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Research Networking and Related Systems (RNS): A Framework for Design, Description, and Evaluation of their Functionality

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Introduction

This is the first draft of a framework for describing /designing / analyzing / evaluating the functions and characteristics of Research Networking Systems (Research Networking Tools, Faculty Reporting Systems, …) and related systems. (For simplicity, we use RNS in this much expanded sense).

The functions of RNS are too complex to be represented in a simple checklist. Often several concepts need to be combined to describe a function. For example, general RNS characteristics such as *usability*, should be combined with many different functions, such as *data input* or *search*.

The functions are arranged in a table with three columns:

Column 1 The general function

Column 2 Specific values of/for the general function
The difference between Col. 1 and Col. 2 is not clear-cut. Sometimes the general function specifies a data field in a RNS description and Col. 2 gives (sample) values of that data field. Sometimes Col. 1 gives broad subdivisions in a hierarchy of data values and Col. 2 gives specific values within the broad subdivision. The general idea is for Col. 1 to give an overview and Col. 2 to flesh out detail.

Column 3 Col. 3 serves two purposes.
(1) It is a place for elaboration through notes and
(2) it is a place to indicate who would use a certain function (user) and for what purpose (uses). (That part is not worked out in this document.)

In a database representation of these data there would be two tables, the first looking just the same except with a *FunctionID* column, and the second having three columns, *Function ID*, *User*, U*se*, with multiple rows for each function, one for each User + Use combination. That way one could look at the entire list from the perspective of different user groups.

In the table we use *researcher* generically for any type of person covered by a RNS, faculty, student assistants, staff, whatever. (See note under #3 **Main types of entities dealt with.)**

This design and evaluation framework addresses RNS at the software product level. Much of it applies also to the instance level, but additional criteria come into play, such as coverage / acceptance rate at an institution or in a larger community, and data quality.

Despite its length, this document is far from complete. In some areas it just scratches the surface.

Table of Contents

The outline is structured so that items of most interest to system users (faculty and administrators are in in the beginning (#1 - #5) and data of interest primarily to the people who implement and run the system at the end (#6 - #8). The exception is usability, part of #8, which is of interest to everyone.

RNS Functions	**Examples of Specific Values**	**Notes** **Users and Uses**
#1 Basic RNS information		
. Name		
. Acronym		
. Developer / owner		
. Link to product page		
. Open source (see administrative arrangements)	Yes / no	

RNS Functions	Examples of Specific Values	Notes Users and Uses
#2 Administrative arrangements		
. **Property rights and access management for the RNS as a whole**		**Note 1:** See #5 **Data content, Facet 4**, which also covers Property rights and access management, detailed issues **Note 2:** At the level of the RNS as whole, his is an issue primarily for RNS that are "sold" or provide as a service rather than as software to run under the control of the institution
. **Cost**		
. . Is there a cost per person included?	Yes No	**Note**: Very important. If there is there a cost per person included, institutions have a tendency to limit the scope of people included in the RNS (for example, do not include research assistants or auxiliary staff) and to purge data for people who leave the institution, thus making historical analyses impossible.
. . Effort required to set up and run the RNS		**Note:** Description of resources required. This will be high for many open source RNS
. . . Availability of outside consultants		
. **User Services**	Training (User Education)[1] user help desk (Call, email, chat) Tech support (call, chat, email)	**Note:** User services can become costly for open source RNS, institutions may be required to create these services in house where as private source networks tend to offer these services as part of the fee. These services help promote use of the RNS.
. **Installed base of (1) the RNS and (2) compatible systems**		**Note:** This is an indicator of how the RNS would support collaboration with other institutions
. . Number of installations		
. . Installations at collaborating institutions		
. . Installations at institutions in prestigious groups		American Association of Universities (AAU) International Alliance of Research Universities (IARU) www.iaruni.org/ International Research Universities Network (IRUN) www.irun.eu

[1] https://www.ctsacentral.org/consortium/education-and-training

RNS Functions	Examples of Specific Values	Notes Users and Uses
#3 Main types of entities dealt with	Person Organization / Organizational unit (research team, institute, department, etc.) Funding opportunity Project (research projects and others) Research resource (such as an instrument, a computer program, lab animals, a biospecimen bank, cell line) Service (such as consulting on research design, recruitment of study participants, analyzing biospecimens, imaging) Event (meeting, lecture, etc.) Activity Document Course More	**Note:** This section is intended for listing the types of entities included in the RNS in their own right, to become the focus of searches. Ideally an RNS instance would cover all such entity instances within a defined scope. Most RNS focus just on people. Information on other entities is included primarily to provide information about people. For example, a VIVO instance might include the information that a person is in charge of specialized imaging equipment, but VIVO is not optimized for a search for resources (eagle-I focuses on that). Other RNS, such as eagle-i focus on research resources, still others on funding opportunities, and of course there are systems that focus on documents. But a RNS could enable a focus on two or more of the entity types given as examples. Information on documents would generally be included only as information about other entities since there is such a vast amount of them. However, a RNS could provide a gateway to document search systems. Many of the functions in this document are written from the perspective of a RNS that focuses on persons, mostly referred to as "researcher" in this document. For a RNS that deals with entity types other than person, "researcher" needs to be replaced with the another entity type or wit the generic "entity".

RNS Functions	Examples of Specific Values	Notes Users and Uses
#4 Application functionality, capabilities What the system can do for the user		
. **Produces CV's and related documents in various formats**	NIH biosketch IMLS biosketch Institutional preferred CV format Canadian government funding CV format long CV (standard) Abridged CV Academic Funding CV Non Academic Funding CV Student CV[2] Quantitative profile of scholarly activities (for promotion and tenure review) Accomplishments over a given time period (for yearly reviews, mentoring, etc.)	**Users:** Researchers and staff. Also individuals who assemble grant proposals. Ease of specifying templates for customized CVs is important **Notes:** Would usually be done by modifying an existing template. Could be implemented through XSLT or similar format, possibly using SPARQL queries. Best would be an interface where a user can interact easily with a template. **Users:** Could be end users who want to have their own specific CV format. Could be a system administrator who wants to specify a format that is standard for the institution. Or a funding agency who wants to supply a standard CV / biosketch template to be used for grant proposals.
. . Possible to specify format for citations in CV (or elsewhere for that matter)	APA MLA AMA Chicago	**Notes:** Could be achieved by tight integration with EndNote or other bibliography managers.
. . Possible to specify data selection for a specific CV		**Notes:** For example, in an NIH biosketch the personals statement is generally written specifically for a specific proposal and the selection of relevant publications is also specific to a proposal. Instead of writing the personal statement directly into the biosketch Word document (where it is pretty well lost for reuse), researchers should be able to create a new personal statement (often starting from a previous one) in the RNS and mark it as to be included in the new biosketch. Likewise mark publications to be included. For this purpose, each CV must have an ID.

[2] http://dictionary.casrai.org/

RNS Functions	Examples of Specific Values	Notes Users and Uses
. . Create and update researcher website in accordance with specs from the researcher		Ideally, what is on the website would be live from the RNS
. **Show faculty and institutional expertise and capabilities**		**Uses:** Promotion and tenure cases Grant writing
. . Allow search for faculty, departments, research resources, funding opportunities, etc. using many criteria		**Note:** See Search under #7, especially with respect to scope of search. Ideally, a RNS should support search across many outside sources/systems
. . Showcase institutional research capabilities	Publications Patents Resources Research Activity Profiles (faculty, post docs, graduate students) participant availability (research match)	Users: Institutions can increase cross institutional collaboration.
. . Supports departmental research websites		
. . Supports institutional faculty expertise directory		**Note:** For hospitals and medical schools this would include physician search, a feature often offered
. . Supports faculty and staff directories at all levels of an institution. Directory Services[3]		
. . Similarly, supports directories of research resources, projects, etc. at all levels of an institution.		
. **Recommend specifically tailored funding opportunities**		
. . Recommend funding opportunities tailored to individual or existing lab or work group		

[3] http://direct2experts.org/?pg=about

RNS Functions	Examples of Specific Values	Notes Users and Uses
. . Put together a team suitable for research on a given topic (possibly in response to an announced funding opportunity) across one institution or several institutions		
. **Support establishing collaboration across disciplinary and organizational boundaries**		
. . Enhance collaboration with other institutions		Note: See #2 Administrative arrangements
. **Supports management of researcher's work plan**		"CV in the making". Related to calendar
. . Keeping track of deadlines (e.g., submission of papers and other deadlines		
. . . Keeping track of grant deadlines and milestones		
. . Assists with effort tracking		
. **Track and predict usage of equipment and services**		
. . Integrated usage tracking for equipment and services across the institution		**Note:** See http://profiles.ucsf.edu/leslie.yuan
. . . Integrated with billing and grant fund administration		
. . Produce a report on need for / expected demand for equipment and services		
. **Property rights and access management, detailed issues**		**See #5 Data content, Facet 4** Data access. Intellectual property rights

RNS Functions	Examples of Specific Values	Notes Users and Uses
. **Characterization, analysis, measurement, and evaluation of activities and capabilities at all levels. Research, teaching, and service/engagement analytics** Comparison over time and across units The following lists the aspects evaluated, as applicable		Note: Sample levels/units of analysis are • Individual researcher (results can be used for promotion and tenure, salary, awards, etc. • Departments, institutes, etc. • Schools, colleges • University as a whole • Projects • Funding agency research program • Funding agency
. . Teaching / learning outcomes		
. . Research and funding		
. . . Analysis of funding patterns for researchers and organizational units by funding agency and subject area		
. . . . Analysis of research conducted by discipline, real-world problems, institutional priorities		
. . . . Derive researcher standing and impact from bibliographic data	Compute impact measures such as using tools such as • Citation Counts[4] • CitedIn[5] • ReaderMeter[6] • h Index[7] • ImpactStory[8] • Google Scholar Ranking Algorithm • Trend analysis[9] • Microsoft Academic Search • ArnetMiner •	

[4] http://thomsonreuters.com/products/ip-science/04_030/using-bibliometrics-a-guide-to-evaluating-research-performance-with-citation-data.pdf
[5] Not listed as tools in any system table but discussed in http://guides.library.jhu.edu/content.php?pid=67345&sid=497444
[6] Not listed as tools in any system table but discussed in http://guides.library.jhu.edu/content.php?pid=67345&sid=497444

RNS Functions	**Examples of Specific Values**	**Notes** **Users and Uses**
. . Service/engagement		
. . Overall impact measures	E.g. • Economic impact of inventions • Public health impact of medical discoveries • Public health impact of healthy living programs	
. . Social network analysis to reveal team science and collaboration across disciplines and organizational boundaries, at one time and over time	Network Reach	
. . Compute AAU and similar metrics		
. . There is a lot more here		

[7] http://thomsonreuters.com/products/ip-science/04_030/using-bibliometrics-a-guide-to-evaluating-research-performance-with-citation-data.pdf
[8] Not listed as tools in any system table but discussed in http://guides.library.jhu.edu/content.php?pid=67345&sid=497444
[9] http://thomsonreuters.com/products/ip-science/04_030/using-bibliometrics-a-guide-to-evaluating-research-performance-with-citation-data.pdf

RNS Functions	Examples of Specific Values	Notes Users and Uses
Data		The data stored in or accessible through the RNS can be specified through seven facets: #5 includes **Facet 1. Content**. Data about what are in the RNS? **Facet 2. Data origin. Original data input and in-sharing. Data sharing sources and destinations.** **Data checking, verifying, cleaning data.** **Consistency checks** How is original input organized? What sources/systems can the RNS work with for data in-sharing (data import or live access) and data out-sharing (data export or providing live access)? **Facet 3. Time dimension of data. Update, retention, preservation.** In updates, are previous data retained? How long are data retained? **Facet 4. Data access. Intellectual property rights** #6 includes **Facet 5. Data format / data definition**. According to what definition are data recorded? According to what definitions can the RNS share data? **Facet 6. Data sharing method.**. By what method are data (1) getting into the RNS (import or live access) and (2) from the RNS to other systems (export or live access) **Facet 7 Data origin management** Values from Facets 2 - 7 are often specific to a given type of content

RNS Functions	Examples of Specific Values	Notes Users and Uses
#5 Data content elements included in or accessible through the RNS **Data needed for the application functionality (Data Facets 1 - 4)**		**Note:** This will be a very long list. For actual RNS evaluation for a given institution this list needs to be available in full detail and checked against the needs of the institution. Required data analyses and outputs clearly dictate requirements for data elements. Specification can and should draw on existing ontologies, such as the Integrated Semantic Framework developed by CTSAconnect, and data dictionaries such as CASRAI http://dictionary.casrai.org/ and CERIF www.eurocris.org/Index.php?page=CERIFreleases&t=1 See also under ontologies and data standards below. The sample values column gives just some broad areas of data to indicate the range
. Facet 1. Content: Data about what are in the RNS?		
. .		

RNS Functions	Examples of Specific Values	Notes Users and Uses
. . **Data about people: Biographic and position data**	Name Office Address phone fax email education website Status (Active or Passive) rank research interests, weighted by importance active network links (can be imported from other systems) passive network links, computed by RNS grants (with funding share) research and other projects student research projects, including theses courses taught professional relationships . advisors . protégées . collaborators . lead collaborators . co-authors Distinctions Contributions (Examples of) impact Professional associations Photograph Links to publications News stories about	**Uses:** A lot of this inform*ation can be gathered from existing sources,* saving researchers time in entering such data, either into the RNS or as they prepare/update CVs From http://profiles.catalyst.harvard.edu/ • Users can manually create active networks [i.e. active network links] by [actively] identifying [or accepting] advisor, mentor and collaborator [and many other] relationships with colleagues. Profiles RNS will soon support the OpenSocial standard, which will let researchers use the same types of plug-in collaboration gadgets found on LinkedIn and Google within their active networks. • Passive networks [i.e. passive network links] are automatically created based on [professional relationships found in administrative records and other sources,] current or past co-authorship history, organizational relationships and geographic proximity. It extends these networks by discovering new connections, such as identifying "similar people" who share related keywords [interests]. Offering these additional suggestions, Profiles RNS can lead you to unexpected opportunities for collaboration and new sources of expertise. Passive network relationships can also be computed from members of same department, members of collaborating departments, administering similar resources, A needs resource that B has.

RNS Functions	Examples of Specific Values	Notes Users and Uses
. . **`Data about organizations / Organizational units (research teams, institutes, departments, etc.)**		
. . **`Data about funding opportunities**	Funding organization Subject area Eligibility Award range Deadlines	
. . **Data about projects (research projects and others)**	Title Funding Source (if any) PI with funding share co-PIs with funding share Other staff Major findings Impact (if known)	**Uses:** *Administrators* can evaluate faculty output and determine research area strengths and shortcomings. *Researchers* can review and evaluate potential collaborators.
. . **Data about research resources (such as instruments, computer programs, biospecimen banks)**		
. . **Data about services (such as consulting on research design, recruitment of study participants, analyzing biospecimens, imaging)**		
. . **Data about events (meetings, lectures, etc.)**		
. . . Data on meetings	Call for papers Deadlines	Notify researchers of upcoming meetings of interest and their submission deadlines.
. . **Data on researcher activities**		
. . . Meetings attended data (internal and external)		Can be used to compute passive networking links. Also to derive interests
. . . Calendar data		
. . . Data on researcher effort spend by task, project		

RNS Functions	Examples of Specific Values	Notes Users and Uses
. . **Data about documents: Bibliographic data**		
. . . Status of publication	Planned In progress, draft Submitted Accepted Published	For faculty annual reports
. . . Citation data		To notify researchers when their work is cited and were. To construct a quantitative profile of scholarly activity
. . . Full text of documents		Possibly through link to institutional repository or other source of full text.
. . **Data about courses**	Courses offered Faculty Course Schedules Classroom schedules Classroom Locations Classroom uses	**Uses:** *Administrators* can analyze data to streamline faculty workloads and manage facility space more efficiently
. **Facet 2. Data origin. Original data input and in-sharing. Data sharing sources and destinations. Data checking, verifying, cleaning data. Consistency checks** How is original input organized? What sources/systems can the RNS work with for data in-sharing (data import or live access) and data out-sharing (data export or providing live access)?		How is original input organized? What sources/systems can the RNS work with for in-sharing and out-sharing of data? Data in-sharing is defined to include (1) data import, incorporation of data from another source into the local database and (2) dynamic live access to another source. Likewise, data out-sharing is defined to include (1) exporting data to an external system for incorporation there and (2) making the local system available for dynamic live access by an external system. Since there is great overlap between systems that are data sources and systems that are data destinations it is best to create a single list and indicate for each system whether it is used as a data source (for what data items), a data destination (for what data items), or both. Technical aspects of data sharing fall under#6 , Facet 6

RNS Functions	**Examples of Specific Values**	**Notes** **Users and Uses**
. . Original data input. Organization aspects		Technical aspects are under #6, except to the extent How this is organized is mostly defined at the RNS instance level
. . . Input by researcher		
. . . Input by central staff		
. . . Level of support for formatting data, for example from a researcher's CV or citation from the bibliography of a paper or from a Web page		Note: Technical issues are similar to harvesting from Web pages
. . Harvesting data from unformatted or slightly formatted data, especially mostly textual Web pages		This is between original data input and data import (or live access if the RNS launches a Web search to answer a question). It requires more or less intelligent agents that can extract data from text and compile and integrate data from multiple sources. At the high end, such an application could be run regularly to compile data on each researcher for incorporation into the RNS store (subject to correction by the researcher). Such an application could also be called on by someone who inputs data to extract data from a specific document or Web page. Examples of the techniques can be found in SRI's CALO system (http://en.wikipedia.org/wiki/CALO) that contributed components to Apple's Siri. Specific methods would fall under #6; here is just a description of capabilities in general terms.
. . . Parsing data into the correct format		**Note:** Data coming from Web pages, full-text documents, databases, researcher CV
. . . . Parsing document citations into the correct format		
. . Automated indexing / metadata assignment based on text or image analysis		Example: Elsevier Fingerprint

RNS Functions	**Examples of Specific Values**	**Notes** **Users and Uses**
. . Derive researcher expertise profile from analysis of - publications, - case histories of patients treated, - legal cases a law faculty member was involved in, - etc.		
. . Deriving data through analysis, such as establishing links between researchers from co-authorship or citations		Related to harvesting, but somewhat different
. . Obtaining data from other systems (in-sharing). Below is a list of types of systems with some examples in Column 2		The assumption here is that these systems contain formatted (structured) data
. . . Encompassing systems that provide both a data and software environment and a networking component	VIVO with instances eagle I with instances	**Note:** For an extensive list see http://en.wikipedia.org/wiki/Comparison_of_Research_Networking_Tools_and_Research_Profiling_Systems
. . . . Entire researcher profile can be copied from one RNS to another		
. . . Institutional information systems by area	Human Resources Information System Course catalog and scheduling information system Grants administration IRB Clinical trial management system Scheduling and charging for use of resources at the institution (e.g., imaging, gene sequencing) Note: Often many systems are involved Institutional and personal calendars Email system Library catalog Institutional repository of digital documents	This is to a great extent instance-specific. It depends, among other things, on the software used by an institution for a given function, see next row. If the RNS can import/access many of these systems and export/provide access to many of these systems, it can serve as a hub that saves researchers much time. For example, basic data about the researcher and a specific project can be transmitted to a gene sequencing facility without re-input, and charges for the services can be made directly to the project budget in the grant system.

RNS Functions	**Examples of Specific Values**	**Notes** **Users and Uses**
. . . Multi-type databases and database vendor systems	Pub Med EBSCO HOST Research Gate, Google Scholar Microsoft Academic Search ArnetMiner	
. . . Bibliographic and related data sources	Medline Web of Science / Web of Knowledge, Scopus USPTO Patents and Applications ERIC Agricola Proquest Erasmus Publication repository Social Science Research Network (SSRN) www.ssrn.com	
. . . Biographic / expert databases	SciVal Experts COS pivot ORCID Open Resource Contributor ID www.researcherid.com (Thomson-Reuter)	
. . . Funding databases	Sci Val Funding Opportunities Agency program announcements COS pivot ScienceWire http://thomsonreuters.com/products/ip-science/04_022/caes_fs_en.pdf	
. . . Other databases	Clinical Trials.gov www.researchmatch.org	

RNS Functions	**Examples of Specific Values**	**Notes** **Users and Uses**
. . . Agency and organization websites	National Institutes of Health (NIH), incl. NIH Reporter Department of Defense (DOD) National Science Foundation (NSF) Department of Human Services Department of Agriculture Department of Education (DOE)	
. . . Social networking and communication sites	Research Gate LinkedIn Facebook Twitter	Another example where import and export can work together, for example, getting LinkedIn data into Research Gate
. . Notify researchers upon import of data (incl. publications) pertaining to them and allow researchers to verify and correct the data		**Note:** Publications and other data automatically derived from external sources may result in incorrect or missing publications, this tool enables faculty to make corrections and additions. On the other hand data input by researchers need to be verified to avoid errors and false claims.
. . **Checking, verifying, cleaning data. Consistency checks**		b
. . . Person and organization name consolidation. Co-referent identification		

RNS Functions	Examples of Specific Values	Notes Users and Uses
. . . Person and organization name disambiguation		This tool should use a number of factors to build an authentic publication history • Name variations • Email address • Institutional Affiliations • Known co authors • Journal Titles and Subject areas • Known relevant key words Some apps that do this[10] Researcher ID Profiles Author Disambiguation Engine AuthorClaim ISNI International Standard name Identifier VIAF Virtual International Authority File Probability Threshold Disambiguator Google Scholar "My Citations" Function Institution Directory Authenticators XML Based Disambiguators
. . . Document citation consolidation		
. . . . identifying citations that refer to the same document		
. . . . identifying citations that refer to different versions of same document		**Note:** Such as a conference presentation (and possibly its slides) and a subsequent publication
. **Facet 3. Time dimension of data. Update, retention, preservation**		In updates specify for each data item or group of data items • Are previous data retained? • How long are data retained?.
. . Historical data are preserved		
. . Historical data are preserved even if researcher leaves institution	o	

[10] Not listed as tools in any system table but discussed in http://guides.library.jhu.edu/content.php?pid=67345&sid=497444

RNS Functions	Examples of Specific Values	Notes Users and Uses
. . For data that are imported from external sources: How often are data updated?		
. Facet 4. Data access. Intellectual property rights		
. . **Property rights and access management for the RNS as a whole**		**Note:** This is an issue primarily for RNS that are "sold" or provide as a service rather than as software to run under the control of the institution
. . . Who owns what data?	RNS vendor Institution Individual researcher	
. . . Where are data physically kept?	RNS vendor's computer or under RNS vendor's control Institution's computer or under institution's control	
. . . . If data are kept on vendor's computer, can institution freely access the data for any kind of analysis, possibly in combination with other data?		**Note:** Very important
. . **Property rights and access management, detailed issues**		See #5 Data content, Facet 4 Data access management
. . . Information property rights and access restrictions management		**Note:** The ability of the RNS to keep track on rights and restrictions for every piece of data in relation to user privileges. Different pieces may belong to and have access restrictions imposed by • the RNS vendor • an external data source (for example, a university may buy the use of external proprietary data where the contract specifies that access is restricted to people affiliated in some way with the university) • the institution • the individual researcher (for data about the researcher that are not in the public domain)

RNS Functions	**Examples of Specific Values**	**Notes** **Users and Uses**
. . . . Who is authorized to enter and change what information property rights and access restrictions for what data		
. . . . . Researchers can manage access to non-public information about them		**Note:** Researchers can select which of their data are available to whom in any kind of display – staff directory, institutional expertise directory, their own Web page. This really depends on institutional policy but such a policy can be implemented only if the RNS has the capability of managing information property rights and access restrictions. **Note:** This feature helps promote usability by faculty by reassuring them they have final decisions over their profile information.
. . Information input and information change rights management		**Note:** For example, there may be some types of data that only the researcher can change (whether the researcher did the original input or whether the data came from elsewhere). On the other hand, researchers should not be allowed to enter or change funding data; such data should come from the grant administration system.
. . Information access controls (implementation of access restrictions)	Log In User Access Levels Implementation of user-specific access to particular data	**Note:** This can allow for greater access to RNS (public, students, participating institutions, government agencies) by controlling which user groups can have access to which information

RNS Functions	Examples of Specific Values	Notes Users and Uses
#6 Data, technical aspects: Data format, data-sharing, and data origin management Includes Data Facets 5 - 7		
. **Facet 5. Data format/ data definition**. According to what definition are data recorded? According to what definitions can the RNS share data?		Date definition has three levels **Level 1. Syntactic** data definition and formats and associated query possibilities. **Level 2. Semantic data definition, general.** Specifies the entity types and relationship types used, conceptual data schema **Level 3. Semantic data definition, specific**. Specifies entity values used for each entity type. The border line between adjacent levels is not sharp. A standard or other specification system may include specifications on Level 2 and Level 3. Data definition at any level must be specified for internal data storage, data in-sharing, and data out-sharing. (Data definition may or may not be the same for the different functions.) Data definition, especially levels 2 and 3, may vary for specific data items.

RNS Functions	Examples of Specific Values	Notes Users and Uses
. . Data definition Level 1. Syntactic data definition and formats and associated query possibilities	Relational tables Relational tables with object-oriented extensions . SQL . PL/SQL XML RDF / linked data . SPARQL JSON OWL . Reasoners CSV RTF PDF MS Word MS Excel Endnote Expert format	
. . Data definition Level 2. Semantic data definition, general.	Ontologies . Vivo Ontology[11] . Integrated Semantic Framework (ISF) . Bibliographic Ontology Specification BIBO www.bibliontology.com/ Data standards . Dublin Core . MARC . FOAF	Specifies the entity types and relationship types used. Also called conceptual data schema. Sample values to be used under any of the subordinate categories Ontologies may specify data standards (often expressed as entity types and relationship types) or entity values or both. CASRAI for mapping Other sources http://arademaker.github.io/files/ewg-dss-slides.pdf

[11] http://direct2experts.org/?pg=about

RNS Functions	Examples of Specific Values	Notes Users and Uses
. . Data definition Level 3.Semantic data definition, specific..	Ontologies . Vivo Ontology[12] . Integrated Semantic Framework (ISF) Classifications, controlled vocabularies . US DoE Classification of Instruction Programs (CIP) Code for higher education . Medical Subject Headings (MeSH) . SNOMED CT . Scopus taxonomy	Specifies entity values used for each entity type
. . Data definition for internal storage and data sharing		These distinctions apply at Levels 1, 2, and 3
. . . Internal data definition		
. . . Data definition for in-sharing (data import or live access to external system)		
. . . Data definition for out-sharing (data export or providing live access to external system)		
. **Facet 6. Methods for original data input and data sharing.**		How are data entered into the RNS data store or made available through live access to other systems? By what method (1) are data getting into the RNS or (2) are data accessed? By what method are data (1) exported to or (2) made accessible to other systems Different methods may be applicable to different data elements and data sources / data destination These methods fall also under **Functionality etc.** There are also administrative aspects: How frequent is the import or export? Automatic on a schedule or run manually? Note: Content aspects are covered under #5, Facet 2

[12] http://direct2experts.org/?pg=about

RNS Functions	**Examples of Specific Values**	**Notes** **Users and Uses**
. . Original data input, technical aspects		
. . . General approach to original data input. Usability		
. . . Support for original data input. Features that facilitate data input e. g.		
. . . . Incremental input app on researcher computer		Such an app would function as a structured notepad where researchers can document activity as it occurs, such as reviewing for a journal or conference or a new publication (to be parsed into fields by the app). From time to time the researcher could upload these data. The availability of such an app has the potential of significantly increasing researchers' compliance with institutional reporting requirements.
. . . . Harvesting user activity history		If a history of all user activity (email, Web pages visited; searches; files opened /modified / created; appointments / meetings; instruments used, as seen from electronic scheduling; etc.) is available, it can be mined for information that should be reported to the RNS to make suggestions to the user.
. . . . Apps for extracting data from documents and Web pages (technical description, capabilities)		Note: General capability description under #5, Facet 2
. . Data sharing with other systems, technical aspects		
. . . Getting data from other systems, technical aspects		
. . . . Data import		
. . . . . Data import from formatted system / DB		Elaborate on ease of creating data element mapping specifications. Also on loss of data as applicable.

RNS Functions	Examples of Specific Values	Notes Users and Uses
. . . . . Data import from institutional database software	Institutional human resources and administration management software[13] . Banner . Peoplesoft . SIS+ . Ascential . Datatel/Ellucian . Informatica . Meeting Maker . Sciquest . Vignette . IRBnet	If an institution uses one of these software packages, the institutional information systems in the corresponding area will work with RNS, assuming adaptation of the data element mapping to the institution customization.
. . . . Live access to other systems, e.g., through queries		
. . . . . Federated search		
. . . Providing data to other systems		
. . . . Data export		See also Output below
. . . . Provide live access to other systems, e.g., through queries		
. . . . . Enabled as target of federated search		
. **Facet 7. Data origin management**		**Note:** Keeping track of all the data sources and where each piece of data comes from (the same piece of data could come from several sources) and the surety level for each data element – data source pair. This includes sources used for data validation

[13] http://www.universitybusiness.com/article/hr-software-options-can-be-overwhelming

RNS Functions	Examples of Specific Values	Notes Users and Uses
#7 Technical functionality, import, processing / analysis, export/output, using other systems to enhance functionality		How the system achieves application functionality. The meat of system functions is in **#4 Application functionality** This section deals with technical aspects, primarily using apps, search, and communications **Note:** Processes related to data input data sharing, and data checking are under #5 `Data, Facet 2. Data origin. This section first covers principles for using apps and then goes through RNS functions, whether they are native to the RNS or accomplished through an app.
. **General principles for using apps**		**Note:** RNS functionality achievable through apps should be noted in RNS descriptions, giving the specific app.
. . Facet 1: Which apps. / plugins can be used with the RNS	apps repositories such as . www.orng.info/gadget-library.html SciVal Funding Recommender Vivo Apps . Vivo Harvester . Vivo Searchlight . Vivo Search Direct2Experts[14] http://opensocial.org/	
. . . Number of apps available. Size of developer community		
. . Facet 2. Method of using app		
. . . apps added to local code base		
. . . apps run on external computer		

[14] http://direct2experts.org/?pg=about

RNS Functions	Examples of Specific Values	Notes Users and Uses
. . Gateway to other systems	Examples Google search Search of library catalog, bibliographic databases, other databases. IRBnet for submission Scheduling of a central (core) research resource clinicaltrials.gov	**Note:** Data can be transferred from the RNS to the other system to avoid re-entering. For example, . query data for a search . project title and researcher data to IRBnet . project and funding data to central (core) research site
. Types of analysis		
. . Reasoning		**Note:** For example, by working with any reasoner, such as Pellet
. Search		
. . What types of entities can be searched?	People, search for experts . search for collaborators Projects Documents Research resources . Laboratories . equipment, instruments Service for recruitment of study participants.	**Uses:** Being able to find research resources gives researchers the opportunity to apply for grants that normally would be out of range due to lack of resources and build a cross institutional collaborative reach Also allows for better utilization of resources and savings in establishing resource
. . Scope of search	Integrated Search[15] Aggregate Search[16] Federated Search[17] Cross-Platform Search Include other databases, such as PubMed	
. . Search features		**Note:** There are many criteria for search; these are just some examples

[15] http://direct2experts.org/?pg=about
[16] http://direct2experts.org/?pg=about
[17] Profiles Fact Sheet http://profiles.catalyst.harvard.edu

RNS Functions	**Examples of Specific Values**	**Notes** **Users and Uses**
. . . Free Text Search		
. . . KOS (ontology)-enhanced search		
. . . Fielded search		
. . . Search operators		
. . Search templates for different kinds of searches		
. . Sort Options[18]	Rank by relevance Round Robin (Best match from each Institution) Alphabetical by Name Alphabetical by Institution	
. . Alerting service		Also called SDI (Selective Dissemination of Information) based on researcher interest profile (possibly created automatically) Could be for any of the following (examples): . publications and other documents . conferences, calls for paper . new agency rules affecting the researcher's areas . funding opportunities (see next row) . new researcher joining institution or large research community
. **Communication options to enhance collaboration** (not complete)		Note: RNS features that enable collaboration and enhanced communication through document share and virtual conferencing can be effective tools and help to make best use of resources across institutions and enhance research productivity. Such communication support can, of course, provided outside the RNS but can be much easier to use when integrated with the RNS.

[18] http://direct2experts.org/?pg=about

RNS Functions	**Examples of Specific Values**	**Notes** **Users and Uses**
. . Modes of collaboration	Email Virtual conferencing Document share Chat Screen share	
. . Meeting support		
. . Scope of collaboration	Institution Across institutions . national . international Within a research area For specific projects	Note: More of an application function

RNS Functions	Examples of Specific Values	Notes Users and Uses
#8 General system characteristics applicable across the RNS		**Note:** Can be indicated globally, but intended chiefly for combination with specific items This list gives just an inkling of what should be looked at
. Usability		
. . Learning curve		
. Extensibility		
. Customizability		
. Quality		
. Completeness		
. Efficiency		
. Value		
. . Value to the researcher		The higher the value/utility to the researcher, the more complete participation. If the researcher can use data he or she inputs to the RNS in multiple places and save time, he or she is much more likely to input such data.
. . Value to the institution		