

NIH Enterprise Conceptual Data Model v1.0

Status of this Memo

This document specifies a standard for the National Institutes of Health (NIH) and requests discussion and suggestions for improvements. Distribution of this memo is unlimited.

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1 Introduction

This standard provides a specification of the key data entities that support NIH's business processes and provide an overarching framework to organize more detailed data architecture efforts and provide a common taxonomy for describing data assets across NIH.

1.1 Purpose of the CDM

The purpose of the Enterprise Conceptual Data Model (CDM) is to provide a conceptual view of the key data entities and their relationships that support NIH's mission. The Federal Enterprise Architecture (FEA) Data Reference Model (DRM) defines a conceptual data model as:

A data model represents an abstract view of the real world; (ISO 11179-3) a higher-level data artifact that is often used to explore domain concepts with project stakeholders.

Logical data models are often derived from conceptual data models. At this level, the data modeler attempts to identify the highest-level relationships among the different entities.¹

NIH requires such a model in order to provide an organizing framework for further enterprise data architecture efforts. The Enterprise CDM acts as a high-level taxonomy organizing all of NIH's data assets into groups and rules. This high-level presentation allows NIH management and stakeholders to effectively understand the current state of the data architecture and to plan for a future state data architecture that will enhance NIH's ability to share information across the enterprise and build more integrated, flexible systems.

1.2 Intended Audience

This standard is available to the entire NIH community, but it is most relevant to the following NIH stakeholders:

- *Data Architects* – Those responsible for providing Data Architecture leadership at the enterprise and IC levels will use the CDM as a reference and will map their work products to the data entities and subject areas identified within the CDM.
- *Solution Architects* – Architects responsible for the overall design of a new solution will be a key audience of the Enterprise CDM. Systems developed at NIH will often instantiate the high-level conceptual entities and relationships identified in the CDM in their logical and physical database designs. Solution architects will need to map their data entities to the subject areas and entities in the Enterprise CDM.
- *Database Designers* – The CDM will help feed current state and future state documentation that will provide database designers with an understanding of the sources of record for key data elements within NIH and will provide a high level overview of how the data to be managed in their database relates to the overall structure of information across NIH.
- *IT Program Managers* – The managers of solution implementation efforts must be aware of the Enterprise CDM and other Enterprise Data Architecture artifacts and the alignment

¹ More detail on the purpose of CDMs and how they are differentiated from other types of data models is provided in Appendix A.

of their solution with these artifacts. The NIH Capital Planning and Investment Control (CPIC)² process will require mapping for IT solution development efforts to the Enterprise Conceptual Data Model.

- *IT Leaders and Planners* – CIOs within NIH Institutes and Centers and other senior IT leadership must use the CDM as the common taxonomy for identifying NIH data assets in strategy and IT planning documents and as an aid for defining data governance.
- *Business Owners of Data* – The data entities described in this standard should be consistent with commonly used NIH business language and the definitions of the entities should be understandable to business users.

1.3 Scope of Standard

This standard is intended to provide a conceptual view of key data entities required to support NIH's mission across the entire enterprise. Therefore, this standard is applicable to all of NIH. In practical terms, this means that all data architecture artifacts developed within the NIH must:

- Provide a mapping of the artifact to the Enterprise CDM.
- Align the naming of data elements with those used in the CDM.

For the purposes of this standard, data architecture efforts are defined as efforts to define cross-system and/or cross-organization strategies for data management that may include a current state, target state, and transition strategy for data architecture. This may also include documents addressing the governance of NIH data assets. It is assumed that the majority of data architecture efforts within NIH will take place in the Office of the Chief IT Architect (OCITA), but data architecture deliverables may also be developed by data architecture within the ICs and in support of major solution implementation efforts.

Further, solution development efforts subject to compliance with the NIH Enterprise Architecture must:

- Develop data models in support of specific solutions that reflect the business rules implicit in the Enterprise CDM even though the specific data structures may differ in order to support system performance and address other implementation constraints.
- Develop data models and map them to the entities and/or subject areas defined as part of the Enterprise CDM.
- Provide a mapping of the data exchanged with other systems to the Enterprise CDM.

This scope of this standard is limited to only a high-level, conceptual view of the data entities and their relationships. More detailed descriptions of NIH data standards and logical and physical data models are left for subsequent data architecture efforts or specific implementation efforts. It is recognized that this model represents a subset of the data entities required to support all NIH business processes and that most architecture and implementation efforts will create data entities that are not addressed in this standard.

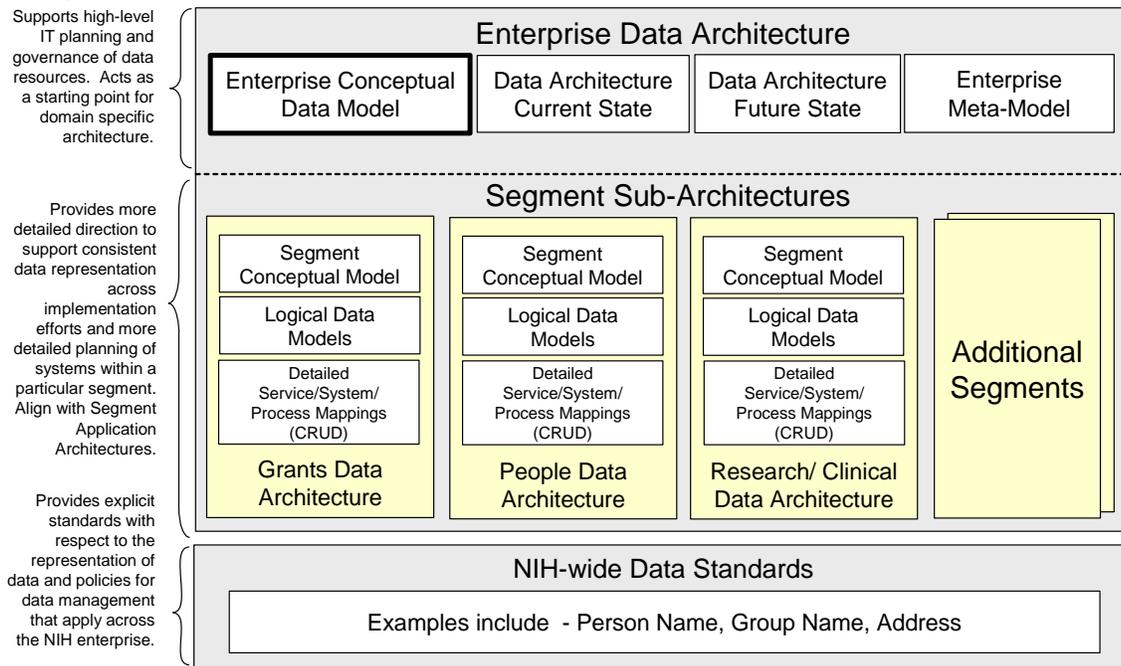
2 Context – Enterprise Data Architecture Overview

The Enterprise CDM is one part of an overarching Enterprise Data Architecture that will be developed in order to better align NIH's information systems with NIH's mission. Figure 1

² The NIH CPIC process guidelines can be found at <http://irm.cit.nih.gov/itmra/CPIC.html>.

shows the decomposition of data architecture and data standard components that may be used to manage NIH's data assets.

Figure 1 - Data Architecture Framework



The NIH Data Architecture can be broken into 3 major components:

- *Enterprise Data Architecture* – This component of the architecture identifies the key data subject areas and entities that are shared across the NIH and the current and future state environment supporting data management. The current and future state may include the distribution of data across data repositories, movement of data between repositories and systems, and data ownership and stewardship.
 - *Enterprise Conceptual Data Model* – As described above, the Enterprise CDM provides a listing of the core data entities and relationships that are used
 - *Data Architecture Current State* – A summary of the current infrastructure of databases and information flows supporting NIH and a description of the challenges and opportunities associated with the current state.
 - *Data Architecture Future State* – A description of the future direction of NIH's overall data architecture including the databases that hold information and the information flows between systems and databases mapped to Enterprise CDM.
 - *Enterprise Meta-Model* – A description of the basic components of enterprise data models. This model will define the structures used in describing data standards across the NIH.
- *Segment Sub-Architectures* – These are more detailed and are still part of the overall NIH Data Architecture, but they are focused in specific subject areas. In addition to high-level conceptual models, more detailed logical data models may also be included. Domain specific current state and target state visions will also be developed.
 - *Segment Conceptual Model* – This is a conceptual data model that is similar to the Enterprise CDM, but addresses a limited area of focus in somewhat more depth.

These more detailed conceptual models allow for detailed planning in a specific area.

- *Logical Data Models* – Logical models provide additional detail about each data entity including key attributes and more detailed description of requirements
- *Detailed Service/System/Process Mappings* – To support effective impact analysis and planning for data architecture, it is necessary to understand the relationships between data and other components of the enterprise architecture. This is accomplished by mapping data entities to business processes, systems, and software services that use them. This is often represented using CRUD (Create, Read, Update, Delete) matrices.
- *NIH-wide Data Standards* – These artifacts define specific implementation guidance and policy related to data management within NIH. This may include detailed technical specifications for formats used in data exchange and processes for data management.

The Enterprise CDM provides the overall organizing taxonomy for the enterprise-wide components of the Data Architecture and the domain specific sub-architecture. Further, the CDM provides the basic entities and groupings of data that act as the context for detailed data standards and are used to specify the relationships between standards.

3 Enterprise CDM Overview

Then Enterprise CDM is comprised of a number of components. These components align with widely accepted nomenclature for the elements of a data model and are consistent with the approach to data description described in the Federal Enterprise Architecture (FEA) Data Reference Model (DRM). These are defined in Table 1³.

Table 1 - Enterprise CDM Components

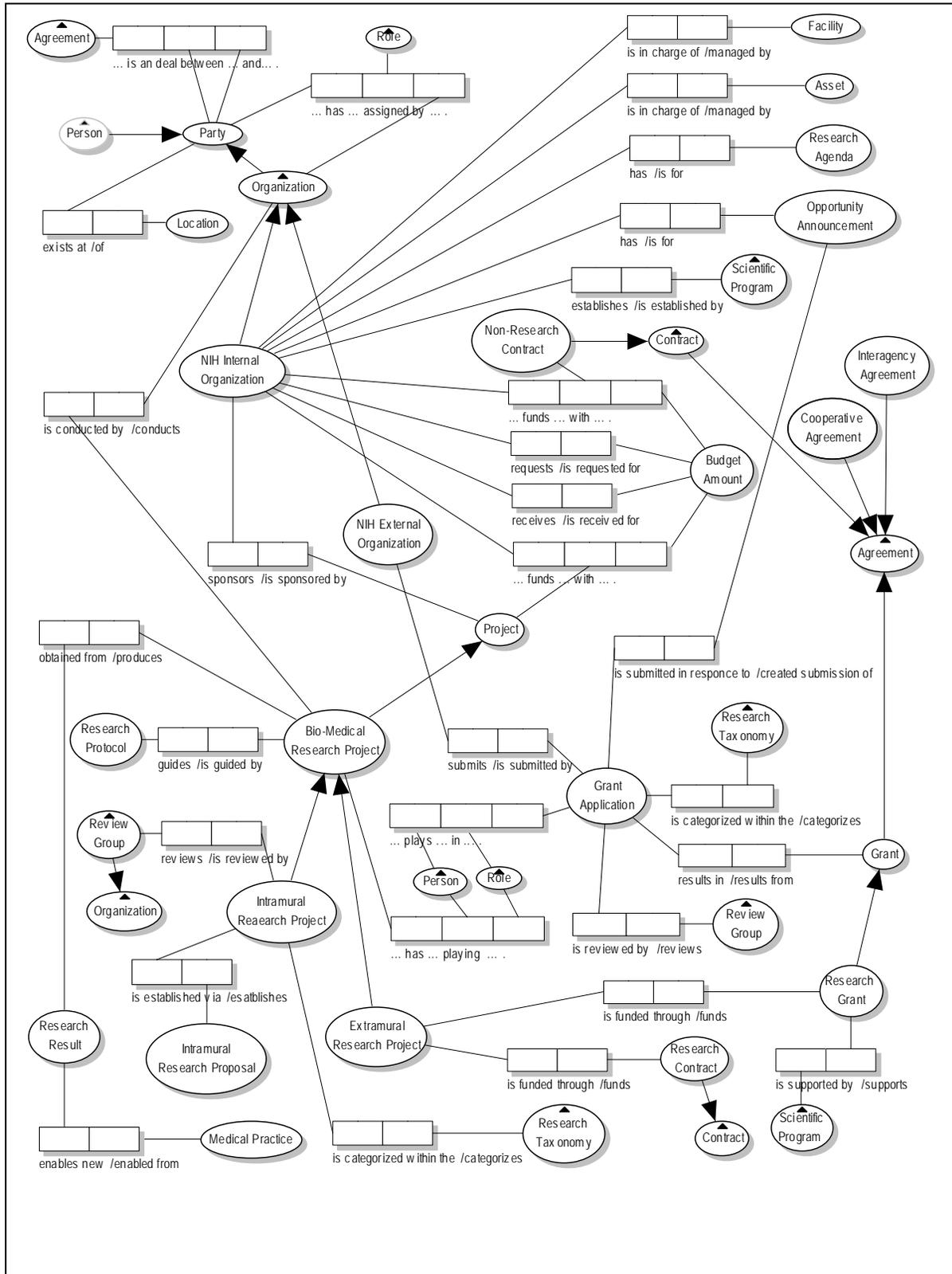
Component	Description
Subject Areas	A topic of interest shared within a community. The full list of subject areas of interest to a community form the context for that community. A super type is a subject area that spans multiple Communities of Interest (COIs); (DRM usage). In NIH’s CDM, subject areas are used to group entities and align them with business processes.
Entities	An abstraction for a person, place, object, event, or concept described (or characterized) by common Attributes. For example, “Person” and “Agency” are Entities. An <i>instance</i> of an Entity represents one particular occurrence of the Entity, such as a specific person or a specific agency.
Relationships	Describes the association between two Entities. Relationships may also be described as business rules that specify the nature of the interaction between two entities.
Attributes	A characteristic of an Entity whose value may be used to help distinguish one instance of an Entity from other instances of the same Entity. For example, an Attribute of a “Person” Entity may be “Social Security Number (SSN)”.

A diagram of the CDM is presented in Object Role Modeling (ORM)⁴ notation in Figure 2. This diagram is not considered normative, it is one of many possible notations that could be used to represent the model and it is intended to provide a summary view of the model and its component entities and relationships.

³ These definitions are based on those found in the DRM version 2.0, but have been modified to reflect NIH’s specific needs. The DRM version 2.0 can be found at http://www.whitehouse.gov/OMB/egov/documents/DRM_2_0_Final.pdf.

⁴ For more information on the ORM notation and interpreting ORM models see <http://www.orm.net/>.

Figure 2 - Enterprise CDM Diagram



4 Subject Areas

Table 2 describes the subject areas reflected in the Enterprise CDM. Subject areas provide a high-level set of categories into which NIH's data entities can be placed. Subject areas are used to group entities based on the business areas they most closely align with, the stakeholders they impact, and the extent or degree to which they are dependent on one another and need to be managed as a unit. In Table 3, each of the entities defined for the Enterprise CDM is assigned a subject area.

Table 2 - Subject Area Definitions

Subject Area	Description
Global	Entities that are shared across process areas.
Party	Information about people, organizations, and other actors in NIH processes, and their roles.
Sustaining Services	Information related to NIH supporting processes such as acquisition of assets, property management, telecommunications, information technology, budget formulation, funds tracking, and funds allocation.
Research Administration	Information about the management of grants, research contracts, cooperative agreements and other aspects of NIH funded research. Information about the management and administration of intramural research.
Clinical and Research	Clinical information about the treatment of patients at the clinical center and data resulting from research, both extramural and intramural.

5 Data Entities

Table 3 shows the data entities that have been defined as part of the Enterprise CDM. These entities are intended to represent the core business data that needs to be collected and managed throughout the NIH. For each of the entities, the following information is provided:

- *Entity Name*: The name used to refer to the entity.
- *Definition*: A description of the entity in plain language consistent with common usage within NIH whenever possible.
- *Subject Area*: A topic of interest shared within a community.
- *Super-Type*: An entity is a specialized form of its super-type and may introduce additional attributes. For example, an organization internal to NIH is a specialized type of organization that may include additional information such as a NIH mail stop or detailed information about membership.
- *Examples*: An illustrative example of the entity being described.

Table 3 - Enterprise CDM Entities

#	Entity Name	Definition	Subject Area	Super Type	Examples
1	Agreement	Statement of an exchange of promises.	Sustaining Services		
2	Asset	Property, funds, receivables, and other items that positively impact an organization's balance sheet.	Sustaining Services		
3	Biomedical Research Project	A basic and clinical investigation in biology or medicine.	Research Administration		See subtypes – Extramural and Intramural Research Project.
4	Budget Amount	The amount of funds available to an organization and the allocation of those funds across various accounts, programs, offices, initiatives, operations, etc. A budget may be composed of several budgets allocated to sub-organizations.	Sustaining Services		\$250,000.00
5	Contract	A binding agreement between NIH and an external party with specified performance requirements.	Sustaining Services	Agreement	
6	Cooperative Agreement	Agreement between NIH and a research institution in which there is substantial NIH involvement in the assisted activity.	Research Administration	Agreement	

#	Entity Name	Definition	Subject Area	Super Type	Examples
7	Extramural Research Project	A biomedical research project funded by NIH and performed outside of NIH.	Research Administration	Biomedical Research Project	Grant Number: 1R41EY017781-01 Project Title: Recombinant T-cell Receptor Ligands for Treatment of Uveitis
8	Facility	A collection of capabilities associated with a place, an owner, and the cost of operation and maintenance.	Sustaining Services		
9	Grant	Financial assistance from Public Health Service agency for approved activities. Performance responsibility rests primarily with a grantee with little or no government involvement in the research; term covers grants and cooperative agreements	Research Administration	Agreement	Grant Number: 1R41EY017781-01 Project Title: Recombinant T-cell Receptor Ligands for Treatment of Uveitis
10	Grant Application	Application for financial assistance from a Public Health Service agency.	Research Administration		Application with title "sar-mediated regulation in Staphylococcus aureus" from Univ. of Arkansas for Medical Science
11	Interagency Agreement	An agreement between two government entities that defines rules for interaction.	Sustaining Services	Agreement	
12	Intramural Research Project	A biomedical research project performed within NIH.	Research Administration	Biomedical Research Project	Intramural Project Number: 1 Z01 EY000396-04 DIR, Project Title: Evaluation And Treatment Protocol For Patients With Retinal Disease
13	Intramural Research Proposal	Proposal from within NIH to fund biomedical or behavioral research to be conducted internally by the NIH.	Research Administration		
14	Location	A place where an event can occur.	Sustaining Services		
15	Medical Practice	A formal position or recommendation for clinical practice, disease treatment, or disease prevention that results from a scientific body that has concluded a review of an amalgamation of available scientific information.	Research Administration		
16	NIH External Organization	An organization created and managed outside of NIH.	Party	Organization	

#	Entity Name	Definition	Subject Area	Super Type	Examples
17	NIH Internal Organization	An organization created and managed by the NIH regardless of whether it is composed of NIH employees, external people, or a combination.	Party	Organization	NIAID
18	Non-Research Contract	A contract that does not involve the conduct of biomedical research.	Sustaining Services		Contract: DHHS-NIH-OD-2004-IW2-1037-T00 Title: DEAS Workflow Management and Monitoring System Contractor: National Micrographics Systems, Inc. Amount: \$493,044.00
19	Opportunity Announcement	An official announcement from NIH of a grant or contract research opportunity, for which interested parties may apply.	Research Administration		Program Announcement Number: PA-06-537 Title: Immunology of Biofilms (R01)
20	Organization	A formal grouping of people and/or organizations coordinated to perform a specific purpose or obtain a specified objective.	Party	Party	Weill Medical College of Cornell University
21	Party	A type of entity that is able to act or perform a specific role(s) within the context of a process.	Party		See subtypes "Person" and "Organization".
22	Person	Any individual of interest to the NIH for which the NIH maintains information.	Party	Party	Bill Jones
23	Project	An undertaking that encompasses a set of tasks or activities having a definable starting point and well defined objectives.	Sustaining Services		
24	Research Agenda	The prioritized list of specific research areas that drives an IC's research focus.	Research Administration		
25	Research Contract	A contract that funds biomedical or behavioral research.	Research Administration	Contract	Title: Simian Vaccine Evaluation Units (SVEU) Contract: HHSN266200600005C, Contractor: Advanced BioScience Laboratories, Inc., Amount: \$33,807,678
	Research Grant	A grant that funds biomedical or behavioral research.	Research Administration	Grant	
26	Research Protocol	A structured set of procedures, steps, and/or guidelines directing the methodology of a specific research effort.	Research Administration		Protocol Number: 06-N-0139, Title: Treatment for Psychogenic Movement

#	Entity Name	Definition	Subject Area	Super Type	Examples
					27Disorders
27	Research Result	A description of the outcome and accomplishments of biomedical research projects are available to the research community and to the public at large with special provisions that cover patents and licensing. ⁵	Research Administration		
28	Research Taxonomy	A system of classification for medical research that structurally defines the research areas of interest or other categorizations for research.	Research Administration		Decomposition of high-level taxonomies such as disease, treatment, science and demographics
29	Review Group	Any scientific/ managerial/ technical assembly of individuals that provide advice on NIH medical research.	Research Administration	Organization	Scientific Review Group/Study Section, Advisory Council
30	Role	An assigned grouping of Parties that provides permissions and responsibilities for actions.	Party		Principal Investigator
31	Scientific Program	A collection of several research projects with focused research in a particular area of interest that is budgeted, funded and managed by a program manager.	Research Administration		NLM Research Grants in Biomedical Informatics & Bioinformatics (R01) (PA 06-094)

⁵ NIH Grants Policy Statement

6 Enterprise Data Relationships and Rules

In addition to the basic entities defined as part of the Enterprise CDM, there are relationships between entities that can be expressed as statements of business rules. For each of the relationships, a statement of the relationship and an example are provided. In the case of “is a type of” or subtype relationships, examples are not applicable. Subtype rules allow for the restricting of populations within relation entities. They are enforceable rules on the meta-model level and examples do not provide further clarification of the rule. Some examples have placeholder variables to denote that there are no real world examples at NIH for these high level objects. In each case, the corresponding lower level objects are individually identified.

Table 4 - Enterprise CDM Relationships

#	Relationship/Rule	Example
1	<Agreement> is a deal between <Party 1> and <Party 2>.	Contract 14998 is a deal between CIT and System Inc.
2	<Biomedical Research Project> has <Person> playing <Role>.	XXX project has Jill Smith playing the role of principle investigator.
3	<Biomedical Research Project> is a type of <Project>.	
4	<Biomedical Research Project> is categorized within the <Research Taxonomy>.	Project xxx is categorized within the lung cancer; disease taxonomy.
5	<Biomedical Research Project> is conducted by <Organization>.	Project xxx is conducted by NCI/xx.
6	<Biomedical Research Project> is guided by <Research Protocol>.	Project xxx is guided by research protocol yyy.
7	<Biomedical Research Project> produces <Research Result>.	Project xxx produces research result of new treatment for urinary tract infections.
8	<Contract> is a type of <Agreement>.	
9	<Cooperative Agreement> is a type of <Agreement>.	
10	<Extramural Research Project> is a type of <Biomedical Research Project>.	
11	<Grant Application> is categorized within the <Research Taxonomy>.	Grant application ‘Non-asbestos caused mesothelioma’ is categorized within the lung cancer; disease taxonomy.
12	<Grant Application> is reviewed by <Review Group>.	Grant application ‘Effects of Cranberry Juice on Urinary Tract Infections’ is reviewed by ‘NCCAM Initial Review Group.’
13	<Grant Application> is submitted by <NIH External Organization>.	Grant application ‘Effects of Cranberry Juice on Urinary Tract Infections’ is submitted by John Hopkins University Medical Center.
14	<Grant Application> is submitted in response to <Opportunity Announcement>.	Grant application ‘Effects of Cranberry Juice on Urinary Tract Infections’ is submitted in response to opportunity announcement ‘Herbal Treatment of Kidney Disorders.’
15	<Grant> is a type of <Agreement>.	
16	<Grant> results from <Grant Application>.	Grant 1 R01AT001507-01 results from grant application ‘Effects of Cranberry Juice on Urinary Tract Infections’
17	<Interagency Agreement> is a type of <Agreement>.	
18	<Intramural Research Project> is a type of <Biomedical	

#	Relationship/Rule	Example
	Research Project>.	
19	<Intramural Research Project> is reviewed by <Review Group>.	Intramural research project 'Etiology of Anemia' is reviewed by 'Scientific Review Group.'
20	<Intramural Research Proposal> is submitted by <NIH External Organization>.	Intramural research project 'Etiology of Anemia' is submitted by the NIA Hypertension Unit Laboratory.
21	<NIH External Organization> is a type of <Organization>.	
22	<NIH Internal Organization> establishes <Scientific Program>.	NCI has scientific program 'role of NKT cells and myeloid cells in regulating immunosurveillance.'
23	<NIH Internal Organization> funds <Non-Research Contract> with <Budget Amount>.	CIT funds contract 14998 with budget amount of \$187,000.
24	<NIH Internal Organization> funds <Project> with <Budget Amount>.	CIT funds xxx with budget amount of \$187,000.
25	<NIH Internal Organization> has <Opportunity Announcement>.	NCI has opportunity announcement 'Immunoregulation of Gastrointestinal Carcinogenesis (R01).'
26	<NIH Internal Organization> has <Research Agenda>.	NCI has 'Menthol Cigarettes-Setting' research agenda.
27	<NIH Internal Organization> is a type of <Organization>.	
28	<NIH Internal Organization> is in charge of <Asset>.	CIT is in charge of the computer network.
29	<NIH Internal Organization> is in charge of <Facility>.	Physical Plant is in charge of building 31.
30	<NIH Internal Organization> receives <Budget Amount>.	CIT receives budget amount of \$22,500,000.
32	<NIH Internal Organization> sponsors <Project>.	NCCAM sponsors xxx project.
33	<Non-Research Contract> is a type of <Contract>.	
34	<Organization> is a type of <Party>.	
35	<Party> exists at <Location>.	CIT exists at the Fernwood Building.
36	<Party> has <Role> assigned by <Organization>.	Joe Smith has the role 'Administrator' assigned by CIT.
37	<Person> is a type of <Party>.	
38	<Person> plays <Role> in <Grant Application>.	Joe Smith plays the role of principle investigator in grant application 12334.
40	<Research Grant> funds <Extramural Research Project>.	Grant 1 R01AT001507-01 funds xxx project.
41	<Research Grant> is a type of <Grant>.	
42	<Research Grant> supports <Scientific Program>.	Grant 1 R01AT001507-01 supports the lung cancer scientific program.
43	<Research Result> enables new <Medical Practice>.	Research result xxx enables new medical practice yyy.

7 References

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http://grants.nih.gov/grants/policy/nihgps_2003/NIHGPs_Part5.htm#_Access_to_Research (18 Oct. 2006)

8 Contact

To contact the NIHRFC Editor, send an email message to EnterpriseArchitecture@mail.nih.gov.

9 Security Considerations

This NIHRFC raises no security issues.

10 Changes

Version	Date	Change	Authority	Author of Change
0.1	10/11/2006	Original Draft	NIHRFC0001/BCP0001	John Sharp/ Demetrios Kotsikopoulos
0.2	12/11/2006	Updated to reflect feedback from review session on 11/1/2006. Changes include the inclusion of additional entities to better reflect NIH’s business needs, the collapse of the “Finance and Administration” and “Locations and Assets” subject areas into “Sustaining Services”	NIHRFC0001/BCP0001	John Sharp/ Demetrios Kotsikopoulos
0.3	12/20/2006	-Applied NRFC number -Corrected “Status of This Memo”.	-NRFC0001	Steve Thornton, NRFC Editor
0.4	1/22/2006	- corrected suggested typos	NIHRFC0001/BCP0001	John Sharp/ Demetrios Kotsikopoulos

Version	Date	Change	Authority	Author of Change
1.0	1/24/2007	Approved by ARB	ARB	Steve Thornton

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Appendix A: Categories of Data Models

Table 6 shows the definitions and purpose of different types of data models that may be created as part of NIH's Enterprise Data Architecture or in support of specific solution implementations.

Table 6: Categories of Data Models

	Description	Purpose
Conceptual Data Model	A CDM represents the overall logical structure of a database, which is <u>independent</u> of any software or data storage structure. A conceptual model often contains data objects not yet implemented in the physical databases. It gives a formal representation of the data needed to run an enterprise or a business activity.	Suitable as an enterprise level artifact to provide an overall set of key data entities to facilitate management of enterprise data resources and support effective information sharing.
Logical Data Model	A logical view of the conceptual data model. Data Architecture theories such as "normalization" are applied to transform the conceptual data model into the logical data model that moves the data modeling further towards the ultimate prescription for the data architecture to be implemented. Relationships get absorbed as "attributes" known as foreign keys or pointers within appropriate logical model entities. This may be explicit or implied in the logical data model. As long as the resulting physical data model includes the necessary foreign key columns and joins, the inclusion of foreign-keys in the logical data model is a matter of convenience. Logical Data Model does not have any specific restrictions and/or requirements imposed by the Database Management System (DBMS) to be used for creating the actual database.	Suitable for representing the detailed business rules governing the structure of data elements and their relationships. Provides a more detailed view of the data and is more suitable for specific systems designs of for the description of enterprise data standards.
Physical Data Model	The mapping of conceptual or logical database design data groupings into physical database areas, files, records, elements, fields , and keys while adhering to the physical constraints of the hardware, DBMS software, and communications network to provide physical data integrity while meeting the performance and security constraints of the services to be performed against the database.	Suitable for the design of specific implementations of a data model. Generally not suitable for enterprise standards or architecture specification