Towards Global Data Interoperability

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Interoperability: Introductory concepts

Interoperability intended as the ability of two entities to work together very much depends on:

- The working context in which the two entities are embedded (web services, digital libraries, cultural heritage, control and command systems, e-Science, etc.)
- The nature of the interoperable entities (people, software components, organizations, etc.)

Interoperability: introductory concepts (II)

Due to its inherent complexity and multifaceted nature, interoperability has been often misunderstood:

- Simple information/data exchangeability has been confused with interoperability
- Several forms of compatibility (composability, replaceability) have also been confused with interoperability
- when addressing interoperability between two entities the fact that often these belong to two different organizations which have their own policies has been ignored

Interoperability: Definition

"The ability of two or more systems to exchange information and to use the information that has been exchanged" (IEEE)

(i) The two entities must be able to exchange meaningful information objects (exchangeability)

(ii) The two entities must be able to exchange logically consistent information objects (when the exchanged information objects are descriptions of fuctionality, policy, or behavior (compatibility)

(iii) The consumer entity must be able to use the exchanged information in order to perform a set of tasks that depend on the utilization of this information (usability)

Exchangeability

The heterogeneity Problem

Different sources of heterogeneity can be encountered depending on:

- How the information objects are represented
- How information objects are requested
- The semantic meaning of each information object
- The use of different terminologies
- How information objects are actually transported over a network

Exchangeability (II)

Three types of heterogeneity to be overcome in order to achieve a meaningful exchange of information objects:

- Heterogeneity between data languages/query languages

(syntactic exchangeability)

- Heterogeneity between the data models adopted for representing information objects

(structural exchangeability)

- Heterogeneity between the "semantic universe of discourse" of the producer and consumer entities

(semantic exchangeability)

Exchangeability (III)

The three levels of exchangeability i.e., syntactic, structural, and semantic allow a meaningful exchange of information objects between the two entities and thus guarantee the exchangeability between them.

Compatibility

The Logical Inconsistent Problem

Logical inconsistencies between:

- functional description of services (producer) and requests (consumer)
- policy descriptions
- behavioral descriptions

Usage

The Usage Inconsistent Problem

"The consumer's goal cannot be achieved by using the producer's resources"

Inconsistencies between the consumer goal and the producer resource description:

Quality mismatching

Policy mismatching

Data-incomplete mismatching

Usage (II)

Quality mismatching

The quality profile associated with the exported

information object does not meet the quality expectations of the consumer entity

Policy mismatching

The data policies of the organizations to which the two entities belong are incompatible

Data-incomplete mismatching

The exported information object is lacking some useful information to enable the consumer to fully exploit the received information object

Usage (III)

The exchanged information objects must be complemented with some descriptive information (contextual, provenance, security, privacy, etc.) which gives additional meaning.

The descriptive information should be modeled by purpose-oriented descriptive data models (metadata models).

In a multidisciplinary context it could be necessary to associate different descriptive metadata models with the exchanged information object.

Relationships between exchangeability, compatibility, usability and interoperability

Exchangeability is a necessary but not sufficient condition for achieving interoperability

Exchangeability is a necessary but not sufficient condition for assuring compatibility of functions/policies/behaviors

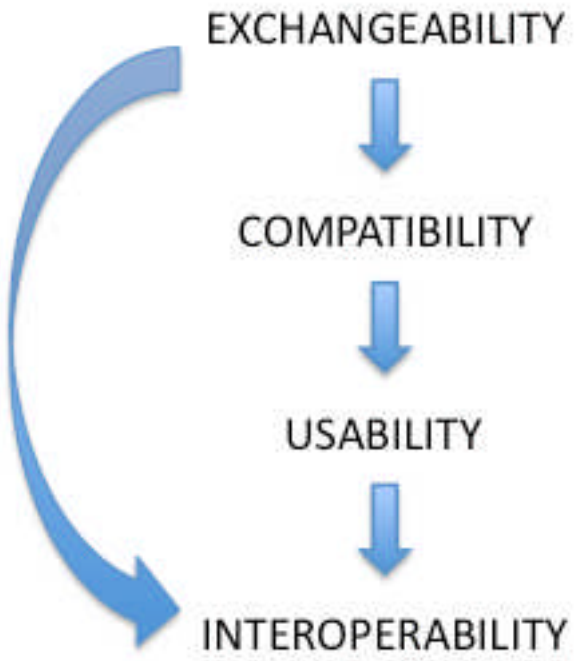
Compatibility is a weaker concept than the interoperability

Usability implies Exchangeability but the reverse is not true

Compatibility implies Exchangeability but the reverse is not true

Usability implies Compatibility but the reverse is not true

Relationships between exchangeability, compatibility, usability and interoperability (II)



Mediation

The main concept enabling “meaningful” exchange of information objects is mediation

The mediation concept is implemented by a mediator, which is a software device capable of establishing exchangeability or compatibility of resources by resolving heterogeneities and inconsistencies

A key feature of the mediation process is the kind of intermediation function implemented by a mediator:

mapping

matching

consistency checking

Mediation (II)

Mediation scenarios

- mediation of data structures
- mediation of functionalities
- mediation of policies
- mediation of protocols

Information Modeling

Automated mediation heavily relies on adequate modeling of the exchanged information objects

The effectiveness, efficiency, and computational complexity of the intermediation function very much depend on the characteristics of the data models:

expressiveness

semantic completeness

reasoning mechanisms

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Standards

The role of standards for achieving data interoperability is of paramount importance.

Standards for:

(Meta)

Data models

Languages

Discipline-specific metadata models

Domain-specific ontologies

The Final Objective

The ultimate aim should be the definition and implementation of an "integrated mediation framework" capable of providing means to handle and resolve all kinds of heterogeneities and inconsistencies that may hamper the effective usage of the resources of an information infrastructure

End of the presentation!

Thank you