, and open source organizations. These organizations may operate differently and focus on different aspects, but they all have a stake in big data. Integrating additional big data initiatives with ongoing collaborative efforts is a key to success. Identifying which collaborative initiative efforts address architectural requirements and which requirements are not currently being addressed is a starting point for building future multi-stakeholder collaborative efforts. Collaborative initiatives include, but are not limited to the following:

— International Standard development organizations e.g.: ISO, IEC, ITU-T;

— National Standard development organizations e.g: ANSI, BSI, DIN, JISC, SAC;

— Industry consortium e.g.: W3C, OASIS, DMTF;

— others e.g. OSS-Association specification.

Some of the leading SDOs and industry consortia working on big data related standards include:

— International Organization for Standardization (ISO)—de jure standards process;

— Institute of Electrical and Electronics Engineers (IEEE)—de jure standards process;

— International Electrotechnical Commission (IEC);

— Internet Engineering Task Force (IETF);

— World Wide Web Consortium (W3C)—Industry consortium;

— Open Geospatial Consortium (OGC®)—Industry consortium;

— Organization for the Advancement of Structured Information Standards (OASIS)—Industry consortium;

— Open Grid Forum (OGF)—Industry consortium.

NOTE The organizations and initiatives referenced in this document do not form an exhaustive list. It is anticipated that as this document is more widely distributed, more standards efforts addressing additional segments of the big data mosaic will be identified.

There are many government organizations that publish standards relative to their specific problem areas. Many of these are based on other standards (e.g., ISO, IEEE, ANSI) and could be applicable to the big data problem space. However, a fair, comprehensive review of these standards would exceed the available document preparation time and may not be of interest to much of the audience for this document. Readers interested in domains covered by the government organizations and standards, are encouraged to review the standards for applicability to their specific needs.

Open source implementations are providing useful new technology that is being used either directly or as the basis for commercially supported products. These open source implementations are not just individual products. One needs to integrate an eco-system of products to accomplish ones goals. Because of the ecosystem complexity, and because of the difficulty of fairly and exhaustively reviewing open source implementations, such implementations are not included in this section. However, it should be noted that those implementations often evolve to become the de facto reference implementations for many technologies.

7 Existing standards

This section presents a list of existing standards from the above listed organizations that are relevant to big data and the BDRA. Determining the relevance of standards to the big data domain is challenging since almost all standards in some way deal with data. Whether a standard is relevant to big data is generally determined by impact of big data characteristics (e.g. volume, velocity, variety) on the standard or, more generally, by the scalability of the standard to accommodate those characteristics. A standard can also be applicable to big data depending on the extent to which that standard helps to address one or more of the big data characteristics. Finally, a number of standards are also very domain or problem specific and, while they deal with or address big data, they support a very specific functional domain and developing even a marginally comprehensive list of such standards would require a massive undertaking involving subject matter experts in each potential problem domain, which is beyond the scope of this document.

Documents included in Table 1 focus on standards that would do the following:

— facilitate interfaces between BDRA components;

— facilitate the handling of data with one or more big data characteristics;

— represent a fundamental function needing to be implemented by one or more BDRA functional components or activities;

— be commonly available standards which facilitate big data, regardless of the application domain.

Table 1 represents a portion of potentially applicable standards from a portion of contributing organizations working in big data domain.

As most standards represent some form of interface between components, Table 1 is annotated with whether the BDRA component would be an Implementer or User of the standard. The definitions of Standard Implementer and Standard User are provided in Clause 3.

NOTE While the above definitions provide a reasonable baseline, for some standards the difference between implementation and use can be negligible or non-existent for others.

The BDRA functional layers and multilayer functions are abbreviated in the table columns as follows:

— DP = Data Provider layer;

— DC = Data Consumer layer;

— AP = Application Provider layer;

— PR = Processing layer;

— PL = Platform Layer;

— INF = Infrastructure Layer;

— INT = Integration Layer;

— S&P = Security and Privacy Layer;

— MGT = Management Layer.

Please refer to ISO/IEC 20547-3[4] for the complete descriptions of the layers and the names of the types of functional components within the layers.

Within the table, each standard is annotated as to whether that layer would be an Implementer or User of the standard. The definitions of a Standard Implementer and Standard User are provided in Part 3. Standards are ordered by the SDO and industry consortia, and then alphabetically/numerically by standard name/number.

Table 1 — Existing big data standards

Standard Name/ Number	Description	BDRA Functional Layers							
		DP	DC	AP	PR	PL	INF	INT	S&P	MGT
ISO 6709:2008	Standard representation of geographic point location by coordinates	I	U	IU	IU	I				
ISO/IEC 9075-*	ISO/IEC 9075 defines SQL. The scope of SQL is the definition of data structure and the operations on data stored in that structure. ISO/IEC 9075-1, ISO/IEC 9075-2 and ISO/IEC 9075-11 encompass the minimum requirements of the language. Other parts define extensions.	I	IU	U	U	I			U	U
ISO/IEC TR 9789 (Technical Report)	Guidelines for the organization and representation of data elements for data interchange	IU	IU	IU	IU	IU		IU		
ISO/IEC 9798-*	Information technology — Security techniques — Entity authentication	IU	U	U	U	U	IU	U	IU	U
ISO/IEC 10728-*	Information Resource Dictionary System (IRDS) Services Interface			U	I	I		I		I
ISO/IEC 11770-*	Information technology — Security techniques — Key management	IU	U	U	U	U	I	U	IU	U
ISO/IEC 11179-*	The 11179 standard is a multipart standard for the definition and implementation of metadata registries. The series includes the following parts: Part 1: Framework Part 2: Classification Part 3: Registry metamodel and basic attributes Part 4: Formulation of data definitions Part 5: Naming principles Part 6: Registration Part 7: Metamodel for data set registration	I	IU	IU	U	IU			U	
ISO/IEC 13249-*	Database languages – SQL multimedia and application packages Part 1: Framework Part 2: Full-Text Part 3: Spatial Part 5: Still image Part 6: Data mining	I	IU	U	U	I		U		

DP = Data Provider layer; DC = Data Consumer layer; AP = Application Provider layer; PR = Processing layer
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MGT = Management Layer
I = Standard implementer; U = Standard user

Table 1 *(continued)*

Standard Name/ Number	Description	BDRA Functional Layers								
		DP	DC	AP	PR	PL	INF	INT	S&P	MGT
ISO/IEC TR 14516:2002	Information technology — Security techniques — Guidelines for the use and management of Trusted Third Party services	I	U	IU			I		U	
ISO/IEC 15408-*	Information technology — Security techniques — Evaluation criteria for IT security						I		I	
ISO/IEC TR 19075-*	This is a series of Technical Reports on SQL related technologies. Part 1: Xquery Part 2: SQL Support for Time-Related Information Part 3: Programs using the Java programming language Part 4: Routines and types using the Java programming language Part 5: Row Pattern Recognition in SQL Part 6: SQL support for JSON Part 7: Polymorphic table functions in SQL	I	IU	U	U	I		U	U	U
ISO 19110	Geographic information —Methodology for feature cataloguing	I	U	IU	U	I				
ISO 19114	Geographic information — Quality evaluation procedures			I						
ISO 19115-*	Geographic information — Metadata	I	U	IU	U	I				
ISO 19119	Geographic information — Services	I	U	IU	I	I				
ISO 19139	Geographic information — Metadata — XML Schema Implementation	I	U	IU	U	I				
ISO 19157	Geographic information —Data quality	I	U	IU	U	I				
ISO/IEC 19503	Extensible Markup Language (XML) Metadata Interchange (XMI)	I	IU	U	IU	I			U	U

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Table 1 *(continued)*

Standard Name/ Number	Description	BDRA Functional Layers								
		DP	DC	AP	PR	PL	INF	INT	S&P	MGT
ISO/IEC 19763-*	Information technology — Metamodel framework for interoperability (MFI). Multipart standard that includes the following parts: Part 1: Framework Part 3: Metamodel for ontology registration Part 5: Metamodel for process model registration Part 6: Registry Summary Part 7: Metamodel for service model registration Part 8: Metamodel for role and goal model registration Part 9: On demand model selection (Technical Report) Part 10: Core model and basic mapping Part 12: Metamodel for information model registration Part 13: Metamodel for form design registration	I	IU	U	U	I		IU		
ISO/IEC 19773	Metadata Registries Modules	I	IU	U	U	I			IU	
ISO/IEC 19944	Information technology — Cloud computing — Cloud services and devices: Data flow, data categories and data use						I			U
ISO/IEC 20933	Information technology — Distributed application platforms and services (DAPS) — Access Systems	I	U	IU	I	I				
ISO/IEC TR 20943	Metadata registry content consistency	I	IU	U	U	I			U	U
ISO/IEC 27010:2015	Information technology — Security techniques — Information security management for inter-sector and inter-organizational communications	I	U	IU			I		IU	
ISO/IEC 27017	Information technology — Security techniques — Code of practice for information security controls based on ISO/IEC 27002 for cloud services								I	
ISO/IEC 27033-1:2015	Information technology — Security techniques — Network security	IU	IU	IU	IU	IU	I	IU	IU	IU
ISO/IEC 27035-*	Information technology — Security techniques — Information security incident management						I		I	U
ISO/IEC 27037:2012	Information Technology — Security Techniques — Guidelines for Identification, Collection, Acquisition and Preservation of Digital Evidence						I		I	
ISO/IEC 29100:2011	Information technology — Security techniques — Privacy framework	IU	IU	U	U	U	I	U	I	U

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Table 1 *(continued)*

Standard Name/ Number	Description	BDRA Functional Layers								
		DP	DC	AP	PR	PL	INF	INT	S&P	MGT
ISO/IEC TR 30102	Information technology — Distributed Application Platforms and Services (DAPS) — General technical principles of Service Oriented Architecture	I		IU	I	I	I			U
IEEE 2200-2012	Standard Protocol for Stream Management in Media Client Devices	I	U	IU						
W3C Data Catalogue Vocabulary (DCAT)	DCAT is an RDF vocabulary designed to facilitate interoperability between data catalogs published on the Web. This document defines the schema and provides examples for its use.	I	U	IU						
W3C Document Object Model (DOM) Level 1 Specification	This series of specifications define the DOM, a platform- and language-neutral interface that allows programs and scripts to dynamically access and update the content, structure and style of HyperText Markup Language (HTML) and XML documents.	I	U	IU	IU	I		U		
W3C Efficient XML Interchange (EXI) Format 1.0 (Second Edition)	This specification covers the EXI format. EXI is a very compact representation for the XML Information Set that is intended to simultaneously optimize performance and the utilization of computational resources.	I	U	IU	IU	IU		IU		
W3C HTML5 A vocabulary and associated APIs for HTML and XHTML	This specification defines the 5th major revision of the core language of the World Wide Web — HTML.	I	U	IU						
W3C Internationalization Tag Set (ITS) 2.0	The ITS 2.0 specification enhances the foundation to integrate automated processing of human language into core Web technologies and concepts that are designed to foster the automated creation and processing of multilingual Web content.	I	U	IU	IU					
W3C JavaScript Object Notation (JSON)-LD 1.0	JSON-LD 1.0 A JSON-based Serialization for Linked Data W3C Recommendation 16 January 2014	I	U	IU	IU	I		IU		
W3C OWL 2 Web Ontology Language	The OWL 2 Web Ontology Language, informally OWL 2, is an ontology language for the Semantic Web with formally defined meaning.	I	U	IU	IU	IU				
W3C Platform for Privacy Preferences (P3P) 1.0	The P3P enables Web sites to express their privacy practices in a standard format that can be retrieved automatically and interpreted easily by user agents.	I	U	IU	U	U		U	IU	
W3C Protocol for Web Description Resources (POWDER)	POWDER — the Protocol for Web Description Resources — provides a mechanism to describe and discover Web resources and helps the users to make a decision whether a given resource is of interest.	I	U	IU						

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Table 1 *(continued)*

Standard Name/ Number	Description	BDRA Functional Layers								
		DP	DC	AP	PR	PL	INF	INT	S&P	MGT
W3C Provenance	Provenance is information about entities, activities, and people involved in producing a piece of data or thing, which can be used to form assessments about its quality, reliability or trustworthiness. The Provenance Family of Documents (PROV) defines a model, corresponding serializations and other supporting definitions to enable the inter-operable interchange of provenance information in heterogeneous environments such as the Web.	I	U	IU	IU	I		U	U	
W3C Resource Description Framework (RDF)	The RDF is a framework for representing information in the Web. RDF graphs are sets of subject-predicate-object triples, where the elements are used to express descriptions of resources.	I	U	IU	IU	I		U		
W3C RDF Data Cube Vocabulary	The Data Cube vocabulary provides a means to publish multi-dimensional data, such as statistics on the Web using the W3C RDF standard.	I	U	IU						
W3C Rule Interchange Format (RIF)	RIF is a series of standards for exchanging rules among rule systems, in particular among Web rule engines.	I	U	IU	IU	I		U		
W3C Service Modeling Language (SML) 1.1	This specification defines the SML, Version 1.1 used to model complex services and systems, including their structure, constraints, policies, and best practices.	I	U	IU	IU	I				U
W3C Simple Knowledge Organization System Reference (SKOS)	This document defines the SKOS, a common data model for sharing and linking knowledge organization systems via the Web.	I	U	IU	U	I				
W3C Simple Object Access Protocol (SOAP) 1.2	SOAP is a protocol specification for exchanging structured information in the implementation of web services in computer networks.	I	U	IU						
W3C SPARQL 1.1	SPARQL is a language specification for the query and manipulation of linked data in a RDF format.	I	U	IU	U	I				
W3C Web Service Description Language (WSDL) 2.0	This specification describes the WSDL Version 2.0, an XML language for describing Web services.	I	U	IU	I					
W3C XML	XML 1.0 (Fifth Edition) W3C Recommendation 26 November 2008	IU	IU	IU	IU	IU		IU	IU	IU
W3C XML Encryption Syntax and Processing Version 1.1	This specification covers a process for encrypting data and representing the result in XML.	I	U	IU	U	I				

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Table 1 *(continued)*

Standard Name/ Number	Description	BDRA Functional Layers								
		DP	DC	AP	PR	PL	INF	INT	S&P	MGT
W3C XML Key Management Specification (XKMS) 2.0	This standard specifies protocols for distributing and registering public keys, suitable for use in conjunction with the W3C Recommendations for XML Signature [XML-SIG] and XML Encryption [XML-Enc]. The XKMS comprises two parts — the XML Key Information Service Specification (X-KISS) and the XML Key Registration Service Specification (X-KRSS).	I	U	IU	U	U				
W3C XML Signature Syntax and Processing Version 1.1	This specification covers XML digital signature processing rules and syntax. XML Signatures provide integrity, message authentication, and/or signer authentication services for data of any type, whether located within the XML that includes the signature or elsewhere.	I	U	IU	IU	IU		IU		
W3C XPath 3.0	XPath 3.0 is an expression language that allows the processing of values conforming to the data model defined in [XQuery and XPath Data Model (XDM) 3.0]. The data model provides a tree representation of XML documents as well as atomic values and sequences that may contain both references to nodes in an XML document and atomic values.	I	U	IU	IU	I				
W3C XProc	This specification describes the syntax and semantics of *XProc: An XML Pipeline Language*, a language for describing operations to be performed on XML documents.	I	U	IU	IU	I		IU		
W3C XQuery 3.0	The XQuery specifications describe a query language called XQuery, which is designed to be broadly applicable across many types of XML data sources.	I	U	IU	U	I		IU		
W3C XSL Transformations (XSLT) Version 2.0	This specification defines the syntax and semantics of XSLT 2.0, a language for transforming XML documents into other XML documents.	I	U	IU	IU	I				
OGC® network Common Data Form (netCDF)	netCDF is a set of software libraries and self-describing, machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data.	I	U	IU	U	I				
OGC® Open Modelling Interface Standard (OpenMI)	The purpose of the OpenMI is to enable the runtime exchange of data between process simulation models and also between models and other modelling tools such as databases and analytical and visualization applications.	I	U	IU	IU	IU		IU		
OASIS Advanced Message Queuing Protocol (AMQP) Version 1.0	The AMQP is an open internet protocol for business messaging. It defines a binary wire-level protocol that allows for the reliable exchange of business messages between two parties.	I	U	U	U	U		IU		U

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OASIS Application Vulnerability Description Language (AVDL) v1.0	This specification describes a standard XML format that allows entities (such as applications, organizations, or institutes) to communicate information regarding web application vulnerabilities.	I	U	I					U	
OASIS AS4 Profile of ebMS 3.0 v1.0	Standard for business to business exchange of messages via a web service platform.	I	U	IU				IU		
OASIS Biometric Identity Assurance Services (BIAS) Simple Object Access Protocol (SOAP) Profile v1.0	This OASIS BIAS profile specifies how to use XML (XML10) defined in ANSI INCITS 442-2010—BIAS to invoke SOAP -based services that implement BIAS operations.	I	U	IU					U	
OASIS Content Management Interoperability Services (CMIS)	The CMIS standard defines a domain model and set of bindings that include Web Services and ReSTful AtomPub that can be used by applications to work with one or more Content Management repositories/ systems.	I	U	IU	IU	I				
OASIS Digital Signature Service (DSS)	This specification describes two XML-based request/response protocols - a signing protocol and a verifying protocol. Through these protocols a client can send documents (or document hashes) to a server and receive back a signature on the documents; or send documents (or document hashes) and a signature to a server, and receive back an answer on whether the signature verifies the documents.	I	U	IU	U	I		IU		
OASIS Directory Services Markup Language (DSML) v2.0	The DSML provides a means for representing directory structural information as an XML document methods for expressing directory queries and updates (and the results of these operations) as XML documents	I	U	IU	U	I				
OASIS ebXML Messaging Services	These specifications define a communications-protocol neutral method for exchanging electronic business messages as XML.	I	U	IU	U			I		
OASIS ebXML RegRep	ebXML RegRep is a standard defining the service interfaces, protocols and information model for an integrated registry and repository. The repository stores digital content while the registry stores metadata that describes the content in the repository.	I	U	IU	U	I		IU		
OASIS ebXML Registry Information Model	The Registry Information Model provides a blueprint or high-level schema for the ebXML Registry. It provides implementers with information on the type of metadata that is stored in the Registry as well as the relationships among metadata Classes.	I	U	IU	U	I		I		

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Standard Name/ Number	Description	BDRA Functional Layers								
		DP	DC	AP	PR	PL	INF	INT	S&P	MGT
OASIS ebXML Registry Services Specification	An ebXML Registry is an information system that securely manages any content type and the standardized metadata that describes it. The ebXML Registry provides a set of services that enable sharing of content and metadata between organizational entities in a federated environment.	I	U	IU	U	I		IU		
OASIS eXtensible Access Control Markup Language (XACML)	The standard defines a declarative access control policy language implemented in XML and a processing model describing how to evaluate access requests according to the rules defined in policies.	I	U	IU	IU	I			IU	
OASIS Message Queuing Telemetry Transport (MQTT)	MQTT is a Client Server publish/subscribe messaging transport protocol for constrained environments such as for communication in Machine to Machine and Internet of Things contexts where a small code footprint is required and/or network bandwidth is at a premium.	I	U	IU	U			IU		
OASIS Open Data (OData) Protocol	The OData Protocol is an application-level protocol for interacting with data via RESTful interfaces. The protocol supports the description of data models and the editing and querying of data according to those models.	I	U	IU	U	I				
OASIS Search Web Services (SWS)	The OASIS SWS initiative defines a generic protocol for the interaction required between a client and server for performing searches. SWS define an Abstract Protocol Definition to describe this interaction.	I	U	IU						
OASIS Security Assertion Markup Language (SAML) v2.0	The SAML defines the syntax and processing semantics of assertions made about a subject by a system entity. This specification defines both the structure of SAML assertions, and an associated set of protocols, in addition to the processing rules involved in managing a SAML system.	I	U	IU	IU	I		IU	IU	
OASIS SOAP-over-UDP (User Datagram Protocol) v1.1	This specification defines a binding of SOAP to user datagrams, including message patterns, addressing requirements, and security considerations.	I	U	IU						
OASIS Solution Deployment Descriptor Specification v1.0	This specification defines schema for two XML document types: Package Descriptors and Deployment Descriptors. Package Descriptors define characteristics of a package used to deploy a solution. Deployment Descriptors define characteristics of the content of a solution package, including the requirements that are relevant for creation, configuration and maintenance of the solution content.						IU			IU

DP = Data Provider layer; DC = Data Consumer layer; AP = Application Provider layer; PR = Processing layer

PL = Platform Layer; INF = Infrastructure Layer; INT = Integration Layer; S&P = Security and Privacy Layer

MGT = Management Layer

I = Standard implementer; U = Standard user

Table 1 *(continued)*

Standard Name/ Number	Description	BDRA Functional Layers								
		DP	DC	AP	PR	PL	INF	INT	S&P	MGT
OASIS Symptoms Automation Framework (SAF) Version 1.0	This standard defines reference architecture for the Symptoms Automation Framework, a tool in the automatic detection, optimization, and remediation of operational aspects of complex systems,						I			IU
OASIS Topology and Orchestration Specification for Cloud Applications Version 1.0	The concept of a "service template" is used to specify the "topology" (or structure) and "orchestration" (or invocation of management behavior) of IT services. This specification introduces the formal description of Service Templates, including their structure, properties, and behavior.			U	IU		I			IU
OASIS Universal Business Language (UBL) v2.1	The OASIS UBL defines a generic XML interchange format for business documents that can be restricted or extended to meet the requirements of particular industries.	I	U	IU	U	I		U		
OASIS Universal Description, Discovery and Integration (UDDI) v3.0.2	The focus of UDDI is the definition of a set of services supporting the description and discovery of (1) businesses, organizations, and other Web services providers, (2) the Web services they make available, and (3) the technical interfaces which can be used to access those services.	I	U	IU						U
OASIS Unstructured Information Management Architecture (UIMA) v1.0	The UIMA specification defines platform-independent data representations and interfaces for text and multi-modal analytics.			U	I					
OASIS Unstructured Operation Markup Language (UOML) v1.0	UOML is interface standard to process unstructured document; it plays the similar role as SQL to structured data. UOML is expressed with standard XML.	I	U	IU	I					
OASIS/W3C WebCGM v2.1	Computer Graphics Metafile (CGM) is an ISO standard, defined by ISO/IEC 8632-*, for the interchange of 2D vector and mixed vector/raster graphics. WebCGM is a profile of CGM, which adds Web linking and is optimized for Web applications in technical illustration, electronic documentation, geophysical data visualization, and similar fields.	I	U	IU	U	IU	I			
OASIS Web Services Business Process Execution Language (WS-BPEL) v2.0	This standard defines a language for specifying business process behavior based on Web Services. WS-BPEL provides a language for the specification of Executable and Abstract business processes.	I	U	IU	I					

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