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Health informatics — Information models — Biomedical Research Integrated Domain Group (BRIDG) Model

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Foreword

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This document was prepared by Technical Committee ISO/TC 215 *Health informatics.*

This second edition cancels and replaces the first edition (ISO 14199:2015), which has been technically revised.

The main changes are as follows:

— in the Introduction a description was added about the difference between this document and the BRIDG model, which is predominantly represented as a large UML Model, not captured in this document;

— the main differences between BRIDG version 3.2 and BRIDG version 5.3.1 have been identified;

— a sentence was added in 9.1 indicating that all artefacts of the BRIDG model are downloadable from the BRIDG website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The Biomedical Research Integrated Domain Group (BRIDG) Model is a collaborative effort engaging stakeholders from the Clinical Data Interchange Standards Consortium (CDISC), the HL7 BRIDG Work Group, the US National Cancer Institute (NCI), the US Food and Drug Administration (FDA), and the International Organization for Standardization's (ISO) Technical Committee on health informatics, TC 215. The BRIDG model was developed to closely integrate medical research information with healthcare, as well as integrate information within medical research. Clinical research data processes use a variety of meanings, formats, and data types that inhibit the ability and potential to share, integrate, and disseminate clinical research data, thus slowing and, in many cases, ending promising drug discovery and development processes. Vast bodies of medical knowledge data either do not exist in an electronic format that is useful for today's dynamic decision support systems or are electronic but are locked into discrete proprietary systems. Once freed, information that is locked away in static documents and discrete databases can flow through the processes of medical research. In an ideal world, critical data can be accessed, read, and aggregated by any tool at any point in the process. The tools would become the effective means of communication crossing all the existing boundaries and would enable automation of many procedures that currently take place manually. Removing the time-consuming procedure of translating and transcribing data contained in dissimilar and proprietary information stores would allow scientists to focus on science and innovation. For this to become reality, medical research data must be machine-readable and semantically interoperable.

The BRIDG model provides an approach to remove semantic ambiguities present in medical research. The BRIDG is intended to represent a shared view of the semantics of the domain of protocol-driven research and its associated regulatory artefacts. The need for BRIDG became clear when various source projects contributed semantic content which was not interoperable. These source projects are documented in the model using tags in each class and attribute as well as other associations. These tags indicate the source project elements from which the concept was derived or to which the element maps.

Information about the projects contributing to the BRIDG content can be found in the BRIDG user's guide in the section entitled "Projects Contributing to the BRIDG Model" and in the BRIDG mapping spreadsheet[2] and the Download Release Packages & Browse Online page on the BRIDG website[2] for a table listing the projects that were harmonized in each version throughout BRIDG's history.[2] The background page under the About tab includes an overview of the history of the BRIDG model noting contributing projects.

Since BRIDG v3.2, there have been a few versions and many model changes. The current version, BRIDG v5.3.1, is now a complex, 300+ class model with hundreds of attributes and relationship, definitions and examples, etc., all captured in a Unified Modelling Language (UML) tool called Enterprise Architect. It is also available in an XMI format export, and is accompanied by a User's Guide, a mapping spreadsheet detailing use cases for all the semantics and a change list identifying all the changes from v3.2 to v5.3.1.

The key differences between the 2015 version of BRIDG (v3.2) and the latest version of BRIDG (v5.3.1) can be summarized as follows:

— harmonization of models, projects and standards with the BRIDG model;

— new semantics added as a result of model harmonization include a range of topics in the areas of life science, SDTM 3.1.3, 3.2 and Pharmacogenomic, Pharmacogenetics domains, clinical research organization administration, and imaging and annotation;

— artefacts updated include pertinent files from the release package for BRIDG 5.3.1 and a report detailing the differences between BRIDG 3.2 and BRIDG 5.3.1.

Health informatics — Information models — Biomedical Research Integrated Domain Group (BRIDG) Model

1 Scope

This document is complementary to the Biomedical Research Integrated Domain Group (BRIDG) model. It is a high-level overview of BRIDG in general and BRIDG version 5.3.1 in specific. This document also provides necessary links to artifacts that detail the changes between BRIDG v3.2 and BRIDG v5.3.1[5] and to the BRIDG Release Download page.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1
adverse event
unfavourable and unintended sign, symptom, disease or other medical occurrence with a temporal association with the use of a medical product, procedure or other therapy, or in conjunction with a research study, regardless of causal relationship

EXAMPLE Death, back pain, headache, pulmonary embolism, heart attack.

[SOURCE: BRIDG Model Report, p. 15[2]]

3.2
attribute
descriptive feature of a *class* (3.3) depicted as being contained within the class

[SOURCE: BRIDG 5.3.1 User's Guide, Section 5.6.3[2]]

3.3
class
entity that represents a person, place, or thing

[SOURCE: BRIDG 5.3.1 User's Guide, Section 5.6.2[2]]

3.4
domain analysis model
DAM
abstract representation of a subject area of interest, in this case protocol-driven research, that is the basis for development of lower-level design artefacts for computer software, databases, or data exchange standards

3.5
unified modelling language
UML
standardized general-purpose modelling language used to specify semantic requirements for a particular domain

3.6
web ontology language
OWL
web-based language designed for use in applications that processes the content of information

4 Abbreviated terms

CDISC	Clinical Data Interchange Standards Consortium
US FDA	US Food and Drug Administration
HL7	Health Level Seven
US NCI	US National Cancer Institute
RIM	Reference Information Model
SCC	Semantic Coordination Committee

5 Overview of conceptual representations of the BRIDG model

The BRIDG model is a formal DAM which can be defined by the following characteristics:

— an implementation-independent view of a domain of interest;

— shared understanding of concepts;

— use of domain terminology, understandable to domain experts who might have little or no information technology knowledge, but are a primary consumer;

— unambiguous definitions;

— use of complex data types designed specifically for the domain of focus, in the case of this document, the clinical research area of healthcare;

— good modelling practices;

— built by analysts and subject matter experts who develop consensus.

The BRIDG model is a conceptual model from which detailed design level artefacts for computer-related systems can be built. This domain analysis model is focused on the static (or data) semantics of the domain of clinical research that is the representation of the structures of and relationships between information within the domain. Therefore, most domain semantics are represented as UML class diagrams.

The model is specifically constructed to be implementation-independent, i.e. the semantics of the model are restricted to those that characterize the “problem domain” as described by the domain experts. The BRIDG model specifies the use of tags in each class and attribute (and many an association as well). These tags indicate the source project elements from which the concept was derived or to which the element maps.

BRIDG version 3.2 version included three representations of the model, a UML Class Diagram (the canonical representation), an HL7 RIM v3-based model, and OWL. Subsequent versions did not include the HL7 RIM and OWL versions.

6 UML-based canonical representations

6.1 General considerations

The UML representation is the canonical representation of the BRIDG model. UML offers a variety of diagrams to visually represent the semantics. BRIDG primarily uses class and instance diagrams to visualize the data semantics of clinical research.

There is one large comprehensive UML model and ten subdomain-specific model views. The comprehensive model is large and complex, so the subdomain views were created to allow for easier access and understandability. The subdomain views are described more fully in 6.2.

6.2 Subdomain UML views

6.2.1 Adverse Event

The Adverse Event subdomain is intended for those involved in safety and security related activities, such as detection, evaluation, follow-up, and reporting. This includes safety issues involving people or products. It also includes safety-related activities during or after a research protocol, such as post-market adverse event reporting.

6.2.2 Biospecimen

The Biospecimen subdomain includes concepts related to a biologic specimen, including collection and processing. With the broader scope of BRIDG 4.0 covering translational research and the harmonization of Life Sciences Model and CDISC Pharmacogenomics & Pharmacogenetics domains, it is likely that there is some overlap of concepts between BRIDG Biospecimen subdomain concepts and the models being developed in the HL7 Specimen (Orders & Observation) and Anatomic Pathology work groups.

6.2.3 Common

The Common subdomain is not intended for any one specific audience. It represents the semantics that are common to all (or most) of the other subdomains. Most of the content is not even specific only to the BRIDG domain but might be common to any healthcare-related domain analysis model, including semantics for such things as people, organizations, places and materials.

Note that the larger scope of BRIDG in support of translational research has resulted in many new higher-level concepts in the Common subdomain. Review the BRIDG Backbone view in the common subdomain to understand the new Project related concepts. There are many other new classes that were added to the Common Subdomain in Release 4.0.

6.2.4 Experiment

The Experiment subdomain includes concepts related to the design, planning, resourcing, and execution of experiments, which are intended to test hypotheses or lead to discoveries. Most of the concepts in this subdomain are from the Life Sciences (LS) Model that is harmonized in BRIDG 4.0.

6.2.5 Imaging

The Imaging subdomain represents the core concepts related to imaging studies, images, annotations, and other related concepts. This includes harmonization of semantics from parts of the DICOM standard and an NCI Imaging project [Annotation and Imaging Markup (AIM)]. It is not intended to replicate all the semantics of imaging studies, series, images, annotations, and reports, but rather contains summary-level key concepts which could serve as search criteria for interfacing between a BRIDG-based CTMS and a DICOM-based imaging system.

6.2.6 Molecular Biology (out-of-scope for balloting)

The Molecular Biology subdomain represents the core concepts related to genetics and genomics, including gene, protein, genetic observations, and biomarkers. It is also anticipated to eventually include some overlapping concepts with the HL7 Clinical Genomics (CG) Working Group's domain analysis model when that model is complete. In anticipation of that change, several of the molecular biology classes have been deprecated since they are not used by or have no mapping tags from a project other than LS DAM.

Note that the Molecular Biology subdomain was started initially by harmonizing concepts from the LS DAM project and then was extended by harmonizing CDISC's Pharmacogenetics and Pharmacogenomics domains (PGx). LS DAM was substantially developed in a "top-down" approach which means analysts and subject matter experts modelled concepts related to molecular biology from scratch essentially, by discussing terms, meanings, characteristics, and relationships between concepts. However, the PGx domains were developed in a more "bottom-up" kind of approach which means that contributing projects identified specific semantics from applications that need to exchange data with one another, and the concepts are grouped and organized accordingly. The resulting differences are that top-down modelling often identifies a wide range of high-level information about which domain experts are concerned but doesn't provide the detailed model elements or semantic rigor that a bottom-up approach typically provides. The current deprecation changes are a step in the direction toward preparing to interface with an HL7 Clinical Genomics domain analysis model or another similar model.

Collaboration with other HL7 Work Groups: With the broadening of the scope with BRIDG 4.0 to cover translational research and the harmonization of Life Sciences Model and CDISC Pharmacogenomic & Pharmacogenetics domains, it is likely that there is some overlap of concepts between BRIDG Molecular Biology subdomain concepts and the models being developed in the HL7 Clinical Genomics (CG) work group.

6.2.7 Protocol Representation

The Protocol Representation subdomain is intended for those involved in the planning and design of a research protocol. Most business requirements have come from those involved in clinical trial protocols. It focuses on the characteristics of a study and the definition and association of activities within the protocols, including "arms" and "epochs". It also includes the definitions of the roles that participate in those activities.

6.2.8 Regulatory – Change in Deprecation Plans

This subdomain is currently deprecated, however a use case is under consideration that can impact the standard, i.e. reverse deprecation, or delete this subdomain. According to BRIDG deprecation policy, any model element can be marked for deprecation and will be retained for a minimum of one year to allow the user community to raise a use case to retain the element.

It has come to the attention of the BRIDG modelling team that a use case for retaining some of the regulatory data elements may be presented by a BRIDG user. Consequently, the modelling team is deferring the deletion of the elements even though the subdomain and classes have been deprecated for longer than the required minimum of year.

6.2.9 Statistical Analysis

The Statistical Analysis domain analysis model includes concepts describing the planning and performance of the statistical analysis of data collected during clinical trial research and their relationships. This subdomain currently represents the Statistical Analysis Plan semantics.

6.2.10 Study Conduct

The Study Conduct subdomain is intended for those involved in the execution of a research study. Most business requirements have come from those involved in clinical trials. It focuses on the activities of conducting the study as well as the results from those activities.

6.3 UML-based models and views

The BRIDG Model UML Representation includes the complete set of definitions, attributes, associations, constraints, and mappings for each class. The BRIDG model is available in the following formats.

— HTML: The html format requires an Internet browser for viewing and is a web-based version of the contents of the EAP file format mentioned below. This format is available at the BRIDG website.[2]

— The following formats are available in the release package via the CDISC website:

  — EAP file format: The EAP file format is used by the modelling software tool Enterprise Architect. A viewer which enables full traversal and inspection of the complete BRIDG model can be downloaded from the Sparx Systems[3] website.

  — Microsoft Word®[1)] file format: The Word file is generated from the EAP file format using the Enterprise Architect tool.

  — XMI file format: Readers interested in a serialized, non-graphical version of the model can use the XMI file that is part of the BRIDG release package. It is the representation of the model that is generated by the Enterprise Architect tool as using the somewhat-less-than-standard XML Metadata Interchange (XMI) format. There are known problems with this format, therefore the XMI version of the BRIDG model is not considered to be canonical.

7 RIM-based HL7 representation (version 3.2 only)

7.1 General considerations

The HL7 Reference Information Model (RIM) is a highly abstract comprehensive information model for the "healthcare domain". The healthcare domain is interpreted broadly encompassing clinical care (inpatient and outpatient), healthcare administration, reimbursement, community care, veterinary care, genomics and imaging.

Due to its breadth, the RIM tends to use generic class, attribute, and association names that are not necessarily domain friendly. In addition, the RIM is completely free of the constraints and business rules that apply to domain-specific models. Its purpose is to provide a single set of reference semantics that can be leveraged across all healthcare domains. Additional, more specific, models are then created with strict derivation relationships to the RIM to support the implementation of communication interfaces.

Although the RIM is, for the most part, relatively free of implementation details, it is not a DAM because it is not readily understandable by domain experts in any one of the listed domains (e.g. "Where are vaccinations in the RIM?", "How do I represent a provider credential?", and "Where is an SNP found?"). This is due to the requirement that the RIM must be an abstraction of cross-domain semantics. However, certain BRIDG stakeholders require that BRIDG semantics be expressible in HL7 v3 XML.

Since the HL7 representation is a representational view of the semantics in the canonical representation using HL7 syntax, the underlying semantics in the HL7 representation and the canonical representation must be synchronized. There are no tools to automatically generate the HL7 models, therefore qualified HL7 modellers should perform this transformation manually.

7.2 RIM-based models

In the BRIDG model, the RIM-based representation is defined in accordance with ISO/HL7 21731. The RIM-based part of the BRIDG model is represented in JPEG-formatted files, which are images of the Visio®[2)] (VSD) files created in the HL7 Visio tool.

1) Microsoft Word is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

2) Visio is the trade name of a product supplied by Microsoft. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product named. Equivalent products may be used if they can be shown to lead to the same results.

The RIM-based models are represented in Excel®[3], JPEG, HTML file formats in the BRIDG release model.

The organization, filename conventions, and background of the content of the RIM models are given in the BRIDG RIM Representation document.

The mapping from UML to RIM is specified in an Excel file, (BRIDG UML to RIM Mapping.xls).

While the BRIDG HL7 models are "standard" HL7 models, they are not intended to be used directly as the foundation for exchanging messages. Instead, they serve as a basis of discussion with other HL7 groups who are modelling content relevant to BRIDG. This permits the expression of BRIDG semantics clearly in HL7 terms and can easily be incorporated into the various HL7 standards specifications related to the domains covered by BRIDG. For this reason, this part of the model is being presented using JPEG rather than schema, Visio®, or Management Information Format (MIF) files.

8 Ontological OWL-based representation (version 3.2 only)

The OWL-based ontological representation is a translation of the BRIDG semantics into a knowledge representation language for authoring ontologies.

One of BRIDG's primary purposes is to act as a focus for mapping of data elements from different standards, specifications, and implementations. OWL provides several capabilities that are useful in this process, including helping to verify that mappings are not contradictory.

The OWL representation is specified in the file BRIDG.OWL in the BRIDG model and is expressed using OWL XML. This representation can be navigated using web ontology tools such as the freely available Protege Ontology Editor.[4]

9 Additional information

9.1 Uses of BRIDG

BRIDG as a domain analysis model can be and is being used in several applications, including:

— as a basis for a database design;

— as a reference model to build instances of clinical models;

— as a source for information semantics to be used by multiple software programs or systems that need to intercommunicate;

— as a structured model to describe and document healthcare information requirements.

All artifacts (User Guide, change list, Comprehensive Domain Information Model and documentation) are available for download on the BRIDGE website under "Download Release Packages & Browse Online".[2]

9.2 User's guide for the BRIDG model

The user's guide includes further explanation about two use cases for BRIDG.

The user's guide for the BRIDG model 5.3.1 is available on the BRIDG website.[2]

The specific file names in the release package in this category are the BRIDG 5.3.1 User's Guide.doc.

3) Excel is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.