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Digital Library Interoperability,
Best Practices and Modelling Foundations

What is a Digital Library?

Modeling things is making our life easier: the Reference Model

Yannis Ioannidis

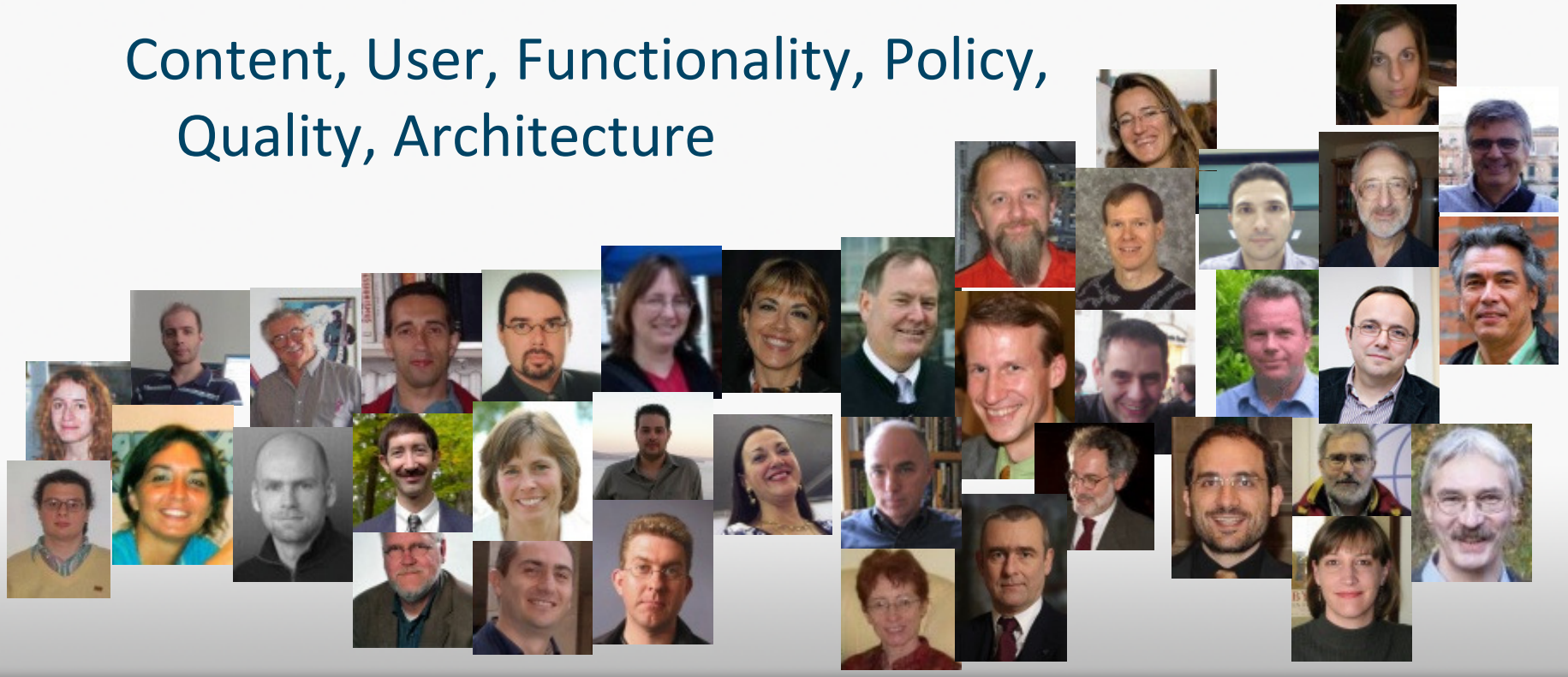
University of Athens

Theory and practice in Digital Libraries: a European approach
Athens, 13 December 2010

DL.org Network of DL Stakeholders

- WGs on six Digital Library Universe Domains
  [DELOS DL Reference Model]

  Content, User, Functionality, Policy, Quality, Architecture



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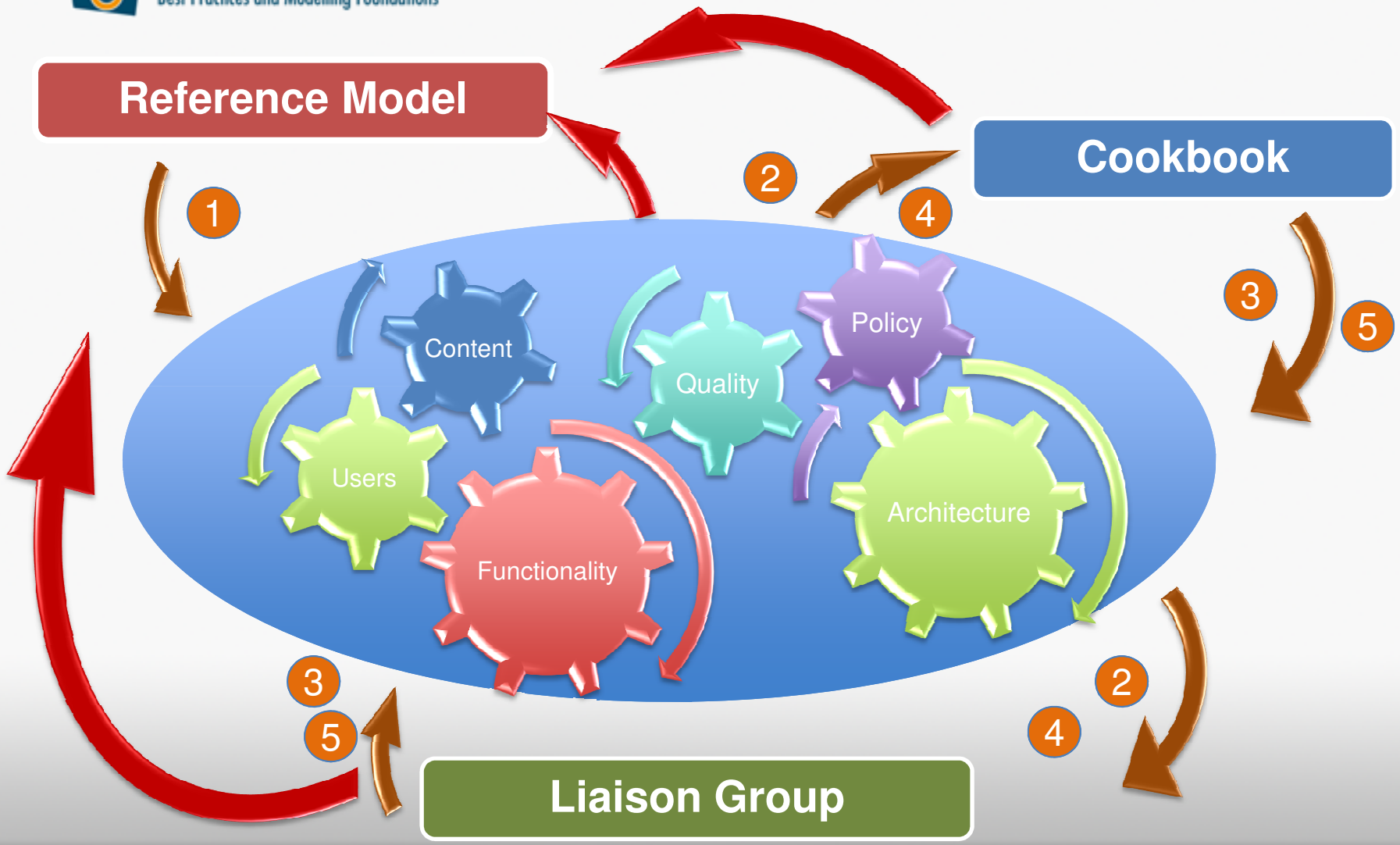
Interactions and Output



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Outline

- Motivations
- RM Overview
- The RM Domains
- Discussion

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Libraries….

and…

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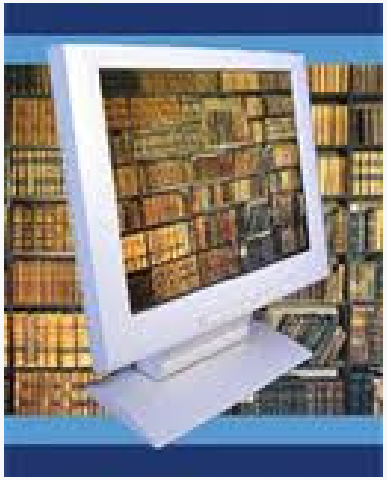
...Libraries?



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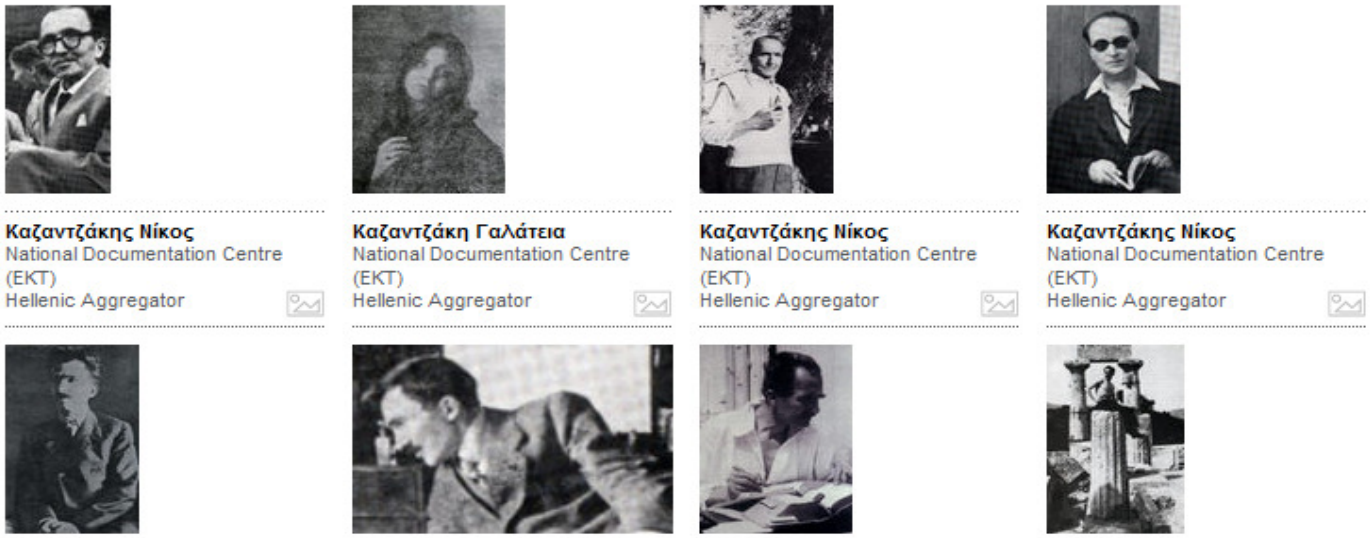

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ACM Digital Library

ACM DL DIGITAL LIBRARY

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1 The generalized pre-grouping transformation: aggregate-query optimization in the presence of dependencies
Aris Tsois, Timos Sellis
September 2003 **VLDB '03: Proceedings of the 29th international conference on Very large data bases - Volume 29** , Volume 29
Publisher: VLDB Endowment
Full text available: Pdf (345.15 KB)
Bibliometrics: Downloads (6 Weeks): 0, Downloads (12 Months): 20, Downloads (Overall): 69, Citation Count: 2

One of the recently proposed techniques for the efficient evaluation of OLAP aggregate queries is the usage of clustering access methods. These methods store the fact table of a data warehouse clustered according to the dimension hierarchies using special ...

2 Data Warehouse Configuration
Dimitri Theodoratos, Timos K. Sellis
August 1997 **VLDB '97:** Proceedings of the 23rd International Conference on Very Large Data Bases
Publisher: Morgan Kaufmann Publishers Inc.
Bibliometrics: Downloads (6 Weeks): n/a, Downloads (12 Months): n/a, Downloads (Overall): n/a, Citation Count: 69

3 Data management research at the Knowledge and Database Systems Lab: (NTU Athens)
Timos Sellis, Yannis Vassiliou
June 2006 **SIGMOD Record** , Volume 35 Issue 2
Publisher: ACM

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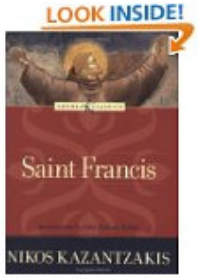
1. 

Saint Francis by Nikos Kazantzakis and John Michael Talbot (Apr 2005)
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Paperback	~~$13.95~~ **$11.16** Prime	$9.10	$8.98	$7.49
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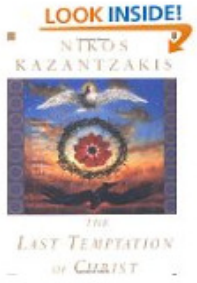
2. 

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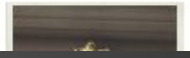
3. 

Report to Greco by Nikos Kazantzakis (Jun 18, 2001)

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[PDF] The R-tree: A dynamic index for multi-dimensional objects — [PDF] from psu.edu
T **Sellis**, N Roussopoulos... - The VLDB Journal, 1987 - Citeseer
The problem of indexing multidimensional objects is considered. First, a classification of existing methods is given along with a discussion of the major issues involved in multidimensional data indexing. Second, a variation to Guttman's R-trees (R + -trees) that avoids overlapping ...
Cited by 1274 - Related articles - View as HTML - All 35 versions

Multiple-query optimization — [PDF] from psu.edu
TK **Sellis** - ACM Transactions on Database Systems (TODS), 1988 - portal.acm.org
Some recently proposed extensions to relational database systems, as well as to deductive database systems, require support for multiple-query processing. For example, in a database system enhanced with inference capabilities, a simple query involving a rule with multiple definitions may ...
Cited by 495 - Related articles - All 19 versions

A model for the prediction of R-tree performance — [PDF] from psu.edu
..., T **Sellis** - Proceedings of the fifteenth ACM SIGACT- ..., 1996 - portal.acm.org
Abstract: In this paper we present an analytical model that predicts the performance of R-trees (and its variants) when a range query needs to be answered. The cost model uses knowledge of the dataset only, ie, the proposed formula that estimates the number of disk accesses is ...
Cited by 267 - Related articles - BL Direct - All 23 versions

Topological relations in the world of minimum bounding rectangles: a study with R-trees — [PDF] from psu.edu
D Papadias, T **Sellis**, Y Theodoridis... - Proceedings of the ..., 1995 - portal.acm.org
Dimitris Papadias Department of Computer Science and Engineering University of California, San Diego CA 92093-0114, USA dimitris@cs.ucsd. edu ... Times **Sellis** Department of Electrical and Computer Engineering National Technical University of Athens GREECE ...
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Nikos **Kazantzakis** - Wikipedia, the free encyclopedia
Nikos **Kazantzakis** (Greek: Νίκος Καζαντζάκης) (February 18, 1883, Heraklion, Crete, Ottoman Empire - October 26, 1957, Freiburg, Germany) was arguably the ...
Biography - Literary work - Bibliography of English ... - Further reading
en.wikipedia.org/wiki/Nikos_**Kazantzakis** - Cached - Similar

Nikos **Kazantzakis**
Nikos **Kazantzakis** was born in Megalokastro, Ottoman Empire, now Iráklion, Crete, the son of Michael **Kazantzakis**, a farmer and dealer of in animal feed, ...
kirjasto.sci.fi/kazantza.htm - Cached

Nikos **Kazantzakis** Quotes
12 quotes and quotations by Nikos **Kazantzakis**. ... Nikos **Kazantzakis** Beauty is merciless. You do not look at it, it looks at you and does not forgive. ...
www.brainyquote.com/quotes/.../n/nikos_**kazantzakis**.html - Cached - Similar

Nikos **Kazantzakis** - Wikiquote
Nikos **Kazantzakis** (1883-02-18 – 1957-10-26) was a Greek novelist, poet, playwright and ...
As quoted in Nikos **Kazantzakis** (1968) by Helen **Kazantzakis** ...
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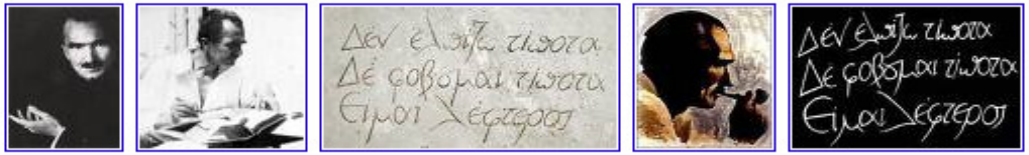

The Nikos **Kazantzakis** Files
The Nikos **Kazantzakis** Files first appeared on the World Wide Web in 1997, to mark the fortieth anniversary of the author's death. They were compiled by the ...
www.historical-museum.gr/**kazantzakis**/en/index.html - Cached - Similar

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What is Digital Library?

- Simulation of “real” Library?
- Digitized/Digital Content ?
- Digital Repository?
- Data/Knowledge Base ?
- Webpage?
- User Online Community
- Online Organization ?
- Heritage Preservation tool?
- eLearning tool?
- Research tool?

None of these,
all of these,
and many **more**!!!

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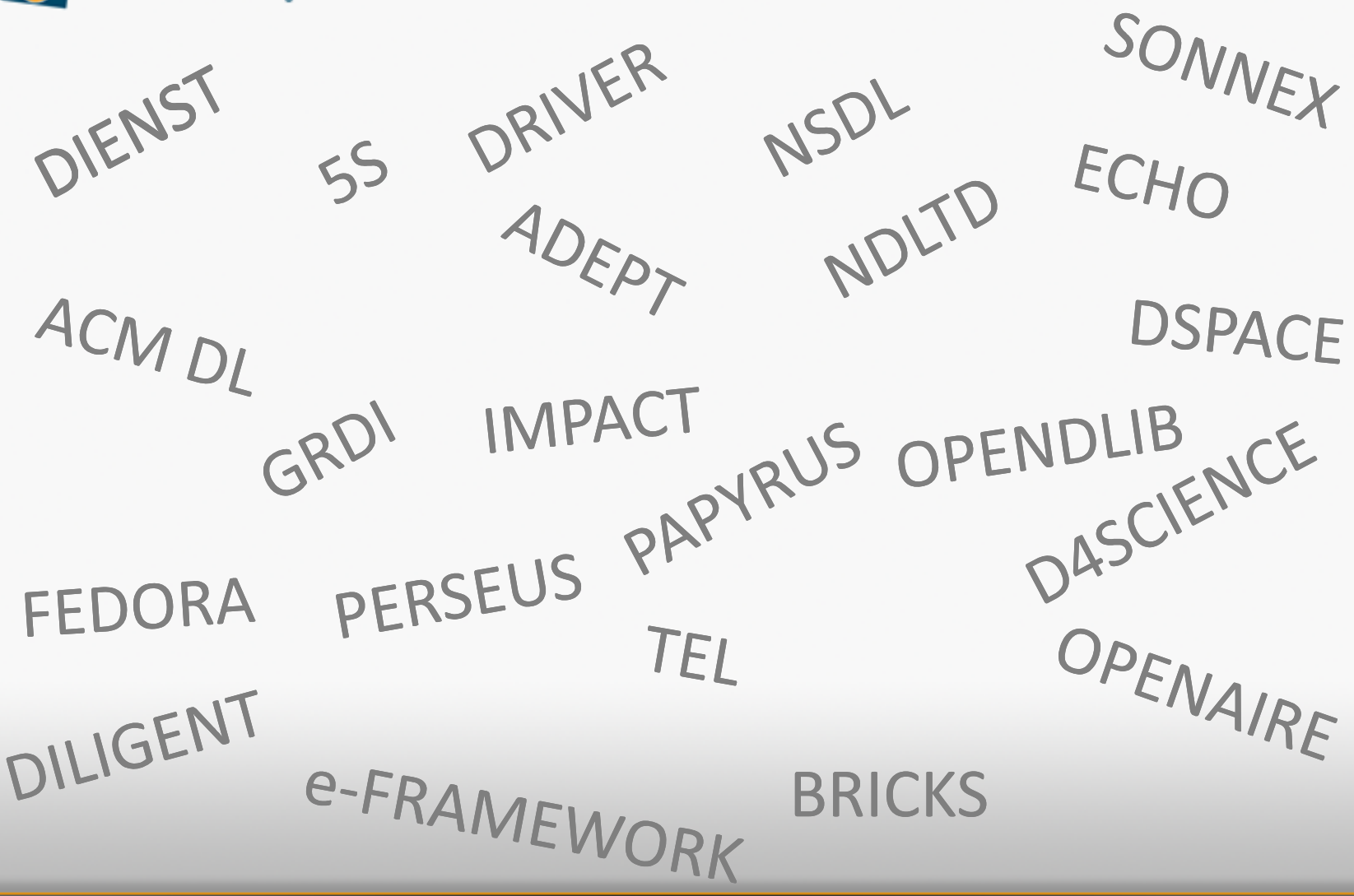
DL Universe



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Digital Library Issues

- Comparison among systems is hard
  - Different focus
  - Different concepts
  - Different terminology
- No guidelines for DL education
- Lack of DL systems design and development methodologies
- No systematic approach to interoperability & integration of solutions

Lack of foundations !

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Reference Model

- A reference model is an abstract framework for understanding significant relationships among the entities of some environment, and for the development of consistent standards or specifications supporting that environment
- A reference model is based on a small number of unifying concepts and may be used as a basis for education and explaining standards to a non-specialist
- A reference model is not directly tied to any standards, technologies or other concrete implementation details, but it does seek to provide a common semantics that can be used unambiguously across and between different implementations

DL Reference Model

Objective

To set the foundations and identify the cornerstone concepts within the universe of Digital Libraries, facilitating the integration of research and proposing better ways of developing appropriate systems

Consists of 3 parts:

- Digital Library Manifesto
- Digital Library Reference Model in a Nutshell
- Digital Library Reference Model Concepts & Relations.

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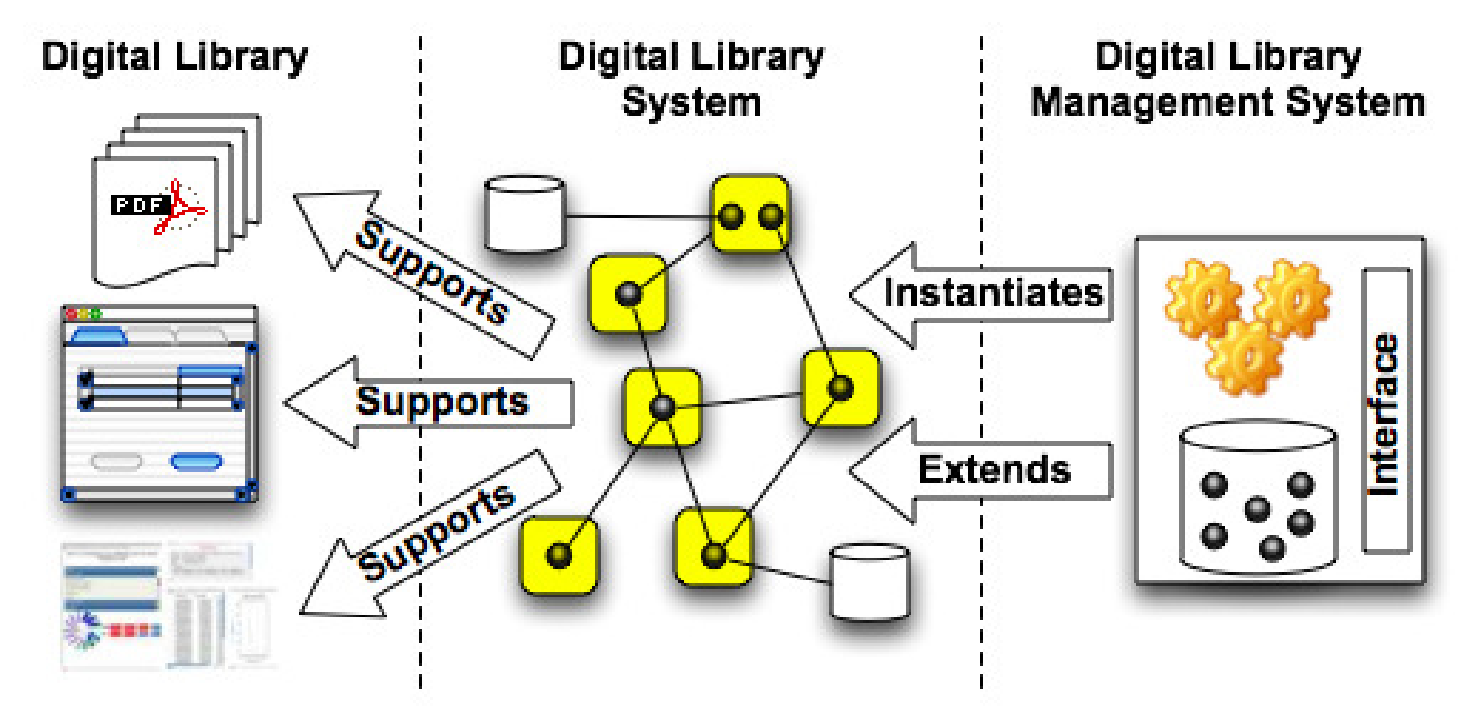
The DL "Systems"



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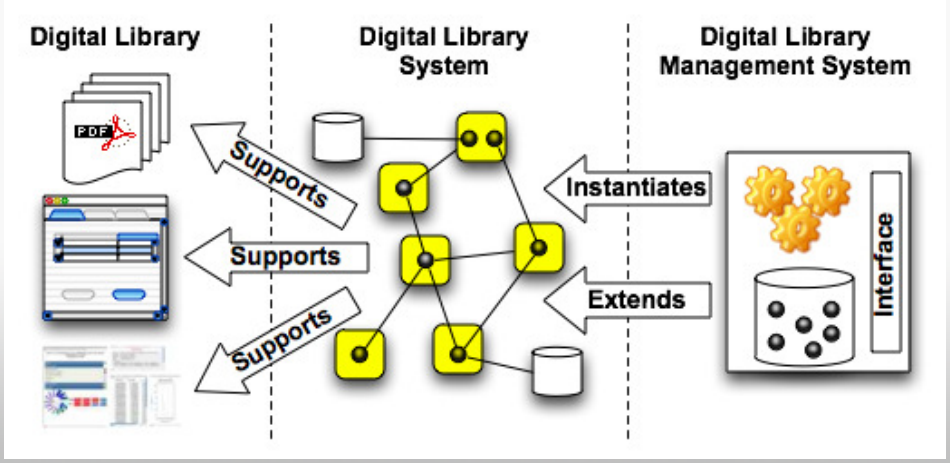
Digital Library

A (potentially virtual) **organization** that comprehensively collects, manages, and preserves for the ***long term, rich curated*** digital **content**, and offers to its ***targeted*** **user** communities ***specialized*** **functionality** on that content, of ***measurable high*** **quality** and according to ***comprehensive codified*** **policies**.

The DELOS Digital Library Reference Model



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Digital Library

ABSTRACT CHARACTERISTICS	***MAIN CONCEPTS***
• *long term*	**organization**
• *rich curated*	**content**
• *targeted*	**users**
• *specialized*	**functionality**
• *measurable high*	**quality**
• *comprehensive codified*	**policies**

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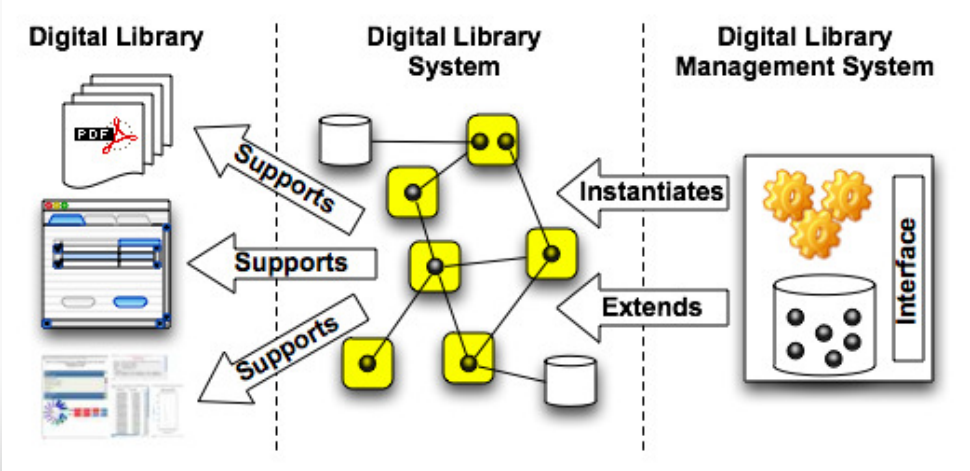
Digital Library

- Concepts for any info environment or system
- Characteristics distinguish DLs
  - Abstract and subject to interpretation
  - Conceptual yardsticks for comparison
  - Psychological lower bounds

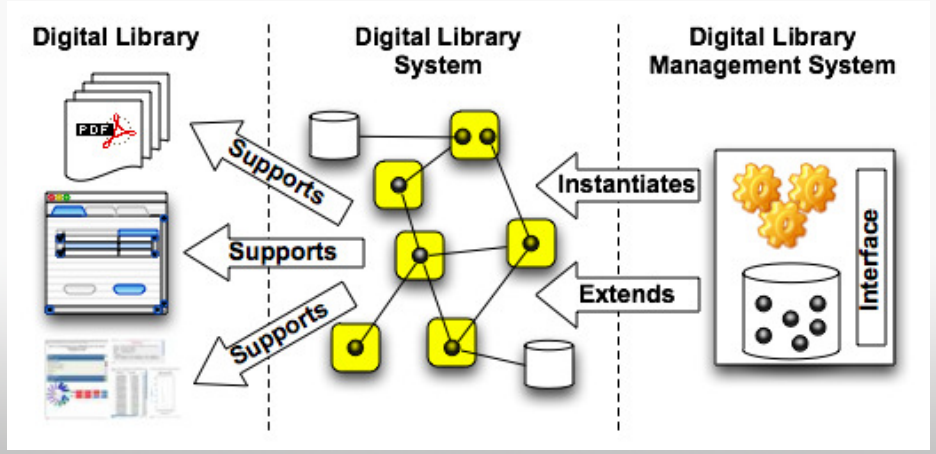
Digital Library System

A software system that is based on a (potentially distributed) **architecture** and provides all functionality that is required by a particular Digital Library. Users interact with a Digital Library through the corresponding Digital Library System.



DL Management System

A generic software system that provides the appropriate software infrastructure to both (i) produce and administer a Digital Library System that incorporates all functionality that is considered foundational for Digital Libraries and (ii) integrate additional software offering more refined, specialized, or advanced functionality.



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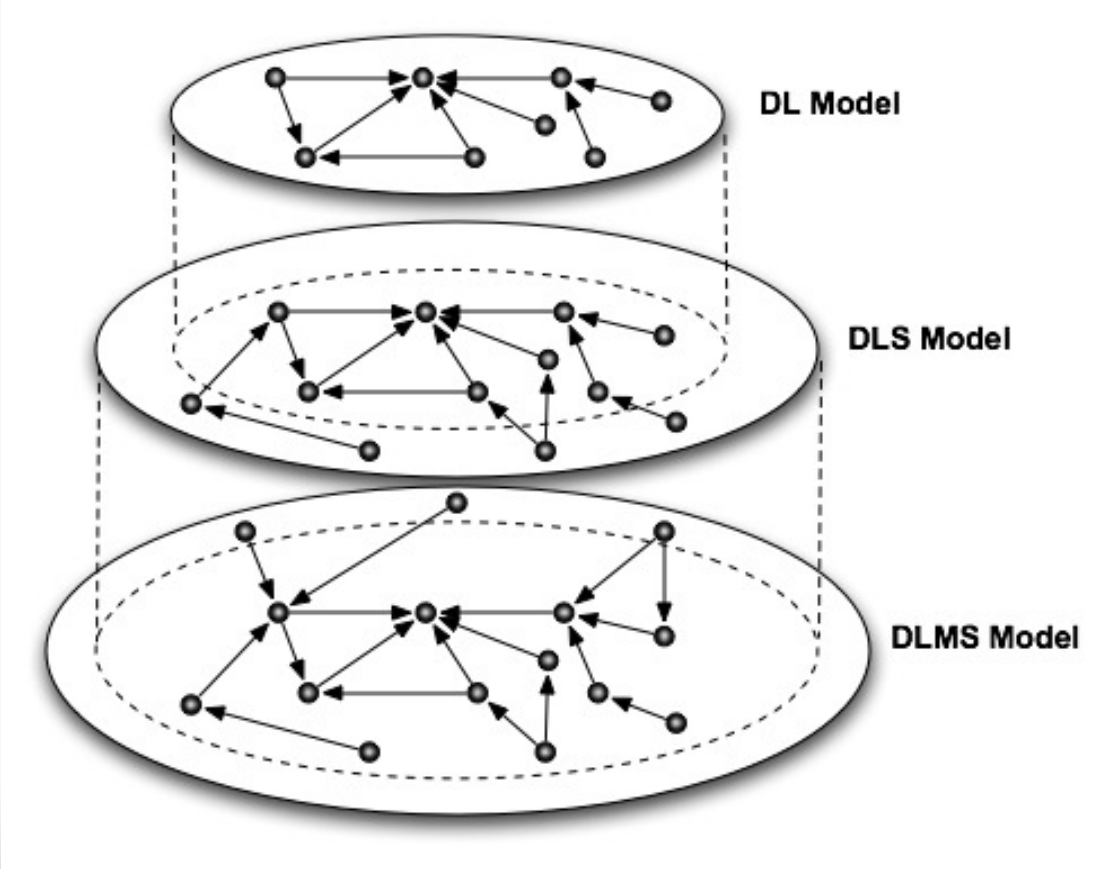
Hierarchy of Conceptualizations



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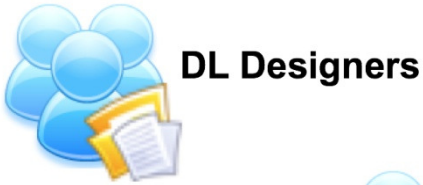
Main Roles of Actors

- End-Users

- DL Designers



- DL System Administrators

- DL Application Developers

Main Roles of Actors

- DL End-Users
- DL Administrators
- DL Software Developers

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DL End Users

Exploit the DL functionality for providing, consuming, and managing DL Content and some of its other constituents.

Further partitioned into

- *Content Creator*
- *Content Consumer*
- *Digital Librarian*

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Digital Librarian

Select DL content and its sources

Catalogue DL content

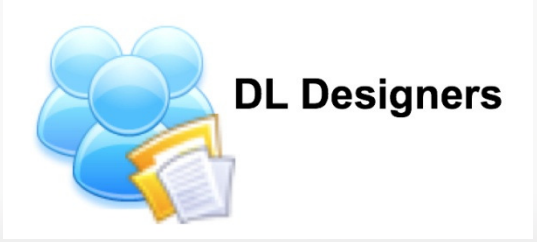
Curate DL content

Select supporting content, e.g., repositories, ontologies, authority files, …

Establish all resources, e.g., policies, quality, …

DL Designers

Exploit their knowledge of the application semantic domain to define, customize, and maintain the Digital Library so that it is aligned with the information and functional needs of its end-users. To perform this task, they interact with the DLMS providing functional and content configuration parameters.



DL System Administrators

Select the software components necessary to create the Digital Library System needed to serve the required DL and decide where and how to deploy them. They interact with the DLMS by providing architectural configuration parameters, such as the selected software components, the hosting nodes, and the components allocation.

DL Administrators

Interact with DLMS

Define, customize, and maintain DL
Provide functional & content configuration parameters
- Content format
- User profile format
- Document model

Select software components
Decide where and how to deploy them
Provide architectural configuration parameters
- Match software components with hosting nodes

DL Software Developers

Develop software components for DLMSs and DLSs

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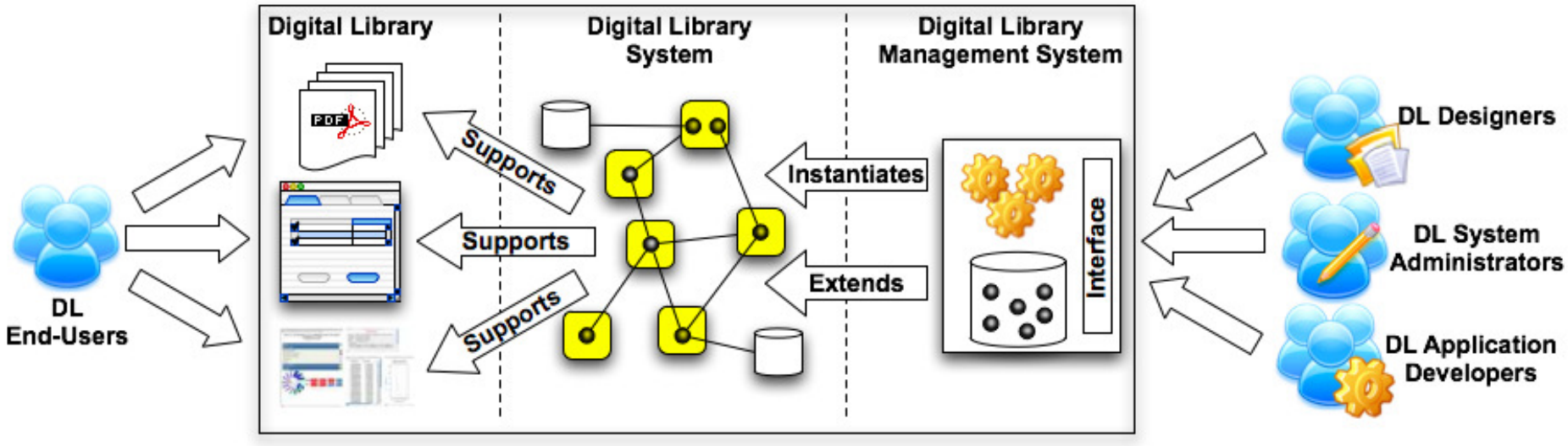
The user's views



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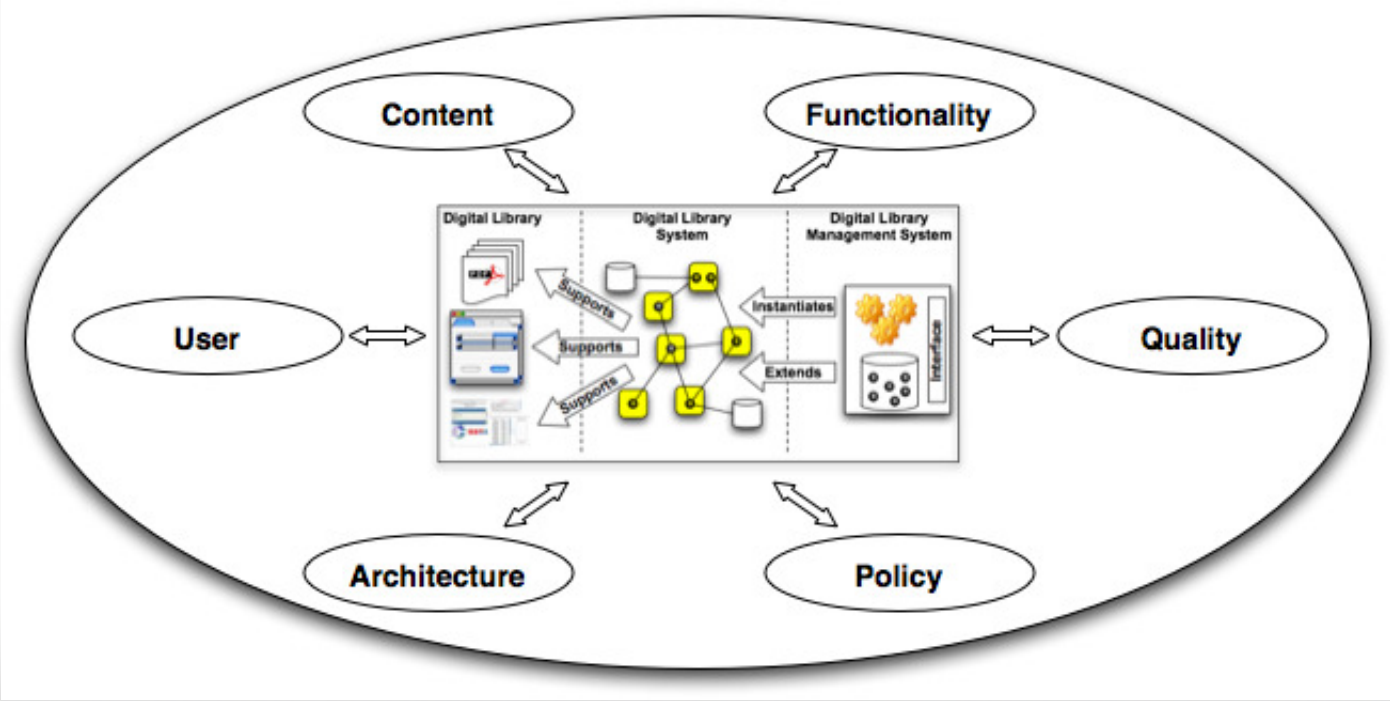
The Model

Concepts and relationships that represent the significant aspects of the different type of DL "systems"



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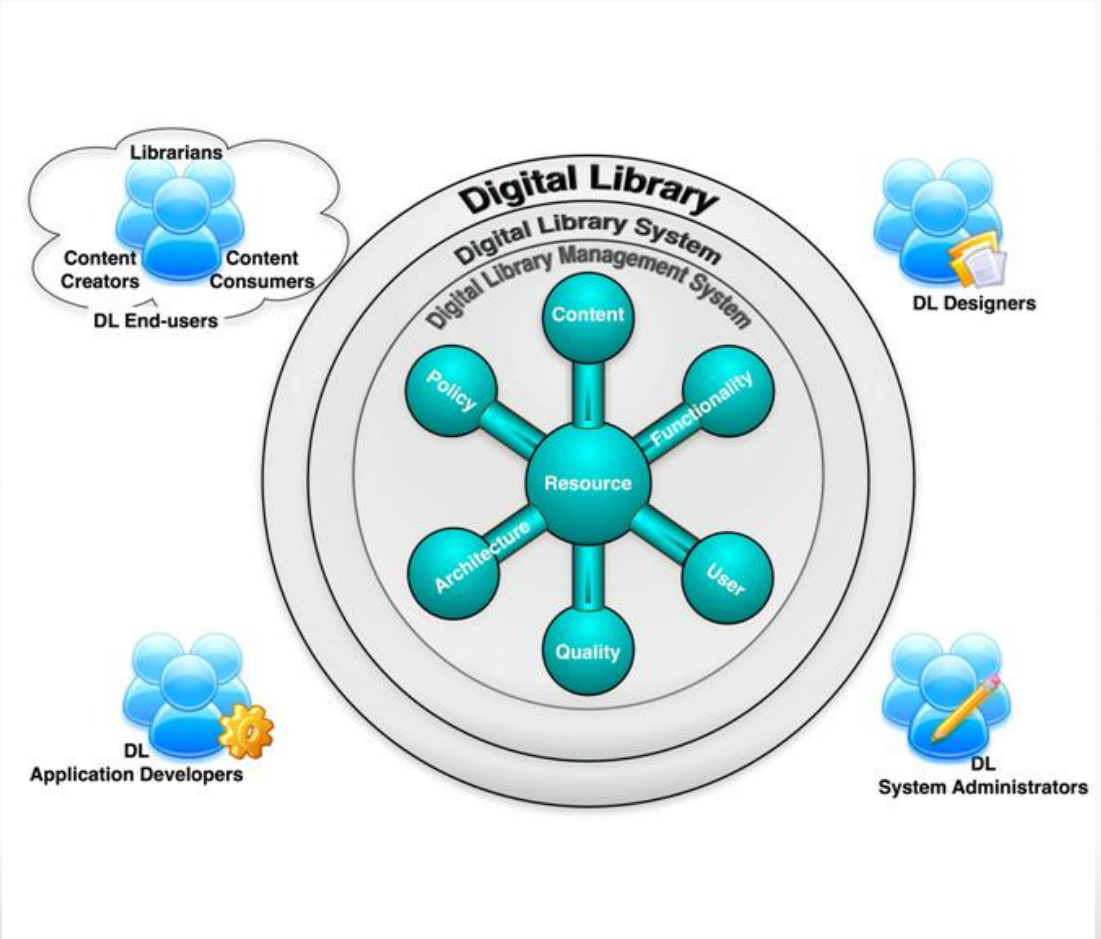
The Digital Libraries Reference Model in a Nutshell

The DL Universe

3 types of systems

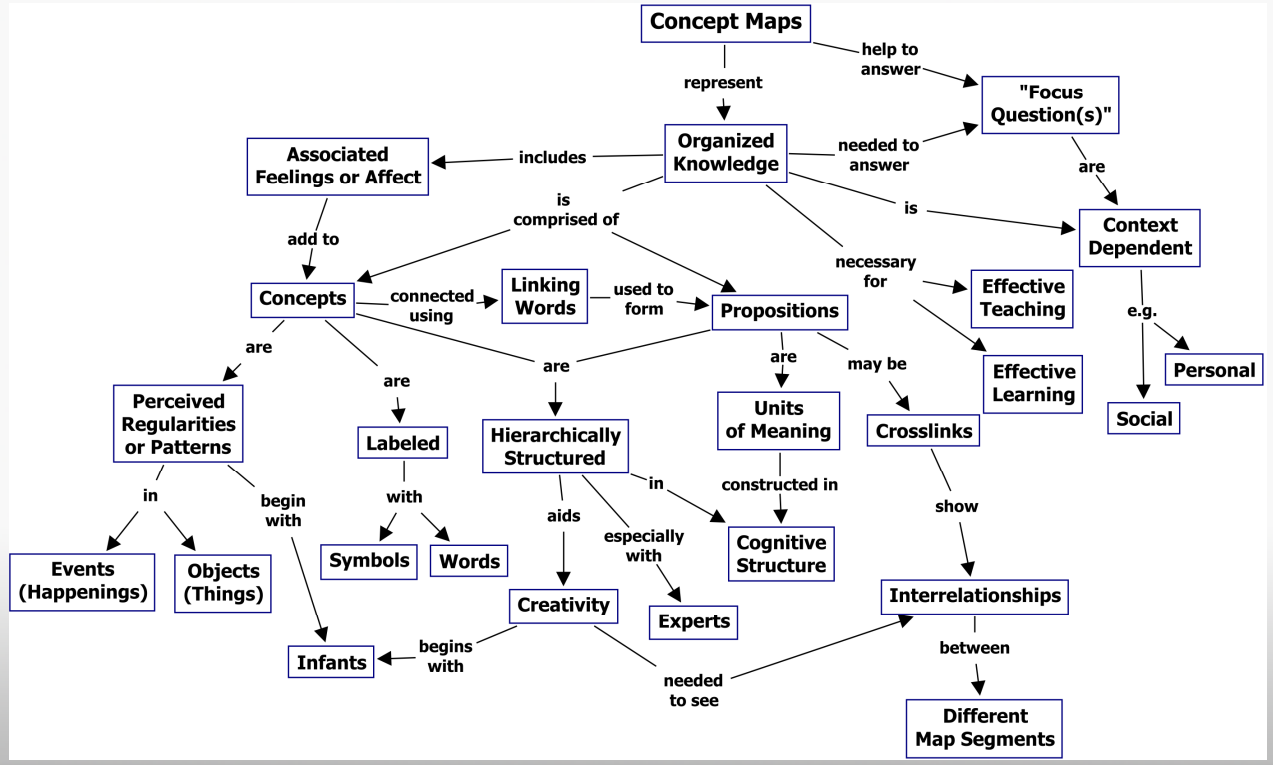
- DL
- DL System
- DL Management Systems

- **6 (7) +1 Domains**
  - (Organization)
  - Content
  - User
  - Functionality
  - Policy
  - Quality
  - Architecture
  - + Resource
- **4 Role of Actors**
  - DL end-Users
  - DL Administrators
  - DL Software Developers



Concept Maps

The Reference Model describes the Digital Library Universe **by Concept Maps** i.e. graphical tools for organizing and representing knowledge in terms of **Concepts** and **Relationships**



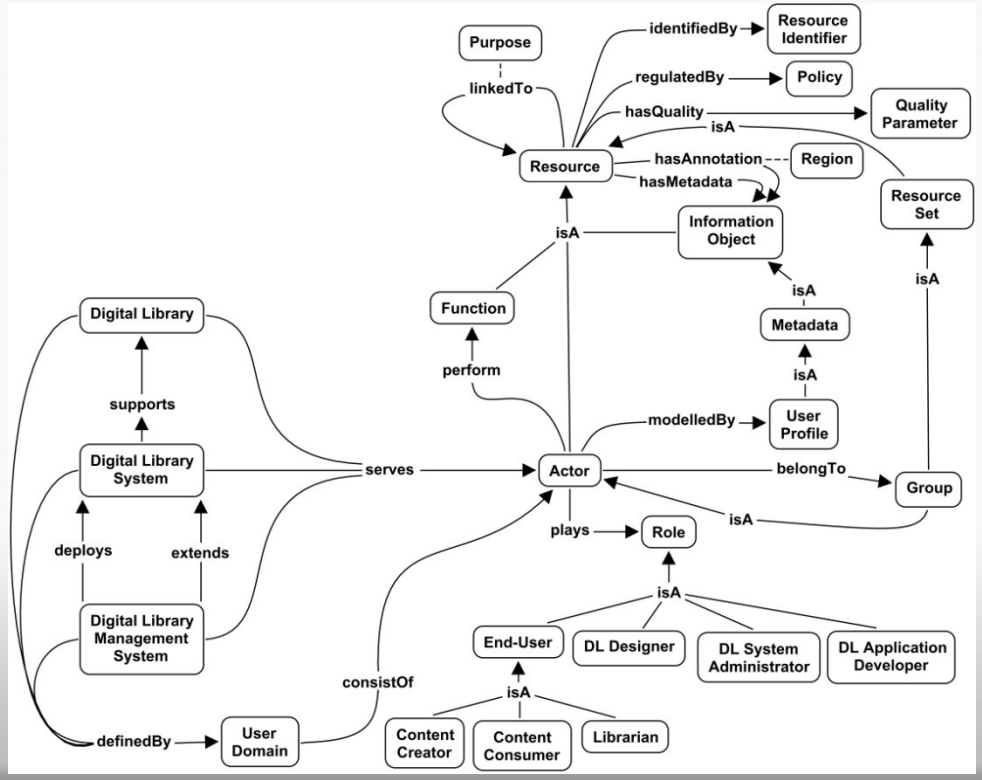
Concepts and Relationships

Definition: A set of *Actors* sharing certain characteristics, that may interact with one another, accept expectations and obligations as members of the group, and share a common identity.

Relationships: ……

Rationale: ….

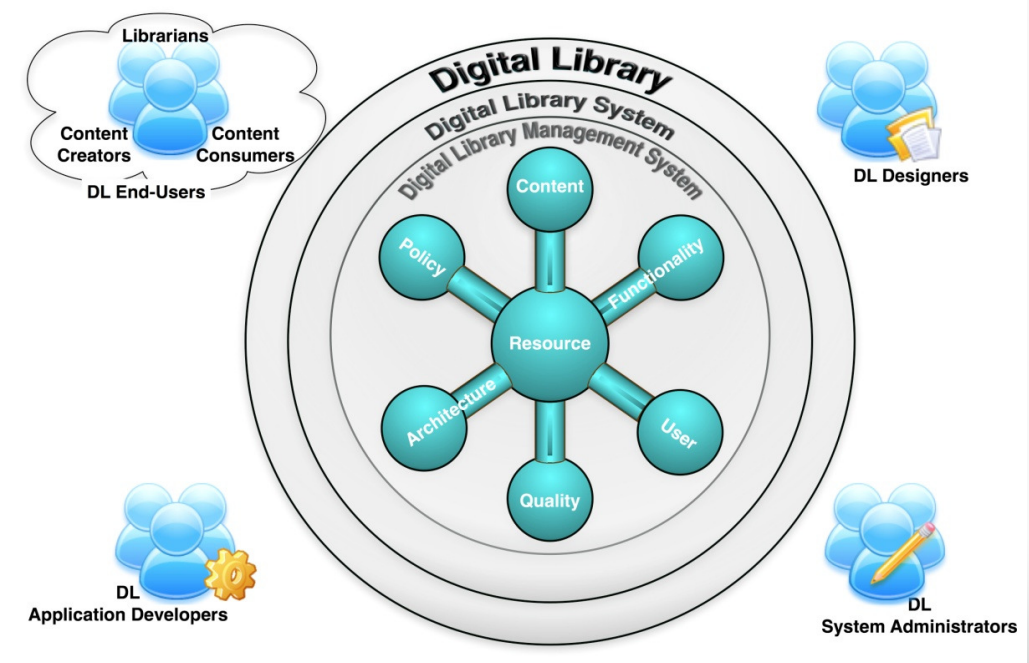
Examples: ….



The RM is founded on 6 + 1 Domains

1. **Content** – information available
2. **User** – actors interacting with system
3. **Functionality** –operations supported
4. **Policy** – rules and conditions governing operation
5. **Quality** – qualitative & quantitative characterisations of system
6. **Architecture** –physical software (&hardware) constituents concretely realising the DL

Resource – captures generic characteristics (super-domain)



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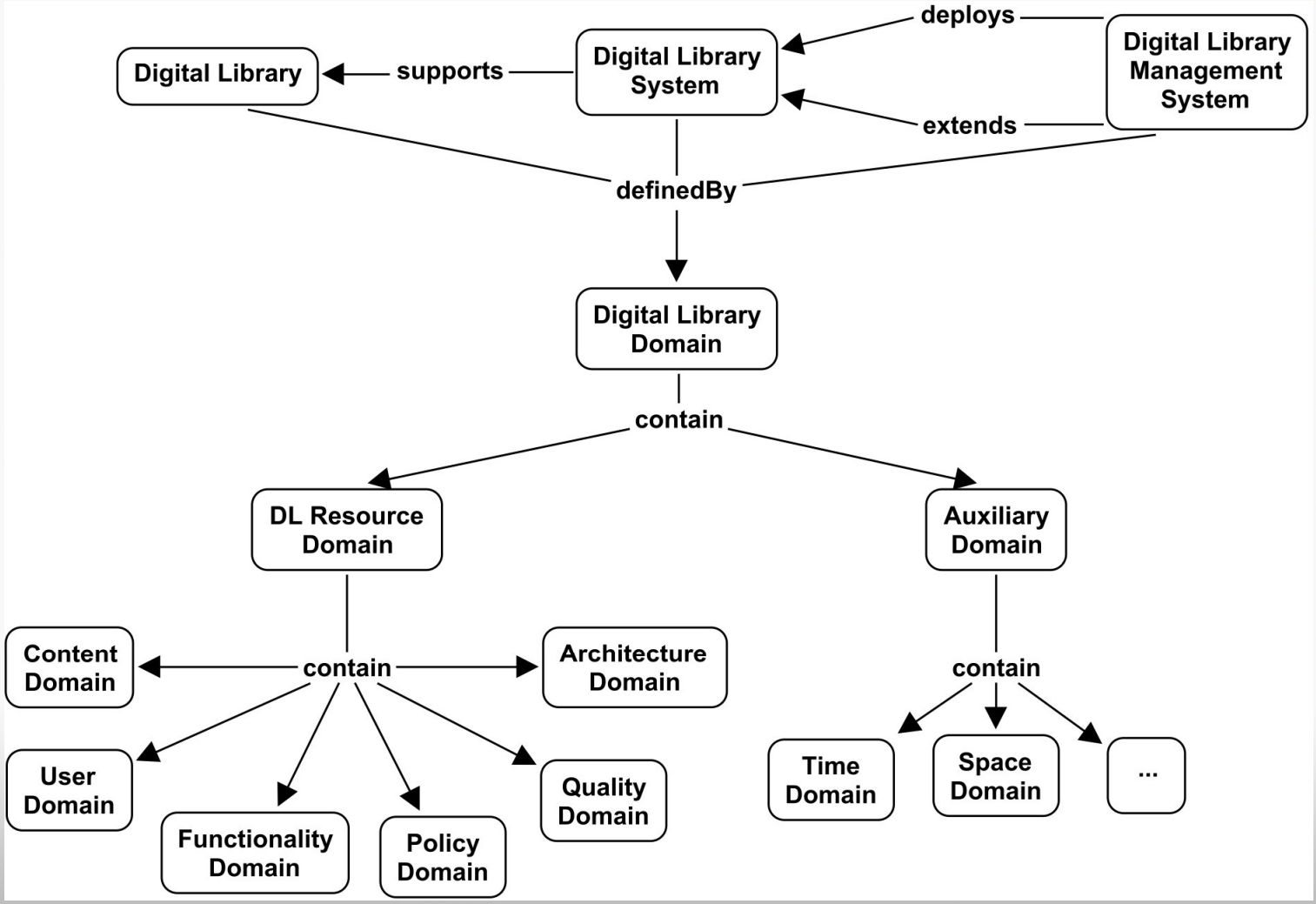
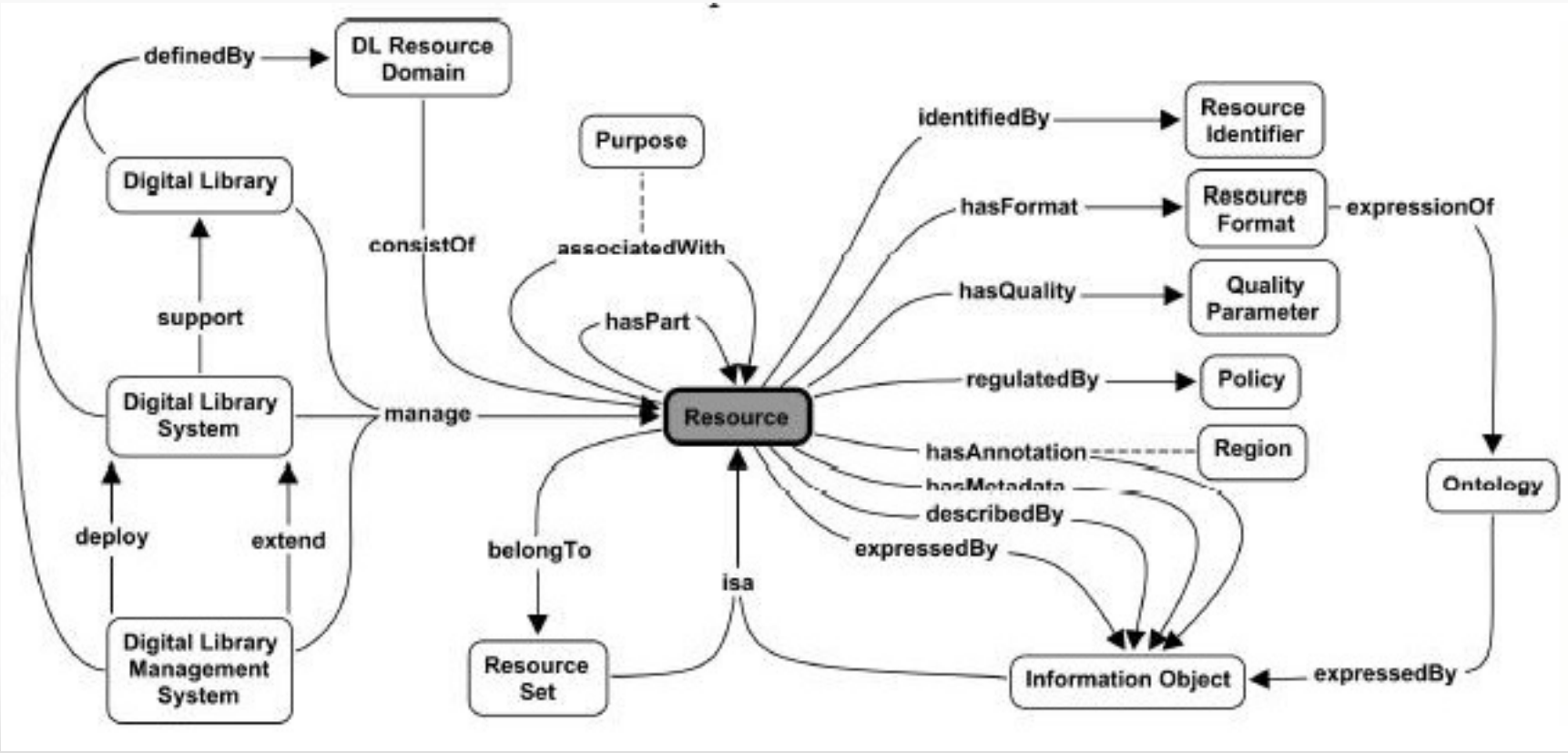
The DL Domains



The DL Resource Domain (1/3)



The DL Resource Domain (2/3)

Resource Domain

- At the highest-level
- Represents all entities and relationships managed in DL Universe

Resource

- Most general concept of the *DL Resource Domain*
- Captures any Digital Library entity
- Can be grouped into **Resource Sets**

The DL Resource Domain (3/3)

Each **Resource** is

- identified by a ***Resource Identifier*** (<*identifiedBy*>)
- expressed by an **Information Object** (<*expressedBy*>)
- described by or commented on by **Information Objects**, such as **Metadata** (<hasMetadata>) and **Annotations** (<hasAnnotation>)
- arranged or set out according to a ***Resource Format*** (<*hasFormat*>), which may be drawn from an Ontology
- characterised by **Quality Parameters**, each capturing how resource performs with respect to some attribute (<*hasQuality*>)
- regulated by **Policies** (<*regulatedBy*>) governing all aspects of its lifetime

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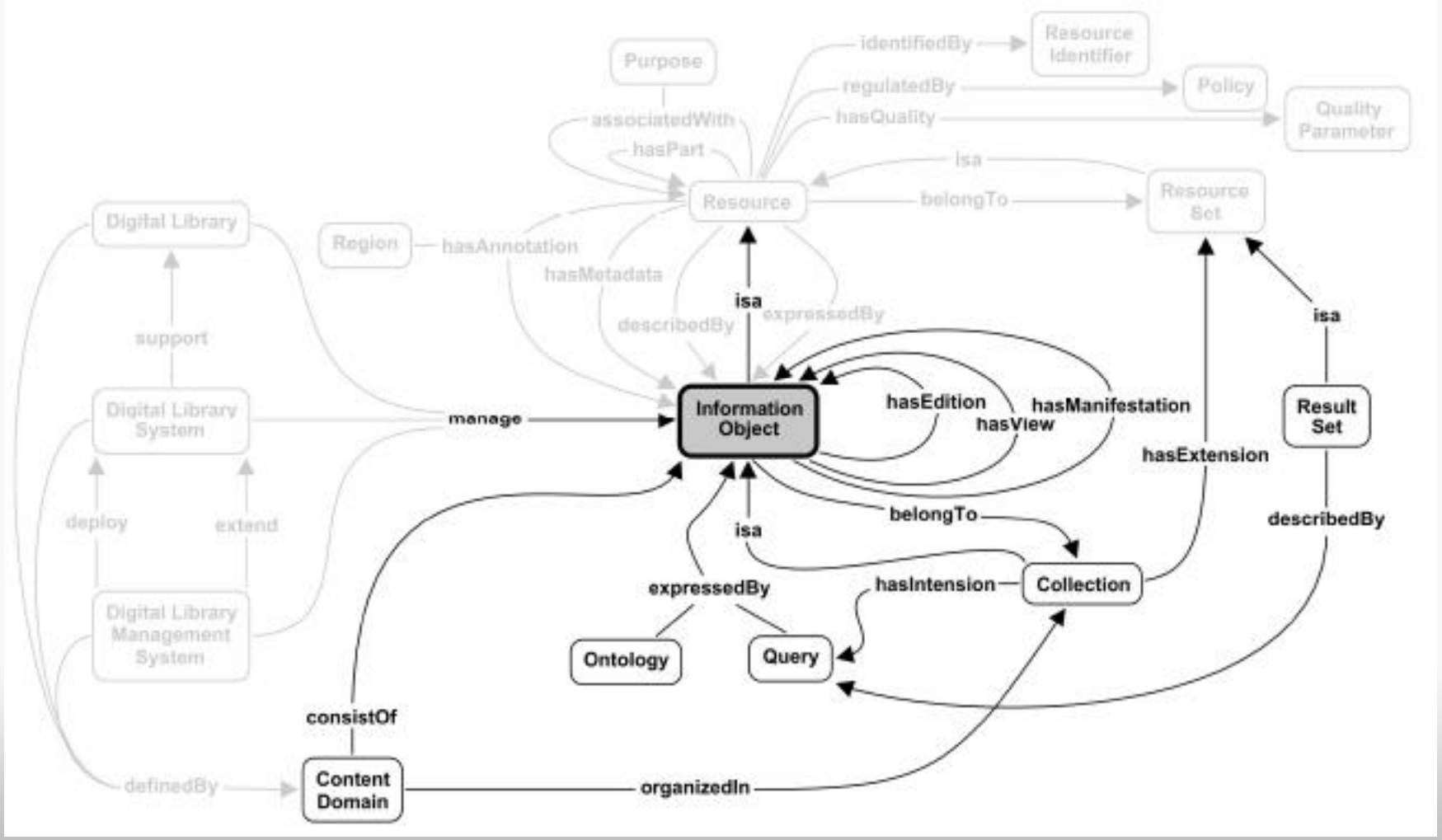
The Content Domain



The Content Domain (cont.)

Content Domain

represents all entities related to the DL information

Information Object is a **Resource**

Information Object includes

- Text documents
- Images, sound, multimedia, 3-D objects, games and virtual reality documents
- Data-sets, databases
- Composite objects and collections

The Content Domain:

Further classification of Information Objects (1)

By type of knowledge, information, or data

- Raw data captured directly from outside world (especially data or data streams captured by instruments)
- Data processed through or generated by the mind or some other system - often called knowledge or information (and not raw data)

By type of information representation or encoding

- Encoded in natural language and embodied in a document, including pictorial or sound representations
- Encoded in a formal structure, including database tables or formal entity-relationship statements and ontologies

The Content Domain:

Further classification of Information Objects (2)

By state of digital representation

- Information object born digital (text or image)
- Information object produced by digitization of a non-digital information object
- Non-digital information object represented by metadata record

By level of abstraction

To choose one existing method, e.g., IFLA FRBR:

Work, e.g., general idea of a story , **Expression**, e.g., telling of a story in a text, **Manifestation**, e.g., graphic image showing letters and words that make up text, **Item,** e.g., an individual, physical object (e.g., printed copy) of a manifestation

The Content Domain: example

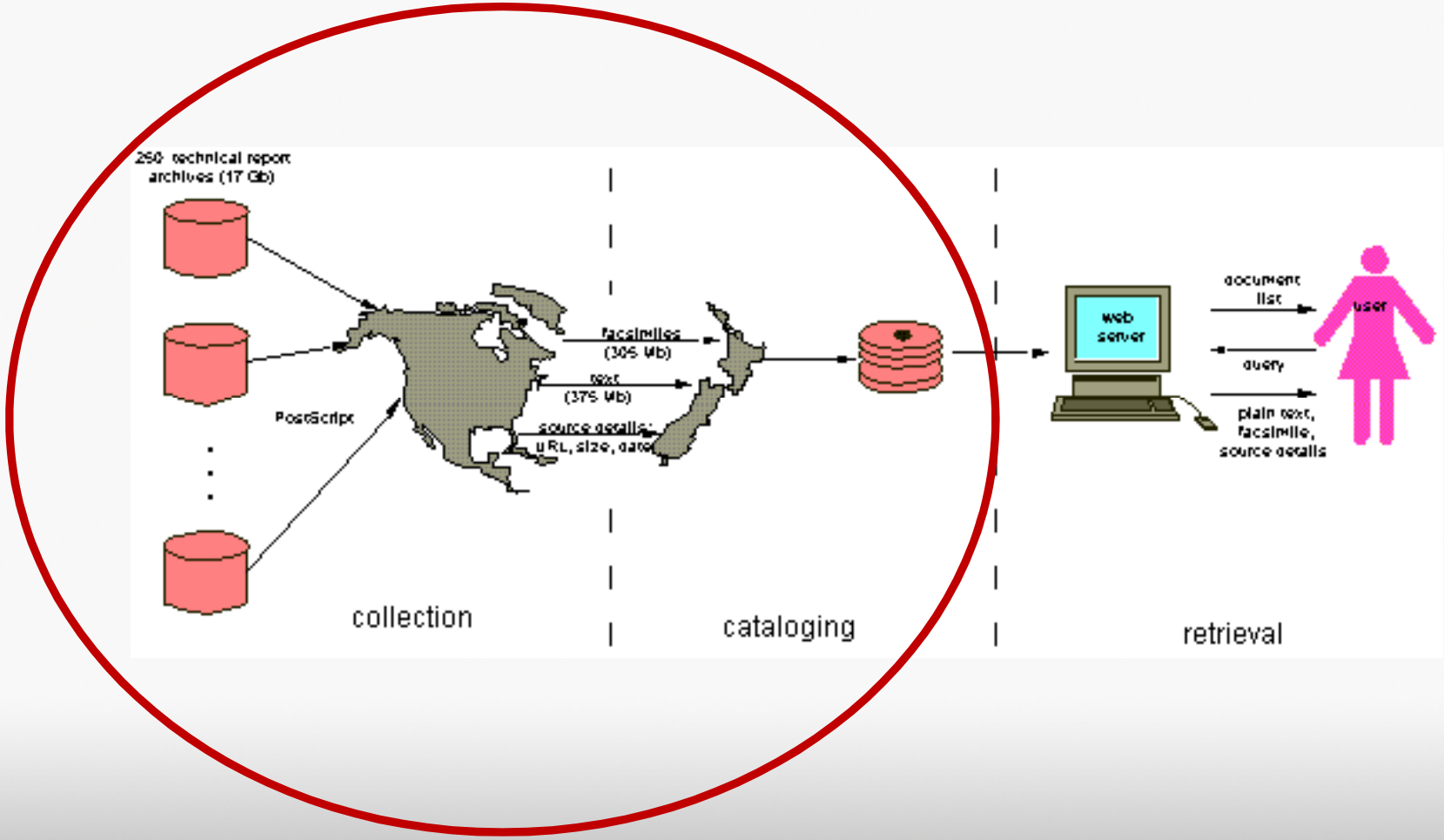
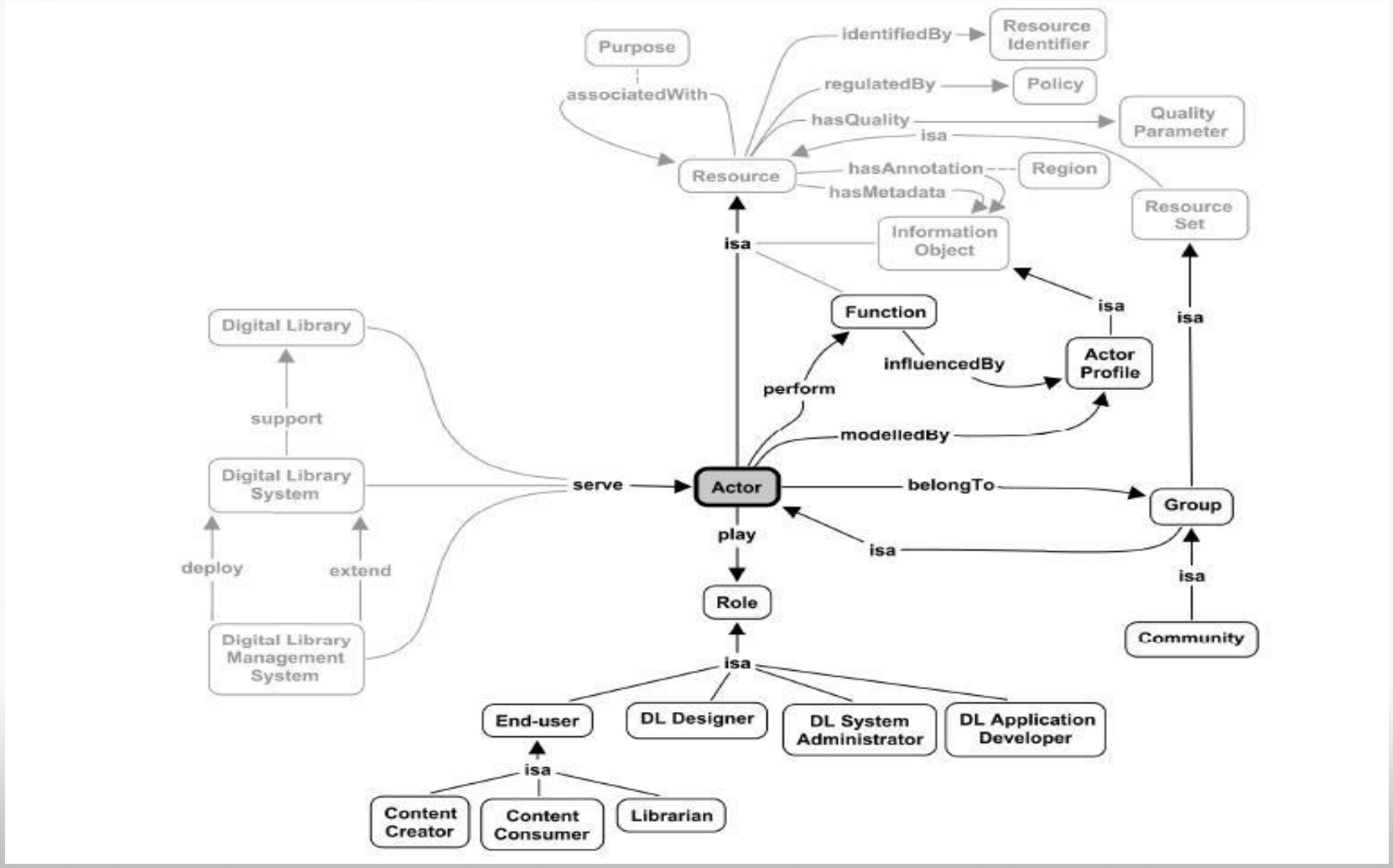


Image: Digital Libraries Based on Full-Text Retrieval, Ian H. Witten, Craig G. Nevill-Manning and Sally Jo Cunningham

The User Domain



The User Domain (cont.)

User Domain

represents all external entities interacting with DL humans, as well as software programs or physical instruments

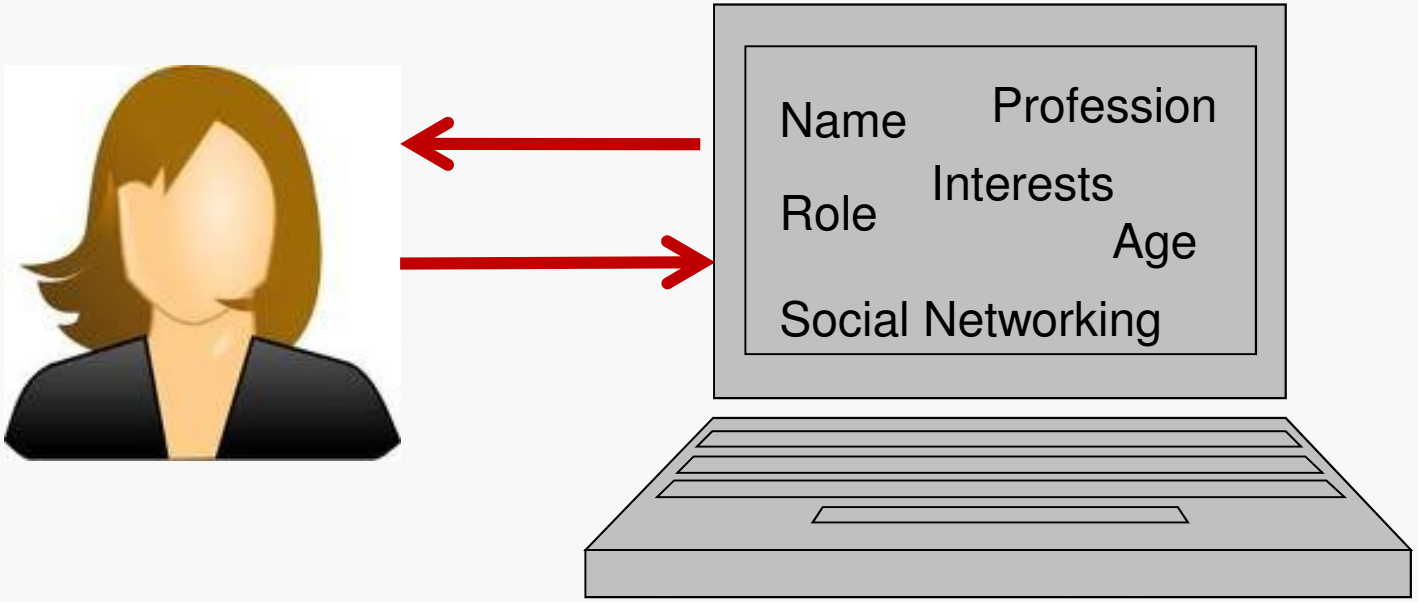
Actor is a **Resource**

Actor has an **Actor Profile** and one or more **Actor Roles**

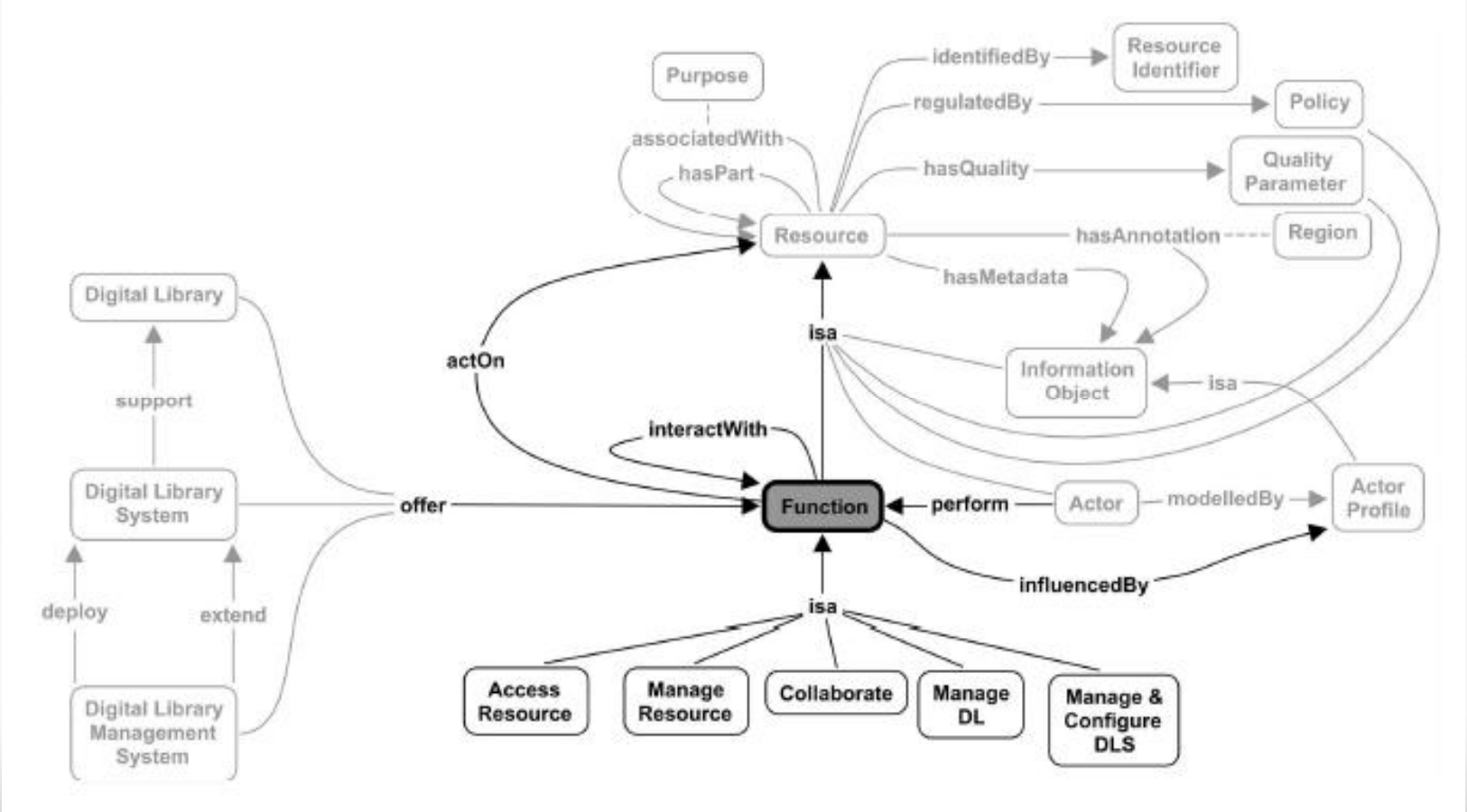
Roles includes

- End User – Content Creator, Content Consumer, Librarian
- DL Designer
- DL System Administrator
- DL Application Developer

The User Domain: example



The Functionality Domain



The Functionality Domain(cont.)

Functionality Domain captures all processing on *Resources* (most often on *Information Objects*) and other necessary activities

Function is the most central concept

Function is a **Resource**

Actors perform **Functions**

Main **Function** specializations

- Access Resource
- Manage Resource
- Collaborate
- Manage DL
- Manage & Configure DLS

The Functionality Domain: example

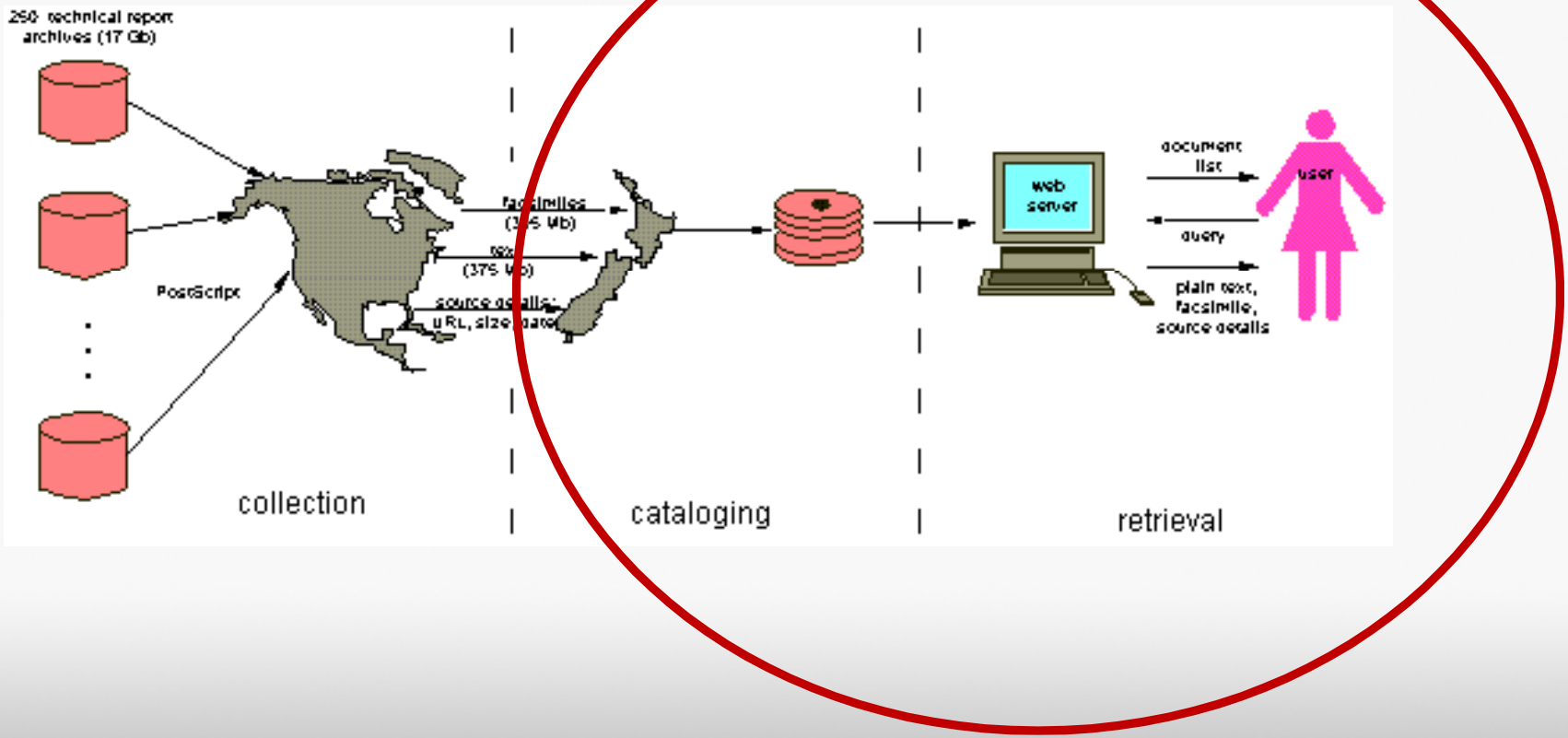
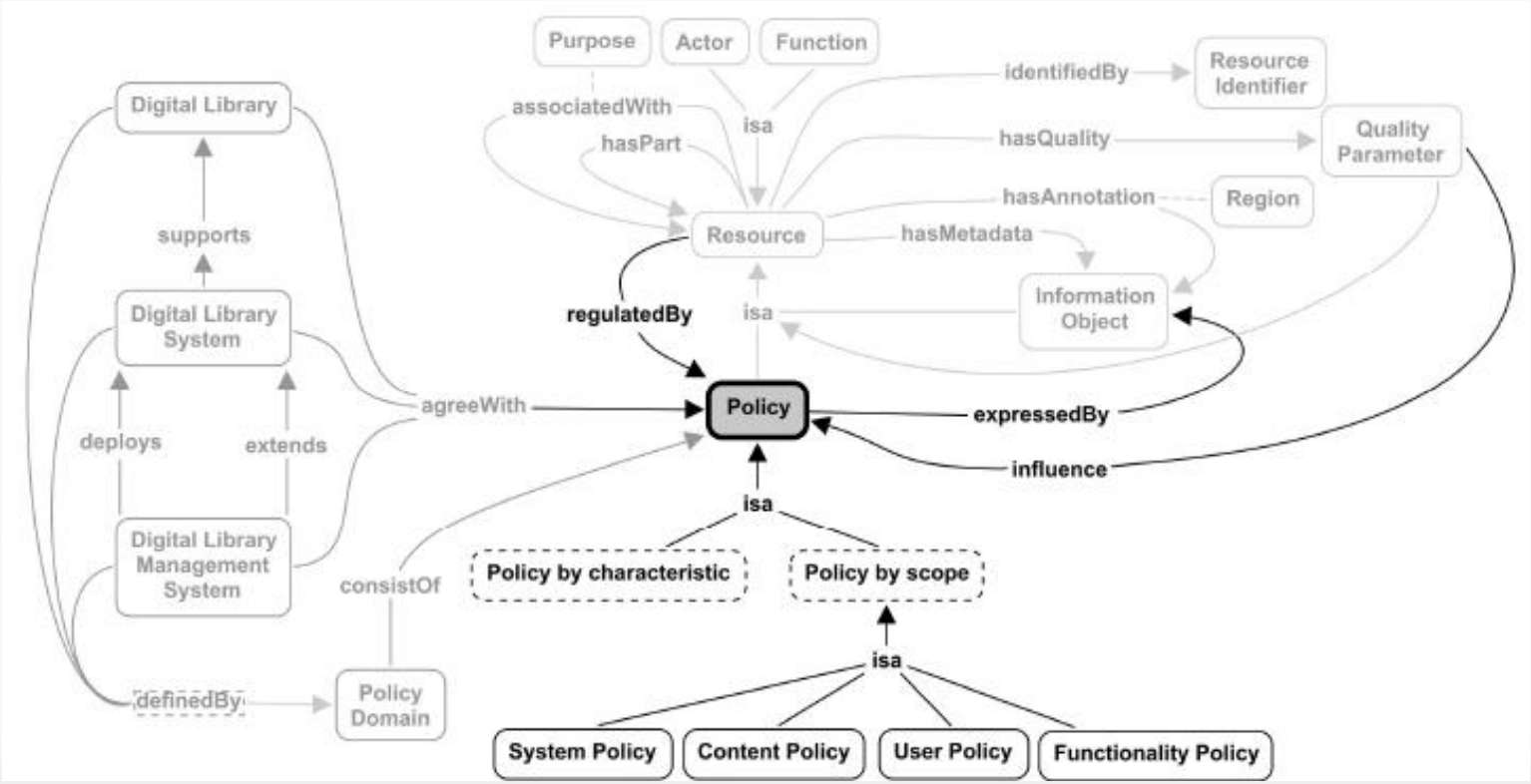


Image: Digital Libraries Based on Full-Text Retrieval, Ian H. Witten, Craig G. Nevill-Manning and Sally Jo Cunningham

The Policy Domain



The Policy Domain (cont.)

Represents the set of most critical conditions, rules, terms or regulations governing the operation of DL

broad and dynamic by nature

elto3 **Policy** – the most central concept in the Domain

Policy is a **Resource**

Policy by Characteristic:

Extrinsic Policy *vs.* **Intrinsic Policy**

Implicit Policy *vs.* **Explicit Policy**

Prescriptive Policy *vs.* **Descriptive Policy**

Policy by Type

- System Policy
- Content Policy
- User Policy
- Functionality Policy

Diapositiva 55

elto3 Αυτό ίσως μπερδέψει. Είτε να το περιγράψουμε ενώ δείχνουμε το concept map για να φανεί ότι είναι διαφορετικό από το όνομα domain, είτε να το βγάλουμε;
Αξίζει να προτείνουμε στο πλαίσιο των αλλαγών που εισάγουμε στο RM, να αντικατασταθεί η λέξη αυτή από κάποια άλλη με το ίδιο νόημα;
elto, 12/9/2010

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The Policy Domain: examples

- Risk management
- Collection Development
- Object delivery
- Support
- Purchasing
- Appraisal
- User management

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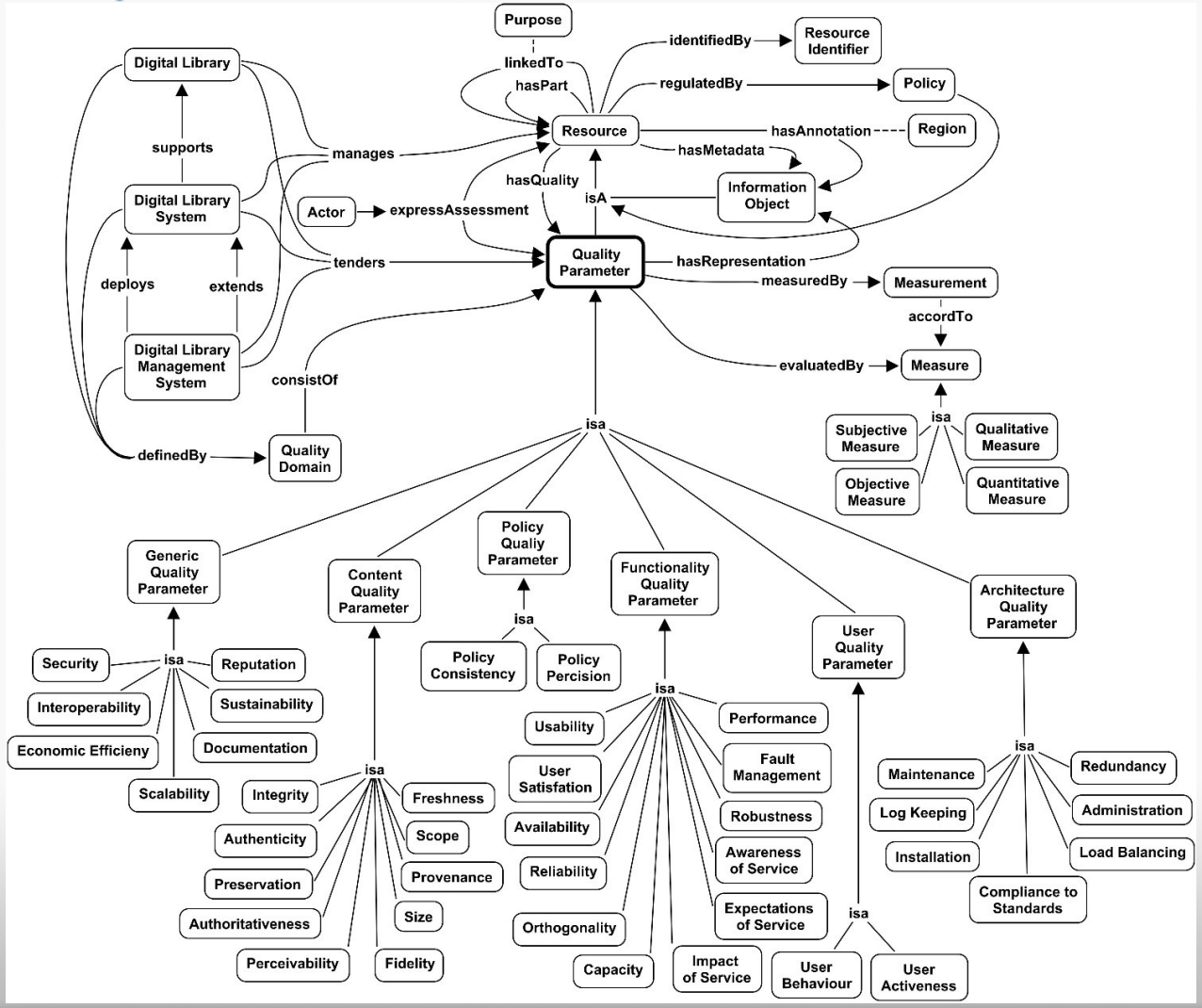
The Quality Domain



The Quality Domain (cont.)

Represents the aspects that need to be consider from a quality point of view in the DL

Quality Parameter: Most central concept in the Domain

Quality Parameter is a **Resource**

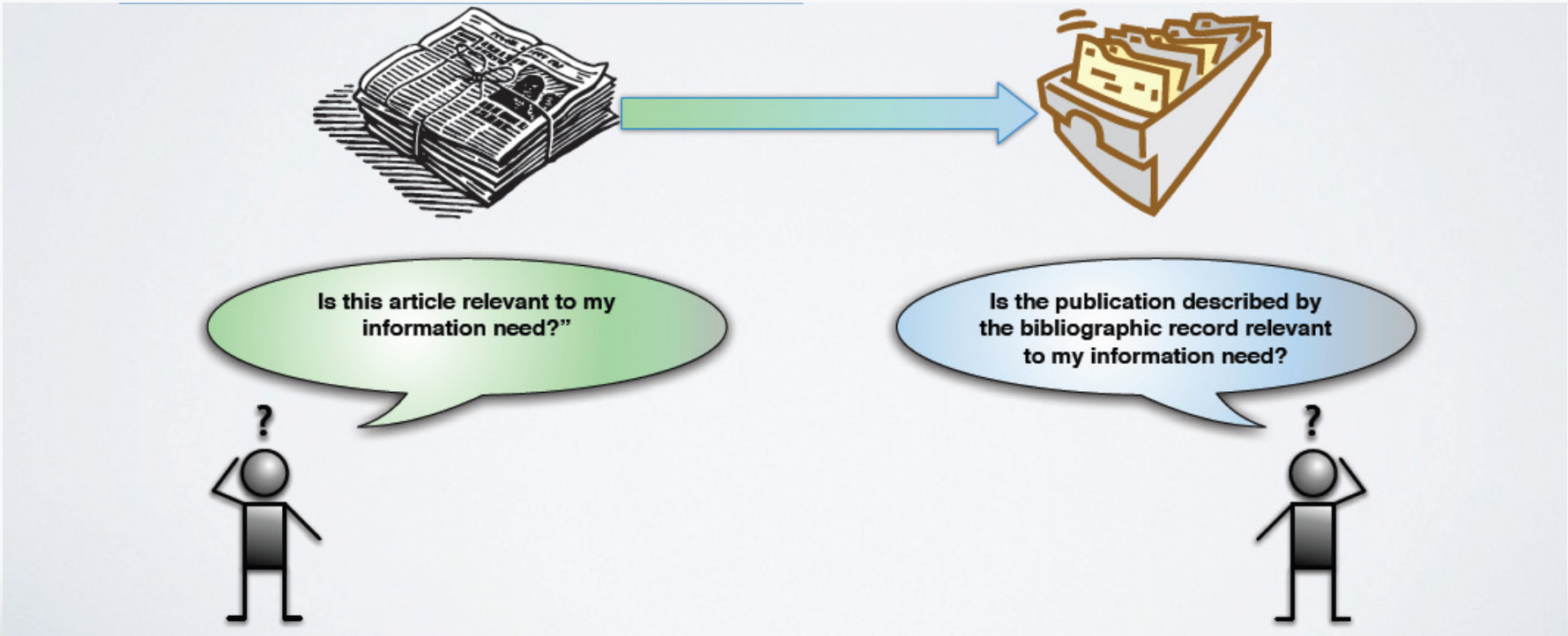
express the assessment of an **Actor**, about a **Resource**
can be evaluated according to different **Measures**
are actually measured by a **Measurement**

Generic Quality Parameters

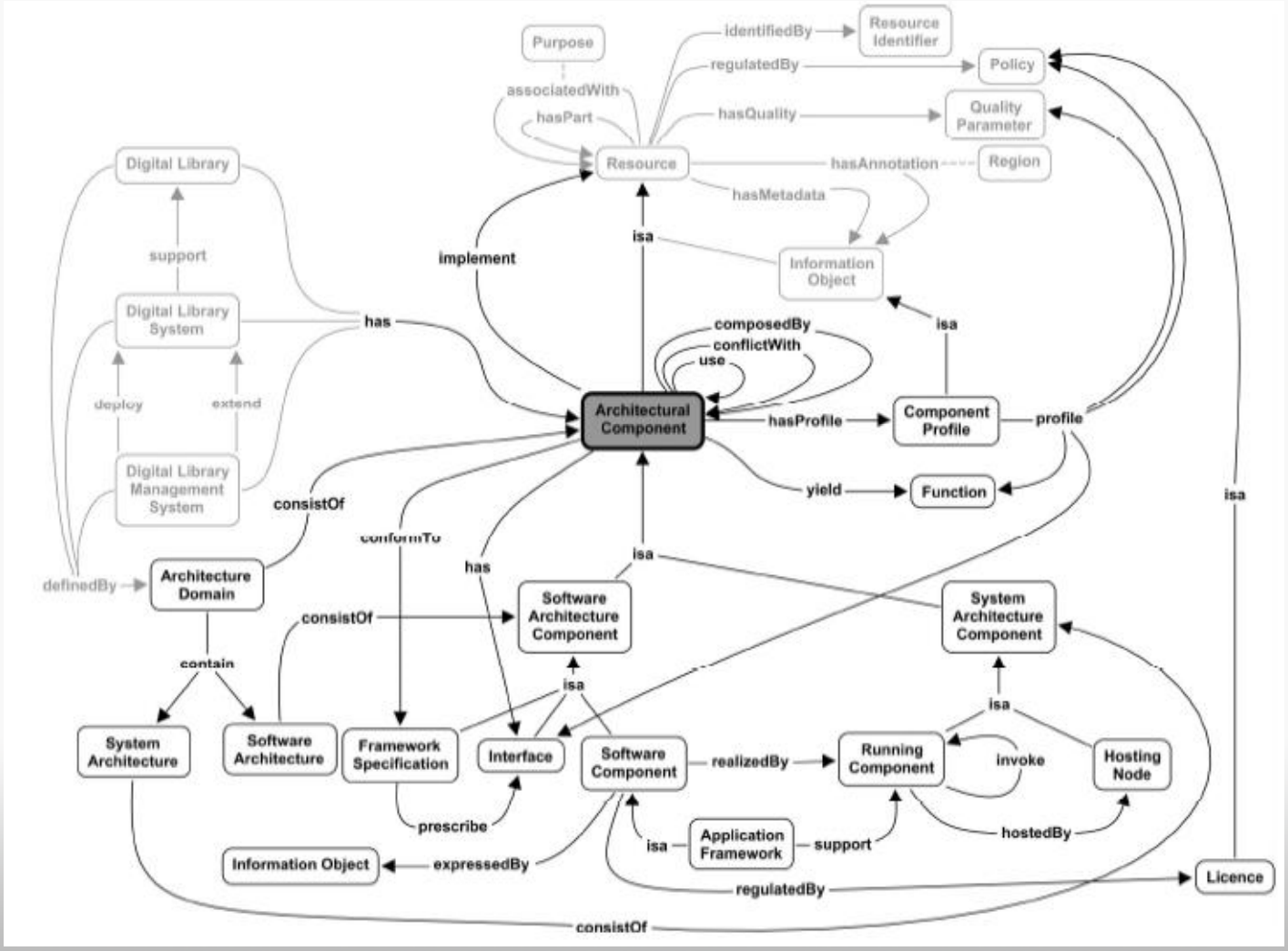
System Quality Parameters

Domain related Quality Parameters (content, user, functionality, policy, architecture)

The Quality Domain: example



The Architecture Domain



The Architecture Domain (cont.)

Architecture Domain:

Captures concepts and relationships characterising the two software systems playing an active role in the DL universe, i.e. DLSs and DLMSs

Architectural Component:

the most central concept in the Domain

Architectural Component is a **Resource**

an encapsulated part of a system

Ideally a non-trivial, nearly independent, and replaceable part of a system that fulfils a clear function in the context of a well-defined architecture

The Architecture Domain (cont.)

"Component-based approach":

- System assembled from discrete executable components
- System may be upgraded with smaller increments, i.e., upgrading only some of constituent components
- Components may be shared by systems
- Though not strictly related to their being component-based, such systems tend to be distributed

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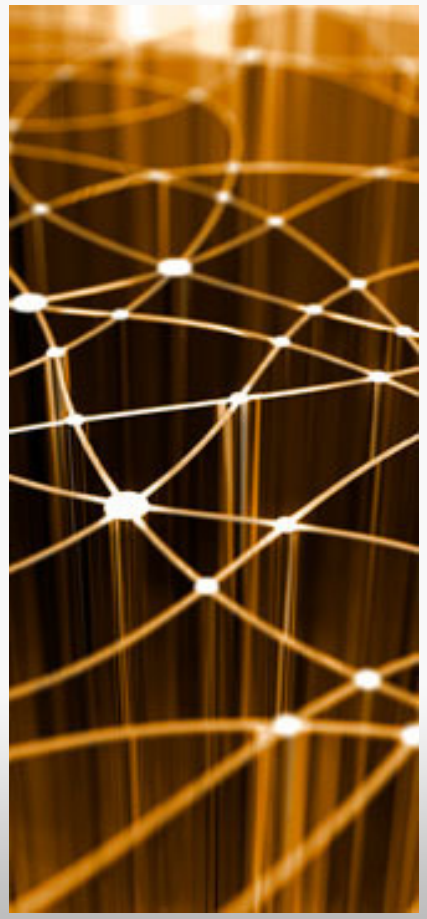

Ευχαριστώ!

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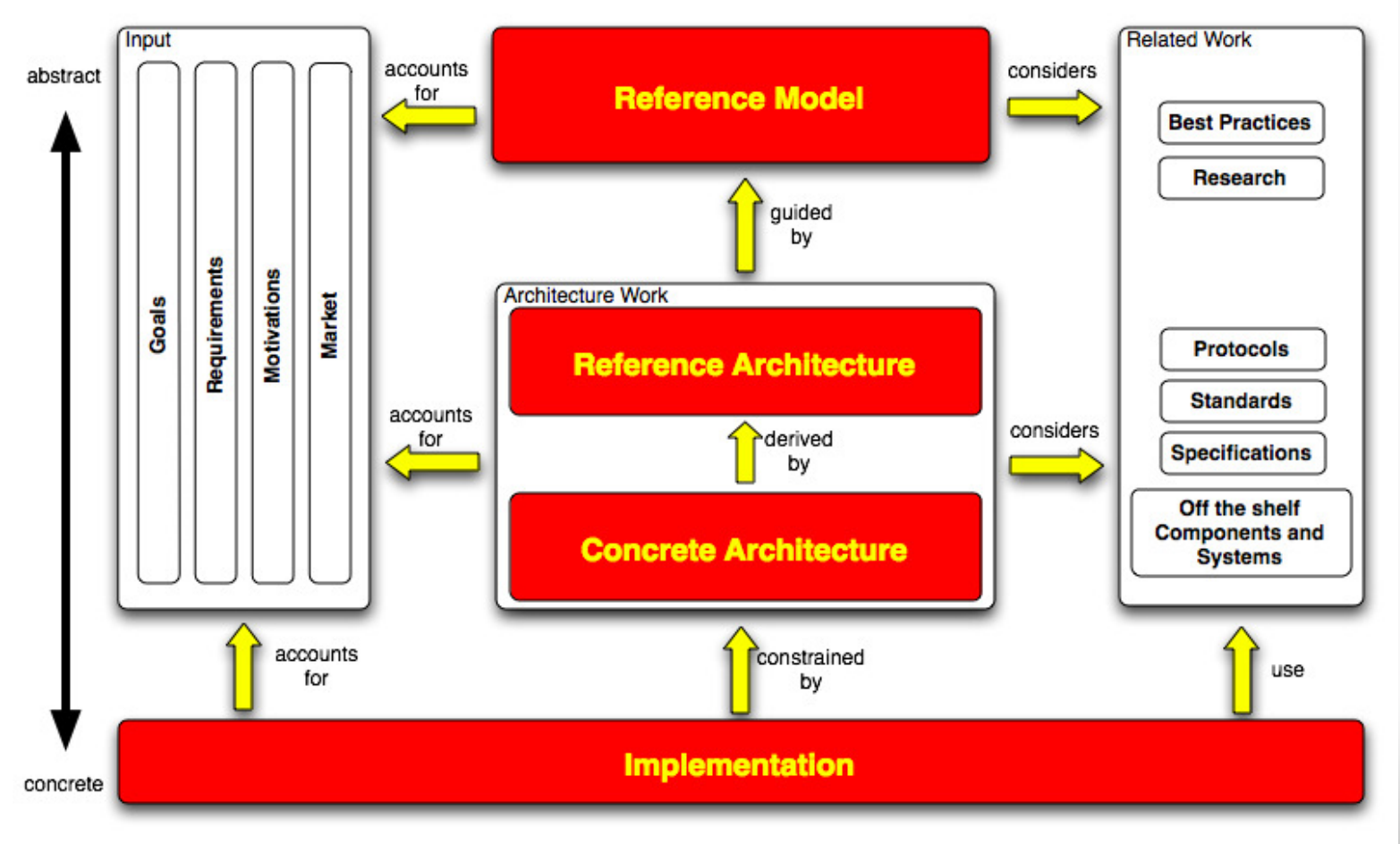
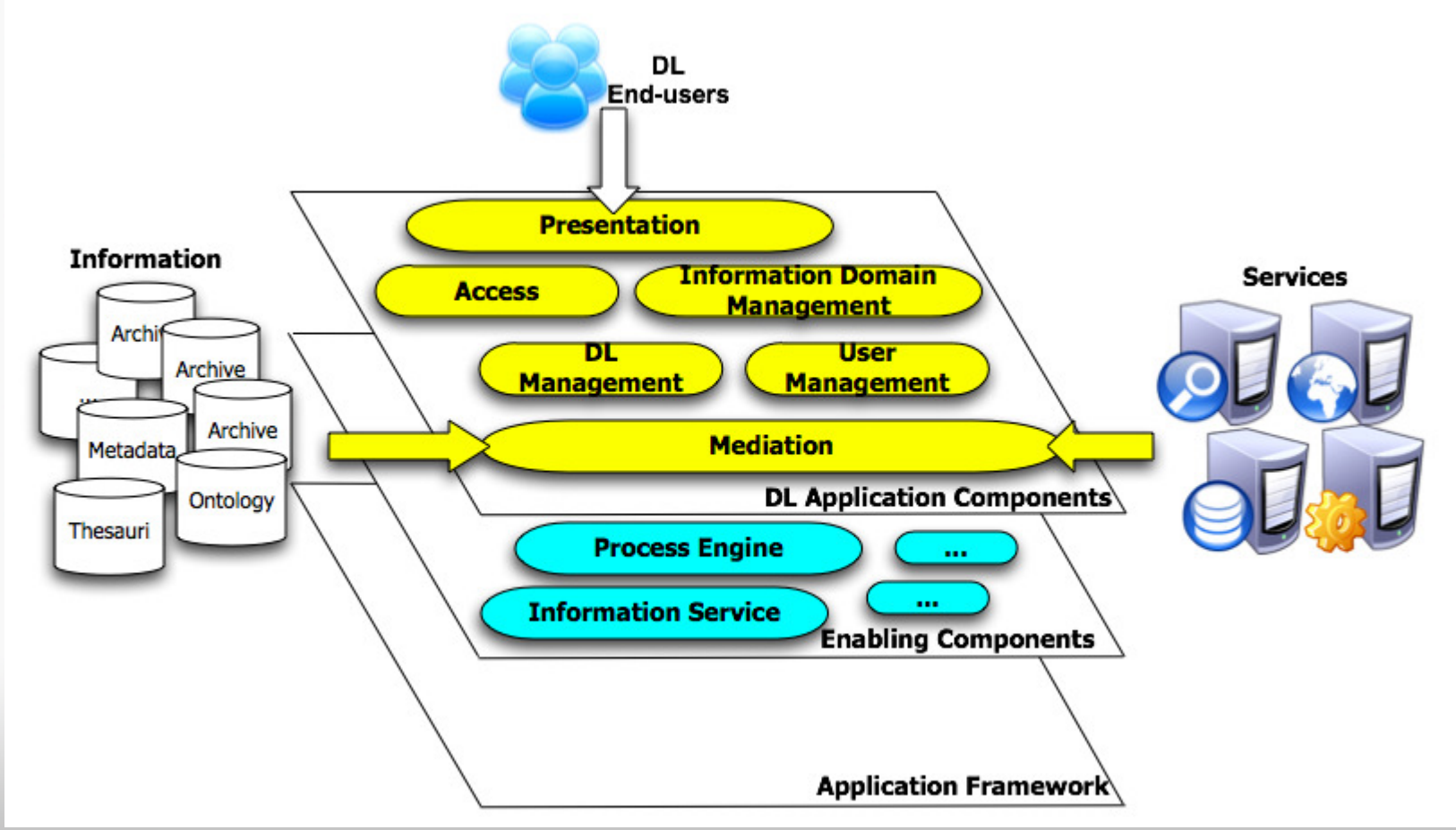
Reference Frameworks



Reference Architecture Functional Areas



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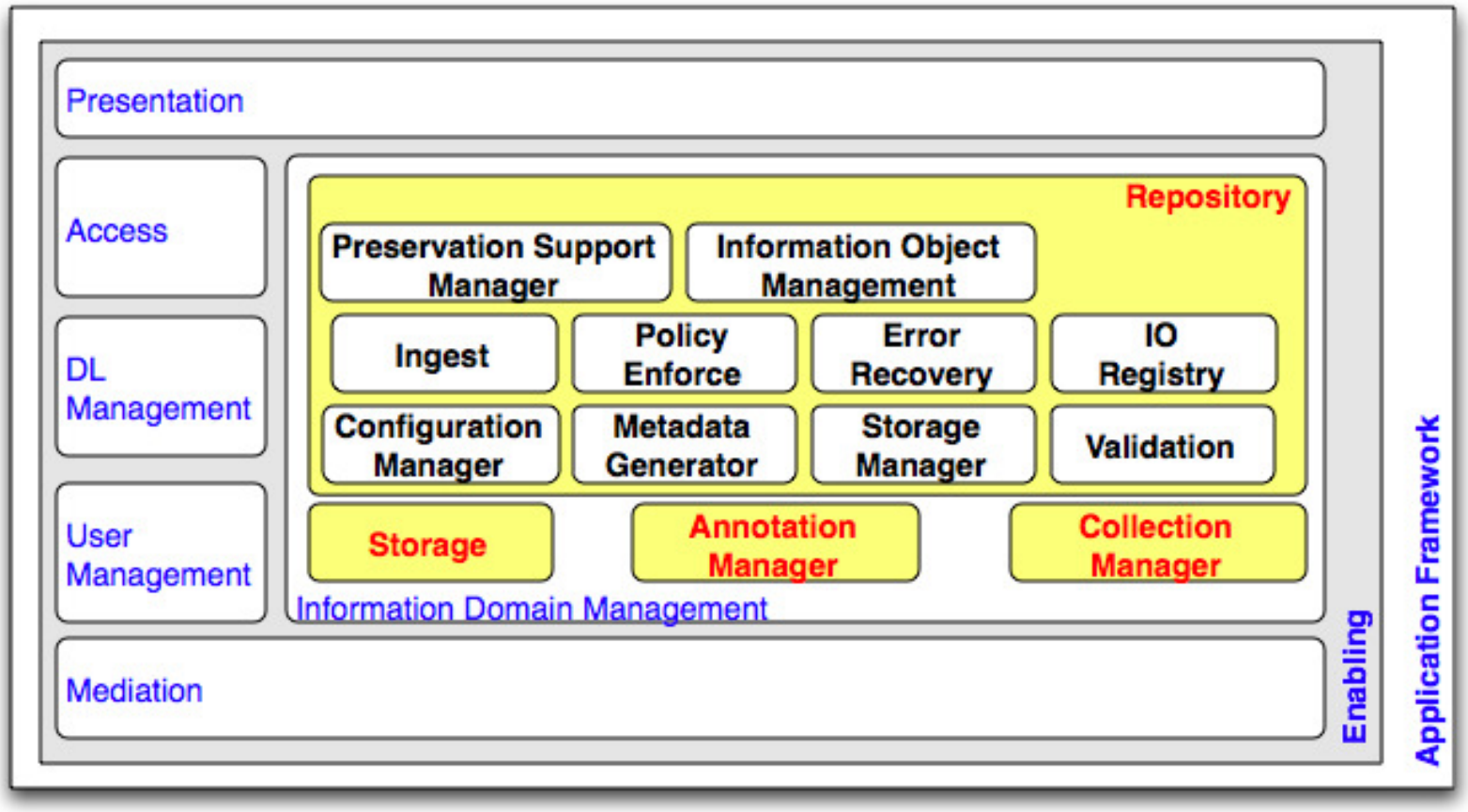
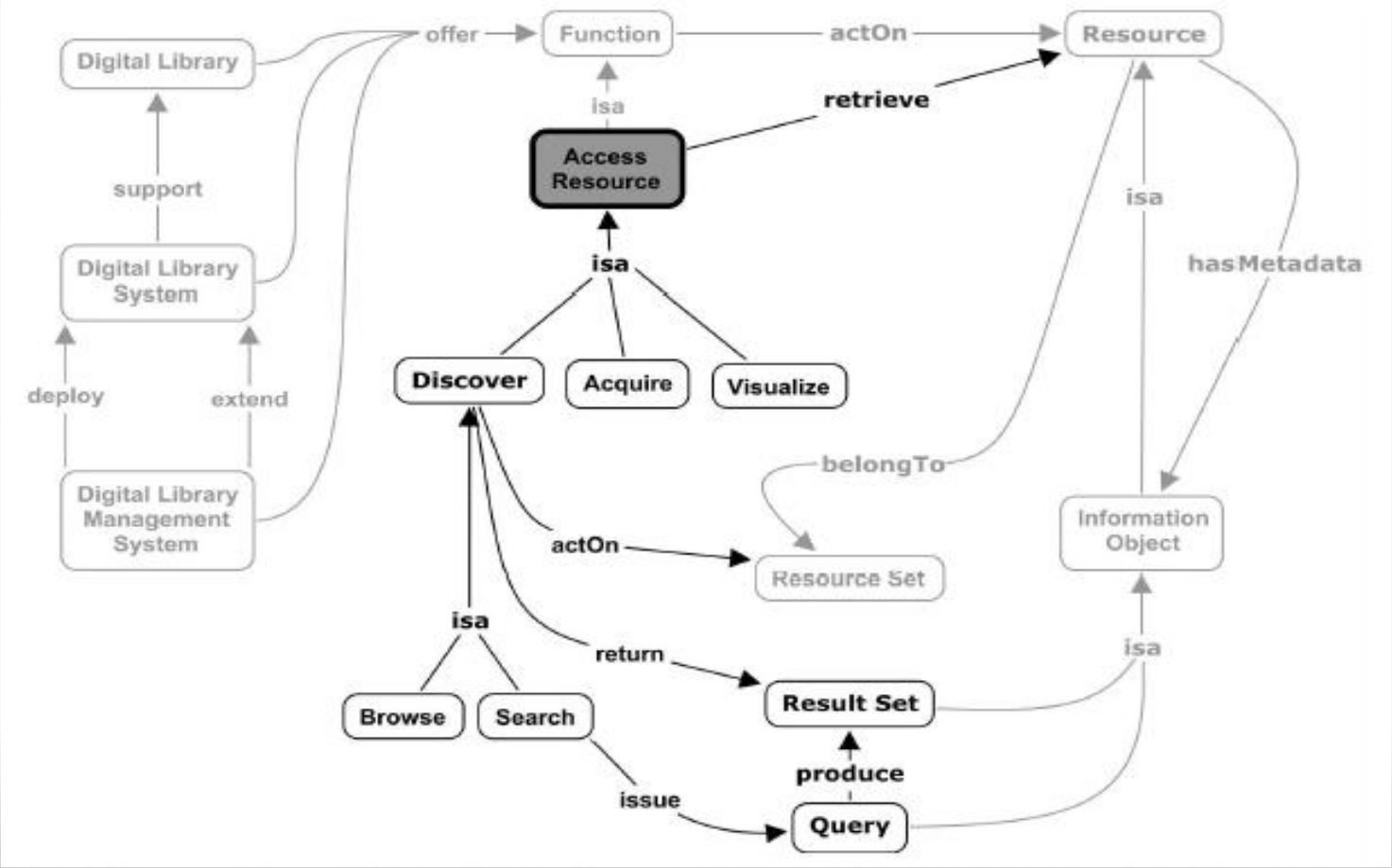
Functional components



The Functionality Domain(3/11)



The Functionality Domain(4/11)

Access Resource Functions

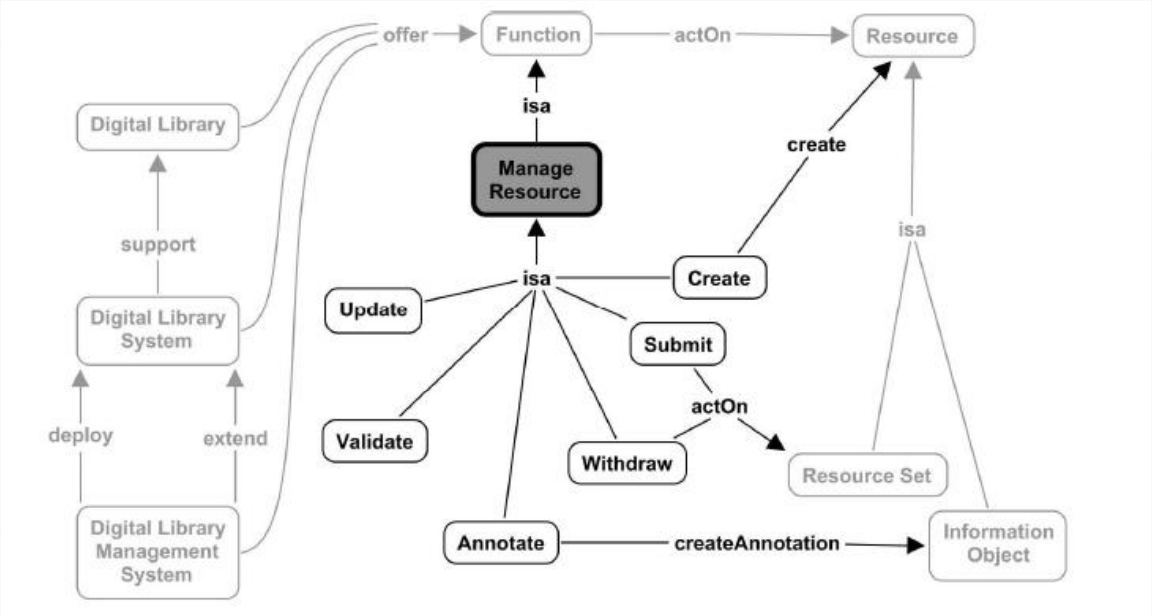
All activities are related to requesting, locating, retrieving and finally delivering *Resources* to requestor

Do not modify the DL or convert its Resources - extract some of its content and deliver it to user

In most cases act on Resource Metadata

The Functionality Domain(5/11)

Manage Resource
General Functions that may be applied on all Resources
These Functions may be specialized for the particular domains

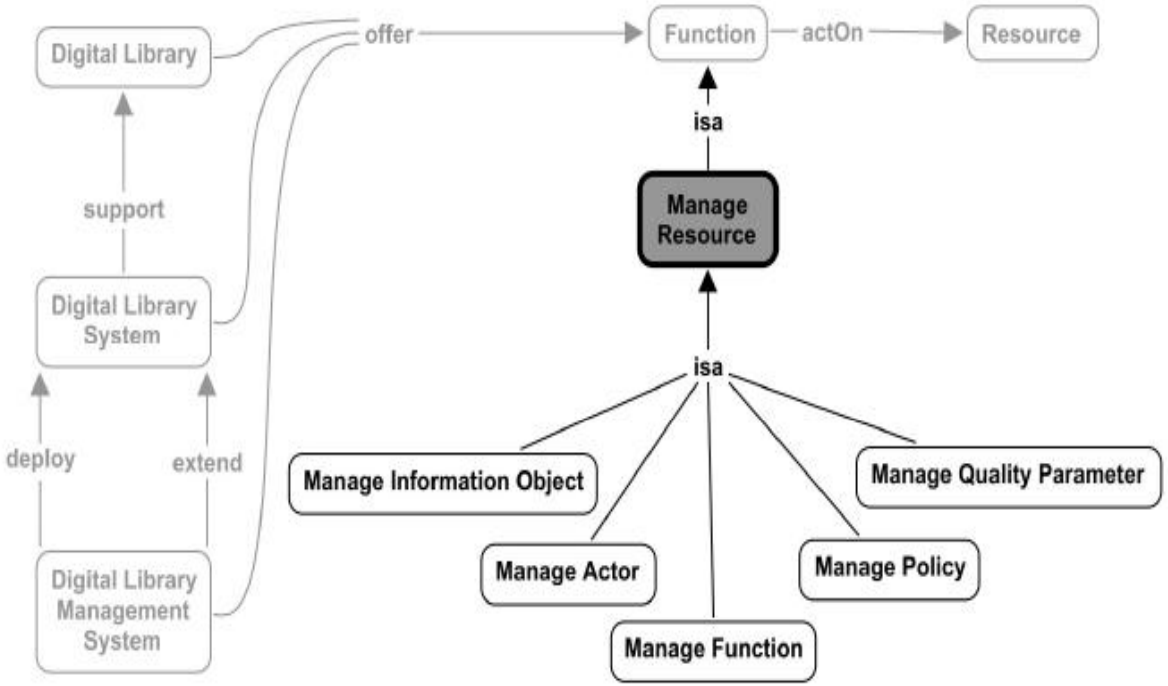


Contains general families of Functions for managing individual Resource Types

The Functionality Domain(6/11)

Manage Resource

- All activities related to management of Resources:
  - Creation, update, deletion
  - Analysis
  - Conversions and Transformations

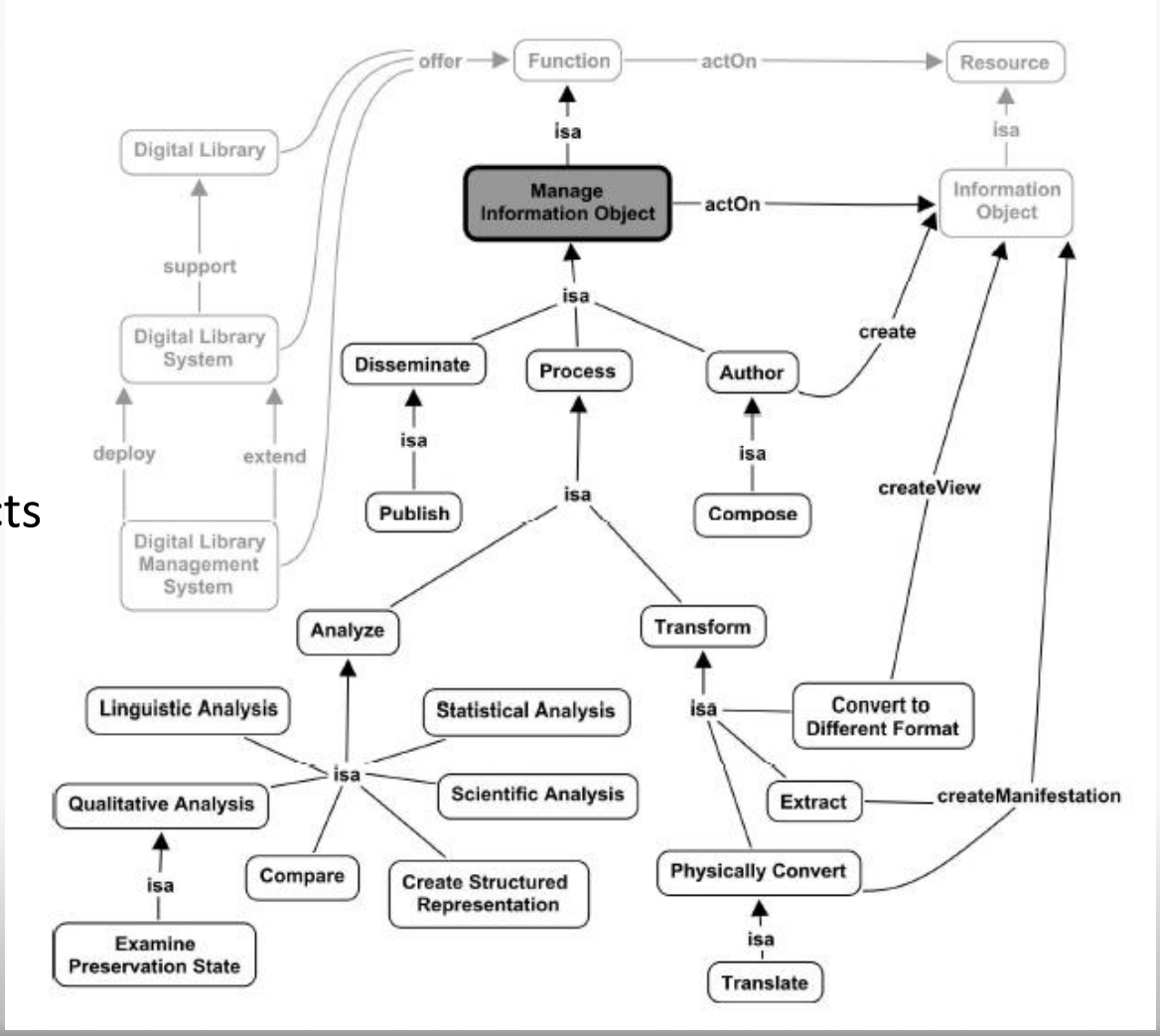


The Functionality Domain(7/11)

Manage Information Object

Captures creation, processing, transformation

- primary Information Objects
- other Information Objects or Resources in general

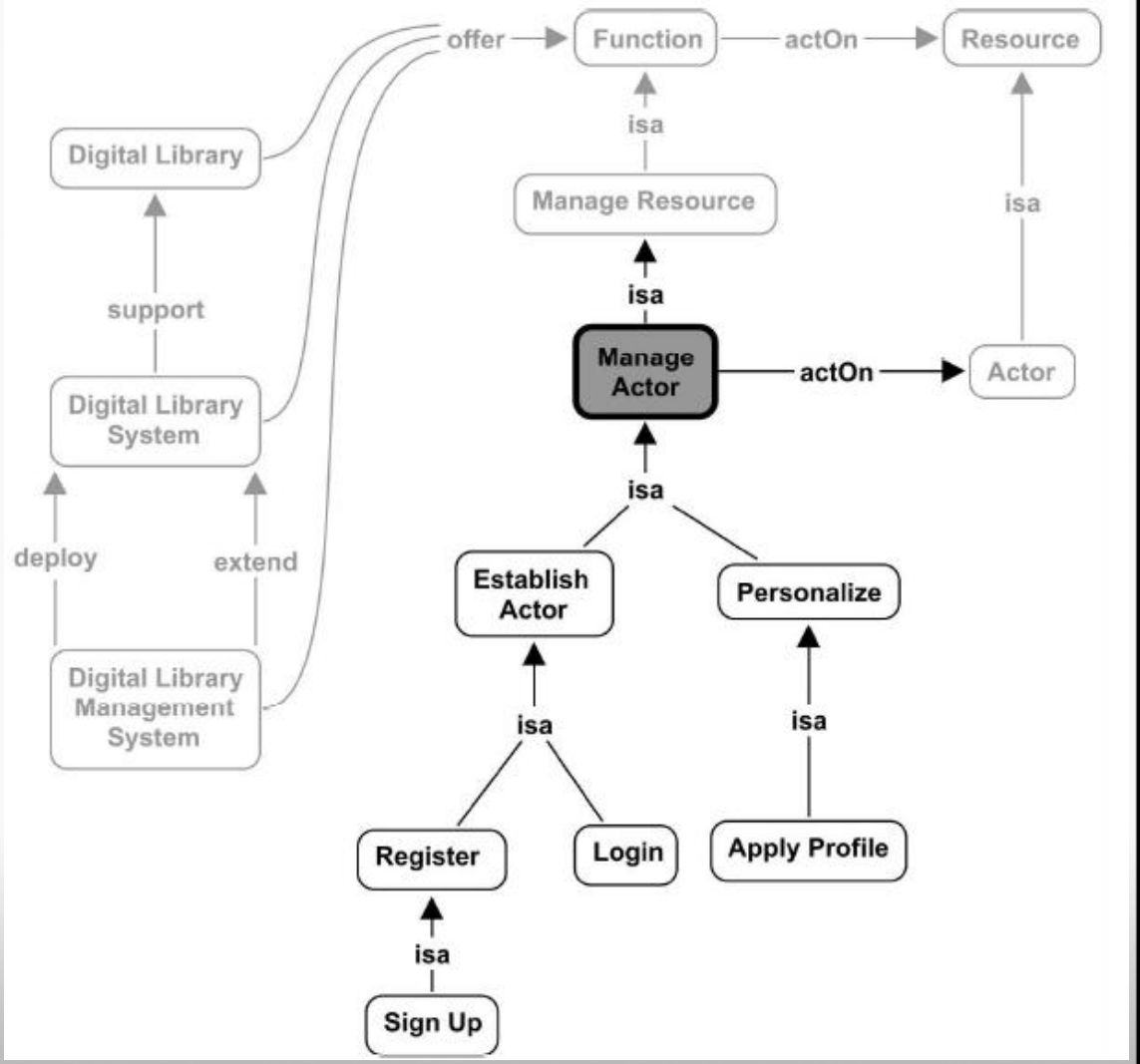


The Functionality Domain(8/11)

Manage Actor

Captures management of individual Actors

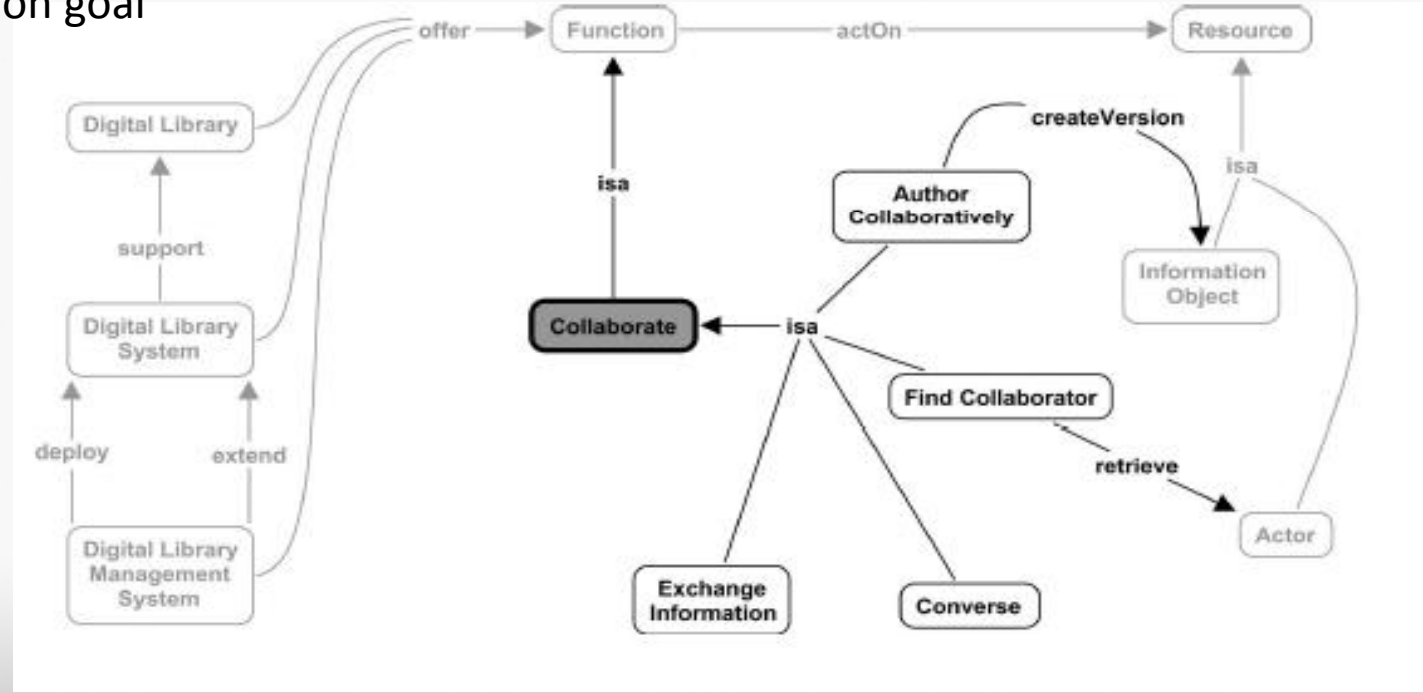
- registration & subscription
- Login
- personalization of allowed functionality



The Functionality Domain(9/11)

Collaborate

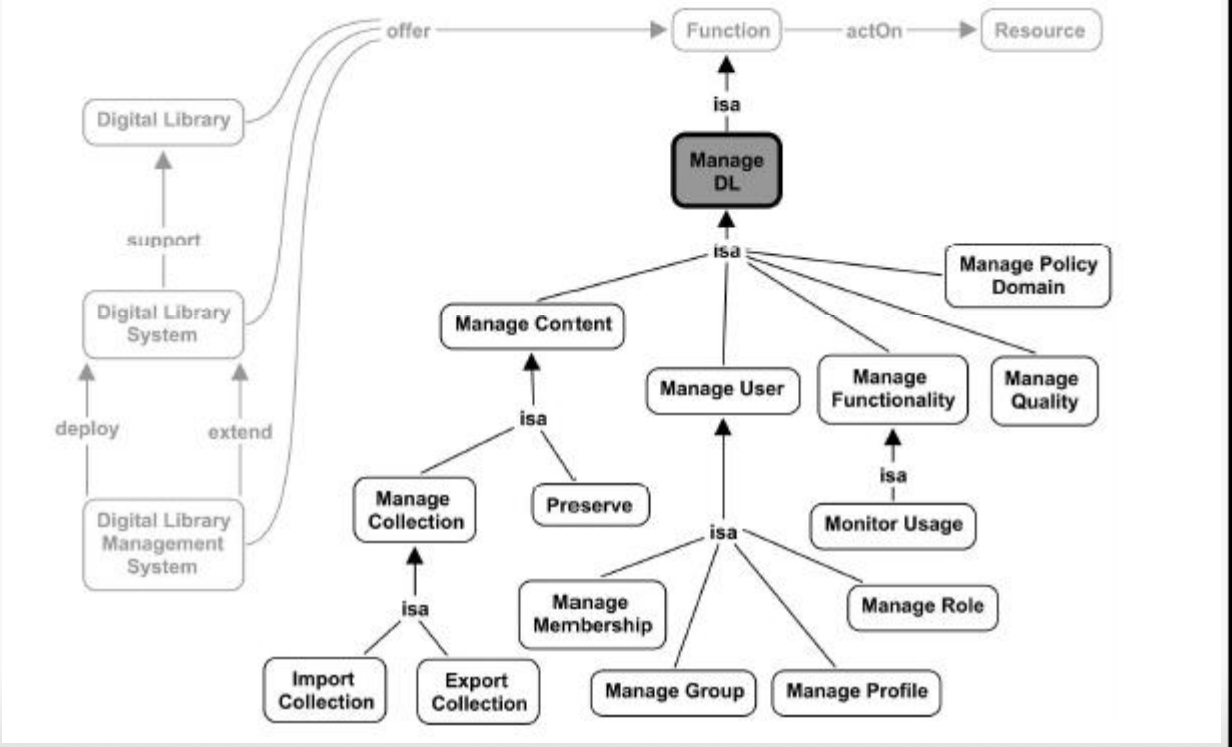
Captures all activities that allow multiple Actors to work together through a DL to achieve a common goal



The Functionality Domain(10/11)

Manage DL

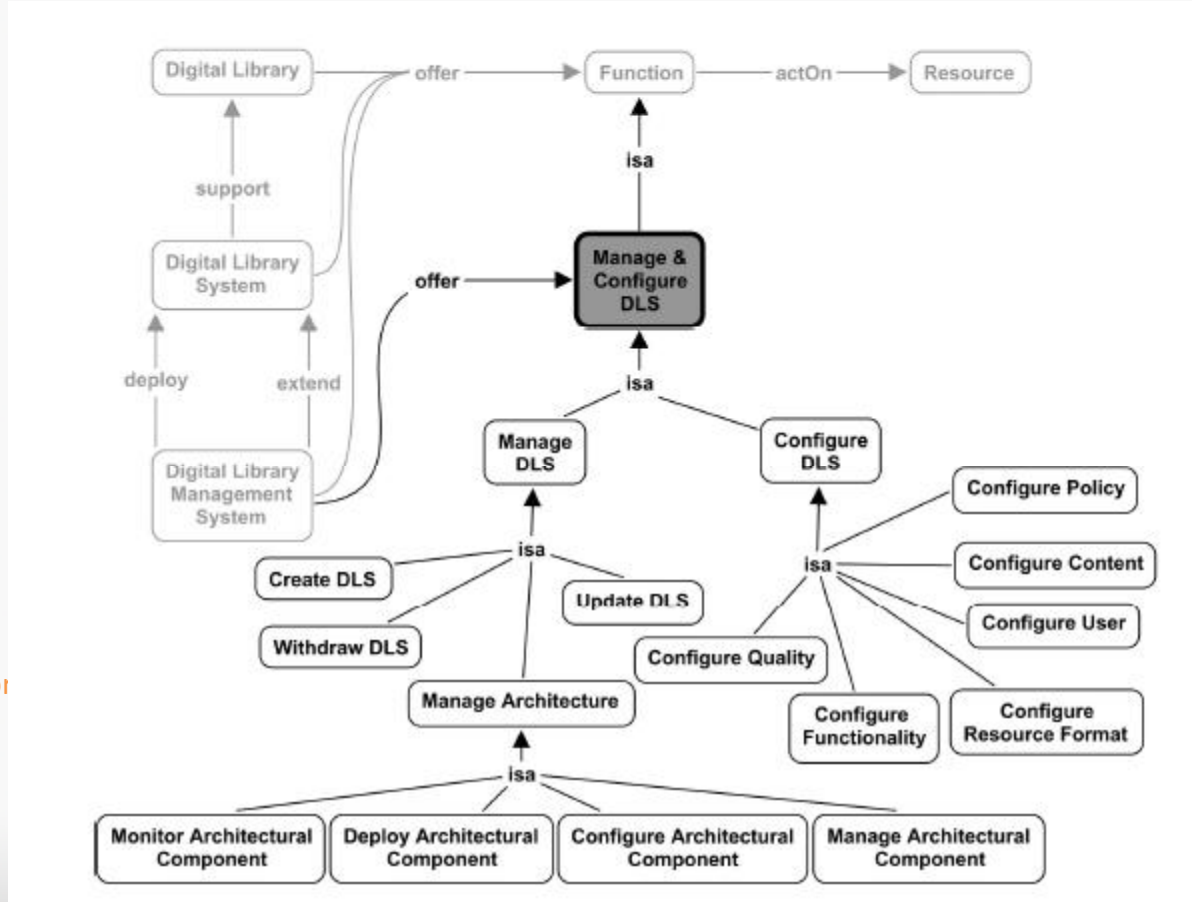
supports the day-by-day DL management, concerning all DL domains



The Functionality Domain(11/11)

Manage and Configure DL

supports setting up, configuring, monitoring the DL



The Quality Domain (3/4)

Quality Parameter Groups*:*

Generic Quality Parameters apply to any kind or most kinds of resources
System Quality Parameters apply to *Digital Library*, or a *Digital Library System*, or a *Digital Library Management System*.
Content Quality Parameters apply to *Resources* in the *Content Domain,* primarily *Information Objects*.
Functionality Quality Parameters apply to *Resources* in the *Functionality Domain,* primarily *Functions*.

The Quality Domain (4/4)

Quality Parameter Groups*:*

User Quality Parameters apply to *Resources* in the *User Domain,* primarily *Actors*
Policy Quality Parameters apply to *Resources* in the *Policy Domain,* primarily *Policies*
Architecture Quality Parameters apply to *Architectural Components*, i.e., *Resources* belonging to the *Architecture Domain*

From DELOS Reference Model to DL.org Outcomes

- Enhanced and expanded Digital Library Reference Model, V1.0, further enhancements foreseen as a part of an ongoing process
- The State of the Art Survey
- Technology and Methodology Cookbook